A conceptual paper on the benefits of a non-governmental search and rescue organization

Wengelin, Mattias; deWet, Tim

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2010

NORWEGIAN SCHOOL OF SPORT SCIENCES

XI[th] INTERNATIONAL SYMPOSIUM
Biomechanics and Medicine in Swimming
OSLO 2010 NORWAY

XIth International Symposium for Biomechanics and Medicine in Swimming

Oslo, 16th – 19th June 2010

Program & Book of Abstracts

Per-Ludvik Kjendlie, Robert Keig Stallman and Jan Cabri (eds)

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Contents

Welcome message from the organizing committee

Dear Colleagues, scientists, coaches, physicians and students. Dear Friends.

On behalf of the Norwegian School of Sport Sciences, we are proud to welcome you to the XIth International Symposium for Biomechanics and Medicine in Swimming in Oslo. The BMS symposium series is celebrating it's 40th anniversary. Our goal in Oslo has been to encourage contributions from more scientific disciplines and aquatic activities than previosly represented. We feel we have succeded. The International Steering Group for BMS has entrusted us with the organization of this symposium and we have done our best to organize BMS XI in a manner worthy of their faith in us.

The 123 oral presentations, 127 poster presentations, 9 invited lectures, poolside demonstration, workshops and social happenings will bring swimming science to new heights.

Oslo is the capital of Norway and is situated at the head of the Oslo fjord. A unique city, surrounded by forested ridges and with close proximity to the sea. The congress venue offers you unlimited possibilities to exercise and enjoy the surroundings. We hope you will enjoy this unique spot of Northern Europe, it's nature and the city, and wish all participants a pleasant stay and productive meetings.

Per-Ludvik Kjendlie

Robert Keig Stallman

Jan Cabri

Oslo, June 16th 2010

Welcome message from Sigmund Loland, Rector

On behalf of The Norwegian School of Sport Sciences (NSSS), I am delighted to welcome you to Norway and to Oslo for the XIth International Symposium for Biomechanics and Medicine in Swimming.

The theme of this conference is "Forty Years of Swimming Science". Having started in Brussels in 1970, you were one of the very first of the sport/physical activity areas to launch such a peer reviewed scientific conference. The BMS Proceedings have been the backbone of aquatic research ever since. Today, BMS has a respected and prestigious position in the world of sport science.

Aquatic sports and activities are unique within the realm of sport and physical activity. Perhaps firstly we can agree that all aquatic activities have an element of drowning prevention. Research in human aquatic movement contributes to reducing the huge global burden of drowning. Secondly, aquatic activities contribute to health and well being in a unique way. Many persons unable to obtain training benefits from land based activities are able to train in the water. Thirdly, aquatic sports at high levels of performance demonstrate human potential and the ideal of realizing one's potential to the highest possible degree.

All of these values of aquatic activities however, depend upon knowledge and competence. The significance of research and teaching skills cannot be overestimated. At NSSS, we are proud to be able to do our part in stimulating important work in this area.

Oslo, the capital of Norway, is special in many ways. The city is nestled between Oslo Fjord on the south and the rolling hills of the Nordmarka Forest on the north, both the playground of residents and visitors. In addition to the scientific program, I encourage you to see as much of our city and surroundings as possible.

On behalf of NSSS and the Local Organizing Committee, I congratulate you on your 40th Anniversary and wish you a successful conference and a pleasant stay in Norway.

Sigmund Loland
Rector,
The Norwegian School of Sport Sciences

Greetings from the Mayor of Oslo

It is a pleasure to welcome you to Oslo for the XIth International Symposium for Biomechanics and Medicine in Swimming.

The history of Norway is inextricably linked to water, and so is the history of this city. The first people to settle in Norway foraged the seashore for molluscs and fish, and as their skills at boat building developed, our forefathers ventured farther from land and harvested one of the world's most abundant fish resources.

Oslo's harbour has always been a prominent part of the city's economic foundation, and this is among the top international centres for shipping. So both this country and this city have a strong connection with the sea.

Learning to swim has been important in this maritime nation since time immemorial. Norway was the first country to introduce swimming as a mandatory part of our primary education.

Today, swimming is mostly a recreational activity, but an extremely popular one during our short but lovely summers. Sadly, we experience many drowning accidents every year. This attests to a need for strengthening the swimming training of children and perhaps even more to a need for a more respectful attitude towards the water. Esteemed scientists such as you are extraordinarily qualified to contribute to such an awakening, and Oslo is proud to host your conference.

There is much to see in Oslo besides the Norwegian School of Sports Sciences and much to do besides discussing scientific questions. For the lover of art, a visit to the National Opera will fascinate both for architectural and for musical reasons, and the Vigeland Sculpture Park is a unique experience. The natural surroundings of Oslo are also splendid, and a boat ride on Oslo Fjord is an experience not easily forgotten.

I am confident that you will enjoy your stay, and I hope your discussions will bear fruit both here and in your respective home countries.

Fabian Stang
Mayor

Greetings from the Norwegian Life Saving Society

Dear Participants,

We welcome you to BMS 2010. The Norwegian Life Saving Society congratulates the local organizing committee with this important conference. We are proud to be a Cooperating Partner of this conference and have benefited greatly from the fine research articles presented here.

Every aquatic activity has an element of drowning prevention. All research promoting a better understanding of human movement in the water contributes to this goal. While some of the papers here are indirectly related to this theme, we are delighted to see so many that are directly relevant for drowning prevention. Globally, this problem has been grossly underestimated.

We have recently celebrated our 100th Anniversary being founded in 1906. Biomechanics and Medicine in Swimming is 40 years old this year. HAPPY BIRTHDAY TO YOU! Forty years of aquatic science is an important milestone and a unique achievement.

Without the work of you researchers, educators and providers, we would not be as far ahead as we are today. Aquatic activities are unique and you are leading the way in understanding and solving important problems. Thank you!

We wish you a successful conference and a joyful stay in Norway and in Oslo. We hope you have the opportunity to see some of the local sites and to enjoy the beautiful nature of Oslo and Norway. We also hope that you will benefit as we have from these outstanding presentations and from meeting like minded friends and colleagues from around the world.

We wish you the very best!

Laila Solhaug Hulleberg
President,
The Norwegian Life Saving Society

Greetings from the Norwegian Rheumatism Association

Dear BMS2010 Participants,

Welcome to Norway, to Oslo and to BMS2010. This unique and prestigious conference has for forty years, examined issues that are of interest for many aquatic enthusiasts and for those who benefit from the work of you, the researchers, educators and providers.

The benefits of warm water activity for persons with chronic muscle and/or skeletal problems has long been known. Hydrotherapy dates back several millennia. Our organization represents persons in Norway with one or another chronic rheumatic problem and there are an estimated 800,000 of these. Many of them benefit from physical activity in warm water.

It was thus natural for us, together with the Norwegian Swimming Federation and the Norwegian Gymnastics Federation, to create an Instructor training program for Water Gymnastics or Aqua-aerobics. Today we are the largest provider of such courses in the country and our instructors conduct activity from North to South. Together with our partners, we are able to provide virtually everyone who is interested, with an opportunity.

It is therefore, a pleasure for us to see so many papers presented here that are relevant for the medical and therapeutic aspects of aquatic activity. We thank you for your contribution.

We are pleased to be a Cooperating Partner for BMS 2010 and delighted that BMS has come to Norway. We wish you a pleasant stay here in Norway and in Oslo and hope that you have a successful and enriching conference. Enjoy this chance to meet your friends and colleagues and to share ideas. The very warmest wishes for your future activities,

Jack P. Skrolsvik
Secretary General
The Norwegian Rheumatism Association

Greetings from the Norwegian Swimming Federation

Welcome to Norway,
It is with great honour that I wish you all welcome to Norway. Swimming is developing very fast, and such a conference is important for our sport.

This conference is not only about research in competitive swimming itself but also about research in other areas, such as learn to swim. This is a matter which we here in Norway take very seriously and have been working towards politically, with the government, for many years. We have also been working together with our fellow federations both in Europe and in the rest of the world. This political work will of course, continue in the future.

Norway has a very high rate of drowning during the summers, and we want of course to change this. One of the most important ways to do so is to improve the national school curriculum and to get the school authorities to better understand their role in combating drowning. Research, development and collaboration across borders, is the key to reaching these goals.

Secondly, it is important to promote research on health and rehabilitative therapy, and of course, ideas for specific facilities for this purpose. We who love swimming know our sport as one of the very best for these purposes.

Finally, I can see on the program that there are many good papers designed to help top swimmers to achieve in their sport and also to promote new knowledge on facilities.

During the days of this conference I also hope that you have some spare time to enjoy the beautiful area here at the edge of what we call "Marka", the Oslo Forest. We really look forward to this conference and hope all of you participants achieve your goals.

Good luck

Per Rune Eknes,
President: The Norwegian Swimming Federation

Organization

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Kjendlie, Per-Ludvik (Chair)
Cabri, Jan (Chairman)

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Dahl, Dagmar
Keskinen, Kari (int. advisor)
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Moran, Kevin (NZL)
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Psychariakis, Stelios (GBR)
Pyne, David (AUS)
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Sponsors

The XIth International Symposium for Biomechanics and Medicine in Swimming was supported by:

The World Commission for Sport Sciences
The Norwegian School of Sport Sciences
Department of Physical Performance
Norwegian Research Centre for Training and Performance

Norwegian Swimming Federation
Norwegian Life Saving Society
Norwegian Rheumatism Association

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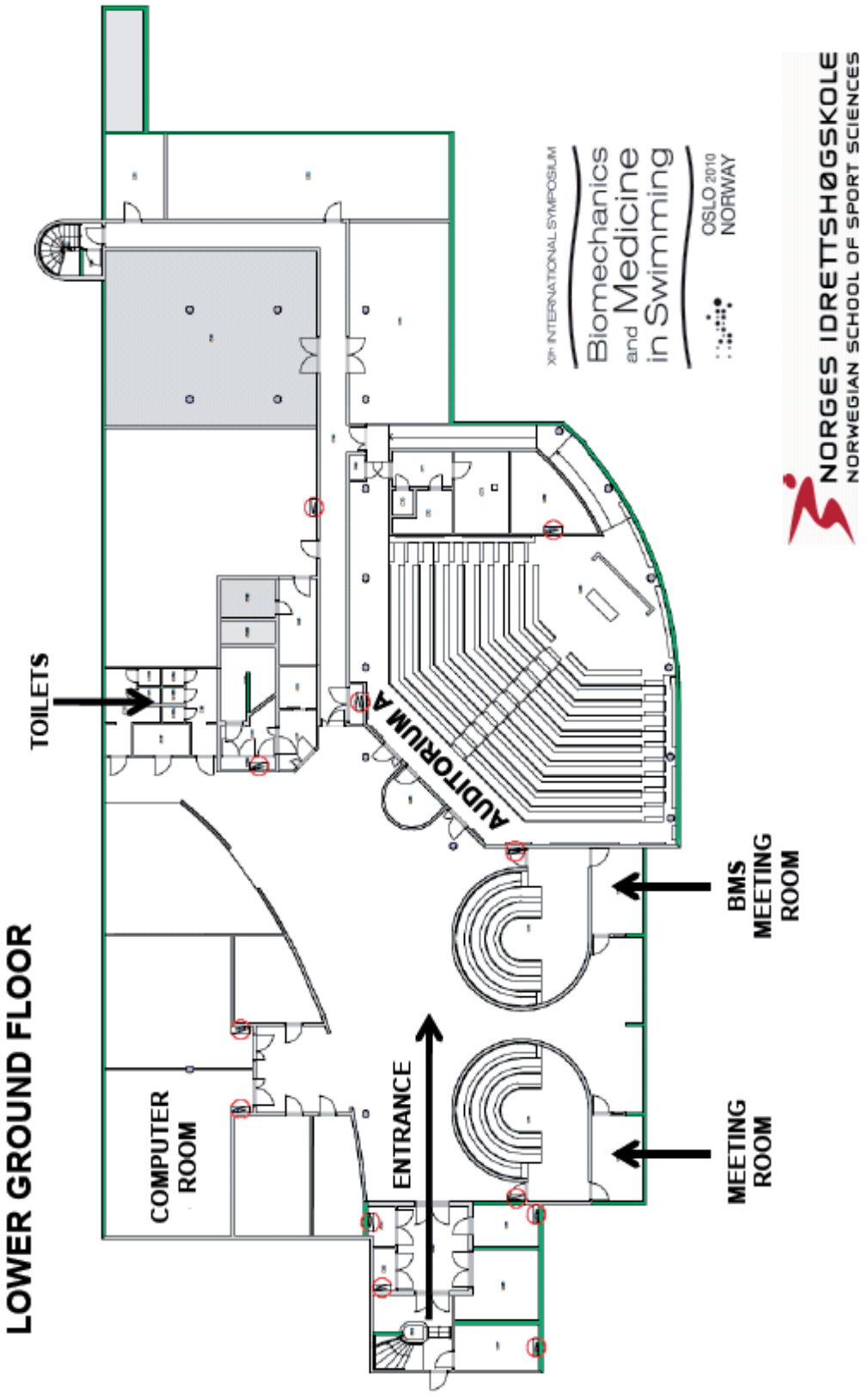
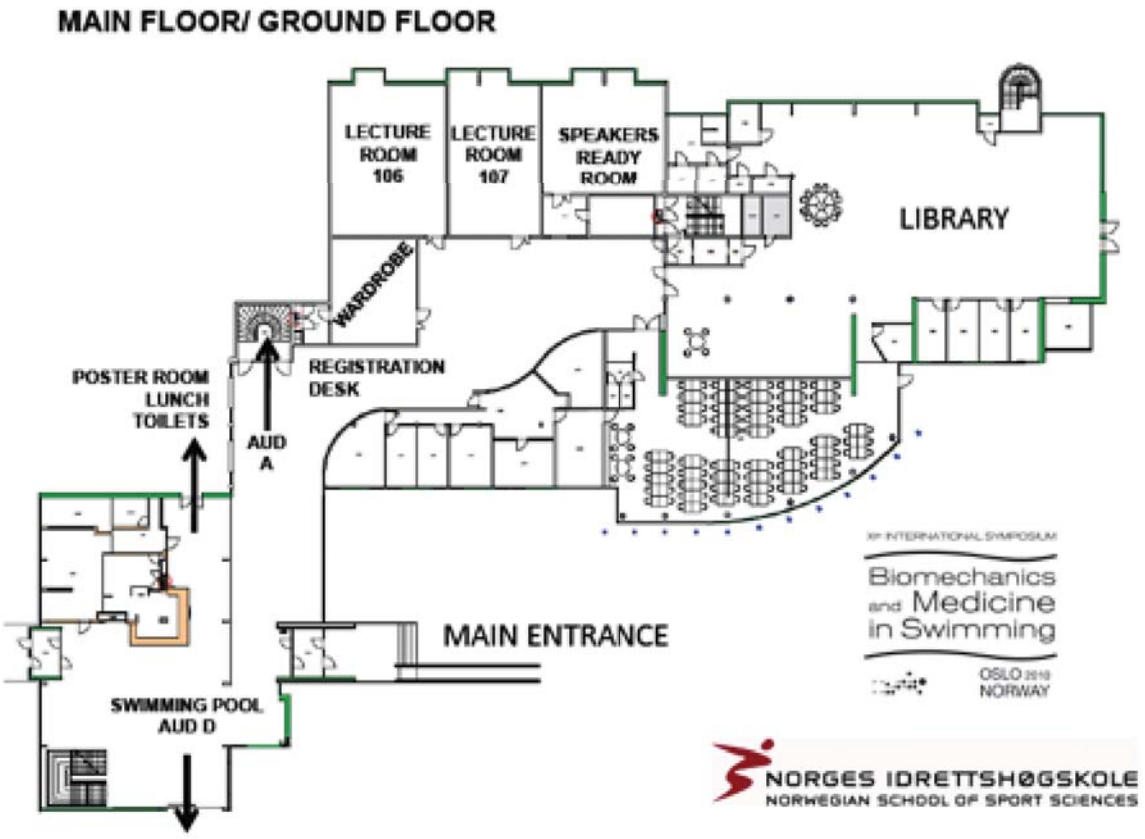
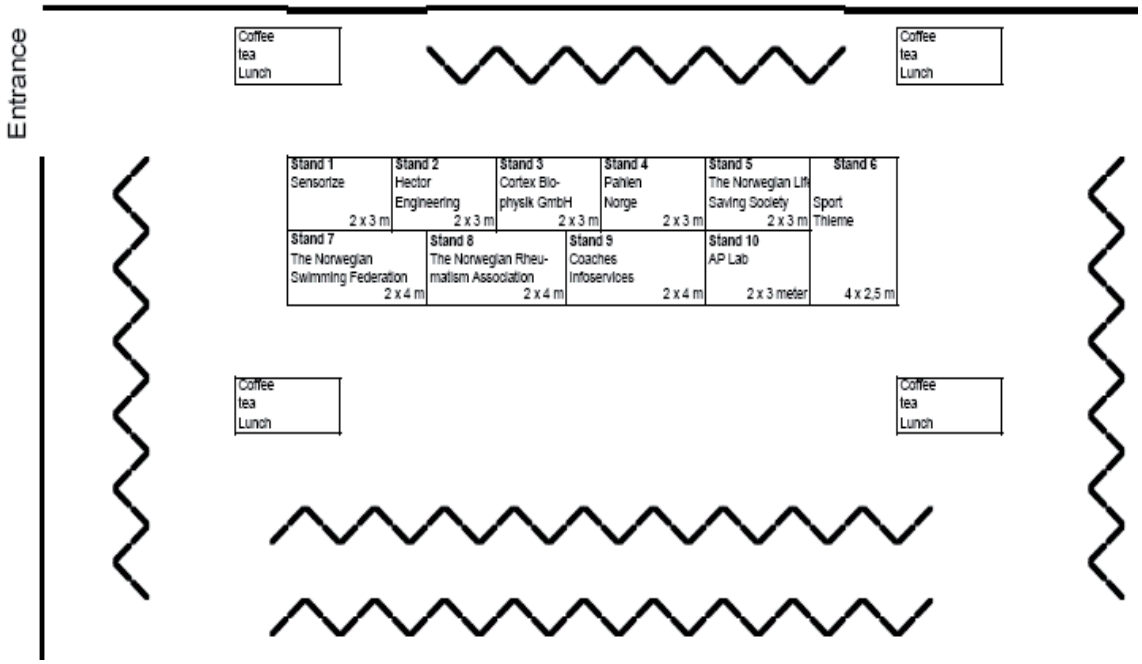
Floorplans


LOWER GROUND FLOOR
TOILETS
AUDITORIUM A
BMS MEETING ROOM
MEETING ROOM
ENTRANCE
COMPUTER ROOM
XIth INTERNATIONAL SYMPOSIUM
Biomechanics and Medicine in Swimming
OSLO 2010 NORWAY
NORGES IDRETTSHØGSKOLE
NORWEGIAN SCHOOL OF SPORT SCIENCES



Exhibition and poster floorplan for the X[th] International symposium of Biomechanics and medicine in swimming

Lenght 47 m Width: 24 m



General Information

Badges

Your personal badge is your entrance ticket to the conference centre and all scientific sessions. Please wear your badge at all times.

Clothing / Dresscode

June is the first real summer month in Norway. This means that the temperature in Oslo can vary from 10 to 30 degrees Celcius. It is good advice to take a look at the weather report before you pack your bags. In any case remember to bring your swimsuit if you would like to take a swim during the conference. It can also be possible to take a walk or a run around Sogn Lake. You should therefore bring some good shoes and maybe a sweat suit. For the banquette Saturday night (combined outdoors and indoors) the dress code is nice but casual (a warm sweater may come in handy).

Exhibition

LOCATION:
The indoor sports arena. (Same venue as for the poster presentations, lunch and coffee breaks).

EXHIBITION OPENING HOURS

Wednesday 16th of June 2010	02:00PM – 04:00PM
Thursday 17th of June 2010	09:30AM – 04:30PM
Friday 18th of June 2010	09:30AM – 04:30PM
Saturday 19th of June 2010	09:30AM – 04:00PM

EXHIBITORS
Stand 1: Sensorize, www.sensorize.it
Stand 2: Hector Engineering, www.hectorengineering.com
Stand 3: Cortex Biophysik GmbH, www.cortex-medical.de
Stand 4: Pahlén Norge / BECO, www.pahlennorge.no
Stand 5: The Norwegian Life Saving Society, www.livredning.no
Stand 6: Sport-Thieme, www.sport-thieme.de
Stand 7: The Norwegian Swimming Federation, www.svomming.no
Stand 8: The Norwegian Rheumatism Association, http://re.revmatiker.no
Stand 9: Coaches Infoservices, www.coachesinfo.com
Stand 10: APLab, www.aplab.it

Hotels of the Symposium

Thon Hotel Munch:
Munchs gate 5, 0165 Oslo
Tlf: 23 21 96 00
http://www.thonhotels.no/munch

Thon Hotel Astoria:
Dronningens gate 21, 0154 Oslo
Tlf: 24 14 55 50
http://www.thonhotels.no/astoria

P- hotels:
Grensen 19, 0159 Oslo
Tlf: 800 46 835
http://www.p-hotels.no/

Rica Travel:
Arbeidergata 4, 0159 Oslo
Tlf: 22 00 33 00
http://www.rica.no/Hoteller/Rica-Travel-Hotel-Oslo/?utm_source=gulesider&utm_medium=cat&utm_term=RicaTravelHotelOslo&utm_campai

Radisson Blu Nydalen:
Nydalsveien 33, 0484 Oslo
Tlf: 23 26 30 00
http://www.radissonblu.com/

Anker Hostel:
Storgata 55, 0182 Oslo
Tlf: 22 99 72 00
http://www.ankerhostel.no/

Insurance

The Organizers accept no liability for personal injuries sustained, or loss or damage to property belonging to symposium participants or accompanying persons, either during or as a result of the Symposium.

International phone calls

To dial abroad from Norway dial 00, followed by the country code

Language

The official language of the Symposium is English

Non-smoking policy

Please observe that smoking is not permitted in the symposium and exhibition areas.

Registration and Information

The registration desk will be located at the Norwegian School of Sport Sciences. Opening hours will be:
Wednesday 16th of June 1400-1800. Thursday, Friday and Saturday: 0800-1800

The registration desk will be at your assistance for any problem that may arise.

Tickets

Tickets for all social events must be presented upon notice. Please contact the Secretariat for available tickets for the social events.

Videorecordings

BMS is cooperating with coachesinfo.com to spread the knowledge of swimming science to coaches. In this regard we plan to record on video all oral presentations, and to publish them at www.coachesinfo.com . To record your presentation we

need your consent. Please give your consent to the chair of your session. If you do not give your consent, we will turn off the camera. If you give consent, but wish to withdraw it after the presentation, please inform the chair before the end of the day of your presentation. In the case of key lectures and other selected lectures presenters will be asked for consent to live video-streaming over the internet. Because it is live there is no option to withdraw afterwards for these lectures.

Wardrobe service

During the conference it will be possible to keep your jacket, bags etc in a wardrobe close to the reception area. The wardrobe will be attended.

Wi-Fi / Internet access

Delegates may use the wireless internet access at the venue. Log in with:
Username: BMSGuest
Password: Swimming2010

How to connect: a description will be in your delegate bag or at the reception desk.

Transportation

All delegates will be given a free pass to the subway and public transport in Oslo. The ticket is valid from the moment you receive it (after registering for the conference), until 19th of June (00:22)

From Gardemoen / OSLO Airport to Oslo City Centre:

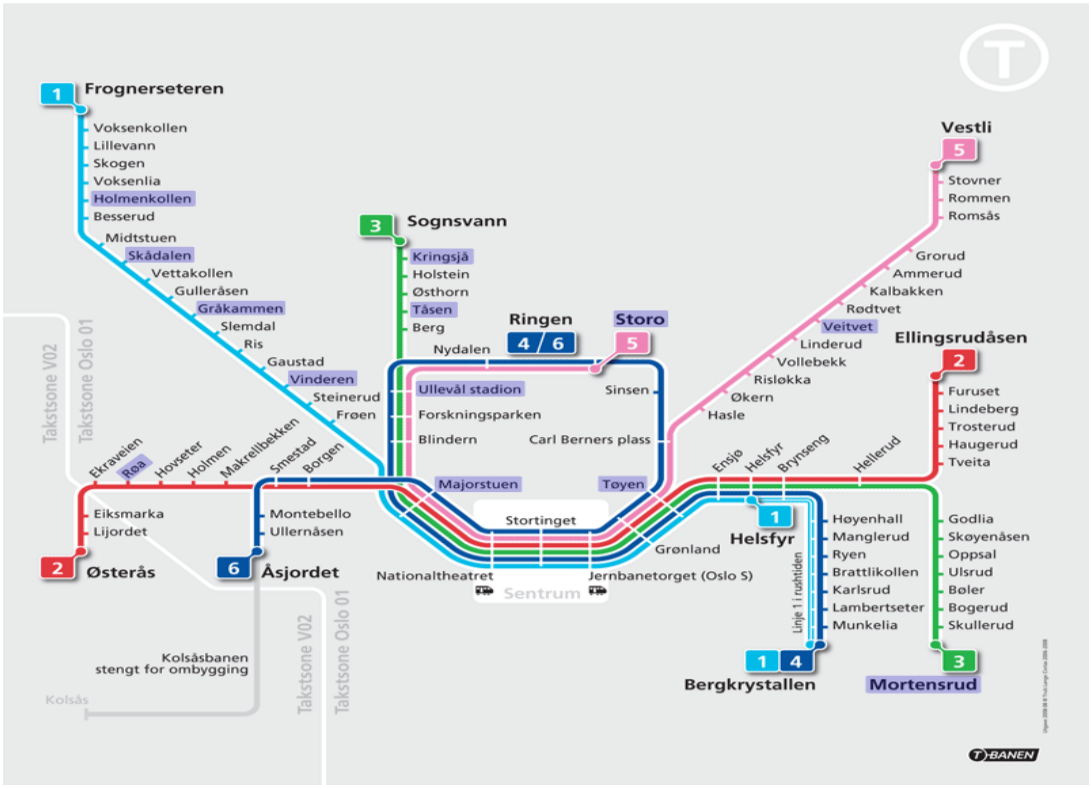
Take the Airport Express Train to Oslo Central Station (Oslo S). The Airport Express Train leaves every 20 minutes and uses about 20 minutes to downtown (cost 170kr). You can also take the local train (cost 102 kr), to Oslo Central Station, direction Kongsberg or Skien. This takes about 38 or 26 minutes respectively and leaves 2 times per hour. Then take the subway from Oslo Central Station (see subway below).

Transport from hotels to conference venue

Taxi: All taxi drivers are familiar with Sognsvann and The Norwegian School of Sport Sciences. The address is Sognsveien 220. Your taxi should have a taxi sign (indicating that it is official and registered) on top to ensure your security and that you are not gouged. Tipping is unnecessary. Approximate cost from downtown Oslo to Songsvann is about NOK 150,- (full car, four persons).

Subway : Oslo's underground train network is called the T-bane and signified by a blue circle around a large blue ("T"). Five lines scattered around Oslo's suburbs on each side converge on five or six central stations, sitting in a row. Three of these stations are adjacent to hotel locations: Nationaltheatret station, Stortinget station (Parliament) and the Central station. Just go to your closest T-bane station. Use the subway, line 3, direction Sognsvann, it leaves every 15 minutes and takes about 20-25 minutes from Oslo Central Station (cost 25 kr). Get off at the last station which is Sognsvann Station. Here you can find NIH (Norwegian School of Sport Sciences). Make sure you get on the train going the appropriate west direction. During BMS in June 2010 every participant will have access to the subway and bus system for free with their registration at the conference venue. The ticket is valid from the 16 -19th of June. You must bring your ticket at all times. The ticket is valid until the last subway leaves from Sognsvann at 00.22 after the Banquet on Saturday.

Map of the campus.



Subway map

Food and Meals

Banquet
Saturday, 19th of Jun 2010 at 19.30
The closing dinner will be in the backyard at The Norwegian School of Sport Sciences. On the lawn there will be a barbeque, and free beer will be served all night. Dress code is nice but casual. The expected closing time is 00.00, and the last metro leaves at 00.22. Please take care of your ticket and present it at the entrance. If you have not registered for the banquet, a limited number of tickets will be available at the reception until thursday evening.

The Welcome Reseption
Please dress nicely for the welcome by the Mayor of Oslo at the City Hall. This event is free of charge. The building is well worth seeing. There will be a guided tour and a welcome drink and small snacks will be served.

Coffee breaks
Coffee and a snack will be served in the exhibition / poster hall.

Kiwi food store
Five minutes walking distance, open 7-23 (9-21).

Lunch
Lunchtime is 13.00 – 14.30. It will comprise two days with a baguette type meal, and one day a salad type meal. Fruits, juice, water, coffee and tea will be served all three days. Lunch is served in the exhibition / poster hall.

Norwegian School of Sport Sciences Canteen
Open 9-17 (11-16).

Activities

Would you like to take a morning or midday swim?
On Thursday, Friday and Saturday the swimming pool will be available from 0700 until 0800. Thursday and Friday it will also be available from 1300 until 1400. Bring your swimsuit and take a swim before or between interesting lectures.
Remember the relay race on Saturday!!

Tour de Sogn
On **Thursday** you can join us and take a 3,3 km walk around Sognsvann Lake. Sognsvann lies next to the Norwegian School of Sport Sciences and is a popular recreational area for the citizens of Oslo. We will meet in the reception area at 1800.

Orienteering run
Egil Johansen is one of our colleagues and an excellent orienteering runner (World Champion in 1976- and 1978). On **Friday** Egil will make an orienteering challenge in the woods close to Lake Sognsvann. Take this opportunity and meet Egil in the reception area at 1800 on Friday.

Guidelines for Oral and Poster Presentations

ORAL SESSIONS

Each oral session will last for 15minutes in total, with 10 minutes for the author to present his findings and 5 minutes dedicated to questions from the audience and change of speakers. All presenters must be available in the respective presentation room 15 minutes before the session starts. The chair person will introduce the speakers and keep track of the exact time line (10 minutes presentation + 4-5 minutes discussion + change). The speakers are kindly requested also to follow the time line. Each session will consist of six presentations of 15min duration, or 90 minutes total. By strictly following the time line, we show respect for each other and all speakers get the same chance to present. It will also allow people to come and go in between speakers without disruption. If a presenter does not appear for his/her presentation, the following presentations will start as indicated in the program. The chair is requested to remain in the session room until the session time line has expired. The chair is also requested to make sure all mobile phones are turned off. There will be a Congress Staff Member assigned to each lecture room.

Computer Equipment Personal laptops will not be used during your presentation. (except for invited speakers). The computers in the session rooms will be Windows XP based PC with Microsoft PowerPoint 2003. Verification of proper performance of your presentation in the Speaker Ready Room is essential, particularly if video and animation is included in the presentation. Internet access will not be available during your presentation.

You must load your power point files via the Speaker Ready Room. However, support is available in the Speaker Ready Room for file transfers from your laptop. Please make sure you have all power, video, and networking adapters with you. You should still bring a backup of the presentation on alternate media such as a flash/usb drive.

AV Equipment in Session Rooms
The following will be available: Floor lectern with microphone, computer, mouse, laser pointer, LCD monitor, speaker timer, screen, LCD projector, and audience microphone.

*Macintosh users: Please make sure that all inserted pictures are JPEG file-types. Quicktime (.mov) files are also an accepted video format. Individuals using Apple Keynote will need to bring their files directly to the speaker ready room to have them correctly transferred to our system.

Video Format The proper video format for Windows-based presentations is Windows Media (.wmv). More detailed information regarding sound, video, and general compatibility can be found at http://office.microsoft.com/en-us/powerpoint/FX100648971033.aspx

DURING YOUR PRESENTATION
Each session room will be staffed with an AV technician who will assist in starting each presentation. Once the presentation is launched, the presenter will control the program from the podium using a computer mouse or the up/down/right/left keys on the keyboard.

SPEAKER READY ROOM
All presenters are requested to check in to the Speaker Ready Room, preferably the day before, and no later than 2h before the session starts. The speaker ready room will be open Wednesday from 1400 to 1700, Thursday and Friday from 0800-1800, Saturday from 0800-1400.

When reviewing your presentation in the Speaker Ready Room, make sure all fonts, images, and animations appear as expected and that all audio or video clips are working properly.

IF THE PRESENTATION DOES NOT PLAY PROPERLY IN THE SPEAKER READY ROOM, IT WILL NOT PLAY PROPERLY IN THE MEETING ROOM.

You may edit your presentation up to two hours prior to the session start time. When you are finished reviewing and/or making changes to your presentation, you must tell BMS personnel you have viewed your presentation file before you leave the Speaker Ready Room.

INSTRUCTIONS FOR POSTER PRESENTATIONS

Poster Presentation - session format:
There will be 3 formal poster sessions, with each session divided into several thematic groups. In each session there will be approximately 50 posters, divided in groups of approximately 12 posters. You will be able to put your poster on display for the whole conference period. The poster rooms are open from 1400-1700, Wednesday, 0830 to 1800 Thursday and Friday, and 0830-1600 Saturday. Mounting of your poster should be done before 10 o'clock Thursday 17th. We recommend that you leave the poster up until Saturday 19th, at 1400. It is requested that you remove the poster no later than Saturday 19th at 1600h.

During the poster sessions, authors are required to be present by their poster for the entire scheduled session. Furthermore, each author will be given 2 minutes to present the brief content of the poster to an audience, led by a chairman. This is followed by a brief discussion / questions from the audience (1-2 min), before changing to the next speaker.

Each poster board will be numbered in the top right corner. You will be given a poster board number to identify the correct space for putting up your poster.

Instructions for Poster Presentations:
The poster must not exceed the limits of 90 cm wide and 120cm high. The orientation is 'portrait' style. The title, author(s) and institution are to be prominently displayed across the top border of your poster.

Accessories and adhesive material will be available from the Congress Staff in the exhibition areas.

Include and arrange your material so a coherent and straight-forward story is told without your presence. Emphasize the most important points and avoid overwhelming the viewer with too much detail. Specific recommendations include:

- In the **Introduction** - *briefly* summarize the necessary background that led to this work, clearly identify the purpose or specific aims of the present experiment, and identify the questions asked or hypothesis tested.
- Provide sufficient detail of the **experimental design** and the **methods** employed to do the work, including number and necessary demographics of the human or animal subjects studied.
- **Results** can be presented by tables, figures, illustrations and/or photograph. Make each stand on its own, so the viewer doesn't have to refer elsewhere on the display to understand the important message(s). For each table, figure, etc., a logical **interpretative legend** will go a long way in highlighting and *briefly* discussing the essential points.
- **Summary and Conclusion** - *briefly*, what are the essence and important interpretation of your work.
- Consider distributing a **handout** during your presentation time if there is need for exchange of large data sets or other details.
- Keep tables and figures simple and uncluttered
- The text should be readable from a 2-3 m distance so that more than one person can read it at the same time.
- Strong visual contrast is important. Many people have difficulty distinguishing closely related colors, like green from blue, or among subtle shades of a primary color.

When traveling to the conference, carry your poster as **carry-on luggage**; don't entrust it to checked and possible missing baggage.

Scientific Program

Wednesday, 16 June 2010
16:00 - 16:30 Opening Session (Chair: R. Stallman) Room: Aud A

16:30 - 17:15 Keynote Lecture 1: The Leon Lewillie Memorial Lecture (Chair: P.L. Kjendlie) Room: Aud A

16:30 Biomechanics and Medicine in Swimming, Past, Present and Future KL-001
João Paulo Vilas-Boas (PORTUGAL)

18:00 Departure for City Hall

19:00 The Mayor of Oslo's welcoming reception

Thursday, 17 June 2010
08:30 - 10:00 DRAG & PROPULSION (Chair: R. Sanders) Room: Aud A

08:30 Wave Formation as a Possible Mechanism of Propulsion in the Freestyle Stroke O-001
M. Keys; A. Lyttle; L. Cheng; B.A. Blanksby (AUSTRALIA)

08:45 Direct Measurement of Stroke Propulsion in Real Swimming by Means of a Non-Invasive Guage O-002
AS. Bottoni; N Lanotte; S Bifaretti; G Gatta; M Bonifazi; P Boatto (ITALY)

09:00 The Effect of Angle of Attack and Depth on Passive Drag O-003
David Pease[1]*; R. Vennell*[2]
[1](AUSTRALIA); [2](NEW ZEALAND)

09:15 Measuring Active Drag within the Different Phases of Front Crawl Swimming O-004
D.P. Formosa; BR Mason; BJ Burkett (AUSTRALIA)

09:30 Prediction of Propulsive Force Exerted by the Hand in Swimming O-005
S Kudo; M. K. Lee (SINGAPORE)

09:45 A Method to Estimate Active Drag over a Range of Swimming Velocities which may be used to evaluate the Stroke Mechanics of the Swimmer O-006
B.R. Mason1; D.P Formosa[1]*; H.M. Toussaint*[2]
[1](AUSTRALIA); [2](NETHERLANDS)

Thursday, 17 June 201
08:30 - 10:00 BLOOD LACTATE (Chair: R. Fernandes) Room: Aud D

08:30 Critical Velocity And The Velocity At Maximal Lactate Steady State In Swimming O-007
M.A. Espada; F.B. Alves (PORTUGAL)

08:45 Factors Affecting Blood Lactate Accumulation and Clearance in Elite Competitive Swimmers during Competition O-008
GD Wells; O Falenchuk; G Gannon; JD Vescovi (CANADA)

09:00 Maximum Blood Lactate Concentration after Two Different Specific Tests in Freestyle Swimming O-009
G Rozi[1]*; V Thanopoulos*[1]*; M Dopsaij*[2]
[1](GREECE); [2](SERBIA)

09:15 Does the y-intercept of a Regression Line in the Critical Velocity Concept Represent the Index for Evaluating Anaerobic Capacity ? O-010
Y Shimoyama; K Okita; Y Baba; D Sato (JAPAN)

09:30 Critical Swimming Speed Obtained by the 200-400 Meters Model in Young Swimmers O-011
R. Zacca; F. Castro (BRAZIL)

09:45 Extending the Critical Force Model to Approach Critical Power in Tethered Swimming, and it Relationship to the Indices at Maximal Lactate Steady-State O-012
Dalton Müller Pessôa Filho; B. S. Denadai (BRAZIL)

Thursday, 17 June 2010
08:30 - 10:00 ADAPTED ACTIVITIES (Chair: J. Prins) Room: 106

08:30 Swimming, Cycling, Running and Cardiovascular Health O-013
A. Bagheri; Hamid Mohebbi; Masoumeh Azizi; Abdolamir Saiiari (ISLAMIC REP. of IRAN.)

08:45 Comparison of Respiratory Function to Swim Training in Paraplegic vs Amputee Swimmers O-014
M.M. Abouzeid (EGYPT)

09:00 The Comparison of the Effects of Corrective Exercise on Land and in Water on the some Selected Parameters Related to Kyphosis in Kyphotic girls O-015
K Asadi; Y Sokhngouei; M Azizi; M Eslami; M Hematinejad (ISLAMIC REP.of IRAN)

09:15 Analysis Of The Aerobic/Anaerobic Performance In Functional Disabled Swimmers: Low Classes Vs High Classes O-016
J. De Aymerich; J De Aymerich; J Benavent; V Tella; JC Colado; LM Gonzalez; X García Massó; J Madera (SPAIN)

09:30 The Effect of Tethered Swimming Speed on External Power Output of Well-Trained Disabled Swimmers O-017
C.J Lee; C.J Payton (UNITED KINGDOM)

09:45 Can Aquatic Exercise Improve Function in Elderly Persons with and without Chronic Disability? : A Systematic Review O-018
D Daly; G Vanlanthen; T Vanhullebusch; J Lambeck (BELGIUM)

Thursday, 17 June 2010
08:30 - 10:00 MEDICINE I (Chair: E. Kristiansen) Room: 107

08:30 Prevalence of Airway Hyperresponsiveness in International Level Synchronised Swimmers O-019
V. Bougault[1]*; J Turmel*[2]*; LP Boulet*[2]
[1](FRANCE); [2](CANADA)

08:45 Differences in Body Composition Between Swimmers and Synchronized Swimmers O-020
MA Martínez; S Hernández; P Esteban; G Díaz; S Labrado; V Muñoz; F Jímenez; JM González-Ravé (SPAIN)

09:00 An Agaricus Blazei Murill-based Mushroom Extract may be Beneficial for Athletes because it Protects Against Inflammation, Infection and Allergy O-021
G Hetland (NORWAY)

09:15 Effect of two Aquatic Training Programs on Risk Factors of Hip Fracture. Osteoaqua Project O-022
G. Diaz; M. Carrasco; F. Jiménez; A. Barriga; M.A. Martinez; F. Navarro (SPAIN)

09:30 Elite Child Athletes are our Future. Cardiac Adaptation to Monofin Training in Prepubescent Athletes O-023
M.M. Abouzeid; Magdy Abouzeid (EGYPT)

09:45 Estimation Method for Energy Expenditure by Acceleration of Human Head during Water Walking O-024
K. Kaneda; Y. Ohgi; C. Tanaka (JAPAN)

Thursday, 17 June 2010
10:30 - 11:15 Keynote Lecture 2 (Chair: J. Cabri) Room: Aud A

10:30 Inter-Limb Coordination in Swimming KL-002
Ludovic Seifert (FRANCE)

11:15 - 12:00 Keynote Lecture 3 (Chair: J. Cabri) Room: Aud A

11:15 Muscle Fatigue in Swimming KL-003
Annie Rouard (FRANCE)

Thursday, 17 June 2010
12:00 - 13:00 Poster session Biomechanics 1 (Chair: J.P. Vilas-Boas) Room: Poster and Exhibition Hall

12:00 Comparison of Manikin Carry Performance by Lifeguards and Lifesavers When Using Barefoot, Flexible and Fiber Fins P-001
J.A. Abraldes[1]*; S. Soares*[2]*; A.B. Lima*[3]*; R.J. Fernandes*[2]*; J.P. Vilas-Boas*[2] [1](SPAIN); [2](PORTUGAL); [3](BRAZIL)

12:00 Swimming Forces: A Review P-002
S. Avramidis (GREECE)

12:00 Kinematical Characterisation of a Basic Head-out Aquatic Exercise During an Incremental Protocol P-003
T M Barbosa; C Oliveira; G Teixeira; MJ Costa; DA Marinho; AJ Silva (PORTUGAL)

12:00 Kinematic Analysis of Take-off Performance in Elite Swimmers: New OSB11 versus Traditional Starting Block P-004
K Biel; S Fischer; A Kibele (GERMANY)

12:00 Application of CAST Technique to 3D Motion Analysis of Front crawl Swimming P-005
E. Ceseracciu; S. Ceccon; Z. Sawacha; S. Fantozzi; M. Cortesi; C. Cobelli; G. Gatta (ITALY)

12:00 Which is the Recommend Duration for the Tethered Swimming Test? P-006
M. Cortesi; E Cesaracciu; Z Sawacha; G Gatta (ITALY)

12:00 The Effect of Wearing a Synthetic Rubber Suit on Hydrostatic Lift and Lung Volume P-007
M. Cortesi; P Zamparo; E Tam; M Da Boit; G Gatta (ITALY)

12:00	Kinematical Analysis of Butterfly Stroke: Comparison of Three Velocity Variants *K. de Jesus; K. de Jesus; P.A. Figueiredo; P. Gonçalves; J.P. Vilas-Boas; R.J. Fernandes* (PORTUGAL)	P-008
12:00	Biomechanical Characterization of the Backstroke Start in Immersed and Emersed Foot Conditions *K. de Jesus[1]; K. de Jesus[1]; P.A. Figueiredo[1]; P. Gonçalves[1]; S.M. Pereira[2]; J.P. Vilas-Boas[1]; R.J. Fernandes[1]* [1](PORTUGAL); [2](BRAZIL)	P-009
12:00	Tethered Force Production in Standard and Contra-standard Sculling in Synchronized Swimming *V. Diogo[1]; S. Soares[1]; C. Tourino[2]; J.A. Abraldes[2]; C. Ferragut[2]; P. Morouço[1]; P.A. Figueiredo[1]; J.P. Vilas-Boas[1]; R.J. Fernandes[1]* [1](PORTUGAL); [2](SPAIN)	P-010
12:00	Pulling Force Characteristics of 10s Maximal Tethered Eggbeater Kick in Elite Water Polo Players *M Dopsaj* (SERBIA)	P-011
12:00	Motor Coordination during the Underwater Undulatory Swimming Phase of the Start for High Level Swimmers *M Elipot; N Houel; P Hellard; G Dietrich* (FRANCE)	P-012
12:00	Evaluation of the Validity of Radar for Measuring Throwing Velocities in Water Polo *C. Ferragut; P.E. Alcaraz; H Vila; J.A. Abraldes; N Rodriguez* (SPAIN)	P-013
12:00	A Kinematic Study on the Dive-in Behaviour during Swim Start Performance From the Block *S Fischer; A Kibele* (GERMANY)	P-014
12:00	Comparison Between two Different Types of Instruments: an Encoder and an Inertial Sensor Device *G. Gatta; M Cortesi; M Zok; N Lanotte; G Vannozzi* (ITALY)	P-015
12:00	The Mechanical Power Output in Water Polo: a Case Report *G. Gatta; S Fantozzi; M Cortesi; F Patti; M Bonifazi* (ITALY)	P-016

Thursday, 17 June 2010
12:00 - 13:00 Poster session Physiology 1 (Chair: K. Keskinen) Room: Poster and Exhibition Hall

12:00	Technology and Swimming: 3 steps beyond Physiology *G Berthelot; P Hellard; S Len; M Tafflet; JF Toussaint* (FRANCE)	P-048
12:00	The Difference in Red Blood Cell Indices between Elite Female Distance and Sprint Swimmers *H Guo[1]; Y Lu[2] ; JM Stager[1]* [1](UNITED STATES); [2](CHINA)	P-049
12:00	Modeling the Slow Component in Elite Long Distance Swimmers at the Velocity Associated with Lactate Threshold *P. Hellard[1]; N. Houel[1]; M. Avalos[1]; X. Nesi[2]; J.F. Toussaint[1]; C. Hausswirth[1]* [1](FRANCE); [2](UNITED KINGDOM)	P-050
12:00	The Impact of Tension in Abdominal and Lumbar Musculature in Swimmers on Ventilatory and Cardiovascular Functions *T. W. Henrich[1]; R.B. Pankey[1]; G. J. Soukup[2]* [1](UNITED STATES); [2](UNITED KINGDOM)	P-051

12:00	Relationship between Propelling Efficiency and Swimming Performance in Elite Swimmers *Z Huang; K Kurobe; M Nishiwaki; G Ozawa; T Tanaka; N Taguchi; F Ogita* (JAPAN)	P-052
12:00	The Effect of Snorkel Breathing during Front crawl Swimming on Respiratory Muscle Fatigue *C Iggleden; M Lomax; R Fricker; O Jones; S Moffatt; R Poole* (UNITED KINGDOM)	P-053
12:00	Can High Intensity Workloads be Simulated at Moderate Intensities by Reduced Breathing Frequency *J. Kapus; V. Kapus; A. Ušaj* (SLOVENIA)	P-054
12:00	Swimming and Respiratory Muscle Endurance Training: A Case Study *F Lemaitre; F Chavallard; D Chollet* (FRANCE)	P-055
12:00	Comparison of Respiratory Muscle Fatigue between Swimming Strokes in National Standard Age-group Swimmers *M Lomax; C Iggleden; A Tourell; S Castle; J Honey* (UNITED KINGDOM)	P-056
12:00	Effect of Systemic Arterial Stiffness on Underwater Blood Pressure in middle-aged and Elderly Japanese Women *N. Matsumoto; H. Yamanaka; M. Miyachi; S. Onodera* (JAPAN)	P-057

Thursday, 17 June 2010
12:00 - 13:00 Poster session Training 1 (Chair: B. Ungerechts) Room: Poster and Exhibition Hall

12:00	13th FINA World Championships: Analysis of Swimsuits Used By Elite Male Swimmers *HP Neiva; JP Vilas-Boas; TM Barbosa; AJ Silva; DA Marinho* (PORTUGAL)	P-081
12:00	Swimsuits Used By Elite Male Swimmers in the 13th FINA World Championships: Analysis of Freestyle Events *HP Neiva; JP Vilas-Boas; TM Barbosa; AJ Silva; DA Marinho* (PORTUGAL)	P-082
12:00	Effect of Subjective Effort on Stroke Timing in Breaststroke Swimming *M Ohba; S. Sato; Y. Shimoyama; D. Sato* (JAPAN)	P-083
12:00	Technical and Physiological Changes during Continuous vs. Intermittent Swims at and above Maximal Lactate Steady State *M.F. Oliveira[1]; F Caputo[1]; J Dekerle[2]; B.S Denadai[1]; C.C Greco[1]* [1](BRAZIL); [2](UNITED KINGDOM)	P-084
12:00	The Relationship of Arm-Stroke Index to some Physical Characteristics and Performance in Swimming *Bahtiyar Ozcaldiran* (TURKEY)	P-085
12:00	Effects of Aerobic and Anaerobic Training on Blood Nitric Oxide Levels and the Role of Gender *Z Özkol; F Turgay; S. R Varol; B Özçaldýran; F Vural; T Akþit; G.R. Nalçakan* (TURKEY)	P-086

12:00 Analysis of the Shots According to Set Playing (6-6) Position in Waterpolo Game at European B Waterpolo Championships in Lugano 2009 P-087
Z Ozkol[1]; S Turunc[1]; M Dopsaj[2] [1](TURKEY); [2](SERBIA)

12:00 Identification of a Bias in the Natural Progression of Swim Performance P-088
J. M. Stager; C. L. Brammer; D. A. Tanner (UNITED STATES)

12:00 Swimming Performances of Japanese Masters Swimmers P-089
M Tachi; J Takahashi; T Takano; T Nomura (JAPAN)

12:00 Tendencies in Natural Selection of Qualified Young Swimmers P-090
T. Timakova; M.V. Klyuchnikova (RUSSIAN FEDERATION)

12:00 Tethered Swimming as an Evaluation Tool for Arm Strength Imbalances P-091
A. Toubekis; V. Gourgoulis; SP. Tokmakidis (GREECE)

12:00 Blood Lactate Responses During Interval Training Corresponding to Critical Velocity in Different Age-group Female Swimmers P-092
G. Tsalis; A. Toubekis; D. Michailidou; V. Gourgoulis; H. Douda; SP. Tokmakidis (GREECE)

12:00 Predicting Performance using Critical Swimming Speed in Young Swimmers P-093
R. Zacca; F. Castro (BRAZIL)

12:00 Competition Specific Diagnostics and Results for Elite Water Polo Players P-094
C. Zinner; T. Focke; B. Sperlich; M. Krueger; J. Mester (GERMANY)

Thursday, 17 June 2010
13:30 - 14:15 Workshop

13:30 Invited Workshop in CFD methodology: its usefulness and basic steps WS-001
V. Mantha[1]; D. Marinho[1]; P.L. Kjendlie[2]; A. Silva[1]
[1](PORTUGAL); [2](NORWAY)

Thursday, 17 June 2010
14:30 - 15:15 Keynote Lecture 4 (Chair: R. Stallman) Room: Aud A

14:30 Invited Lecture: Biomechanical Services for Top Level Swimming Development, the AIS Model KL-004
Bruce Mason (AUSTRALIA)

Thursday, 17 June 2010
16:00 - 17:45 TRAINING GENERAL (Chair: T.M. Barbosa) Room: Aud A

16:00 Aquatic Space Activities – Practice Needs Theory O-025
B E Ungerechts; J Klauck (GERMANY)

16:15	Increased Training Intensity and Reduced Volume for 12 weeks has Detrimental Effects on Swimmers Maximal Oxygen Uptake *Mogens Theisen Pedersen; A Kilen; TH Larsson; M Jørgensen; B Rocha; NB Nordsborg* (DENMARK)	O-026
16:30	The Effect of Cognition-Based Technique Training on Stroke Length in Age-Group Swimmers *A C Schmidt; B E Ungerechts; W Buss; T Schack* (GERMANY)	O-027
16:45	Monitoring Swim Training based on Mean Intensity Strain and Individual Stress Reaction of an Elite Swimmer *B E Ungerechts; R Steffen; K Vogel* (GERMANY)	O-028
17:00	Accelerometry as a Means of Quantifying Training Load in Competitive Swimmers *Brian / Vincent Wright; M.G. Hinman; J.M. Stager* (UNITED STATES)	O-029
17:15	Effects of Shoulder Compensatory Strength Training Program in Rotator Cuff Strength of Young Swimmers *N. Batalha; A. Raimundo; P. Tomás-Carús; O. Fernandes; J.P. Sousa; A.M. Costa; A.J. Silva* (PORTUGAL)	O-030
17:30	Zen and the Art of Swimming – Impulses for Teaching and Training. *D. Dahl* (NORWAY)	O-031

Thursday, 17 June 2010
16:00 - 17:30 ENERGY COST (Chair: F. Ogita) Room: Aud D

16:00	Effect of Increasing Energy Cost on Arm Coordination at Different Exercise Intensities in Elite Sprint Swimmers *J. Komar[1]; P.M. Leprêtre[1]; M. Alberty[1]; J. Vantorre[1]; R.J. Fernandes[2]; P. Hellard[1]; D. Chollet[1]; L. Seifert1* [1](FRANCE); [2](PORTUGAL)	O-032
16:15	Effect of Time and Exercise Mode on Metabolic, Stroking Parameters and Stroke Phases Responses at Continuous and Intermittent Exercises *JG Pelarigo[1]; BS Denadai[2]; BD Fernandes[2]; DRP Santiago[2]; TEAS César[2]; LF Barbosa2; CC Greco[2]* [1](PORTUGAL); [2](BRAZIL)	O-033
16:30	Some Factors Limiting Energy Supply on 200m Front crawl Swimming *B. Strumbelj; A. U˙aj; N. Kapus; J. Bednarik* (SLOVENIA)	O-035
16:45	Effect of Intermittent Hypoxic Training on Performance in Elite Swimmers *M Anderson; S Widmer* (AUSTRALIA)	O-036
17:00	The Contribution to Total Power Output from the Arms and Legs using a New Whole-body Swimming Training Machine *I Swaine* (UNITED KINGDOM)	O-037
17:15	Comparison Between the Standard Average Muscle Activation wtith the Use of Snorkel and Without Snorkel in Breakstroke Technique *A. Conceição; H Gamboa; S Palma; T Araújo; N. Nunes; D Marinho; A Costa; A Silva; H Louro* (PORTUGAL)	O-034

Thursday, 17 June 2010
16:00 - 17:30 WATER POLO (Chair: A. Hohmann) Room: 106

16:00	Correlation Between Maximal Dynamic Strength of Specific Muscle Groups and Throwing Speed in Elite Water Polo Players *M. Krueger; T. Focke; B. Sperlich; C. Zinner; J. Mester* (GERMANY)	O-038
16:15	Throwing Accuracy of Water Polo Players of Different Training Age and Fitness Level in Static Position and after Previous Swimming *T. Platanou; P. Botonis* (GREECE)	O-039
16:30	A Markov Chain Model of Elite Water Polo Competition *M. Pfeiffer; A Hohmann; A Siegel; S Boehnlein* (GERMANY)	O-041
16:45	A Model of Vertical Swimming Abilities in Elite Female Senior Water Polo Players *M Dopsaj* (SERBIA)	O-042
17:00	Models for Assessing General Horizontal Swimming Abilities of Junior Water Polo Players According to Playing Position *Z Ozkol[1]; M Dopsaj[2]; V Thanopoulos[3]; Z Bratusa[2]* [1](TURKEY); [2](SERBIA); [3](GREECE)	O-043

Thursday, 17 June 2010
16:00 - 17:30 COORDINATION (Chair: D. Chollet) Room: 107

16:00	Arm Coordination, Active Drag and Propelling Efficiency in Front crawl *L Seifert[1]; C Schnitzler[1]; M Alberty[1]; D Chollet[1]; HM Toussaint[2]* [1](FRANCE); [2](NETHERLANDS)	O-044
16:15	Fatigue Analysis of 100 Meters all-out Front crawl using Surface EMG *I. Stirn; T Jarm; V Kapus; V Strojnik* (SLOVENIA)	O-045
16:30	Relationship between Arm Coordination and Energy Cost in Front Crawl Swimming *R.J. Fernandes[1]; P. Morais[1]; K.L. Keskinen[2]; L. Seifert[3]; D. Chollet[3]; J.P. Vilas-Boas[1]* [1](PORTUGAL); [2](FINLAND); [3](FRANCE)	O-046
16:45	Front Crawl and Backstroke Arm Coordination in Swimmers with Down Syndrome *A. Querido[1]; I Marques-Aleixo[1]; P Figueiredo[1]; L Seifert[2]; D Chollet[2]; JP Vilas-Boas[1]; D Daly[3]; R Corredeira[1]; RJ Fernandes1* [1](PORTUGAL); [2](FRANCE); [3](BELGIUM)	O-047
17:00	Co-Ordination Changes during a Maximal Effort 100 m Short Course Breaststroke Swim *S. W Oxford; R James; M Price; C Payton* (UNITED KINGDOM)	O-048
17:15	Muscular Request of Different Fin Uses *G Gouvernet; G Rao; C Barla; L Grelot; L Baly; E Berton* (FRANCE)	O-049

17:30 Effect of Stroke Drills on Intra-cycle Hip Velocity in Front Crawl O-040
R. Arellano; R. Dominguez-Castells; E. Perez-Infantes; E. Sánchez (SPAIN)

Friday, 18 June 2010
08:30 - 10:15 METHODS (Chair: S. Psycharakis) Room: Aud A

08:30 Markerless Analysis of Front Crawl Swimming O-050
E. Ceseracciu[1]*; Z. Sawacha*[1]*; S. Fantozzi*[1]*; M. Cortesi*[1]*; S. Ceccon*[1]*; G. Donà*[1]*; S. Corazza*[2]*; G. Gatta*[1]*; C. Cobelli*[1] [1](ITALY); [2](UNITED STATES)

08:45 50m Race Components Times Analysis Based on a Regression Analysis Model Ap-plied to Age-Group Swimmers O-051
E. Morales[1]*; R. Arellano*[1]*; P. Femia*[1]*; J. Mercade*[1]*; R. Haljand*[2] [1](SPAIN); [2](ESTONIA)

09:00 The Altitude Project: An International Collaborative Research Project on Altitude Training in Elite Swimmers O-052
F.A. Rodríguez[1]*; B.D. Levine*[2] [1](SPAIN); [2](UNITED STATES)

09:15 A New Method to Evaluate Cross-Sectional Area Based on Computer Animation of Swimming O-053
B Bideau[1]*; G Nicolas*[1]*; RH Sanders*[2]*; R Kulpa*[1] [1](FRANCE); [2](UNITED KINGDOM)

09:30 Assessing Mental Workload at Maximal Swimming Intensity Using the NASA-TLX Questionnaire O-054
C Schnitzler; L Seifert; D. Chollet (FRANCE)

09:45 Whole Body Observation and Visualized Motion Analysis of Swimming O-055
S. Ito; K. Okuno (JAPAN)

10:00 The Validity of a Procedure for Competition Analysis in Swimming Based on Individual Distance Measurements O-056
S. Veiga[1]*; A. Cala*[2]*; P. González Frutos*[1]*; E. Navarro*[1] [1](SPAIN); [2](NEW ZEALAND)

Friday, 18 June 2010
08:30 - 10:00 MEDICINE II (Chair: D. Daly) Room: 106

08:30 Bronchial Hyper-Responsiveness, Physiological and Psychological Recovery Among Adolescent Swimmers: A preliminary investigation O-057
E Kristiansen; T Stensrud; K Stadelmann (NORWAY)

08:45 Immune Status Changes and URTI Incidence in the Initial 7 Weeks of a Winter Training Season in Portuguese Swimmers O-058
L. M. Rama; F. Alves; F. Rosado; S. Azevedo; A. Matos; A. Henriques; A. Paiva; AM. Teixeira (PORTUGAL)

09:00 Postexercise Hypotension and Blood Lipoprotein Changes following Swimming Exercise O-059
H Tanaka; SM Sommerlad; CP Renzi; JN Barnes; N Nualnim (UNITED STATES)

09:15 Strategy for the Prevention of Shoulder Pains in the Case of Competitive Swimmers O-060
S. Pagin (SWITZERLAND)

09:30 The Effect of Hydrotherapy on some Selected Parameters Related to Kyphosis in Kyphotic girls O-061
M. Azizi (ISLAMIC REP. of IRAN)

09:45 The Relationship ofRespiratory Symptoms and Bronchial Responsiveness in Competitive Swimmers O-062
T. Stensrud[1]*; K. Stadelmann*[2]; K-H. Carlsen[1] [1](NORWAY); [2](SWITZERLAND)

Friday, 18 June 2010
08:30 - 10:00 EDUCATION (Chair: K. Moran) Room: 107

08:30 Performance Level Differences in Swimming: Relative Contributions of Strength and Technique O-063
R Havriluk (*UNITED STATES*)

08:45 The Effect of Restricting the Perceptual Task in Temporal Organization of Crawl Swimming: Surface Characteristics O-064
C.A.F. Brito; W. C. Belvis; *M. Oliveira* (*BRAZIL*)

09:00 Effect of Target Sound made by one Swimmer's Dolphin Kick Movement on Another Swimmer's Dolphin Kick Performance O-065
H. Shimojo; H. Ichikawa; *S. Tsubakimoto*; *H. Takagi* (*JAPAN*)

09:15 Technology and Innovation in Educating Swimming Coaches and Teachers O-066
H.B. Gudmundsson[1]; *I.T. Jonsson*[1]; *L. Madsen*[2]; *J. Dam*[2]; *Ken Currie*[3]; *R.H. Sanders*[3]
[1](*ICELAND*); [2](*DENMARK*); [3](*UNITED KINGDOM*)

09:30 Using a Scalogram to Identify an Appropriate Instructional Order for Swimming Items O-067
S. J. Langendorfer; J. A. Chaya (*UNITED STATES*)

09:45 Learning and Improving a Swimming Technique within an Inter-disciplinary and Experience based Teaching Approach with two 7th Grade School Classes O-068
Marc Esser-Noethlichs (*NORWAY*)

Friday, 18 June 2010
10:30 - 11:15 Keynote Lecture 5 (Chair: B. Ungerechts) Room: Aud A

10:30 Toward a Better Understanding on the Role of Unsteadiness in Swimming Propulsion by Means of PIV KL-005
Kazuo Matsuuchi (*JAPAN*)

Friday, 18 June 2010
11:15 - 12:00 Keynote Lecture 6 (Chair: B. Ungerechts) Room: Aud A

11:15 Invited Lecture: The Psycho-Physiology of Overtraining and Athlete Burnout in Swimming KL-006
Nicolas Lemyre (*NORWAY*)

Friday, 18 June 2010
12:00 - 13:00 Poster session Biomechanics 2 (Chair: M. Rejman) Room: Poster and Exhibition Hall

12:00 Attack Angle, Resultant Speed and Acceleration of the Hand and Vertical Acceleration of the Greater Trochanter during Sculling Motion: a Case Study P-017
L E Gomes; *J.F. Loss* (*BRAZIL*)

12:00 Comparison of Combinations of Vectors to define the Plane of the Hand in order to calculate the Attack Angle during the Sculling Motion P-018
L.E. Gomes; *M.O. Melo*; *M. La Torre*; *J.F. Loss* (*BRAZIL*)

12:00 Relative Contribution of Drag and Lift Forces in the Separate Phases of the Front Crawl Swimming P-019
V Gourgoulis; A Boli; *N Aggeloussis*; *A.G. Toubekis*; *N Vezos*; *P Kasimatis*; *G Mavrommatis* (*GREECE*)

12:00 Kinematics Analysis of the Undulatory Underwater Swimming during a Grab Start of National Level Swimmers P-020
N. Houel; M. Elipot; *F Andrée*; *P Hellard* (*FRANCE*)

12:00 Comparison of Front Crawl Swimming Drag between Elite and Non-Elite Swimmers Using Pressure Measurement and Motion Analysis P-021
H Ichikawa; T Miwa; *T Takeda*; *H Takagi*; *S Tsubakimoto* (*JAPAN*)

12:00 The Study on the Properties of Power Output of Lower Limbs in Collegiate Swimmers during Vertical jumping Performance P-022
H Jigami; K Takahashi; *Y Shimoyama*; *N Endo* (*JAPAN*)

12:00 Relationships between Entry Skill and 15m time in Competitive Swimming start P-024
O. Kazumasa; S. Shinji; *T. Masahiro* (*JAPAN*)

12:00 Effects of New Hightech-Swim-Suits on Passive Drag P-025
S. Keul; A. Bieder; *P. Wahl* (*GERMANY*)

12:00 Different Frequential Acceleration Spectrums In Front Crawl P-026
J Madera; LM Gonzalez; *X García Massó*; *J Benavent*; *JC Colado*; *V Tella* (*SPAIN*)

12:00 The Gliding Phase in Swimming: The Effect of Water Depth P-027
DA Marinho[1]; *TM Barbosa*[1]; *N Mantripragada*[2]; *JP Vilas-Boas*[1]; *AH Rouard*[3]; *V Mantha*[1]; *AI Rouboa*[1]; *AJ Silva*[1]
[1](*PORTUGAL*); [2](*INDIA*); [3](*FRANCE*)

12:00 Regression Analysis Model Applied to Age-Group Swimmers: Study of Stroke Rate, Stroke Length and Stroke Index P-028
E. Morales; *R. Arellano*; *P. Femia*; *J. Mercade* (*SPAIN*)

12:00 Measurement of Unsteady Fluid Force Acting on Limbs in Swimming Using a Robot Arm and Its Modeling Using the Swimming Human Simulation Model "SWUM" P-030
M. Nakashima; *A. Takahashi* (*JAPAN*)

12:00 Estimating the Added Mass and the Active Drag Force During Push-off at Flip Turns P-031
S. M. Pereira[1]; *S. G. Silva*[2]; *P. Gonçalves*[2]; *R. J. Fernandes*[2]; *L. Machado*[2]; *H. Roesler*[1]; *J. P. Vilas-Boas*[2]
[1](*BRAZIL*); [2](*PORTUGAL*)

12:00 Efficiency Analysis of Swimmers' Start Using Starting Block With Adjustable Raised Foot in Competitions P-032
A.V. Petryaev (*RUSSIAN FEDERATION*)

Friday, 18 June 2010
12:00 - 13:00 Poster session Physiology 2 (Chair: K. Cumming) Room: Poster and Exhibition Hall

12:00 Markers of Cardiovascular Health in Physically Active Masters Swimmers P-058
CM McCracken; *SK Head*; *CD Mattson*; *AK Peirce*; *JD Johnston*; *PR Finn*; *JM Stager* (*UNITED STATES*)

12:00 Heart rate Responses during Gradual increase and Decrease Exercise in Water P-059
K Nishimura; *Y. Nose*; *A. Yoshioka*; *H. Kawano*; *S. Onodera*; *N. Takamoto* (*JAPAN*)

12:00 Relationship between Heart Rate and Water Depth during Standing in Water P-060
S. Onodera; *A. Yoshioka*; *N. Matsumoto*; *T. Takahara*; *Y. Nose*; *M. Hirao*; *K. Seki*; *K. Nishimura*; *W. Baik*; *H. Hara*; *T. Murakawa* (*JAPAN*)

12:00 Body Composition Differences in Elite Waterpolo Players P-061
Z Ozkol[1]; *S Turunc*[1]; *M Dopsaj*[2] [1](*TURKEY*); [2](*SERBIA*)

12:00 Oxygen Uptake Kinetics Around the Respiratory Compensation Point in Swimming P-062
Dalton Müller Pessôa Filho[1]; *J. Reis*[2]; *F. Alves*[2]; *B. S. Denadai*[1]
[1](*BRAZIL*); [2](*PORTUGAL*)

12:00 Hormonal, Immune, Autonomic and Mood States Variation at the Initial Preparation Phase of a Winter Season, in Portuguese Male Swimmers P-063
L. Rama; F. Alves; *AM. Teixeira* (*PORTUGAL*)

12:00 Oxygen Uptake Kinetics in All-Out Arm Stroke, Leg Kicking and Whole Stroke Front Crawl 100-m Swims P-064
F.A. Rodríguez[1]; *E. Lätt*[2]; *J. Jürimäe*[2]; *J. Mäestu*[2]; *P. Purge*[2]; *R. Rämson*[2]; *K. Haljaste*[2] ; *K.L. Keskinen*[3]; *T. Jürimäe*[2]
[1](*SPAIN*); [2](*ESTONIA*); [3](*FINLAND*)

12:00 Determination and Validity of Critical Velocity in Front Crawl, Arm Stroke and Leg Kick as an Index of Endurance Performance in Competitive Swimmers P-065
K. Wakayoshi; *T Shiraki*; *F Ogita*; *M Kitajima* (*JAPAN*)

12:00 Differences in Methods Determining the Anaerobic Threshold of Triathletes in the Water P-066
D Zoretic (*CROATIA*)

Friday, 18 June 2010

12:00 - 13:00 Poster session: Educational Science, Advice and Biofeedback (Chair: B.H. Olstad) Room: Poster and Exhibition Hall

12:00	Developing Competence and Swimming Technique through Teaching from an Aesthetic Learning Perspective *J.A. Dam* (*DENMARK*)	P-095
12:00	The Swimming Ability Of Primary School Children: Achievement Of Desired Competence Goals *K Engvig*; *P-L Kjendlie*; *R K Stallman* (*NORWAY*)	P-096
12:00	The Swimming Ability of Primary School Children: The Influence of Volume and Distribution of Instruction *K Engvig*; *P.L. Kjendlie*; *R.K. Stallman* (*NORWAY*)	P-097
12:00	Analyses of Instruction for Breath Control While Swimming the Breaststroke *H Hara*; *A. Yoshioka*; *N. Matsumoto*; *Y. Nose*; *R. Watanabe*; *Y Shibata*; *S Onodera*; *Y. Shibata*; *S. Onodera* (*JAPAN*)	P-098
12:00	Evaluation of the Kinaesthetic Differentiation Abilities in Male and Female Swimmers *P. L. Invernizzi*; *S Longo*; *R Scurati*; *G Michielon* (*ITALY*)	P-099
12:00	Swimming in Eyesight Deprivation: Relationships with Sensory-perception, Coordination and Laterality *P.L. Invernizzi*; *S Longo*; *F Tadini*; *R Scurati* (*ITALY*)	P-100
12:00	Progression in Teaching Beginning Swimming: Rank Order by Degree of Difficulty *M Junge*; *T Blixt*; *R K Stallman* (*NORWAY*)	P-101
12:00	The Validity of a Traditional 25m Test of Swimming Competence *M Junge*; *T Blixt*; *R K Stallman* (*NORWAY*)	P-102
12:00	School Swimming - a Team Effort: An Intervention Study *B.W. Laakso*; *R.K. Stallman* (*NORWAY*)	P-103
12:00	Observation Skills in Learning processes – A didactic Challenge *L. Madsen* (*DENMARK*)	P-105
12:00	Infants' Behaviors During Aquatic Activities *Marta Martins; T. Barbosa*; *A. Silva*; *N. Batalha*; *D. Marinho* (*PORTUGAL*)	P-106
12:00	Imagery Training in Young Swimmers: Effects on the Flow State and on the Performance *R Scurati; G Michielon*; *S Longo*; *PL Invernizzi* (*ITALY*)	P-107
12:00	Shallow or Deep Water for Settling in? A study in children aged 3 to 6 years *R Scurati; G Michielon*; *S Longo*; *PL Invernizzi* (*ITALY*)	P-108
12:00	The Role of Verbal Information about Sensory Experience from Movement Apparatus in the Process of Swimming Economization *K. Zatoń* (*POLAND*)	P-109
12:00	The Informativeness of Field Tests and Laboratory Assessments in Forecasting the Actual Performance of Swimmers *IJ Zuoziene; JL Poderys* (*LITHUANIA*)	P-110

Friday, 18 June 2010
13:30 - 14:00 Workshop: "Can You Swim Project" (Chair: R. Stallman) Room: 106

13:30 - 14:00 Sponsored Workshop: Torrent E-Rack Swim Training and Analysis D.H. Hector / Hector Engineering Co. Inc. (Chair: B.H. Olstad). Room: Swimming Pool.

Friday, 18 June 2010
14:30 - 15:15 Keynote Lecture 7 (Chair: R. Stallman) Room: Aud A

14:30 Applying a Developmental Perspective to Aquatics and Swimming KL-007
S. J. Langendorfer (*UNITED STATES*)

16:00 - 17:30 PERFORMANCE I (Chair: J. Stager) Room: Aud A

16:00 Stability and Prediction of 100-m Breaststroke Performance During Elite Swimmers Career O-069
M.J. Costa; D.A. Marinho; *V.M. Reis*; *A.J. Silva*; *J.A. Bragada*; *T.M. Barbosa* (*PORTUGAL*)

16:15 Performance Decrease Following Summer break in Youth Swimmers O-070
C. Zinner; B. Sperlich; *M. Krueger*; *J. Mester* (*GERMANY*)

16:30 Talent Prognosis in Young Swimmers O-071
A Hohmann; I Seidel (*GERMANY*)

16:45 Reproducibility of Pacing Strategies in High Level Junior Swimmers O-072
S. Skorski; O. Faude; *K. Rausch*; *T. Meyer* (*GERMANY*)

17:00 A Competition-Based New Research Design to Assess an Intervention Affecting Performance of a Squad of Elite Athletes O-073
T.J. Vandenbogaerde[1]; *W.G. Hopkins*[1]; *D.B. Pyne*[2]
[1](*NEW ZEALAND*); [2](*AUSTRALIA*)

17:15 Overall Trends and Individual Trajectories of Swimming Performance in a Decade of New Zealand National Championships O-074
W.G. Hopkins[1]; *J.C. Pike*[1]; *C. Nottle*[2]
[1](*NEW ZEALAND*); [2](*AUSTRALIA*)

Friday, 18 June 2010
16:00 - 17:30 COMPUTATIONAL FLUID DYNAMICS (Chair: A.J. da Silva) Room: 106

16:00 A Full Body Computational Fluid Dynamic Analysis of the Freestyle Stroke of a Previous Sprint Freestyle World Record Holder O-075
M. Keys; *A. Lyttle*; *B.A. Blanksby*; *L. Cheng* (*AUSTRALIA*)

16:15 Computational Fluid Dynamics Applied to Competitive Swimming: The Role of Finger Position O-076
D.A. Marinho[1]; *T.M. Barbosa*[1]; *P.L. Kjendlie*[2]; *V.M. Reis*[1]; *J.P. Vilas-Boas*[1]; *L.Machado*[1]; *A.I. Rouboa*[1]; *A.J. Silva*[1]
[1](*PORTUGAL*); [2](*NORWAY*)

16:30 Hydrodynamic Characterization of the First and Second Glide Positions of the Underwater Stroke Technique in Breaststroke O-078
L Costa; *J Ribeiro*; *P Figueiredo*; *RJ Fernandes*; *D Marinho*; *AJ Silva*; *A Rouboa*; *JP Vilas-Boas*; *L Machado* (*PORTUGAL*)

16:45 3D Computational Fluid-structure Interaction Model for the Estimation of Propulsive Forces of a Deformable Monofin O-079
N. Bideau; *F Razafimahery*; *L Monier*; *B Mahiou*; *G Nicolas*; *B Bideau*; *L Rakotomanana* (*FRANCE*)

17:00 Human Undulatory Swimming: Kinematics, Flow and Mechanical Model O-080
S. Hochstein; *R. Blickhan* (*GERMANY*)

17:15 Advanced Biomechanical Simulations in Swimming Enabled by Extensions of Swimming Human Simulation Model "SWUM" O-126
M. Nakashima; H. Kiuchi; *S. Maeda*; *S. Kamiya*; *K. Nakajima*; *H. Takagi* (*JAPAN*)

Friday, 18 June 2010
16:00 - 17:30 TURN/START I (Chair: R. Arellano) Room: 107

16:00 The Development of a Component Based Approach for Swim Start Analysis O-081
J Cossor; S. E. Slawson; *L. M. Justham*; *P. P. Conway*; *A. A. West* (*UNITED KINGDOM*)

16:15 Influences of the Back Plate on Competitive Swimming Starting Motion in Particular Projection Skill O-082
T Nomura; T Takeda; *H Takagi* (*JAPAN*)

16:30 A Biomechanical Comparison of Elite Swimmers Start Performance Using the Traditional Track Start and the New Kick Start O-083
KE Honda; PJ Sinclair; *BR Mason*; *DL Pease* (*AUSTRALIA*)

16:45 Comparison Among Three Types of Relay Start in Competitive Swimming O-084
T. Takeda; H. Takagi, S. Tsubakimoto (JAPAN)

17:00 Influence of Swimming Start styles on Biomechanics and Angular Momentum O-085
J. Vantorre[1]; *L. Seifert*[1]; *B. Bideau*[1]; *G. Nicolas*[1]; *R.J. Fernandes*[2]; *J.P. Vilas-Boas*[2]; *D. Chollet*[1] [1](*FRANCE*); [2](*PORTUGAL*)

17:15 Learning Flat and Pike Entries during Swim Start from the Block O-086
S Fischer; A Kibele (*GERMANY*)

Saturday, 19 June 2010
08:30 - 10:15 PERFORMANCE II (Chair: J. Dekerle) Room: Aud A

08:30 Do Fastskin Swimsuits Influence Coordination in Front crawl Swimming? O-087
D Chollet; F Chavallard; *F Lemaitre*; *L. Seifert* (*FRANCE*)

08:45 A Comparison of Characteristics of High Functional Swimwear for Competitive Swimming O-088
T Gonjo; H Ichikawa; *S Tsubakimoto*; *H Takagi* (*JAPAN*)

09:00 Effects of Swimwear Developed in 2008 on Drag During Front Crawl Swimming O-089
F Ogita; Z Huang; K kurobe; G Ozawa; N Taguchi; T Tanaka (*JAPAN*)

09:15 Shaving and Perceptual Sensory Threshold O-090
C L Brammer; D. M. Koceja; J. M. Stager (*UNITED STATES*)

09:30 The Acute Effect of Front Crawl Sprint-resisted Swimming on the Direction of the Resultant Force of the Hand O-091
V Gourgoulis; N Aggeloussis; G Mavridis; A Boli; A.G. Toubekis; P Kasimatis; N Vezos; G Mavrommatis (*GREECE*)

09:45 Mechanical And Propulsive Efficiency Of Swimmers In Different Zones Of Energy Supply O-092
Sergei Kolmogorov; A.R. Vorontsov; O.A. Rumyantseva; A.B. Kochergin (*RUSSIAN FEDERATION*)

10:00 Physiological and Performance Characteristics of 200 m. Continuous Swimming and 4X50m "Broken" Swimming with Different Interval Time.Demands O-093
N. Beidaris; P. Botonis; T. Platanou (*GREECE*)

Saturday, 19 June 2010
08:30 - 10:00 RESCUE (Chair: K. Moran & R. Stallman) Room: 106

08:30 Crucial Findings from the 4W Model of Drowning for Practical and Teaching Applications O-094
S. Avramidis[1]; *J. McKenna*[2]; *J. Long*[2]; *R. Butterly*[1]; *D.J. Llewellyn*[2] [1](*GREECE*); [2](*UNITED KINGDOM*)

08:45 Real and Perceived Swimming Competency, Risk Estimation, and Preventing Drowning among New Zealand Youth O-095
K Moran (*NEW ZEALAND*)

09:00 Keeping the Safety Messages Simple: The International Task Force on Open-Water Recreational Drowning Prevention O-096
K Moran[1]; *L. Quan*[2]; *E Bennett*[2]
[1](*NEW ZEALAND*); [2](*UNITED STATES*)

09:15 Movement Economy in Breaststroke Swimming: A Survival Perspective O-097
R.K. Stallman; J Major; S Hemmer; G Haavaag (*NORWAY*)

09:30 A Model for Drowning Prevention in Lake Victoria; A Case Study from East Africa O-098
S. Wiebenge (*NETHERLANDS*)

09:45 Swimming Ability, Perceived Competence and Perceived Risk Among Young Adults O-099
R.K. Stallman; D Dahl; K. Moran; P.L. Kjendlie (*NORWAY*)

Saturday, 19 June 2010
08:30 - 10:00 MEDICINE III (Chair: D. Daly) Room: 107

08:30 Dietary Thiamin and Riboflavin Intake and Blood Thiamin and Riboflavin Concentrations in Collegiate Swimmers under Intensive Training O-100
A. Sato; Y. Shimoyama; T. Ishikawa; N. Murayama (*JAPAN*)

08:45 Does the Immersion Affect Cortical Activation in Human? :Functional Near Infrared Spectroscopy study O-101
Daisuke Sato; H Onishi; T Iwabe; A Maruyama (*JAPAN*)

09:00 Is Sight the Only Deterrent to Breaststroke Performance in Visually Impaired Paralympic Swimmers? O-102
I Þ Einarsson[1]; *J. Martens*[2]; *D.J. Daly*[2] [1](*ICELAND*); [2](*BELGIUM*)

09:15 Influence of Swimming Speed on the Affected- and Unaffected-Arm Stroke Phases of Competitive Unilateral Arm Amputee Front Crawl Swimmers O-103
C.D. Osborough[1]; *C.J. Payton*[1]; *D.J. Daly*[2] [1](*UNITED KINGDOM*); [2](*BELGIUM*)

09:30 Effect of Buoyant Torque on Bodyroll of Unilateral Arm Amputee Front Crawl Swimmers O-104
C.J Payton; C Osborough; R.H Sanders (*UNITED KINGDOM*)

09:45 The Effect of Higher Ambient Air Temperature on Thermoregulatory Responses and Thermal Sensation during Lower Body Immersion in Cool Water O-105
H. Wakabayashi[1]; *T. Wijayanto*[2]; *J.Y. Lee*[2]; *Y. Tochihara*[2] [1](*UNITED KINGDOM*); [2](*JAPAN*)

Saturday, 19 June 2010
10:30 - 11:15 Keynote Lecture 8 (Chair: K. Keskinen) Room: Aud A

10:30 Training at Real and Simulated Altitude in Swimming: Too High Expectations? KL-008
F.A. Rodríguez (*SPAIN*)

11:15 - 12:00 Keynote Lecture 9 (Chair: K. Keskinen) Room: Aud A

11:15 Swimming and Aquatic Exercise for Rehabilitation and Health KL-009
Jan Prins (*UNITED STATES*)

Saturday, 19 June 2010
12:00 - 13:00 Poster session Biomechanics 3 (Chair: B. Ungerechts) Room: Poster and Exhibition Hall

12:00 Biomechanical Factors Influencing Tumble Turn Performance of Elite Female Swimmers P-033
F. Puel; J. Morlier; M. Cid; D. Chollet; P. Hellard (*FRANCE*)

12:00 Identifying Determinant Movement Sequences in Monofin Swimming Technique P-034
M Rejman; A Staszkiewicz (*POLAND*)

12:00 Patterns of Behavior in the Crawl Technique of the Elite Portuguese Swimmers P-035
N. Ricardo; V. Milheiro; M. Branco; J. Campaniço; J. Freitas; A. ConceiÃ$Ã£o; H. Louro; A. Silva (*PORTUGAL*)

12:00 Evaluation of the Gliding Capacity of a Swimmer P-036
A Roig (*SPAIN*)

12:00 Modelling Arm Coordination in Front Crawl P-037
L Seifert; D Chollet (*FRANCE*)

12:00	Creating the Best Physical Resources for Performing the Underwater Undulatory Swimming, a Case Study *J Setterberg* (*NORWAY*)	P-038
12:00	Observation of Standard Breaststroke Technique Stability *A Silva*; *J Freitas*; *J. R*; *A. Conceição*; *J. Campaniço*; *T. Matos*; *L. Leitão*; *H. Louro* (*PORTUGAL*)	P-039
12:00	Effects of a Blueseventy™ Bodysuit on Spatial-temporal and Coordinative Parameters during an all-out 50-m Front crawl Swim *RP Silveira*; *JY Kanefuku*; *FC Moré*; *FAS Castro* (*BRAZIL*)	P-040
12:00	Relationship Between High Elbow Technique and Motion of Shoulder Joint in Front Crawl Swimming *H. Suito; H Nunome*; *Y Ikegami* (*JAPAN*)	P-041
12:00	A Study About The 3D Acceleration In Front Crawl And Its Relation With Performance *V Tella*; *J Madera; JC Colado*; *J Mateu*; *X García Massó*; *LM Gonzalez* (*SPAIN*)	P-042
12:00	An Analysis of the Underwater Gliding Motion in Collegiate Competitive Swimmer *T. Wada; T Sato*; *K Ohishi*; *T Tago*; *T Izumi*; *T Matsumoto*; *N Yamamoto*; *T Isaka*; *Y Shimoyama* (*JAPAN*)	P-043
12:00	Investigations into Strength Endurance Exercises for Swimmers *M. Witt; J.-K. Götz* (*GERMANY*)	P-044
12:00	Head Out Swimming in Water Polo: a Comparison with the Front Crawl in Young Female Players *P Zamparo; S Falco* (*ITALY*)	P-045
12:00	The Interplay Between Leg Kick Efficiency and Pushing Phase Acceleration in Determining the "Turning Speed" in Front Crawl Swimming *P Zamparo; M Vicentini*; *E Zorzi*; *A Scattolini*; *A Rigamonti*; *M Bonifazi* (*ITALY*)	P-046
12:00	Technical Monitoring and Application of Swimming Competition *J Zhou; H Ba*; *W Xie* (*CHINA*)	P-047

Saturday, 19 June 2010
12:00 - 13:00 Poster session Training 3 (Chair: C. Payton) Room: Poster and Exhibition Hall

12:00	Water Training Effect in Shoulder Rotators Strength in Young Swimmers *N Batalha; P Tomás-Carús*; *O. Fernandes*; *D.A. Marinho*; *A.J. Silva* (*PORTUGAL*)	P-067
12:00	General Indexes of Crawl Swimming Velocity of Junior Water Polo Players at Match *F.Z. Bratusa; S.M. Perisic*; *J.M. Dopsaj* (*SERBIA*)	P-068
12:00	Correlation Between Dry Land Strength Measurements and In Water Force Generation *D L Carl; N Leslie*; *T Dickerson*; *B Griffin*; *A Marksteiner* (*UNITED STATES*)	P-069

12:00	Perceived Exertion at Different Percents of the Critical Velocity in Front Crawl *FAS Castro; M Franken*; *F Diefenthaeler* (*BRAZIL*)	P-070
12:00	Tracking the 2004-2008 Olympic Cycle Performance in Long Distance Freestyle Events *M.J. Costa; D.A. Marinho*; *V.M. Reis*; *A.J. Silva*; *J.A. Bragada*; *T.M. Barbosa* (*PORTUGAL*)	P-071
12:00	Changes of Competitive Performance, Training Load and Tethered Force During Tapering in Young Swimmers *E Drosou; A. Toubekis*; *V. Gourgoulis*; *S. Thomaidis*; *H. Douda*; *SP. Tokmakidis* (*GREECE*)	P-072
12:00	Ventilatory and Biomechanical Response Analysis in Short vs. Long Interval Training Sessions in Elite Long Distance Swimmers *P. Hellard*[1]; *J. Dekerle*[2]; *X. Nesi*[2]; *J.F. Toussaint*[1]; *N. Houel*[1]; *C. Hausswirth*[1] [1](*FRANCE*); [2](*UNITED KINGDOM*)	P-073
12:00	Diagnosis of Swimming Technique by fully tethered Swimming *A. Hohmann; U. Fehr*; *J. Fankel* (*GERMANY*)	P-074
12:00	Specific Strength Training and Start Performance in Swimming *A. Hohmann; U. Fehr*; *A. Reuss*; *S. Kieser*; *S. Straub* (*GERMANY*)	P-075
12:00	Relationship between Egg-beater Kick and Support Scull Skills, and Isokinetic Peak Torque *M. Homma* (*JAPAN*)	P-076
12:00	The Effects of Straight Leg Kick on Race Performance in the Sprint Butterfly *T Ide* (*JAPAN*)	P-077
12:00	Increased Training Intensity and Reduced Volume for 12 Weeks Increases Maximal Swimming Speed on a Sprint Distance in Young Elite Swimmers *L Johansen; S Jørgensen*; *A Kilen*; *T.H Larsson*; *M Jørgensen*; *B Rocha*; *N.B Nordsborg* (*DENMARK*)	P-078
12:00	Biomechanics and Bioenergetics of 100-m Front Crawl Swimming in Young Male Swimmers *E Lätt*[1]; *J Jürimäe*[1]; *J Mäestu*[1]; *P Purge*[1]; *R Rämson*[1]; *K.L Keskinen*[2]; *K Haljaste*[1]; *T Jürimäe*[1] [1](*ESTONIA*); [2](*FINLAND*)	P-079
12:00	Effects Of Applying Different Work Methods At Swimming School Programme For Beginners *E Mirvic; I Radjo*; *M Hodzic*; *Z Agacevic* (*BOSNIA AND HERZEGOVINA*)	P-080

Saturday, 19 June 2010
12:00 - 13:00 Poster session Social Sciences (Chair: N. Vikander) Room: Poster and Exhibition Hall

12:00 Evolution in Swimming Science Research: Content analysis of the "Biomechanics and Medicine in Swimming" Proceedings Books from 1971 to 2006 P-111
T M Barbosa; E Pinto; *AM Cruz*; *DA Marinho*; *AJ Silva*; *VM Reis*; *MJ Costa*; *TM Queirós* (*PORTUGAL*)

12:00 A Model for Raising Water Safety Awareness in a Developing Country: A Case Study from Tanzania P-112
S. Kiluswa[1]; *R. Namkoveka*[1]; *N. Ahmed*[1]; *J. Massudi*[1]; *J. Belela*[1]; *T. Ongala*[1]; *A. Mwaipasi*[1]; *R.K. Stallman*[2]
[1](*UNITED REPUBLIC OF TANZANIA*); [2](*NORWAY*)

12:00 Cognitive Profiles and Neuro-motor Properties of Physically Active Masters Swimmers P-113
CM McCracken; K Kitano; *SK Head*; *JD Johnston*; *PR Finn*; *JM Stager* (*UNITED STATES*)

12:00 Water Safety and the Environment: A Model for Developing Countries - A Case Study from Tanzania P-114
N. Ahmed; T. Ongala[1]; *R. Namkoveka*[1]; Mwaipasi, A; *R.K. Stallman*[2]
[1](*TANZANIA (UNITED REPUBLIC)*); [2](*NORWAY*)

12:00 A Social-Cognitive Investigation of the Coach-Created Motivational Climate and Coaching Behavior in Norwegian Youth Swimming P-115
B.E. Rustad; P.N. Lemyre (*NORWAY*)

Saturday, 19 June 2010
12:00 - 13:00 Poster session Other (Chair: N. Vikander) Room: Poster and Exhibition Hall

This session will start after the previous session (after P-115)

12:00 Framework for Drowning Prevention based on the Haddon Matrix P-116
S. Avramidis; J. McKenna (*UNITED KINGDOM*)

12:00 Head Depth and Velocity during Swim Starts in Competition in 1.22 m Depth Pool P-117
A C Cornett; J.C. White; *B.V. Wright*; *A.P. Willmott*; *J.M. Stager* (*UNITED STATES*)

12:00 Athletic Rehabilitation of a Platform Diver after Shoulder Dislocation for Return to Competitions P-118
O Fujinawa; Y. Kondo; *K. Tachikawa*; *H. Jigami*; *K. Hirose*; *H. Matsunaga* (*JAPAN*)

12:00 Comparisons of Water- and Land- based Physical Activity Interventions in Japanese Subjects with Metabolic Syndrome P-119
A Hanai; K Yamatsu (*JAPAN*)

12:00 The Influence of Ai Chi on Balance and Fear of Falling in Older Adults: a Randomized Clinical Trial P-120
Johan Lambeck[1]; *F Neto*[2]; *R Teixeira*[2] [1](*BELGIUM*); [2](*PORTUGAL*)

Saturday, 19 June 2010
12:00 - 13:00 Poster session Other (Chair: N. Vikander) Room: Poster and Exhibition Hall
This session will start after the previous session (after P-120)

12:00 Predictors of Performance in Pre-Pubertal and Pubertal Male and Female Swimmers P-121
H. Douda; *A. Toubekis*; *C. Georgiou*; *V. Gourgoulis*; *SP. Tokmakidis* (*GREECE*)

12:00 Competitive Systematization in Age-group Swimming: an Evaluation of Performances, Maturational Considerations, and International Paradigms P-122
K Kojima; *J.M. Stager* (*UNITED STATES*)

12:00 The Effect of an Intervention Program of Swim Learning on the Development of Fundamental Motor Skills of Boys and Girls P-123
A.G. Nikolopoulos; *E.K Skordilis* (*GREECE*)

12:00 Wireless Activity Monitoring System for the Water Walking P-124
Y. Ohgi; *K Kaneda*; *C Tanaka* (*JAPAN*)

12:00 The Effects of Rubber Swimsuits on Swimmers Measured by a Lactic Acid Curve Test P-125
T. Shiraki; *K. Wakayoshi*; *H Hata*; *T Yamamoto*; *M Tomikawa* (*JAPAN*)

12:00 Comparison of the Development of Underwater Exercise between China and Japan P-126
Y. Wang[1]; *H. Miwako*[2]; *T. Shozo*[2] [1](*CHINA*); [2](*JAPAN*)

12:00 Preliminary Results of a "Multi-2D" Kinematic Analysis of "Straight- vs. Bent-arm" Freestyle Swimming, Using High-Speed Videography P-127
Jan Prins; *N.M. Murata*; *J.S.III. Allen* (*UNITED STATES*)

12:00 Electromyography in Water Cycling at different Cadences P-128
A Conceição; H Gamboa; V Milheiro; J Freitas; R Fernandes; JP Vilas Boas; A Silva; H Louro (PORTUGAL)

Saturday, 19 June 2010
14:00 - 15:30 THRESHOLD (Chair: I. Swaine) Room: Aud A

14:00 Front Crawl Technique at and Around Maximal Lactate Steady State O-106
J. Dekerle[1]; *M Alberty*[2]
[1](*UNITED KINGDOM*); [2](*FRANCE*)

14:15 Determination of Lactate Threshold with Four Different Analysis Techniques for Pool Testing in Swimmers O-107
K.L. Keskinen; *O.P. Keskinen*; *T. Pöyhönen* (*FINLAND*)

14:30 Can Blood Glucose Threshold be Determined in Swimmers early in the Swimming Season? O-108
Y Sengoku; *K Nakamura*; *T Takeda*; *Y Nabekura*; *S Tsubakimoto* (*JAPAN*)

14:45 Evaluation of Force Production and Fatigue Using an Anaerobic Test Performed by Differently Matured Swimmers O-109
S. Soares; *R. Silva*; *I. Aleixo*; *L. Machado*; *R. Fernandes*; *J. Maia*; *J.P. Vilas-Boas* (*PORTUGAL*)

15:00 Stroke Phases and Coordination Index around Maximal Lactate Steady State in Swimming O-110
JG Pelarigo[1]; *BS Denadai*[2]; *BD Fernandes*[2]; *DRP Santiago*[2]; *TEAS César*[2]; *LF Barbosa*[2]; *CC Greco*[2] [1](*PORTUGAL*); [2](*BRAZIL*)

Saturday, 19 June 2010
14:00 - 15:30 TECHNIQUE AND PERFORMANCE (Chair: F. Castro) Room: 106

14:00 Quantitative Data Supplements Qualitative Evaluations of Butterfly Swimming O-111
T Becker; *R. Havriluk* (*UNITED STATES*)

14:15 The Usefulness of the Fully Tethered Swimming for 50-m Breaststroke Performance Prediction O-112
A Barbosa[1]; *M Dopsaj*[2]; *T Okicic*[2]; *O Andries Júnior*[1] (*BRAZIL*); [2](*SERBIA*)

14:30 Characteristics of Pressure Distribution and Flow Patterns around the Hand during Sculling Motion O-113
T Miwa; S Shimada; *H Ichikawa*; *H Takagi*; *K Matsuuchi*; *J Sakakibara*; *S Tsubakimoto* (*JAPAN*)

14:45 100m Freestyle: Factors Affecting Performance O-114
S T Aspenes; P-L Kjendlie (*NORWAY*)

15:00 Shoulder and Hip Roll Differences between Breathing and Non-breathing Conditions in Front Crawl Swimming O-115
S Psycharakis; C McCabe (*UNITED KINGDOM*)

15:15 Lactate Concentration Comparison Between 100m Freestyle and Tethered Swimming of Equal Duration. O-116
V Thanopoulos; *G Rozi; T Platanou* (*GREECE*)

15:30 Biophysical Analysis of the 200m Front Crawl Swimming: a Case Study O-117
P Figueiredo[1]; *A Sousa*[1]; *P Gonçalves*[1]; *P Suzana*[2] ; *S Susana*[1]; *JP Vilas-Boas*[1]; *RJ Fernandes*[1] [1](*PORTUGAL*); [2](*BRAZIL*)

Saturday, 19 June 2010
14:00 - 15:30 TURN/START II (Chair: B. Mason) Room: 107

14:00 Graphic Removal of Water Wave Impact in the Pool Wall during the Flip Turn O-118
S.M. Pereira[1]; *P. Gonçalves*[2]; *R.J. Fernandes*[2]; *L. Machado*[2]; *H. Roesler*[1]; *J.P. Vilas-Boas*[2]
[1](*BRAZIL*); [2](*PORTUGAL*)

14:15 A Study of Apnea Turn, A New Underwater Turning Method for Butterfly and Breast Stroke Races O-119
K. Taichi; *T. Tsuyoshi*; *T. Hideki*; *T Shozo* (*JAPAN*)

14:30 A Study About the Cognitive Interplay Between Sensory and Biomechanical Features While Executing Flip Turns Wearing Different Swim Suits O-120
S. Vieluf[1]; *B E Ungerechts*[1]; *H M Toussaint*[2]; *H Lex*[1]; *T Schack*[1]
[1](*GERMANY*); [2](*NETHERLANDS*)

14:45 Effect of Specific Training on Swimming Start's Performance O-121
B. De la Fuente; R. Arellano (*SPAIN*)

15:00 Relay Start Strategies in Elite Swimmers O-122
A Kibele; S Fischer (*GERMANY*)

15:15 Analysis of Swim Turning, Underwater Gliding and Stroke Resumption Phases in Top Division Swimmers using a Wearable Inertial Sensor Device O-123
G. Vannozzi; M Donati; *G Gatta*; *A Cappozzo* (*ITALY*)

Saturday, 19 June 2010
16:00 - 17:30 POOL SIDE DEMONSTRATION & RELAY RACE
(Chair: B.H. Olstad) Room: Swimming Pool

16:00 Applications of Wireless EMG Measurements in Water O-124
Ingi Þór Einarsson[1]; *J. Martens*[2]; *S.A. Arngrimsson*[1]; *J. Lambeck*[2]; *D. Daly*[2] [1](*ICELAND*); [2](*BELGIUM*)

16:00 User-Friendly Portable Poolside Video Analysis O-125
Rh Sanders, G. Machtsiras; G Scott (*UNITED KINGDOM*)

16:00 Self Testing of New Swimming Training Equipment

16:00 Torrent E-Rack Swim Training
DH Hector (USA).

16:00 Free Simulation Software "Swimsuit" to Learn and Research Biomechanics in Swimming P-029
M. Nakashima; H. Kiuchi; *S. Maeda*; *S. Kamiya*; *K. Nakajima*; *H. Takagi* (*JAPAN*)

Saturday, 19 June 2010
18:00 - 19:00 Closing Ceremony

1900-00:00 Banquet in NIH Gardens

Abstracts

KL-001

The Leon Lewille Memorial Lecture: Biomechanics and Medicine in Swimming, Past, Present and Future

Vilas-Boas, João Paulo
University of Porto, Faculdade Desporto, PORTUGAL

INTRODUCTION: The aim of this paper was to analyse the ten Biomechanics and Medicine in Swimming (BMS) books available, in order to characterize the past and the actual state of the art on Biomechanics and Medicine in Swimming research, and try to find support to speculate about the future trends of development. METHODS: The first ten books of the BMS series were analysed, characterizing their contents and authorship, and relating the output with the general body of knowledge in swimming science. The approach was tried in four steps: (i) number of papers published; (ii) affiliation of the first author; (iii) number of papers per category of analysis, and (iv) scientific content. The categories of analysis were defined based on Clarys (1996) Foreword to BMS VII. The analysis was performed considering the researcher's personal classification of each paper, considering, by order: (i) title; (ii) key-words; (iii) editorial classification, and (iv) content of the article. A total of 622 papers were analysed. To allow further analysis of the findings, and trying to characterize more globally the swimming science peer reviewed and indexed research tendencies, a PubMedTM search was conducted (15th January 2010). RESULTS: A progressive tendency for a growing number of papers was perceived, particularly in the last 3 volumes. In these books, an increased number of participant countries was also noted, but not proportional to the increased number of papers. A total of 41 countries entered in the BMS series as affiliation countries of the first authors. Japan and USA are the highest contributors. A tendency to the following hierarchy of the three prevalent research domains was observed: (i) Biomechanics; (ii) Physiology, and (iii) Evaluation. It is also possible to perceive a tendency for the preservation of this hierarchy along the BMS series (book to book analysis). From PubMedTM, a slightly different hierarchy of research domains was extracted. A tendency was noted for a higher importance of "Physiology" and "Medicine", and reduced expression of "Biomechanics", inclusively compared with "Training", for instance. DISCUSSION: In order to further explore the results obtained, a deeper critical analysis of the contents of each one of the ten BMS books was conducted. The perceived trends were used to allow foundations for some speculations about the expected future achievements on the domain of Biomechanics and Medicine in Swimming.

KL-002

Inter-Limb Coordination in Swimming

Seifert, Ludovic
Faculté des Sciences du Sport Université de Rouen, FRANCE

In this talk the inter-limb coordination in swimming is discussed with a view to informing coaches of the similarities and differences between the 4 strokes. The effect of skill level, speed and breathing are analysed for incremental tests and race. In the past it has been reported that the inter-limb coordination should show an opposition mode, i.e. a propulsive continuity between the propulsion of one limb and those of the other limb, in order to minimize the intra-cyclic velocity variations. However, the research of our centre of research highlighted the fact that the inter-limb coordination mode adopted by the swimmers corresponds to three types of constraint defined by Newell (1986): organismic, task and environmental constraint. The skill level of the swimmers, the specialty, the gender, the handedness and the breathing laterality act as organismic constraints; the imposed race pace, the stroke frequency, the breathing frequency and pattern could be consider as task constraints while the active drag and his correspondent velocity relate to the environmental constraints. Inter-limb coordination was found to vary from catch or glide coordination mode to superposition mode, showing that the opposition mode is only the best "theoretical" mode and the glide mode is not a technical mistake. Therefore it is advised for coaches to don't consider an ideal coordination mode in the absolute but to teach the swimmers in different ways when developing coordination. This talk presents new information based on recent scientific research conducted at the CETAPS. The variables of interest were: average swim speed, stroke length, stroke frequency, intra-cyclic velocity variations, breathing laterality, relative duration of arm and leg stroke phases, time gap between propulsive actions assessed by total time gap (TTG) in the simultaneous strokes and by index of coordination (IdC) in the alternate strokes. Interesting findings emerged that have implications for the both elite and sub-elite swimmers should be coached.

KL-003

Muscle Fatigue in Swimming

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INTRODUCTION: Fatigue is a complex phenomen defined as an acute impairment of performance. In swimming, few studies are done on biomechanical parameters of fatigue. A review on the effects of fatigue on muscle in swimming is presented. METHODS: Muscular activations were detected from surface or fine wires electrodes. Raw EMG's are full wave rectified, integrated (IEMG) and normalised to quantify the degree of muscle activation. The frequency process is based upon Fourier transform and time-frequency treatments. RESULTS: and DISCUSSION: IEMG decreased for the most sollicitated muscles (M. Deltoideus or M. Flexor carpi)(Wakayoshi et al, 1994) and increased for muscles with submaximal contractions (M int. or ext. rotators) (Monteil,1996). A shift of spectral parameters of the EMG's of the M. biceps and triceps brachii toward lower frequency was observed during maximal voluntary contractions (MVC) realised before and after an exhaustive test (Aujouannet et al, 2006) when a derive of the instantaneous mean frequency (MNF) was noted for the M. antagonist Flexor and Extensor carpi during the swimming test (Caty et al,2006). These changes were associated to decrease in force productions either for the maximal dry strength or to the maximal tethered force or to the maximal power (Rouard et al, 2006). More, the hand path changed with a greater duration of the catch phase, a shorter insweep (Aujouannet et al, 2006) and a decrease in hand velocity (Monteil, 1996). EMG methods allowed resolving individual strategies of swimming and adjustments caused by fatigue. Future investigations will be required to evaluate the load-sharing across muscles and/or to determine the central or peripheral components of the fatigue in swimming. REFERENCES: Aujouannet, Y. et al. (2006). Effects of a high intensity swim test on kinematic parameters in high-level athletes. Applied Physiology, Nutrition and Metabolism, 31, 150–158 Monteil,K.M.et al. (1996) Swimmers'shoulder: EMG of the rotators during a flume test. In: Biomechanics and Medicine in Swimming VII., 83-89.Rouard, A.H. et al. (2006). Isometric force, tethered force and power ratios as tools for the evaluation of technical ability in freestyleswimming. In Biomechanics and Medicine in Swimming X, 249-250. Wakayoshi K, et al. (1994) Electromyographyc evidence of selective muscle fatigue during competitive swimming. In: Medicine and Science in Aquatic Sports,vol 39:16-23.

KL-004

Biomechanical Services for Top Level Swimming Development, the Australian Institute of Sports Model

Mason, Bruce
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INTRODUCTION: The Australian Institute of Sport (A.I.S.) was established in 1981 as a consequence of Australia's poor performance at the

1976 Olympic Games. Swimming is Australia's premier Olympic sport as the national swim team wins more Olympic medals for Australia than any other sport. This paper will focus upon A.I.S. Biomechanical services for elite competitive swimming in Australia. DEVELOPMENT During the first 5 years of the A.I.S., only very basic qualitative servicing was provided for all sports. The next 5 years saw the development of more sport specific servicing, together with small research projects. Following the first 10 years of A.I.S. development saw more research aimed toward developing sports specific analysis systems in the biomechanics of swimming. Such systems as the large analysis system for competition meets were developed, the portable SWAN competition analysis system for individual swimmer analysis in meets and the SWAN start and turn analysis system for the training environment eventuated. In 2006 the Aquatics Testing, Training and Research Unit (A.T.T.R.U) was established along with a new 50m technology pool. With the new pool came the development of the Wetplate analysis system designed to analyse starts, turns and relay changeovers, and the active drag system. RESEARCH Because of the new Wetplate and Active drag analysis systems providing more quantitative information about performance, fundamental research could now be used to solve problems raised by the swim coaches. Research associated with Wetplate included projects linked with optimising the performance off the new kick plate starting blocks, optimising knee bend and extension in turns to generate maximum force off the wall and deciding the placement of the newly permitted dolphin kick in breaststroke starts and turns. Research associated with drag analysis included the generation of video associated with the propulsive force generated by the swimmer to identify stroke inefficiencies. A method has also been established to compute active drag over a range of swim velocities from passive drag values over set velocities and the active drag at the swimmer's maximum velocity. Computational fluid dynamics is also being researched as a possible way to investigated what would eventuate with instigating changes in technique before actually altering the swimmer's technique.

KL-005

Toward a Better Understanding on the Role of Unsteadiness in Swimming Propulsion by Means of PIV

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The highly efficient locomotion of birds, insects and fish is based on unsteady dynamics. The centered mechanism in the locomotion is related with unsteady behaviour of vortices such as the formation in boundary layers and the shedding from it. Attention to the relation between an object and vortex movement was first noticed in the aeronautical field. The problem of a thin airfoil performing small lateral oscillations in a uniform stream of incompressible fluid, received interest for many years, at the heart of all flutter prediction. Much research within the limitation of the linear perturbation theory was published in early times. Well-documented summaries, including Wagner's work (1925) can be seen in Bisplinghoff (1955). While much attention was given to the lift sustaining insect and bird flights against their weight, relatively little interest have been given to the unsteady mechanism in swimming propulsion. In Colwin's book (2002), we can find many detailed sketches of vortices generated in many stroke patterns. The only tool for analysing unsteady flow is the particle image velocimetry (shortly PIV). Even with the use of this sophisticated means, it is difficult to measure a whole flow field directly around human hand and foot. However, a great success was attained in the field of insect and fish locomotion. We mention about the principle of the PIV and its application to swimmers and then several flow fields generated by a motion such as a stroke of front crawl (Matsuuchi et al. 2009), mono-fin, and sculling motion of hand are visualized. Velocity and vorticity fields are especially important to understand the unsteady force generation. How unsteady flow is generated by the motion of hand and foot is discussed. Furthermore, direct measurement of unsteady force acting on a robot arm is made and is also compared with the unsteady properties of flow field obtained by PIV. REFERENCES: 1. Bisplinghoff R L, Ashley H, Halfman RL (1955). Aeroelasticity, Chap. 5, Addison-Wesley Pub. 2. Colwin CM (2002). Breakthrough Swimming, Chap.5, Human Kinetics. 3. Matsuuchi K, Miwa T, Nomura T, Sakakibara J, H. Shintani H, Ungerechts BE (2009). Unsteady flow field around a human hand and propulsive force in swimming, Journal of Biomechanics vol.42-1, pp.42-47.

KL-006

The Psycho-Physiology of Overtraining and Athlete Burnout in Swimming

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Understanding swimmers' response to training and competition continues to be a significant challenge. Although a great deal of research has previously attempted to better understand the psychological and physiological factors leading to maladaptive training responses in an elite swimmer population, very few attempted to integrate these two fundamental perspectives. Therefore, the aim of this study was to investigate the relationship between personal dispositions, contextual motivation factors, subjective performance satisfaction, hormonal variation and burnout in elite swimmers. 53 elite swimmers (F=21, M=32) participated in a protocol of 6x200m progressive intervals during morning (07.00-08.30) and afternoon (14.00-15.30) training sessions. Venous blood was drawn before and after each sets of intervals and was analyzed for adrenocorticotropic hormone (ACTH) and cortisol by radio immune assays. This protocol was used at three time points during the season, corresponding to the easy, very hard and peaking time periods of the swimming season. Questionnaires assessing psychological variables were used together with the two-bout exercise test at three time points during the season. Using hierarchical regression analysis, results indicated that variation in basal cortisol (15%), maladaptive perfectionism disposition (20%), perceived mastery motivational climate (12%) and subjective performance satisfaction explained together a total of 67% of the variance in athlete burnout at season's end. Hormonal monitoring is costly and invasive, current findings support the initial use of psychological monitoring, while hormonal monitoring may be used as a second step to help athletes steer away from maladaptive training outcomes such as athlete burnout

KL-007

Applying a Developmental Perspective to Aquatics and Swimming

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Most typically in the aquatic field instructors and coaches employ an "error correction model" to view all swimming behaviors. Using a "straw person" approach, clinicians expect all learners regardless of age or skill to swim like an elite adult swimmer. In this approach errors are corrected mainly when external experts such as teachers or coaches expunge those errors using command style direct teaching. In command teaching, a coach verbally describes and then demonstrates the expected "expert" way of swimming followed by identifying the "errors" the learner makes that deviate from the expert model. In contrast, a "developmental perspective" is defined as a view in which one expects and anticipates regular, ordered changes to occur in swimming behaviors across the entire lifespan. From a developmental perspective, changes in swimming behavior occur as a result of systemic interactions among individual, task, and environmental characteristics as proposed by Newell (1986). For example, this view expects that someone learning to swim on the

front gradually and systematically will change the arm, leg, and breathing patterns they use to move through the water because their body size or density changes, or the way they interact with the task is altered. In this paper I provide a conceptual overview that compares and contrasts the developmental and error correction approaches in swimming by drawing upon contemporary thinking in dynamical systems and motor development theory. In particular, I highlight the three essential clinical skills that aquatic clinicians need to possess when using "developmentally appropriate practices" (DAP) (i.e., developmental assessment, individualization of instruction, and developmental task analysis). For each DAP clinical skill, I provide practical illustrations for how these DAP skills apply to learning in aquatics and swimming. I argue that the predominance of the error correction model within swimming and aquatics has severely limited the field's acceptance and use of best instructional, learning, and assessment practices as well as unnecessarily constrained thinking about swimming skill acquisition in ways that acceptance of a developmental perspective would remedy.

KL-008

Training at Real and Simulated Altitude in Swimming: Too High Expectations?

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INTRODUCTION: Altitude/hypoxic training (AT) is a common practice among swimmers although scientific evidence is scarce and its benefits remain controversial. This paper aims to overview current methods of AT and to discuss the scientific evidence on the effects and potential benefits on sea level swimming performance. METHODS: A systematic review of peer-reviewed scientific literature on AT for the improvement of swimming performance at sea level was conducted and results critically evaluated. RESULTS AND DISCUSSION: There is no evidence that training at natural altitude enhances swimming performance more than training at sea level. Based on research conducted in other sports, AT would require at least 3 to 4 weeks at 2100 to 2500 m of altitude to elicit a robust acclimatization response (primarily red cell mass increase) in the majority of athletes. The optimal approach is likely to be LH-TL, in which one "lives high" (i.e. 2100-2500 m) to get the benefits of altitude acclimatization and "trains low" (1250 m or less) to avoid the detrimental effects of hypoxic exercise. In fact, training at hypoxia does not appear to provide any physiologic advantage over normoxic exercise and might even impair performance. Whether the performance benefits would be similar for swimmers compared to other endurance trained athletes is not known and requires further research. Swimming performance enhancement by means of intermittent exposure to hypoxia is still controversial. However, it is likely that at least 12 h/day at 2100–3000 m for 3 to 4 weeks may suffice to increase red cell mass. Shorter exposure to more severe hypoxia (e.g. 4000 to 5500 m, 3 h/day for 2 to 4 weeks) combined with sea-level training may enhance VO_2max, ventilatory threshold and middle-distance swimming performance after pre-competition tapering, although the mechanisms are unclear. In any case, there is substantial individual variability in the outcome of every AT strategy. Since none of these approaches has undoubtedly proven to enhance swimming performance, more research is warranted to clarify their effects and mechanisms. REFERENCES: 1. Truijens, M. J. & Rodríguez, F. A. (2010, in press). Altitude and hypoxic training in swimming. In: Seifert, L., Chollet, D. & Mujika, I., Swimming: Science and Performance. Hauppauge, New York: Nova Science Publishers. 2. Wilber, R. L. (2004). Altitude training and athletic performance. Champaign, Illinois: Human Kinetics.

KL-009

Swimming and Aquatic Exercise for Rehabilitation and Health

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The modern approach to rehabilitation is early mobilization and reconditioning. The patient who becomes inactive is predisposed to muscle disuse atrophy and soft-tissue weakness, decreased joint mobility and possible increases in pain. Because early intervention is so important, an excellent case can be made for choosing an aquatic environment to commence physical rehabilitation. The physical properties of water provide a unique environment for conducting strengthening and range-of-motion exercises. The focus of the invited presentation is to provide medical practitioners and allied professionals with an overview of the benefits of swimming and aquatic physical therapy as it applies to the treatment of a wide range of clinical conditions. Also included in the discussion will be the application of technology and related research tools, as used in the biomechanics of aquatic physical rehabilitation.

O-001

Wave Formation as a Possible Mechanism of Propulsion in the Freestyle Stroke

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INTRODUCTION: Computational Fluid Dynamics (CFD) allows simulation of complex fluid flow regimes and geometry to answer problems that physical testing techniques can not provide. One such area arising from CFD analyses is that wave formation effects might aid some propulsion phases of freestyle. METHODS: In a case study approach, one world class swimmer underwent a 3D body scan. A Finite Volume Method of CFD modelling was used incorporating a realisable K-epsilon turbulence model with a multi-phase fluid domain. The fully submerged streamlined simulation was compared with a static streamlined position just under the water surface and the wave created around the body was compared to properties obtained via Linear Wave Theory. Manual video digitising then provided the 3D kinematics of the swimmer's freestyle stroke to animate the model; and resultant forces throughout the freestyle stroke were compared to the wave properties and sub-surface water pressure along the swimmer's length. RESULTS: Critical points along the wave described in Linear (Airey) Wave Theory correlated well with resultant force changes via the CFD simulations of the static position when near the surface compared to at depth. A 122% drag increase was found around the upper body at the surface, with the lower body recording a 104% reduction in drag, leading to a propulsive force on these components. The freestyle wave location found by CFD calculations of sub-surface pressure seems to move with changes in swimmer length when moving arms from the front to the back of the body. This changing wave appears to create a short wave having a high relative acceleration component as when two waves join; and, in turn, create a short surge in the swimming direction at the same time as the peak net force occurs in the stroke. DISCUSSION: In the wave that surrounds a swimmer, acceleration and velocity of the water varies greatly and can influence the forces of the body components in those regions. The transient pressure wave at 0.3m underwater occurs at the same location and time as when the forearm and hand pass through during the upsweep and may have contributed to the peak force occurring later in the stroke. Clarification of this situation is needed to determine the exact cause of this scenario and how it may benefit swimmers. A high velocity with forearm and hand

perpendicular to the direction of flow to ensure maximum volume and added mass capacity at this point, may improve freestyle stroke efficiency.

O-002

Direct Measurement of Stroke Propulsion in Real Swimming by Means of a Non Invasive Gauge

Bottoni, AS.[1]; Lanotte, N[2]; Bifaretti, S[3]; Gatta, G[4]; Bonifazi, M[5]; Boatto, P[2]
[1]Italian Triathlon Federation, ITALY; [2]APLab, Rome, ITALY; [3]University of Rome Tor Vergata, ITALY; [4]University of Bologna, ITALY; [5]University of Siena,Italian Swimming Federation, ITALY

INTRODUCTION: Methods of direct measurement of the arm's propulsive force have several advantages compared with indirect methods, including the possibility of measuring the real action of the athlete, ease of use and lower costs. Limits of the methods using direct measurement used so far, arise however both in the measurement itself and in the validation process. In fact the gauges and supports currently in use, limit hand movements or even change its action, as well as reducing the active surface, thus interfering with the swimmer's technique. Furthermore, almost all these methods require a swimming flume or gauges connected to the poolside. The method here proposed overcomes most of these downsides. METHODS: Five competitive and four novice swimmers wear two mini-paddles (KZ by APLab), whose size and shape do not interfere with the hand's movement and sensibility in the water. The paddles measure the pressure field around the hands and store the data in an ECU contained in a little box, that the athletes wear. The box has neutral buoyancy and the whole system does not interfere with the action of the athletes, who can swim freely. The acquired data can be transmitted via a wireless connection. The validation method is based on the correlation between the pressure signal acquired by the paddles and an external measurement by a load cell of the thrust of the swimmer during zero-speed sculling. RESULTS: The maximum force and pressure measured is respectively 95,6+/-12,5N and 5,85+/- 0,65kPa. The data show excellent correspondence between maximum pressure signal at each sculling movement and propulsive force ($r=0,92+/- 0,03$, $p<0,05$). The pressure signal shows clearly the different unsteady components of thrust and the different intensity applied by the swimmer. The differences in swimming skills and water sensibility between top level and mediocre swimmers are more than apparent. DISCUSSION: This new measurement tool opens the way to a number of possible research projects. Extensive screening on a large group of high level swimmers has revealed important results concerning swimming technique in different styles, differences between top level and mediocre swimmers, effects of fatigue in technique and attitude towards sprint or long distance competitions. The paddles are therefore a effective, low cost tool for evaluating the effects of training, the efficiency of technique and the amount of muscular strength applied in the stroke.

O-003

The Effect of Angle of Attack and Depth on Passive Drag

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INTRODUCTION: In order to expand on earlier findings (Vennell, Pease, & Wilson, 2006) the current study was undertaken to examine the interaction between angle of attack, submergence depth and drag force. METHODS: This was achieved by utilising a flume and an anatomically accurate mannequin whose orientation could be precisely controlled. Data were obtained with the mannequin oriented with the longitudinal axis at angles of attack of -4, -2, 0, +2 and +4 degrees relative to water flow. Measurements were taken at depths ranging from 0.2 – 0.8m and at velocities ranging from 0-2.55ms^{-1}. RESULTS: The most significant finding from this study was the difference between a negative and positive angle of attack near the water surface. As an example, the total drag force, at 0.2m depth for angles of attack of -4 and +4 degrees at a flow velocity of 2.36ms^{-1} were 72.90N ± 1.26N and 104.16N ± 1.68N respectively while at 0.8m depth the total drag forces were 60.56N ± 1.5N and 63.45N ± 0.64N respectively. Despite the approximate equivalence of the frontal area in the respective positive and negative angles of attack (0.1280 and .1282m^2 respectively), the negative angle demonstrated a lower total drag force which appears to be due largely to a decrease in the wave drag contribution (25% and 55% of total drag respectively) near the surface. As with the earlier study, the depth at which the mannequin was suspended also had a great affect on the measured drag forces with very little difference between corresponding angles at greater depths. DISCUSSION: These results highlight the importance of body position near the water surface. It also demonstrates that, due to the decreased drag with a negative angle of attack, if an athlete chooses to utilise a shallow glide depth following a start or turn then it is advantageous to maintain a slightly negative angle of attack for as long as possible before surfacing. Therefore, while it may be beneficial for the athlete to begin the underwater trajectory in a negative angle of attack, they must try and get to the surface as quickly as possible in order to limit the effects of the positive angle attack necessary to achieve surfacing. REFERENCES: Vennell, R., Pease, D. L., & Wilson, B. D. (2006). Wave drag on human swimmers. Journal of Biomechanics, 39(4), 664-671.

O-004

Measuring Active Drag within the Different Phases of Front Crawl Swimming

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INTRODUCTION: An elite swimmer's success is primarily dependent upon their ability to minimise active drag, whilst optimising propulsive force. The aim of this study was to quantify passive and active drag, as a force-time profile. The secondary aim was to examine the force-time profile to determine which part of the stroke phase an athlete produced min and max force, and provide feedback to coaches and athletes. METHODS: Elite freestylers (n=18) completed 3 max swim velocity trials, followed by 3 passive and active drag trials using a towing device mounted upon a force platform. The computed active drag and the propulsive force profiles were represented as a force-time graph synchronised with video footage, allowing identification of intra-cyclic force fluctuations. RESULTS: The mean velocity for the females and males were 1.72 m.s-1, 1.89 m.s-1 respectively. The mean passive drag for the females and males were 49.7 ± 1.8 N, 78.9 ± 1.6 N, respectively and the mean active drag for the females and males were 164.4 ± 11.7 N, 228.4 ± 10.8 N, respectively. DISCUSSION: The mean passive drag values measured are comparable to those previously reported. Kolmogorov and Duplishcheva (1992) observed male and female passive drag ranging from 69.7 – 103.0 N and 44.2 - 56.9 N, respectively at velocities 1.73 - 1.91 m.s-1 and 1.52 - 1.67 m.s-1, respectively. Active drag did not concur with the literature. Toussaint et al. (2004) compared the values collected with MAD and VPM systems. The values at a mean velocity of 1.64 m.s-1 were 66.9 N and 53.2 N, respectively. There was significant variation between min and max propulsive force range for left and right stroke phases, between and within participants. It was evident that mean min propulsive force was generated during the first 'pull' phase of the stroke cycle. The results indicated that the max propulsive force production occurred during the final 'push' phases of the stroke cycle. This study demonstrated the importance of representing active drag as

instantaneous force, rather than a mean value. This provided unique and valuable insight into the intra-cyclic force fluctuations within a stroke cycle. REFERENCES: 1. Kolmogorov SV, Duplishcheva OA. (1992). Active drag, Useful Mechanical Power Output and Hydrodynamic Force Coefficient in Different Swimming Strokes at Max Velocity. J Biomech, 25 (3):311-318. 2. Toussaint HM, Roos PE, Kolmogorov S. (2004). The determination of drag in front crawl swimming. J Biomech, 37(11): 1655-1663.

O-005

Prediction of Propulsive Force Exerted by the Hand in Swimming

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INTRODUCTION: A method was developed to predict hydrodynamic forces acting on the hand in swimming (H) based on the pressure distribution of the hand (Kudo et al., 2008). However, a method to predict propulsive forces exerted by the hand using the pressure method during swimming has not been developed. Thus, the aim of this study is to develop a method to predict propulsive forces exerted by the hand using the pressure method during swimming. METHODS: A portable data logger with 12 pressure sensors was developed to measure pressures and synchronized with an underwater motion capture system. A subject was asked to swim the front crawl stroke in a sub-maximal effort for 18 m. Different sets of best-fit equations including the best-fit equation from the previous study (B-Eq1) and the first order of best-fit equations (B-Eq2) were used to predict H to see if there is a considerable effect of multicollinearity on the prediction. Propulsions exerted by the swimmer's hand were computed using H predicted and kinematic data from the camera. RESULTS: Mean propulsive forces exerted by the hand predicted by B-Eq1 over a stroke was 15 ± 11 N. Mean propulsive forces exerted by the hand predicted by B-Eq2 over a stroke was 33 ± 24 N. The contribution of drag and lift forces to the propulsive force predicted by B-Eq2 was 55% and 45%, respectively. Mean hand speed over a stroke was 2.3 ± 0.3 ms-1. The angle of attack (AP) changed from 24º to 85º. The sweepback angle (SB) changed from 73º to 254º over a stroke. DISCUSSION: A method to predict propulsive forces by the hand in swimming was developed. Feedback of the predicted propulsive forces by the hand can be provided to the swimmer and coach within a few hours by combining the pressure method with kinematic data from the motion capture system. Additionally, the contribution of drag and lift forces to the propulsion by the hand can be provided. The prediction of H by the best-fit equation in the previous study (B-Eq1) may experience error due to multicollinearity. The erroneous effect on the prediction of H can be detected using the information on the magnitude of H, kinematics of hand, as well as AP and SB, and be minimized by choosing the first order of the polynomial best-fit equations. REFERENCES: 1. Kudo, S., Yanai, T., Wilson, B., Takagi, H., & Vennell, R. (2008). Prediction of fluid forces acting on a hand model in unsteady flow conditions. Journal of Biomechanics, 41, 1131-1136.

O-006

A Method to Estimate Active Drag over a Range of Swimming Velocities which may be used to Evaluate the Stroke Mechanics of the Swimmer

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INTRODUCTION: The high relationship between active and passive drag justified the following procedures. The aim was to develop a method to estimate the active drag of the swimmer over a range of swim velocities. The method developed relied upon having mean passive drag measures of the swimmer at various velocities, as well as the mean active drag value for the swimmer at their maximum swim velocity. METHODS: Eleven Australian team swimmers in freestyle participated in the study. The subjects completed three maximum swim velocity trials over a 10 m interval, to determine each subject's maximum swim velocity. Three passive drag tests were performed at the swimmer's maximum velocity. A series of passive drag trials was then completed over a range of 10 different tow velocities between 2.2 and 1.0 m.s -1. Finally, five active drag trials were completed at a five percent greater velocity than the swimmer's maximum swimming velocity. These were used to compute the active drag at the swimmer's maximum velocity. RESULTS: The exponential function as indicated was used to define the passive drag equation. where and are constants for a particular swimmer. The same equation was used to define active drag but here the constant was greater. DISCUSSION: In the active and passive drag equations, the value of the drag force was represented as an exponential function of swimming velocity. The rate of rise in the active and passive drag equations was represented by two separate constants. These constants may be used as indices to describe the individual swimmer's capabilities. The constant in the equation for passive drag would represent an index of the swimmer's innate physical characteristics such as size, shape and cross sectional frontal surface area. The lower the index, indicated a more efficient body shape for aquatics movement. The difference between the constant used in the active drag equation and that in the passive drag equation could be used as an index to represent the efficiency of the swimmer's technique. These two indices may provide insight as to the capability of the swimmer to compete at various distance events. CONCLUSION: The present study demonstrated the importance of being able to generate an equation to represent a swimmer's active drag over a range of velocities. This concept will provide insight as to the suitability of the individual to specific distance events, as well as, indicate the efficiency of the swimmer's technique.

O-007

Critical Velocity and the Velocity at Maximal Lactate Steady State in Swimming

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INTRODUCTION: The number of studies directly determining velocity at the maximal lactate steady state (MLSSv) in swimming is quite limited and its correspondence to critical velocity (CV), implied by well accepted physiological models, has not been proven, contrarily to what has been found for other types of human locomotion. The purpose of this study was to compare CV to the MLSSv in swimming. METHODS: Eighteen male national and international level competitive swimmers performed a maximal 400 m front crawl in order to estimate maximal aerobic velocity (V400). CV was calculated from the slope of the regression analysis between the averaged velocity of the 400 m trial and a 200 m front crawl maximal trial performed for this purpose. All swimmers completed, in random order and in different days, 30-min swims at constant intensity (85, 90 and 85% of V400) for the determination of MLSSv and also of stroke parameters and rate of perceived exertion at MLSS. RESULTS: MLSSv corresponded to 89.7±1.2% and CV to 94.0±1.5% of V400. Only one swimmer achieved MLSS at 85% of V400. Extreme values of 2.6 and 7.8 mmol.L-1 were found associated to MLSSv. CV was significantly faster than MLSSv ($p<0.01$) and both expressed velocities significantly different from V400 ($p<0.01$). MLSSv and CV were highly correlated ($r=0.94$; $p<0.01$). Both were associated with V400 ($r=0.97$, $p<0.01$ and $r=0.95$, $p<0.01$, respectively). Linear regression of MLSSv on CV (MLSSv=0.78 CV + 0.25; SSE=0.02 m.s-1) revealed that the latter can be predicted with reasonable accuracy from the 200 m / 400 m swim trials CV. Stroke cycle parameters were unrelated to performance, MLSSv

or CV. DISCUSSION: MLSS can be achieved using two to three 30-min constant velocity swims. Our results confirm the finding of previous studies that CV overestimates MLSSv in swimmers showing that this parameter does not represent a steady metabolic rate in long distance swimming. Therefore, it appears that CV in swimmers does not demarcate the transition from heavy to severe exercise and may not provide a direct noninvasive measure of MLSSv. However, our data also indicates that MLSSv could be estimated from CV with enough accuracy to be used in training exercises prescription. This has important practical implications, since CV still seems to be a useful tool for aerobic conditioning evaluation, due to the simplicity of its determination.

O-008

Factors Affecting Blood Lactate Accumulation and Clearance in Elite Competitive Swimmers During Competition

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Blood lactate accumulation [BLa] occurs during competitive swimming events and may be influenced by demographic features as well as the characteristics of the swim race. Active recovery after high intensity exercise enhances blood lactate removal, which is beneficial for sports like swimming where multiple events are commonly performed on a single day. The objectives of this field-based observational study were 1) to examine how sex, age, race distance, and swim stroke influenced [BLa] after competitive swimming events and 2) to develop a practical model based on recovery swim distance to help optimize blood lactate disappearance. One hundred swimmers (n=50 males and females) competing in the Canadian National Swim Championships participated in this study. Post-race [BLa] was determined after completing the finals race. Blood lactate concentration was also assessed repeatedly during the warm-down. Generalized estimating equations were used to evaluate the relationship between post-race [BLa] with age and sex of the swimmers as well as the swim stroke and race distance. To evaluate the influence of warm-down distance on blood lactate disappearance an exploratory model building approach was used. The highest post-race [BLa] were observed following 100 and 200 metre events, the lowest after 50 and 1500 metre races. A sex effect for post-race [BLa] was observed for freestyle events, but not for any other swim strokes. There was a negligible effect of age on post-race [BLa]. The following model was developed to estimate an expected change in [BLa] during warm-down: [BLa] change after warm-down = -3.374+1.162(male=0; female=1)+0.789*post-race [BLa]+0.003*warm-down distance. These findings indicate that elite male and female swimmers competing at an elite level (approximately 900 FINA points) display similar post-race [BLa] and that there is little effect of age on post-race [BLa] in competitive swimmers 14-29 years old. Additionally, 50 metre events, regardless of swim stroke, appear to place less emphasis on anaerobic glycolysis compared to 100-400 metre events. Finally, a convenient equation was developed that can help coaches individualize warm-down protocols.

O-009

Maximum Blood Lactate Concentration after Two Different Specific Tests in Freestyle Swimming

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INTRODUCTION: Lactic acid constitutes a useful tool for the determination of anaerobic capacity for researchers and trainers. The highest lactate levels have been recorded following the swimming distances of 100 and 200 meters (Avlonitou 1996). The rate of lactic acid production in muscle fibres depends on swimming speed, rate of oxygen consumption and type of muscle fiber (Maglischo 2003). There is no much information for the comparison of different maximum events in order to determine the most adequate training method for maximal accumulation and tolerance of lactic acid. METHODS: In this study participated 8 swimmers (4 males and 4 female). The following variables were examined: Age (in years), Body Stature (BS in cm) , Body Mass (BM in kg), At the beginning, they swam 2x100 meters freestyle with maximum intensity and 10 sec stop. Afterwards, in two days time the same athletes were tested in 4x50m and 10 sec stop. Time performance and blood lactate accumulation were measured in both tests. In order to determine maximum concentration of lactic acid, samples of blood were taken in 3rd, 5th and 7th minute of recovery time and analysed using the the Lactate Scout. RESULTS: The average time performance of swimmers in 2x100 meters freestyle was 120,79±5,67sec and 146,32±5,26sec while in 4x50m was 120,43±5,96sec and 139,64±5,44sec in male and female respectively. Maximum accumulation of lactic acid in 2x100 meters free-style was 11,3±2,6 and 10,3±2,1 mmol/l, in relation to the test of 4x50 that was 12,1±2,3 and 12,5±3,9 mmol/l in male and female respectively. Significant correlation was found between the two tests only in female ($r=0.871$; $p<0.05$). DISCUSSION: The main finding of the present study was that the blood lactate values measured in 3rd, 5th and 7th min post-exercise demonstrated significantly greater correlation between the two tests in female in 4x50m. From this occurs a definition of a test for the swimmers at 4x50m free-style, which will be further used to improve the technology of swimmers' sport training (Avlonitou 1996). The results obtained showed that the tested female swimmers swam at 4x50m more efficiently than their male counterparts. REFERENCES: 1. Ávlonitou, Å. (1996). Maximal lactate values following competitive performance varying according to age, sex and swimming style. Journal of Sports Medicine and Physical Fitness, 36, 24-30. 2. Maglischo, E. W. (2003). Swimming Fastest. Cham-paign IL: Human Kinetics.

O-010

Does the y-Intercept of a Regression Line in The Critical Velocity Concept Represent the Index for Evaluating Anaerobic Capacity?

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INTRODUCTION: A linear relationship between swimming distances (D) and their sustained times (T) is observed. In this concept, Wakayoshi et al.(1992) suggested that the slope of the linear regression line was referred to as a critical velocity (CV), and CV could be used as an index of the aerobic capacity. The purpose of the present study was to investigate whether the y-intercept of a regression line between D and T could be utilized as an index for evaluating anaerobic capacity in competitive swimming. METHODS: 21 well-trained college swimmers participated in this study. They performed the maximum effort swim at 50-m, 100-m, 200-m and 400-m for taking the regression line and the highest blood lactate concentration (highest LA), 300-m intermittent progressive swim for velocity at OBLA (V@OBLA), and 30-s all-out Wingate Anaerobic Test (WAnT) with arms and legs. RESULTS: Mean ± SD of CV and the y-intercept were 1.42 ± 0.09 m/s and 15.54 ± 2.92 m, respectively. A highly significant correlation was found between CV and V@OBLA ($r = 0.94$, $p < 0.05$). The y-intercept was a significant related to the highest LA ($r = 0.63$, $p < 0.05$) and the mean power of 30-s all-out WAnT with arms ($r = 0.51$, $p < 0.05$) and legs ($r = 0.54$, $p < 0.05$), respectively. DISCUSSION: It has been suggested that the highest LA (Lacour 1990) and mean power during 30-s all-out WAnT with arms and legs (Hawley 1992) are an effective index for evaluating anaerobic capacity. In the present study, the y-intercept was a significant association with the highest LA and the mean power

of 30-s all-out WAnT with both arms and legs. These results suggested that the y-intercept was a valuable index for evaluating anaerobic capacity in competitive swimming. Moreover, measuring the slope and y-intercept of a regression line in the critical swimming velocity concept could evaluate both aerobic and anaerobic capacities at once without using invasive method or expensive equipments. REFERENCES: : 1. Hawley J A et al. (1992) Muscle power predicts freestyle swimming performance. Br J Sports Med. 26:151-5. 2. Lacour J R et al. (1990) Post-competition blood lactate concentrations as indicators of anaerobic energy expenditure during 400-m and 800-m races. Eur J Appl Physiol Occup Physiol. 61:172-6. 3. Wakayoshi K et al. (1992) Determination and validity of critical velocity as an index of swimming performance in the competitive swimmer. Eur J Appl Physiol Occup Physiol. 64:153-7

O-011

Critical Swimming Speed Obtained by the 200-400 Meters Model in Young Swimmers

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Critical swimming speed obtained by the 200-400 meters model in young swimmers. Zacca, R.1, Castro, F.A.S.1 1- Universidade Federal do Rio Grande do Sul (UFRGS), Brasil. INTRODUCTION: The critical swimming speed (CSS) method has been proposed for predicting swimming training velocity because it is simple and can be applied for simultaneous swimmers. Moreover, there are few studies with focus on the comparison between the CSS obtained by the 200-400 meters model (CSS_{10}) and different models to predict the CSS in young swimmers. The primary aim of the present study was to compare CSS_{10} and additional 14 models of distances between 50 m and 1500 m in young swimmers. The secondary aim was to compare CSS_{10} and the 1500 m velocity (V_{1500}). METHODS: 11 young swimmers of national competitive level (Age: 14.4 ± 0.5 years old; Body Mass: 60.6 ± 7 kg; Height: 175.50 ± 5.2 cm; Arm Span: 182.18 ± 4.96 cm; Competitive experience: 5 ± 0.9 years old) have joined the study. Maximal free-style swimming trials were conducted for the distances of 50, 100, 200, 400, 800 and 1500 meters. The CSS was computed for all the possible combinations of two distances to compose the linear regression equation between distance and time values (two parameter model). The t-test for pared sample was used for the comparison between CSS_{10} vs all others 14 CSS models and between CSS_{10} vs V_{1500}. The level of agreement between CSS_{10} and the additional 14 models and V_{1500} has been identified using Bland and Altman analysis. RESULTS: CSS_1 (50-100 m) was the model that most overestimated CSS_{10}. The lowest error on the estimative of CSS was observed for the CSS_3 (50-400 m) (-0.5%) and CSS_7 (100-400 m) (0.8%). CSS_{10} overestimated V_{1500} in 3.5%. DISCUSSION: The main finding of this study showed that the relationship between CSS_{10} and other types of CSS changes a lot according to the combination of distances used. In addition, these differences are likely to suffer changes during the years of development and need to be used with caution. CSS_1 (50-100 m) was the model that most overestimated CSS_{10}. The lowest error on the estimative of CSS_{10} was observed for the CSS_3 (-0.5%) and CSS_7 (0.8%). CSS_{10} overestimated V_{1500} in 3.5%. REFERENCES: 01. Dipla K, Tsirini T, Zafeiridis A, Manou V, Dalamitros A, Kellis E, Kellis S. (2009) Fatigue resistence during high-intensity intermittent exercise from childhood to adulthood in males and females. Eur J Appl Physiol 106:645-653

O-012

Extending the Critical Force Model to Approach Critical Power in Tethered Swimming, and it Relationship to the Indices at Maximal Lactate Steady-State

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INTRODUCTION: Critical force (Fcrit) was defined as the tether force at full-tethered conditions that could be maintained without fatigue (Ikuta *et al*, 1996). The purposes were to access tether-power from critical force model (CP_{Teth}), and to compare CP_{Teth} and power at maximal lactate steady state ($P_{TethMLSS}$), critical velocity (CV) and velocity at MLSS (v_{MLSS}). METHODS: Ten male swimmers (16.6±1.4 years, 69.8±9.5kg, 175.8±4.6cm) were submitted to the measurements of the CP_{Teth} (plotting impulse against time by linear and non-linear two parameters equation), CV (linear adjustment between time and velocity performance in the 200, 400 and 800-m), $P_{TethMLSS}$ (3 or 4 trials ranging from 95 to 105% of non-linear Fcrit), and vMLSS (3 or 4 trials ranging 85-95% of the 400-m crawl performance). A range of 75-100% of the active drag force (Fr) was applied to manager load in the full-tethered swimming conditions. Fr was evaluated according Toussaint *et al.* (1998). The MLSS was considered the greatest fractions that did not elicit a lactate accumulation above 1mmol/L between 10th and 30th minutes. The measure of CP_{Teth} and $P_{TethMLSS}$ was approached to the tether force equation times hydrofoil velocity. Pearson¡¯s coefficient did correlate the variables, and the difference between two means was checked by paired t-test. Significance was set at $p \leq 0.05$. RESULTS: The slope of tether-force vs. time adjustments given a mean value (5.63±0.80kg) closed to that (6.87±1.02kg) reported to Ikuta *et al.* (1996). But, neither CV (1,195±0,116m.s^{-1}) nor the CP_{Teth} (98.49±21.63W) or Fcrit (55.14±7.82N) matches the statements for MLSS, once differences were observed to the v_{MLSS} (1.174±0.109m.s^{-1}), $P_{TethMLSS}$ (89.21±15.11W) and force (51.74±5.63N) at MLSS, respectively. A strong positive relationship was observed between all endurance variables. DISCUSSION: The steady-load/time to exhaustion model in tethered swimming provided a reliable way to estimate CPTeth, and thus modelling critical power. Despite the good relationship between all variables, the interchangeable use of them seems unreliable. REFERENCES: 1. Ikuta Y; Wakayoshi K; Nomura T. (1996) Determinations and validity of critical swimming force as performance index in tethered swimming. (146-151). Biomech Med Swim VII. E & FN SPON, London. 2. Toussaint HM; Wakayoshi K; Hollander AP; Ogita F. (1998) Simulated front crawl swimming performance related to critical speed and critical power. Med Sci Sports Exerc 30(1): 144-151.

O-013

Swimming, Cycling, Running and Cardiovascular Health

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INTRODUCTION: Cardiovascular diseases (CVD) are also reported to be the leading cause of death in the eastern Mediterranean region in clouding the Iran. A number of epidemiological studies have proved the benefits of regular physical activity for the prevention of CHD. Exercise recommendations for health can be obtain from extrapolation between different modes of exercise. METHODS: Subjects: Forty non-athlete youth men with overweight participated to this study. A pre-participatory exercise screening questionnaire [Physical Activity Readiness questionnaire (PARQ)] was administered. Body weight (BW), Body Mass Index (BMI) measured. Five ml of venous blood were collected for pre

and post-test. Subjects divided into four groups randomly; that included ten persons. For three groups assigned training regimens (swimming, running, and cycling), and completed exercise training program. Ten subjects served as controls. Training programs: swimming (crawl), cycling (ergometer) and running three times in week (t/wk) consecutively for 16 weeks. Main effects of training modality and time (pre and post-exercise), were assessed using One-Way Analysis of Variance. Statistical significance was conferred at p≤0.05 . Tukey test was used for post hoc comparisons, when main effects were detected. RESULTS: After 16 week of swimming, cycling and running exercise there were differences between experimental groups and control for TC, TG and HDL-c but in comparison with control group there were no differences for LDL-c. DISCUSSION: In this study after aerobic training, HDL-c increased and LDL-c decreased; so TC and TG decreased. Our findings suggest that moderate training performed over many weeks induces positive changes in the plasma lipid and lipoproteins concentration in youth. But there were different between the three groups. Swimming, running and cycling are best type of exercise for health, although this study have a suggest that observance this arrangement is beter; first:swimming, second:running and third:cycling REFRENCES 1. Henry Zheng, Nicola Orsini, Janaki Amin, Alicja Wolk, Van Thi Thuy Nguyen and Fred Ehrlich (2009) Quantifying the dose-response of walking in reducing coronary heart disease risk: meta-analysis. European journal of Epidemiology 24(4): 181-192 2. M Hamer, Y Chida (2008).Walking and primary prevention: a meta-analysis of prospective cohort studies, Br J Sports Med; 42: 238-243

O-014

Comparison of Respiratory Function to Swim Training in Paraplegic vs Amputee Swimmers

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INTRODUCTION: Athletes with special needs represent a growing population of sports participants. Subjects with paraplegia and amputation don't use their legs in their daily lives which may affect respiratory function and other internal organs of the body. Purpose : Determining and comparing respiratory function after long-term swim training(LTST),24 weeks,6 times per week,120 min per unit in male wheelchair swimmers(amputee vs. paraplegic) . METHODS: Seven below – knee amputee swimmers, aged (18.3 ± 0.88 yr), Ht (168.1 ± 1.67 cm) Wt (68.2 ± 3.7 kg). Compared with seven paraplegic swimmers, aged (18.6 ± 0.92 yr), Ht (167 ± 2.16 cm), Wt (68 ± 4.58 kg). All subjects group under went anthropometric and lung function using spirometric test pre and post long-term swim training (24 weeks). Subjects were matched for age, weight, lung function test. RESULTS: There were significant differences for the respiratory function parameters after swim training for the two groups related (LTST). Swimmers with amputation(group A) reached greater improvement in pulmonary function compared with paraplegia(group P).group(A) increased (VC.L) by 39.9% vs. group(P) 25.4%,FVC.L increased by group(A)46.2% vs. group(P)43.4%.FEV1.L increased 33% by group (A) vs.25% group(P). IRV,ERV,IC,TLC,PEF increased by group(A):23.7%,12.3%,16.2%5.04%,48.85 respectively vs. group(P)10.5%,2.9%,3.5%,2.7%,31.3% respectively. CONCLUSIONS: Swimming training is an effective and suitable sport to enhance physical performance and to induce positive respiratory function adaptation for wheelchair swimmers. Further research is needed to define the capacities of readapting of the different cardio respiratory function as well as the best training methods to the optimization of physical capacities and cardiovascular responses for wheelchair athletes. Key Words: paraplegia,amputee,lung function test:FVC(forced vital capacity,(FEV1)forced expiratory volume in one second,(MVV) max voluntary ventilation,(PEF)peak expiratory flow,(TLC)total lung capacity,(IRV,ERV,IC)inspiratory,expiratory volume,inspiratory capacity. REFERENCES: .Abouzeid Magdy (2008) .Myocardial responses to intensive swim training in wheelchair athletes. The 2008 International Convention on Science, Education and Medicine in Sport (2008 ICSEMIS), Guangzhou, China

O-015

The Comparison of the Effects of Corrective Exercise on Land and in Water on Some Selected Parameters Related to Kyphosis in Kyphotic Girls

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The aim of this study was to compare the effects of a 6-week corrective exercise program on land and in water on the some selected parameters related to Kyphosis in kyphotic girls. After sampling and diagnosing, 20 kyphotic girls at the Azad University (23, 2 +/- 4, 79 years old), were selected. Participants were randomized into one of two groups: hydrotherapy (n=10) and an exercise on land (n=10). All subjects participated in 18 sessions, three times a week and each time for nearly half an hour program. The dependant variables were: back muscles power, spine flexibility, chest expansion, shoulder abduction movement extension. The outcome measures included a back dynamometer for back muscles power, a goniometer (West test) for shoulder abduction movement extension, and the strip meter for spine flexibility (Modified SCHOBER Method) and for chest expansion. Independent t-test was performed to compare the mean of dependent variables between two groups (á=0/05). The result showed that there was a significant difference between groups for the back muscles power (p<0 /05) and shoulder abduction movement (p<0 /05). Whereas, no significant difference for the spine flexibility (p<0 /05) and the chest expansion (p<0 /05) was observed. . In conclusion, the exercise in water affected more on the back muscles power and shoulder abduction movement than on land.

O-016

Analysis Of The Aerobic/Anaerobic Performance In Functional Disabled Swimmers: Low Classes Vs High Classes

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Our main target has been to analyze if there are differences in the lactate accumulation (LA) in with and without disability swimmers. The sample was 38 swimmers, 10 dis-abled swimmers (DS) from class 1 to 5 (G1), 9 DS from class 6 to 10 (G2) and 10 swimmers without disability (G3). The swimmers performed two series: one anaerobic and the other one aerobic-anaerobic. A mixed model 3 (groups) x 2 (series) ANOVA was performed. The results show an effect of groups (F2,26=7,88, p=0,002) and of the series (F1,26=31,4, p<0,001) on the blood lactate levels. The values (mmol/LA) were for G1 7,39±0,8 and 9,52±0,81, G2 9,78±0,45 and 11,93±0,63 and G3 10,55±0,47 and 11,17±0,43. To conclude, the swimmers of the lower classes have a lower LA accumu-lation than the swimmers from higher classes and the swimmers without any disability.

O-017

The Effect of Tethered Swimming Speed on External Power Output of Well-Trained Disabled Swimmers

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INTRODUCTION:Measuring propulsive force (Fp) and external power output (Pext) during swimming is exceptionally difficult due to the continual displacement of water. Tethered swimming is a highly reliable method of measuring Fp and presents a strong relationship with swimming performance. Due to advances in technology, tethered swimming can be adapted so that tether force is recorded as the swimmer progresses down the pool, allowing for the further calculation of power. The aim of the study was to examine the effect of tether speed on Pext and to identify the speed at which swimmers with a disability produce their peak power output (PPext). METHODS: Eight male and thirteen female swimmers with an IPC physical impairment classification ranging from S5 to S10, participated in the study. External power output was measured using a semi-tethered device which restricted the swimmer to a pre-set constant speed, whilst simultaneously measuring the tether force produced. Swimmers performed six maximal effort, short duration (<10 s) front crawl swims at tether speeds ranging from 30 – 80% of their maximal swimming speed (SSmax). RESULTS: As tether speed increased, the tether force decreased. External power output (mean tether force × tether speed) increased to a maximum (PPext) at either 50% or 60% of SSmax, after which power then decreased. A significant correlation was found between PPext and SSmax ($r = 0.85$; $p<0.01$). The less physically impaired swimmers (S8-S10) produced higher power scores (48.6 ± 24.0 W) than the more physically impaired S5-S7 swimmers (31.4 ± 13.3 W). The highest and lowest PPext scores were 19.0 W and 96.9 W, respectively. There was a significant relationship between IPC classification and PPext in both the male ($r = 0.89$; $p<0.01$) and female($r = 0.75$; $p<0.01$) groups. DISCUSSION: As the external power Pext is the product of the tether force and the speed of the swimmer, it does not account for the power required to overcome drag or the power loss to the water. Nevertheless, an improvement in Pext, at any given test speed, indicates that a swimmer has increased their propulsive force production or decreased their drag. The six-speed test identifies the PPext for each individual swimmer and appears to discriminate between impairment classes. It is believed that this test may be a useful tool for monitoring power development in swimmers and may also have future applications in the IPC classification process.

O-018

Can Aquatic Exercise Improve Function in Elderly Persons with and without Chronic Disability? : A Systematic Review

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INTRODUCTION: Exercise has proven to be beneficial for elderly and water seems to be an appropriate environment for these persons to exercise, nevertheless no recent review has concentrated on this population and the evidence remains unclear. The purpose was therefore to evaluate the effect of aquatic exercise on function in elderly with and without chronic diseases. METHODS: PUBMED, PEDRO, CINAHL, Sports Discus and the Cochrane controlled trials register were searched for relevant trials from 1980 to 2007. Studies: randomised controlled trials. Population: mean age 55 yrs or older, independent in ADL-and with or without chronic disability. Interventions: active aquatic therapy (exercise). Outcomes: Cardiovascular fitness, flexibility, balance, strength and body composition. Methodological quality was assessed with the Delphi List. RESULTS: After initial search and title check 114 articles were deemed potentially relevant. Abstracts were reviewed and 84 articles were excluded as not being RCTs, intervention not active, mean age lower than 55 yrs or including persons younger than 40 yrs. After reading the full text 12 more articles were excluded for other reasons. The Delphi Scores ranged from 3 to 7 and was considered medium for 6 studies (score 5 and 6) and high for 2 studies (score 7). In all studies, participants were randomly allocated and similar at baseline for demographic characteristics. Eligibility criteria were always specified and point estimates and measures of variability were presented as M and SE, or M and SD. Care provider was never blinded and patient blinding occurred in 2 trials. The samples used ranged from 12 to 139 persons (M = 106.5) and mean age ranged from 58 to 78 years. The intervention period ranged from 4 to 24 weeks with 1 to 3 sessions a week (total minutes of treatment 240 min to 4320 min, Mean = 1460 min). Water level ranged from waist to chest level (axillary region). Water temperature was between 26° and 30° C. DISCUSSION: The evidence indicated beneficial effects of aquatic exercise on function in elderly. Consistently significant evidence was found for improvement in cardiovascular fitness (12% - 22%) and significant but less consistent evidence was found for improvements in flexibility (+-11%), balance, strength (5% - 30%) and body composition (3.4% increase in lean body mass and 8% decrease in skin-fold thickness). Only 1 study reported an adverse effect of aquatic therapy.

O-019

Prevalence of Airway Hyper-responsiveness in International Level Synchronised Swimmers

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INTRODUCTION: Swimmers show the highest prevalence of airway hyperresponsiveness (AHR) among elite athletes. Synchronised swimmers are usually exposed for prolonged time periods to chlorinated swimming pools environment. Our aim was to document the presence of criteria for asthma and AHR in synchronised swimmers in comparison with other swimmers. METHODS: International level swimming competitors were recruited in 2008. Athletes had allergy skin prick tests, a baseline spirometry, Eucapnic Voluntary Hyperpnea (EVH) and methacholine challenges. A swimmer was considered as having AHR if the FEV1 fall (EVHf) reached 10% or more post-EVH or if the methacholine PC20 was 4 mg/ml or less, in keeping with the IOC-MC criteria. For athletes taking inhaled corticosteroids (ICS) for at least one month, a response is considered positive 3 years; 11W)±if PC20 is ≤16 mg/ml. RESULTS: Eleven synchronised swimmers (22 2 years; 8W;6M) were included. One synchronised swimmer was±and 14 swimmers (20 6 h/week in synchronised±taking ICS. Duration of training hours per week was 37 5 h/week in swimmers (p±swimmers compared with 28 <0.005). Synchronised 2 years (p=0.51). No±4 years and swimmers for 12 ±swimmers trained for 13 significant difference was observed in prevalence of atopy, forced vital 3.4±capacity or FEV1 between the two groups. Mean methacholine PC20 was 4.3 9.1 mg/ml in swimmers (p=0.77). Mean±mg/ml in synchronised swimmers and 7.5 7 in±6 % in synchronised swimmers and 12 ±maximum fall in FEV1 post-EVH was 12 swimmers (p=0.98). There were no significant differences in maximal ventilation, sustained during the 6-min EVH between the two groups (p=0.95). The prevalences of positive diagnostic of AHR to methacholine or EVH challenge were not significantly different between the two groups. Seventy-three percent of synchronised swimmers and 54% of swimmers had AHR to methacholine, and 45% of synchronised swimmers and 46% of swimmers reached a EVHf of at least 10%. Globally, 91% of synchronised swimmers and 77% of swimmers had a positive bronchoprovocation test that could suggest the presence of exercise-induced bronchoconstriction. CONCLUSION: According to

IOC-MC criteria, the majority of swimmers, and more even so elite synchronised swimmers have current criteria for asthma, suggesting that assessment of AHR should be more frequently done in swimmers, especially in synchronised swimmers.

O-020

Differences in Body Composition Between Swimmers and Synchronized Swimmers

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INTRODUCTION: From the literature, have been shown that a variety of factors influence in performance exercise. Apart from the physiological parameters, anthropometric parameters, such as body mass, body fat, height, length of limbs, total skinfold have been shown to influence performance in athletes (Maldonado, Mujika and Padilla, 2002). In swimmers, fat mass, upper extremity length and height seem to influence performance (Tuuri, Loftin and Oescher, 2002; Geladas, Nassis and Pavlicevic, 2005; Jagomägi and Jürimäe, 2005). In female swimmers, height, body weight, percent body fat and fat-free weight have an effect on swimming performance (Siders, Lukaski and Bolonchuk, 1993). From the literature haven't shown this influence in synchronized swimmers. The purpose of this research was to know the differences between female swimmers and synchronized swimmers in body composition. METHODS: 23 female swimmers from Spanish team and 49 female synchronized swimmers participants in Spanish Championship (15,53±0,99 years, 56,12±6,63 kg; 164,28±6,21cm). Body composition was measured by Inbody 230 (Biospace Co., Ltd. Gangnam-gu. Seoul. Korea) the following measurements were taken: body mass, height, BMI, total body water, skeletal muscle mass (SM), percentage body fat (%BF) and body fat (BF). SPSS for Windows 17.0 was used for all statistical, Independent sample T test was used to analyze the differences for each exercises in parametric variables, and Two-Sample Kolmogorov-Smirnov Test in non-parametric variables (body mass). The significant level was $p<0.01$. RESULTS: The results show significant differences between swimmers and synchronized swimmers in height, total body water, skeletal muscle mass and percentage body fat ($p<0.01$). Swimmers (168,11±5,36 cm) are significant taller than synchronized swimmers (162,48±5,79 cm). Synchronized swimmers describe low level of total body water (31,24±3,10 kg), SM (23,33±2,56 kg) and %BF (21,3429±5,69) than swimmers (35,80±2,94 kg; 27,20±2,45 kg and 17,84±4,00 respectively). DISCUSSION: It was concluded that significant different exist between female swimmers from two different exercise, synchronized swimming and swimming. So, swimmers require specific anthropometric characteristics different than synchronized swimmers. There seems to be insufficient literature on body composition in both exercises.

O-021

An Agaricus Blazei Murill-Based Mushroom Extract May be Beneficial for Athletes because it Protects Against Inflammation, Infection and Allergy

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INTRODUCTION: Strenuous exercise suppresses cellular immunity and increases susceptibility to infections (1). In elite swimmers also the frequency of allergy, asthma and airway hyper-responsiveness is increased (2). This is explained by lower type-1/type-2 cytokine ratio in athletes (1) because type-1 protect against cancer and infectγcytokines like IFNions whereas type-2 like IL-4 promote allergy and asthma. Agaricus bM (AbM) is an edible medicinal Basidiomycetes mushroom of Brazilian origin used in traditional medicine and cultivated commercially for its positive health effects. AbM is a known immunomodulator and has antitumor effects in mouse models (3). Recently, we have examined the effect of the AbM-based extract, AndoSanTM, on bacterial sepsis (3) and allergy (4) in mouse models, and inflammation in humans (5, 6). METHODS: AndoSanTM (www.immunopharma.org), a Japanese GMP-certified mushroom extract contaning 82% AbM, or saline was given orally (0.2 ml) to mice either sensitized s.c. with allergen ovalbumin (OVA), or challenged i.p. with lethal pneumococci or fecal bacteria. End points were serum IgE to OVA and cytokines in cultures of spleen cells from the mice, and bacteremia and survival, respectively. Plasma cytokines were measured in healthy volunteers and inflammatory bowel disease (IBD) patients who drank 60 ml AndoSanTM daily for 12d. RESULTS: In OVA-sensitized mice given AndoSanTM, serum IgE to OVA was lower and type-1/type-2 cytokine ratio higher in spleen cell cultures. AndoSanTM reduced bacteremia and increased survival compared with saline control; 50 vs 13% and 34 vs 0%, in the two models. In healthy volunteers and IBD patients AndoSanTM reduced pro-inflammatory cytokines like MIP-1, TNF and IL-1 in plasma. DISCUSSION: The positive effects obtained with AndoSanTM on infection, allergy and inflammation indicates that this AbM-based mushroom extract may improve health and training-related inflammation in elite swimmers and other athletes. REFERENCES: 1. Suzuki K et al. Exerc Immunol Rev, 2002;8:6-48 2. Bougault V et al. Sports Med 2009;39:295-312 3. Hetland G et al. Scand J Immunol 2008;68:363-70 4. Ellertsen LK & Hetland G. BMC Clin Mol Allergy 2009;7:6 5. Johnson E et al. Scand J Immunol. 2009;69:242-50 6. Førland DT et al. Abstract: Gastro 2009 UEGW, London Nov 21-25

O-022

Effect of two Aquatic Training Programs on Risk Factors of Hip Fracture. Osteoaqua Project

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INTRODUCTION: Osteoporosis is the most prevalent chronic illness in the world. It is one of the factors that increase risk of fracture. Hip fracture is the most morbidity fracture above 65 years old. It has a high cost for Public health system Physical activity is one of the non medicine treatments that it can be used. Impact exercise and resistance exercise improve bone mass density (BMD), but it is not so clear that this happen with swimming. The purpose of this study is to assess the effect of two years of two aquatic training programs, one of traditional swimming program and another of impact and resistance swimming program, on Stiffness Index (SI) and the risk of fracture on postmenopausal women. METHODS: They were divided in 3 groups: a) swimming group (n=30); b) impact and resistance group (n=30); c) control group (n=30) RESULTS: After two years of training it was found significance differences between control group and swimming group on SI being highest in the swimming group. Between impact and resistance group and control group there were not significance differences but there was a high trend to this change ($p<0,08$) CONCLUSION: A swimming program helps to reduce the lost of SI with regard to the group which do not make any training. while a low impact and resistance program can help to this improvement.

O-023

Elite Child Athletes are our Future. Cardiac Adaptation to Monofin Training in Prepubertal Athletes

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INTRODUCTION: The elite children athletes are one who has superior athletic talent. Monofin (a single surface swim fin) swimming already proved to be the most efficient method of swimming for human being (1). Little is known about the influence of child monofin training on cardiac adaptation following long – term monofin training (LTMT). METHODS: 14 elite monofin children aged 11.95 years (± 1.09 yr) , height (Ht) (153.07 ± 4.2 cm) , weight (wt) (52.4 ± 3.7 kg), took part in (LTMT) for 36 weeks , 6 session per week , 90 min per session . All subjects under went two-dimension, M-mode, and Doppler echocardiography before and after (LTMT) to evaluate cardiac dimensions and function; septal and posterior wall thickness. Statistical methods of SPSS, means ± SD and paired t test, percentage of improvement were used. RESULTS: There was significant difference (P<0.01) and percentage improvement for all echocardiography parameter after (LTMT). Inter ventricular septal thickness in diastole (IVSd) and in systole (Ivss) increased by 27.9 % and 42.75 %. Left ventricular end systolic dimension (lvesd) and diastole (lvedd) increased by 16.81 % and 42.7 % respectively. Posterior wall thickness in systole (pwts) increased very highly by 283.3 %, and in diastole (pwtd) increased by 51.78 %. Left ventricular mass in diastole (Lvd mass) and in systole (Lvs mass) increased by 44.8 % and 40.1 % respectively. Stroke volume (sv)increased by 25% and resting heart rate (HR)improved and decreased by 14.7%. DISCUSSION: Monofin training is an effective sport to enhance "Heart athletes" for children, because the unique swim fin tool creates propulsion and over come resistance. Further researches are needed to determine the effects of monofin training on right ventricular in children athletes . Key Words: Monofin Training; Heart athlete's, Elite child athlete, Echocardiography REFERENCE 1. Abouzeid Magdy (2008). Cardiopulmonary Adaptation in Elite children following long-term Monofin training. Bulletin No. 54, sep. 2008 ICSSPE, Berlin, Germany.

O-024

Estimation Method for Energy Expenditure by Acceleration of Human Head during Water Walking

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INTRODUCTION: There are many researches and devices estimating energy expenditure (EE) during land activities. Due to its availability, those researches and devices are mostly used accelerometer that was attached on human body. However, those researches and devices cannot apply to water exercise because water has specific characteristics compared to air. We tried to develop estimation equation for EE by accelerations of human head during water walking (WW). Our future goal is to develop an underwater activity monitor by using accelerometer. METHODS: Fifty Japanese males and females were participated in this study. They were conducted WW at three walking speeds of 25 m/min, 30 m/min and 35 m/min (some subjects executed 20 m/min or 40 m/min depending on their physical condition), and walked over 5 minutes. The experiment was carried out at the indoor swimming pool. An accelerometer was attached onto the occipital region of the subjects and recorded three-dimensional acceleration at 100 Hz. The metabolic responses (VO2, l/min/kg and VCO2, l/min/kg) by Douglas bag method, interval times between mid 15 m were also measured by stopwatch at each bout. We developed estimation equation for EE (kcal/min/kg) calculated by VO2 and VCO2 from gained acceleration data (Weir, 1949). RESULTS: There were three components in the estimation equation for EE (kcal/min/kg): resting metabolic rate (RMR, kcal/min/kg), joint energy expenditure (EEj) and energy expenditure against for water drag force (EEwd). The RMR was calculated by sex, age and weight based on the basal metabolic rate table for Japanese. The EEj was assumed to the square root of the sum of squared of both the sagittal and vertical accelerations. The EEwd was regarded as the anterior-posterior acceleration. The all accelerations were considered head inclination angle, and the dimensions of the all components were equivalent to the mechanical power. In this equation, the correlation coefficients were high in both male (r = 0.79) and female (r = 0.77). DISCUSSION: The correlation coefficients of the estimation equation developed in this study were high. Although we could develop theoretical estimation equation, residual analysis showed some large estimation errors that were over 30%. The future study was needed to develop much reliable estimation equation for EE during WW. REFERENCES: 1. Weir JB. (1949). New methods for calculating metabolic rate with special reference to protein metabolism. J Physiol, 109(1-2): 1-9.

O-025

Aquatic Space Activities – Practice needs Theory

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INTRODUCTION: Swimming is an aquatic activity of long history and so is the swimming research. The cause for being moved by self-induced propulsion is traditionally confined to flow physics with experiments under steady conditions assuming that the flow velocity is constant and the moving body is a) rigid and b) fully submerged. In human swimming this is not and was never the case. Fact is, in all aquatic space activities limbs change motion of water mass which cause unsteady flow conditions. METHODS: A surway was done concentrating on chapters of some swimming text books related to biomechanical background of activities in aquatic space. Emphasis was placed on examples referring to studies presented in the congress series of biomechanics and medicine in swimming. In addition, attention was paid to which extend those hydrodynamic features examined by researchers of fast swimming animals were considered and how practical advice and biomechanical knowledge was connected. RESULTS: Most textbooks on swimming prefer simple drag approach. The authors emphasize the intuition about flow condition, e.g. a hand is moving the same block of water either back or moving new blocks by changing hand motion, ignoring that in a current flow, according to the law conservation of mass, water cannot be pushed away in relation to the surrounding water mass. This means among others, hands' actions are not most effective if water resistance is at a maximum. Even when the effect of hand motion has been jugded by analyzing the lift and drag components of hand the connection to known intracyclic changes of the swimming velocity is not mentioned. The question, where the mass of water displaced by the body and its actions is going to is not considered. CONCLUSION: Reactions to induced water mass set into motion have some contra-intuitive features. Studies of flow physics of swimming animals suggest that water mass displaced by the body is potentially supporting thrust production of the action of the feet. In aquatic space it is important to know the relation of peaks between added forces and accleration of body. When water mass is displaced by the hand in form of a vortex ring thrust will surely be enhanced remarkably. Momentum variations or flow unsteadiness due to hand motion generate efficient resultant propelling force. A change in teaching strokes is recommended.

0-026

Increased Training Intensity and Reduced Volume for 12 Weeks has Detrimental Effects on Swimmers Maximal Oxygen Uptake

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INTRODUCTION: The training volume of elite swimmers often reaches 40-50 km per week. Recent reports suggest that an increased amount of supra-maximal interval exercise, carried out as 6-12 times 30 s all-out exercise separated by 3 min of rest, can improve the performance of trained non-elite runners, despite a 25-80 % reduction in training volume. The reduction in volume resulted in an improved running economy but no change in maximal aerobic power. METHODS: A group of male (N=20; 19±3 yrs, mean±SD) and female (N=11; 18±3 yrs) elite swimmers were randomly allocated to an intensity training group (IG, N=16) and a control group (CG, N=15). For 12 weeks, CG carried out their normal training of 25-50 km pr week including supra-maximal high intensity bouts 1-2 times per week. IG swimmers reduced their training volume 50% relative to CG and performed at least 4 sets per week of supra-maximal interval training. Before and after the training period, oxygen uptake (VO2) was measured during swimming at two different sub maximal speeds, followed by a test of VO2-max using stepwise increases in swimming speed until exhaustion. In addition swimmers performed a set of 5x200 m starting every 5 min (1-3 being easy sub-maximal swims; the 4th a hard effort and the 5th an all out effort). RESULTS: VO2 was unchanged during submaximal swimming. In IG Figures for VO2 at the highest submaximal velocity before the training period was 2.56 ± 0.78 l/min and after the training period 2.53 ± 0.94 l/min. For CG the same figures were 2.65±0.64 and 2.59±0.54 l/min respectively. For VO2-max there was a significant decrease ($P<0.05$) in IG from before (3.93±0.81 l/min) to after the training period (3.78±0.94 l/min). There were no changes in VO2- max in CG (Before: 3.85 ±0.71; after 3.84±0.66 l/min). There were no significant changes in 200 m performance. In IG the mean velocity of the 5th 200 m was 1.50±0.08 m/s before the training period and 1.51±0.08 m/s after the training period. For CG the same figures were 1.53±0.09 DISCUSSION: The major findings in this study were that and 1.51±0.08 m/s. reduced training, despite more than a doubling of supra-maximal interval bouts, had a detrimental effect on VO2-max but not on swimming economy or performance in 200 m swimming in this group of elite swimmers. Apparently, a high training volume is required to maintain VO2-max in athletes that depend on their upper body musculature and possibly VO2-max is not a good predictor of 200 m freestyle.

0-027

The Effect Of Cognition-Based Technique Training on Stroke Length in Age-Group Swimmers

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INTRODUCTION: Highly skilled swimmers aspire to cover as much distance per stroke as possible. To reach this, emphasis should be placed how stroking is mentally represented in swimmers. Advanced age-group swimmers have to control the stroke-technique mentally to optimize details of motion sequences. In this context a cognitive intervention can be used which is based on the Structural Dimension Analysis of Motor Memory (SDA-M) according to SCHACK (2003). This method describes mental representation structures and enables statements about the cognitive architecture of complex movements in the long-term memory. METHODS: The empirical study was carried out at 3 test days with 22 age-group swimmers preparing for their participation in national championships. Between the first and the second test day they performed specific workouts for 6 weeks. On the test days the program 'Split' (SCHACK et al., 2000) was used to evaluate the representational structure and the swimmers passed a swimming test of twice 25 meters crawl stroke at full speed. The study was concluded by a final test after 6 weeks. RESULTS: The improvement in mental representation also led to improvements in the swimming parameters. Parameter Test 1 (mean, std) Test 2 (mean, std) Test 3 (mean, std) Speed 1,53 ± 0.09 m/s 1,52 ± 0.11 m/s 1,49 ± 0.09 m/s Stroke rate 49,61 ± 4,2 /min 47,81 ± 3,26 /min 46,70 ± 4,18 /min Stroke distance 1,85 ± 0,16 m 1,92 ± 0,19 m 1,93 ± 0,20 m Tab. 2 Statistical data for group DISCUSSION: Comparing the results it is obvious that the stroke distance increased at nearly similar speed. The specific work on the identified stroking problems triggered most of the swimmers to modify their motion sequences. Even though the changes mostly were not statistically significant the intervention made an impact: the participating swimmers increased their cognitive ability and thus enhanced their own power to better their aquatic space activities. REFERENCES: ARELLANO, R & PARDOLLP, S: An evaluation of changes in the crawl-stroke techniques during training periods in a swimming season. In D. Mac Laren, T. Reilly, A. Lees (eds.), Swimming Science VI (S. 143-149). London. BLÄSING, B, TENENBAUM, G & SCHACK, T, 2009: The cognitive structure of movements in classical dance. Psychology of Sport and Exercise 10 (2009), 350-360. SCHMIDT, A C, 2009: Kognitionsbasiertes Bewegungstraining und Talentförderung. Eine Interventionsstudie zur Kraularmbewegung. Göttingen.

0-028

Monitoring Swim Training Based on Mean Intensity Strain and Individual Stress Reaction of an Elite Swimmer

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INTRODUCTION: From a practical point, swim training mostly aims at enhancement of properties of a person to swim the same distance in less time. Monitoring training regimes is one method to get an idea about the relation of training load and race performance. Most of the documental formats seem to be of little practical value since the large number of variables hinder concluding steps. Mujika et. al. (1996) proposed a more intelligent format by introducing MITS (mean intensity of a training season) which reduces the training components to only one MITS-value. From a biological point, the training load is not the determining factor for biological adaptation. Trainings loads are modulated by personal traits resulting in an internal fatiguing impulse, which is best perceived by the athlete. The purpose is how delayed stress-value is used to control the training load. METHODS: This is a case study a female swimmer after 14 years of regular training recorded over a period of 144 days the training components were and the perceived level of being fatigued a) directly after the workouts and b) in the following morning. Several calculations lead to led to the MITS-values per day and a delayed stress-factor by subtracting the perceived fatigue value in the morning from that reported after workouts the day before. RESULTS: The results of this case study with one elite female swimmer over a period of 144 days are represented graphically; the mean MITS – value was 2.01 ± 0.12 and the delayed stress – value: -1.31 ± 1.81 arbitrary units, respectively. These overall values show a trend towards somewhat more intensive training loads and a slight recovery due to rest at night. The improvement of the best time was 2.8 %. DISCUSSION: The improvement of the personal best time after this macro cycle was of course appreciated, especially because this happened last time some years before. The trend towards higher intensity of trainings loads, pre-

dominantly due to some new methods of dryland training, as indicated by MITS-value, was less risky due to the individual feedback based on the delayed stress-factor. REFERENCES: Mujika, I., Chatard, J-C., Busso, T., Geyssant, A., Barale, F., and Lacoste, L. (1995). Effects of training on performance in competitive swimming. Can. J. Appl.

O-029

Accelerometry as a Means of Quantifying Training Load in Competitive Swimmers

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The purpose of this study was to examine the potential relationships between accelerometer output and swim speed, and output and swim distance. Fifty-three competitive swimmers (age: 17.7 ±3.13 yrs.) fitted with two accelerometers completed two series of multiple swim bouts used to develop prediction equations for swim distance (m) and speed (m•sec-1). Validation for the derived prediction equations was performed using a subset of 13 swimmers. Significant relationships were found for accelerometer output and swim distance (R2= 0.81, $p<0.05$) and swim speed (R2= 0.64, $p<0.05$). Cross-validation for actual vs predicted swim distance and swim speed were significant (Swim Distance: R2 =0.96, $p<0.001$, Swim Speed: R2= 0.53, $p<0.001$). In conclusion, this study demonstrates that accelerometers have the ability to quantify individual swimming distance and speed with acceptable validity after the swimmer completes a swim bout.

O-030

Effects of Shoulder Compensatory Strength Training Program in Rotator Cuff Strength of Young Swimmers

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INTRODUCTION: The purpose of this study was to evaluate de effects of 16 week compensatory strength training program in shoulder strength and respective conventional ratios (concentric ER/IR). METHODS: A total of 40 national level male swimmers were assessed and randomly divided in two groups – experimental group (N=20)-(age:14.65±0.67 years old, height:173.48±6.87 cm, body mass:63.15±5.68 kg) and control group (N=20)-(age:14.60±0.60 years old, height: 170.79±6.48 cm, body mass:61.73±4.68 kg). Experimental subjects participated in a 16 week shoulder strength program with Thera-Band® elastic bands (3 times a week). The peak-torque of shoulder internal (IR) and external rotators (ER) was measured in both groups at baseline and after 16 weeks. Concentric action at 60º/s (3 rep) and 180º/s (20 rep) were measured, in a seated position, with the shoulder at 90º of abduction and the elbow flexed to 90º, using an isokinetic dynamometer (Biodex System 3 – Biodex Corp., Shirley, USA). Anova with repeated measures was used to determine significant main effects in shoulder rotators strength and unilateral ER/IR ratios. The level of significance was set at 0.05. RESULTS: Significant differences were found in all variables that measure the ER shoulder strength at 60º/s in dominant(DT) ($P=0.031$) and non-dominant(NDT) shoulder ($P=0.001$). Meanwhile concentric action at 180º/s, only showed significant differences on DT shoulder ($P=0.032$). In respect of ER/IR ratio, a compensatory strength training programme induces significant differences in both shoulders at 60º/s (DT: $P=0.001$; NDT: $P=0.001$). At 180º/s we just found significant effects on the DT ER/IR ratio ($P=0.002$). DISCUSSION: The results of this study support earlier research [1] that showed that the unilateral shoulder strength ratios increases substantially after a period of a strength training program. Since the ratios describe the quality of muscular balance/imbalance [1], we can conclude that a 16 week compensatory shoulder strength training program using Thera-Band® elastic bands, reduces muscular imbalances in rotator cuff of competitive young swimmers. These results highlight the useful of this kind of compensatory program to prevent shoulder injuries. REFERENCES: 1. Malliou, P.C. Giannakopoulos, K. Beneka, A.G. Gioftsidou, A. and Godolias, G. (2004). Effective ways of restoring muscular imbalances of the rotator cuff muscle group: a comparative study of various training methods. Br. J. Sports Med.;38:766-772.

O-031

Zen and the Art of Swimming – Impulses for Teaching and Training

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INTRODUCTION: There is no other physical activity which concerns human beings as existentially as swimming. In a way our existence is connected with movement in water. If you cannot swim, you can loose your life when falling into water. The first movement after conception for all human beings is swimming in one's mother's womb. Regardless of culture, gender, nationality or religion, swimming has been seen as an essential and basic ability of human beings.The aim is to compare elements from Zen –philosophy and Zen- practice with some core elements of both the learning process and the mastering process of swimming. METHODS: In this paper we shall have a look at a combination of spirituality, physical education and training, in relation to the learning and practice of swimming. For that purpose this study examines the Zen - Buddhist perspective regarding body and movement (cf. Deshimaru-Roshi 1984; Moegling 1987; Sekida 2005). Some elementary concepts from the Zen Buddhist philosophy shall be discussed, in order to reveal and compare constructive elements for and with the "Art of Swimming". By using text analysis and empirical case studies the main aim is to give new impulses for teaching and training swimming activities. RESULTS/DISCUSSION: At first the combination of Zen and Swimming may seem unusual, but on closer scrutiny Zen philosophy and spiritual practice highlights factors supporting the experience of swimming. Notably for tackling problems during the learning process, spiritual experiences from Zen may be complimentary. The paper aims to show possible parallels between the concepts of wholeness, being vs. non-being as well as meditation techniques of breathing and awareness with important elements of swimming on different levels, which could be observed in teaching praxis. One example here is the focus on exhalation in elementary swimming teaching as well as in meditation. Those provide new impulses for teaching and training swimming. REFERENCES: CSIKSZENTMIHALYI,M./JACKSON,S.A.: Flow in Sports. Champaign/IL /Leeds: Human Kinetics 1999 DESHIMARU-ROSHI,T.: Zen in den Kampfkünsten Japans. Weidenthal: Kristkeitz 1984 MOEGLING, K.. Zen im Sport. Haldenwang: Schangrila 1987 SEKIDA,K.: Zen Training. Methods and Philosophy. Boston/London: Shambhala 2005 SHAW,S.: Master the Art of Swimming. London: Collins &Brown 2006 STEVENS,J.: Budo Secrets. Teaching of the Martial Arts Masters. Boston/MA: Shambhala 2002

O-032

Effect of Increasing Energy Cost on Arm Coordination at Different Exercise Intensities in Elite Sprint Swimmers

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INTRODUCTION: In swimming, many constraints have been studied through their effects on the inter-limb coordination. It would be interesting to investigate the effect of energy cost (C) increase on the adopted coordination mode (catch up, opposition or superposition). The aim of this study was to assess the effects of the C increase on the stroking parameters (arm stroke rate, SR and stroke length, SL) and arm coordination in front crawl. We hypothesized that motor organization is influenced by the C. METHODS: Six swimmers, specialists front crawl performed six consecutive 300-m swims separated by 30-sec resting intervals. Video analyses permitted to obtain the clean speed (v in m.s-1), SR (stroke.min-1) and SL (m.stroke-1). Arm coordination was quantified using the index of coordination (IdC). Minute ventilation, oxygen uptake, carbon dioxide production were recorded and a capillary blood sample was obtained from the finger. The aerobic part of swimming energy cost (Caero) was equal to the ratio between VO2net (i.e. the difference between the VO2 measured during the last minute of each swimming stage and its value at rest) and the swimming speed. Anaerobic glycolytic net energy cost (Canaero) was estimated using blood lactate. Thus, C was calculated by addition Caero and Canaero. RESULTS: Results showed strong positive relationships between IdC and C (R2=94.3) and SR and C (R2=83.1) and a negative relationship between SL and C (R2=77.5). The increase of C related to a significant decrease of aerobic part coupled with an increase of anaerobic part of C (anaerobic part from 70.7±10.2% at set one to 60.8±7.8% at set six). DISCUSSION: As hypothesised, the increase of C led to significant changes in motor organization. The strong relationships between SR and C and IdC and C suggested that C could influence the emergence of a specific coordination and ratio between SR and SL for a given speed. Moreover, the increase of anaerobic part of C showed the establishment of fatigue, acting as an additional constraint on swimmers and thus on coordination mode adopted. In the future, it could be interested to be able to assess the energy cost of a given coordination mode for a range of speed, and this for the three coordination modes.

O-033

Effect of Time and Exercise Mode on Metabolic, Stroking Parameters and Stroke Phases Responses at Continuous and Intermittent Exercises

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INTRODUCTION: The swim stroke is composed by propulsive (B and C) and non-propulsive (A and D) phases (Chollet et al., 2000). When swimming continuously at high intensity exercise, there is change in some stroke phases and arm coordination (Alberty et al., 2009) to facilitate the propulsive actions and maintain the swim speed. It is well known that the recovery periods during an intermittent exercise promotes lower metabolic stress when exercising at the same absolute intensity. Therefore, the objective of this study was to analyze the stroking parameters and stroke phases responses when swimming at the same swim speed during continuous and intermittent exercise around maximal lactate steady state (MLSS). METHODS: Twelve endurance swimmers (21 ± 8 yr.) performed the following procedures: 1) two to four 30-min tests to determine the MLSS, and; 2) two constant speed tests at 102.5%MLSS under continuous (C) and intermittent (I) (12 x 150 s with 30 s of rest) conditions. The blood lactate, stroking parameters (stroke rate – SR; stroke length – SL) and stroke phases responses were compared at 10th and 30th minute of the exercise. RESULTS: The difference between predict (102.5%MLSS = 1.26 ± 0.04 m.s-1) and actual swim speed was lower than 2% for both C and I. The blood lactate between C and I was similar at 10th min (3.7 ± 1.5 mM and 3.3 ± 1.3 mM) but higher for C at 30th min (4.7 ± 0.9 mM and 3.7 ± 1.1 mM), respectively. There was increase of SR (30.7 ± 2.8 and 32.2 ± 2.9 cycles. min-1) and reduction of SL (2.46 ± 0.18 and 2.35 ± 0.22 m.cycle-1) between 10th and 30th min only at C, with no differences in these variables between exercise modes. There was increase in Phase B (21.7 ± 3.4% and 22.9 ± 3.9%) between 10th and 30th min only at C, with no effect of exercise mode on these variables. DISCUSSION: Thus, we can conclude that the swimmers adjust swim stroking strategies differently between continuous and intermittent exercise, when swimming at the same absolute swim speed, but with different metabolic conditions. Therefore, the intermittent exercise may help to maintain the stroking technique, which is an important aspect of the training prescription and performance in this modality. REFERENCES: Alberty M, Sidney M, Pelayo P, Toussaint HM. Stroking characteristics during time to exhaustion tests. Med Sci Sports Exerc 2009; 41: 637-644 Chollet D, Chalies S, Chatard JC. A new index of coordination for the crawl: description and usefulness. Int J Sports Med 2000; 21: 54-59

O-034

Comparison Between the Standard Average Muscle Activation wtith the Use of Snorkel and Without Snorkel in Breakstroke Technique

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INTRODUCTION: In swimming the snorkel (K4b^2, Italy, Rome), which consists of a valve train Aquatrainer (Cosmed, Rome, Italy) is often used for analysis of various physiological and biomechanical aspects has allowed researchers to analyze its feability and reliability, as the mechanical constraints caused by this system. Electromyography (EMG) evaluates the neuromuscular activity by plotting the electrical activity of muscle and thus displaying patterns of muscle activation. The purpose of this study was to compare the average pattern of muscle activation in two situations, with and without the use of a snorkel in the breakstroke technique. METHODS: Five male subjects (Mean ± SD: age 19 ± 3,67 years; weight 76.1 ± 6.58 kg; height 178 ± 0.05 cm; fat mass percentage 14,68 ± 1.96; IMC 24 ± 1,66), were subjected to a test consisting of a protocol of 2 x 25m breakstroke, in the first part of the test the swimmers used a snorkel; in the second part they swam without snorkel at 95% of transit time for 200m crawl. Using a wireless signal acquisition system (bioPLUX research, Portugal) and EMG sensors (emgPLUX, Portugal), muscle activity of Biceps Brachii (BB) and Triceps Brachii (TB) of the right arm was recorded throughout the test

and synchronized with the video images. The raw EMG was processed offline using Python (version 2.4) routines to compare morphology of the pattern of EMG signal recorded form BB and TB during both test conditions. The signals were subsampled to a frequence of 200Hz, then low-pass filtered with a smoothing window of 50 samples and full-wave rectified. We selected the (middle-700_middle+2300) samples of the raw signal on all identical pathways (15m). For each subject, muscle and test condition, mean, standard deviation, maximum and minimum values of EMG were determined. In order to compare the pattern EMG wave of the swimming movement with and without snorkel, the mean EMG wave was computed for each subject, muscle and test condition. RESULTS: The results demonstrated that the mean activation (EMG) of the BB and TB are higher with the use of snorkel. With respect to the maximal values, higher values in BB were observed both in the muscles recorded as well as in the condition with use of a snorkel. DISCUSSION: We observed in both muscles higher EMG values when using the snorkel. Since BB higher values mean higher activation in both situations. The curve of the EMG signal pattern of the cycle for each muscle group is different from subject to subject, and was different between each situation.

O-035

Some Factors Limiting Energy Supply in 200m Front Crawl Swimming

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INTRODUCTION: The amount of metabolic energy spent in transporting the body mass of the subject over a unit of distance has been defined as the energy cost of locomotion (di Prampero, 1986). Energy during swimming is estimated as the sum of the energy derived from alactic (AnAl), lactic (AnL) and aerobic (Aer) processes. The aim of the research was to establish whether any measured factors could limit energy supply on 200 m front crawl swimming. METHODS: Twelve male swimmers performed 4 swims on 200 m crawl at intensities from 80%, 90%, 100% to 110% on separate days with a swimming snorkel. Respiratory parameters (VE, Vo2), some parameters in the blood (pH, [LA-]) and heart rate (HR) were measured. RESULTS: From results we were able to demonstrate that limitations in VE (117,4±17,9 l x min-1 at 100%, 108,7±17,2 l x min-1 at 110% velocity), Vo2 (3,8±0,5 l x min-1 at 100%, 3,7±0,5 l x min-1 at 110% velocity) and HR (3,8±0,5 b x min-1 at 100%, 108,7±17,2 b x min-1 at 110% velocity) during swimming occur during supra maximal swims (no further increase of measured maximal parameters and time constant parameters) in comparison to maximal swims. We found also limitations in obtained maximal [LA-] (14,2±2,5 mmol x l-1 at 100%, 12,0±1,9 mmol x l-1 at 110% velocity) and minimal pH values (7,18±0,06 at 100%, 7,23±0,05 at 110% velocity). DISCUSSION: The energy cost of swimming increases as a function of the speed. With increase of swimming speed the sum of energy supply during swimming should increase from either alactic (AnAl), lactic (AnL) and aerobic (Aer) processes. From our results we can conclude that insufficient energy supply because limitations in aerobic and anaerobic lactic processes occur, could limits maximal speed of swimmers on 200 m front crawl. REFERENCES: 1. Capelli C., Pendergast D.R., Termin B. (2005). Energetics of swimming at maximal speeds in humans. Eur J Appl Physiol 78:385-393. 2. Holmer I (1974). Physiology of swimming man. Acta Physiologica Scandinavica supplementum 407, 1 – 55. 3. Prampero PE di. (1986). The energy cost of human locomotion on land and in water. Int J Sports Med 7:55-72.

O-037

The Contribution to Total Power Output from the Arms and Legs Using a New Whole-Body Swimming Training Machine

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A new whole-body swimming training machine can be used to determine the power generated by each limb. The contribution made by each limb to the total power output can be calculated (%) in relation to exercise intensity. 12 swimmers with a mean age of 23.2 * 1.2 (yrs), stature 1.75 * 0.02 (m) and body mass of 73.8 * 2.9 (kg) gave informed consent and performed an incremental whole-body exercise test to exhaustion on the computer-interfaced whole-body swimming training machine. Exercise intensity commenced at 100W and was increased by 50W per minute. Peak oxygen consumption (VO2peak) and peak power output (Wpeak) were determined. The mean values of VO2peak and Wpeak were; 3.7 * 0.8 l.min-1 and 366.7 * 52.6 W respectively. At various exercise intensities the relative contribution of the legs to total power output was as follows: At 20%VO2peak it was 29.7 %, at 40%VO2peak it was 35.8%, at 60%VO2peak it was 41.7% and at 80%VO2peak it was 48.2%. At VO2peak itself, the contribution was 53.5%. These results show that the contribution of the legs (to total power output) can be as much as the contribution from the arms, during high intensity exercise in swimmers. Of course, the extent to which these results can be applied to swimming is limited by the specificity of the exercise, but the results suggest that swimmers can perhaps produce as much power with their legs as they can with their arms, when they exercise with their arms and legs simultaneously.

O-038

Correlation between Maximal Dynamic Strength of Specific Muscle Groups and Throwing Speed in Elite Water Polo Players

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INTRODUCTION: The power shot is the main throwing technique in water polo reaching the highest ball velocities. Several muscle groups are involved in this motion. The aim of the study was to assess the correlation of maximal dynamic strength of the upper bodies and legs muscles on throwing velocity. METHODS: 15 male German elite water polo players and junior national squad members participated in the present study (age: 16.4 ± 3.0 years; height: 184.5 ± 9.2 cm; weight: 84.0 ± 12.5 kg). All subjects were right-handed. Each subject performed 3 power shots in the pool with a distance of 5 meters to the goal to assess maximal throwing velocity, measured by the Speedtrac X sports radar gun. Maximal dynamic muscle strength (FtPmax [N]) was measured using a pull-over machine (left and right hand), twister for lateral abdominal muscles (left and right direction of movement) and ab- and adductor machine for the legs. Relationships between muscle strength and throwing speed variables were evaluated using the Pearson product–moment correlation coefficient. RESULTS: The following results for FtPmax [N] were measured: Pull-over (left hand): 438.9 ± 127.1 N; Pull-over (right hand): 462.5 ± 116.9 N; Twister (to the left): 666.3 ± 146.7 N; Twister (to the right): 707.1 ± 136.7 N; Abductor: 749.9 ± 232.0 N; Adductor: 790.2 ± 200.3 N. Maximal throwing velocity was 68.5 ± 4.8 km/h. The following correlations were calculated between throwing velocity and maximal dynamic muscle strength: Pull-over left ($r = 0.70$, $p < 0.01$) and right hand ($r = 0.52$, $p < 0.01$); abductor ($r = 0.57$, $p = 0.03$),

twister left direction of movement (r = 0.67, p = 0.01). DISCUSSION: Although the throwing technique of a power shot in water polo is very complex, this study indicates a moderate to high correlation between the maximal dynamic strength of the most separately tested muscles and power shot throwing speed. Therefore we recommend the maximal dynamic strength measurement of these muscles to be a part of water polo specific diagnostics. Unexpected results indicate partial non-specific performance in the subjects' position during testing in the laboratory or the muscles' direction of movement. Further research is necessary to modify the testing procedure and generate valid reference data.

O-039

Throwing Accuracy of Water Polo Players of Different Training Age and Fitness Level in Static Position and after Previous Swimming

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INTRODUCTION: The effectiveness of shooting mainly depends on accuracy. In water polo, it has not been examined the effect of training age and swimming performance on the effectiveness of shooting The aim of this study was to compare the accuracy of shooting, in a static position or after previous swimming, in relation to a) training age and b) swimming performance. . METHODS: Totally 50 players (aged: 11-17 yrs) were tested in shooting accuracy in a static position and after previous swimming and divided into 3 groups according to: a) training age and b) swimming performance Each individual executed, from a constant place and 5 m away from the goalpost, 5 shots to a standard target and then 5 more shots after swimming 10m away from the goalpost and stopped in 5m for shooting. ANOVA (2x2) compared the accuracy on throwing, with swimming and static, in relation to age and performance. Statistical significance was set at P<0.05. RESULTS: Significant differences were observed between shooting conditions (p<0.0001), in shooting accuracy between groups of different training age (p<0.0001) and fitness level (p<0.0001). The accurate shots in a static position were significantly more than shots after previous swimming (2.8 ±1.3 vs 1.7 ±1.1, respectively). Players with 6-8 years training age had higher percentage of throwing accuracy (80±14.7%) than players of 4-5 and 2-3 yrs (53.8±22.4, 35±13.9%, respectively). In motion, the number of successful shots for each age group were 53.3±15.6, 34.6±20.0 and 11.7±9.8%, respectively Players, also, with swimming time less than 31.9 s in 50m crawl achieved higher percentage of goals (76.7±14.1%) in a static position, than players of 39.90-32.0 s, and than those of 60-40 s (54.1±22.1, 32±16.6%, respectively). The corresponding values while in motion were: 53.30±15.3, 32.9±15.7 and 10.7±14.9%, respectively. No significant differences were found in shooting accuracy between shot in a static position and after previous swimming (as Ä values), in relation to training age and fitness level. High correlation was found between training age and fitness level. (r=-0.80, p=0.0001). DISCUSSION: Shots in a static position are more accurate than shots after previous swimming. The shooting accuracy depends on training age and fitness level. Regardless of the training age and fitness level, shooting accuracy is negatively affected by previous swimming.

O-040

Effect of Stroke Drills on Intra-cycle Hip Velocity in Front Crawl

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INTRODUCTION: Current teaching and competitive swimming programs are composed by a proper combination of skill acquisition and conditioning exercises. Many swimming books or papers described or classified these swimming exercises proposing guidelines to use them properly or in a skill assessment context. While hip or centre of mass intra-cycle velocity has been studied in the current competitive strokes using observational or biomechanical methods this has not been the case with the stroke drills applied to teach or to train the swimming technique. A first attempt was performed analyzing the differences on body rotation and 3D hand swimming path between freestyle swimming and one arm crawl stroke drills (López, Gutiérrez, & Arellano, 2002). Less body rotation and hand depth were found during the practice of formal one-arm and catch-up crawl stroke, while a modified one-arm stroke drill obtained similar values to that recorded during no breathing freestyle swimming.The purpose of this study is to reveal the differences in intra-cycle hip velocity between formal front crawl and four other front crawl swimming coordination drills. METHODS: Thirteen national and regional level swimmers (five males and eight females, aged 19.58±2.23) participated in this study as volunteers. Each stroke drill was defined as: a) No-breathing formal freestyle swimming (reference technique); b) Crawl catch-up stroke, kicking some seconds after each stroke; c) One arm front crawl with the resting arm extended in front, breathing on the arm-moving side; d) One arm front crawl with the resting arm close to the body, breathing on the no-moving side; e) Controlled two-arm freestyle, kicking some seconds after each stroke, with one arm resting close to the body and the second one resting extended in front. RESULTS: Mean 25m velocity (m/s) a) 1.64; b) 1.10*; c) 1.08*; d) 1.07*; e) 1.00*. Mean % 2nd peak a) 69.9; b) 76.9; c) 38.1 ; d) 80.9 ; e) 69.0 [all n.s.] Mean 2nd peak a) 2.06; b) 1.41*; c) 1.38* ; d) 1.14* ; e) 1.26* * p<0.01 between a) and b), c), d) and e) CONCLUSIONS: The freestyle stroke drills applied to teach or train different types of interlimb coordination reduce the mean and peak value of the intra-cycle hip velocity while the percentage location of peak hip-velocity value during the underwater stroke phase is kept similar without significant statistical differences.

O-041

A Markov Chain Model of Elite Water Polo Competition

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INTRODUCTION: In performance analysis in game sports, it is important to respect the the interactive process between the two teams or players. So, in game analysis problems mostly occur in adequate modelling of the competition. The concept of match-play analysis through mathematical simulation by means of the Markov-chain model was established in several sports games (Lames, 1991; McGarry & Franks, 1994), and in this study used to analyse the performances of the German and Serbian Water Polo team at the World League Final 2007 in Berlin. METHODS: The starting point of our state-transition-model was the possession of the ball. The offensive play was modelled on the basis of offensive attempts, which were characterized by 28 different states. The states represent the different player positions in man-even (6-6) and man-up offense (6-5) as well as specific game situations (e.g. goal). The transitions from one state of the match to another represent the tactical behaviour of the teams and can be quantified in a transition matrix of the states with the transition probabilities. We formalized this matrix by means of a finite Markov-chain (stochastic modelling) to determine the performance relevance of each tactical behavior by mathematical simulation. In this study, 11 games with participation of the two teams were analyzed. RESULTS: The objectivity was determined with two observers in three games. The Cohens-Kappa values of 0.80 to 0.86 can be classified as excellent (Robson, 2002). For both teams the tactical transitions "Win of ball-Counter attack", "Back player-Man-up (6-5)" und "Back player-Center forward" showed the highest performance relevance. Significant differences between the two teams could only be found for the tactical pattern „Flanker player-Driving in". DISCUSSION: Our

results confirm the possibility to model a water polo match by means of a Markov-chains. The simulative calculation of the performance relevance of tactical behavior underlines the importance of the fast break and of intense activities of the back players. REFERENCES: Lames, M (1991). [Performance diagnosis by computer simulation]. Frankfurt/ Main: Deutsch: 7-257. McGarry, T, Franks, IM (1994). A stochastic approach to predicting competition squash match-play. Journal of Sport Science. 12, 573-584. Robson, C (2002). Real world research. Oxford: Blackwell.

O-042

A Model of Vertical Swimming Abilities in Elite Female Senior Water Polo Players

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INTRODUCTION: Although the vertical position in water polo game is dominant while performing the elements of techniques with the ball, duel play and the offense and defense tactics, female players' vertical swimming abilities have yet to be studied comprehensively. This paper aims to define a different models of vertical swimming abilities (VSA) in elite female senior WP players. METHODS: The study included 30 female WP players (Age=21.6±3.3yrs, BH=170.5±5.2cm, training experience=7.7±3.3yrs). The tests were conducted in the season of 2007-2008 using the standard procedure at the beginning of the national team's preparations for the summer season. On the basis of raw data obtained through testing (four different test loads: 10, 12, 13.5 and 16 kg) the function of Power-Time equation was calculated for each subject applying the equation $y=a \cdot bx$. All data are presented in absolute terms as Absolute Vertical Swim Abilities Model (ABSVSWIM) in kg of weight mass, in relative terms as Relative Vertical Swim Abilities Model (RELVSWIM) in % of weight mass in relation to BM, and in terms of reached capacity as Capacity Vertical Swim Abilities Model (CAPVSWIM) in % of weight mass in relation to the b coefficient, which represents the maximal hypothetical working biological capacity load. All data were calculated for the nine time intervals: 5, 10 and 15s - anaerobic alactic; 30, 60 and 120s - anaerobic lactic; and 300, 600 and 1800s – aerobic as the time intervals characteristic of estimating the intensity, power and capacity of those systems. All data underwent the descriptive statistical analysis. RESULTS: The raw data were used to define the following models of VSA in female WP players: ABSVSWIM, y=30.4868x-0.2087, RELVSWIM, y=47.8754x-0.2127, CAPVSWIM, y=91.9195x-0.1846, respectively. DISCUSSION: The female WP players showed the following VSA: they could sustain the vertical position in water at the all energetics intervals with the average load of 22.32, 18.98, 17.30, 14.82, 13.57, 11.03, 9.17, 8.02 and 6.55kg; the values obtained were at the levels of 34.81, 29.53, 26.88, 22.96, 20.99, 16.99, 14.07, 12.27 and 9.98% of BM; with respect to the capacity model, the players showed VSA at the following capacity levels: 69.69, 60.42, 55.69, 48.58, 44.94, 37.42, 31.77, 28.20 and 23.54% of the hypothetical maximum, respectively. The resulting models will be used to control the fitness levels, as well as to assist the development of training technology at WP female players.

O-043

Models for Assessimg General Horizontal Swimming Abilities of Junior Water Polo Players According to Playing Position

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Tactical, technical, physical demands and also playing position differences of the water polo players are very important factors for competitive success. Therefore, the aim of this study was to identify general level of horizontal swim abilities of junior water polo players according to playing positions. The data was consisted of 71 players, members of national junior teams from: Slovenia, Turkiye, Serbia and Greece. Players were divided three main playing position group, peripherals (P,n=41), central defenders (CD,n=20) and centar players (C,n=13). The following six swimming test were performed, crawl; 15m, 25m, 50m, 200m, 25m crawl with head up and 25m crawl with ball. All tests were performed in the 50m swimming pool, the players started in water at the signal of the timekeeper. The results of these tests were analyzed using confirmative model of factorial analysis for the determination of the factorial scores. Following the mathematical multidimensional procedures was determined for creating model for assessing the horizontal swim score (HSS) equation for three different playing positions; for the peripherals HSS(P), for the central defenders HSS(CD) and for the centar players HSS(C). Result of HSS for three different playing positions was expressed numerically. There are no statistical differences between general level of basic horizontal swim abilities according to position. The HSS equation has the following model for the peripherals; HSS(P)=349.882-(m15crawl*5.681)-(m25crawl*3.555)-(m50crawl*1.893) - (m200crawl*0.408)-(m25crawlHUP*3.608) - (m25crawlWB*2.844). The HSS equation has the following model for the central defenders; HSS(CD)=349.872-(m15crawl*5.682)-(m25crawl*3.559)-(m50crawl*1.893) - (m200crawl*0.408)-(m25crawlHUP*3.603)-(m25crawlWB*2.845). The HSS equation has the following model for the centar players; HSS(C)=349.938-(m15crawl*5.679)-(m25crawl*3.557)-(m50crawl*1.893) - (m200crawl*0.408)-(m25crawlHUP*3.607)-(m25crawlWB*2.845). The results showed that best level of HSS according to positions; peripherals, centar players and central defenders at score number level: 50.34, 49.76 and 49.43 respectively. The present study provided effective information on the general level of horizontal swimming performance of elite young water polo players according to playing positions, and defined equations can be used by coaches as effective and easy to apply method for testing actual level of horizontal swimming prepearenes at junior water polo players.

O-044

Arm Coordination, Active Drag and Propelling Efficiency in Front Crawl

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Active drag, regularity and Index of Coordination (IdC) all increase with speed (v) in front crawl swimming, but the link between those parameters remains unclear. The aim of this study was thus to examine the relationships between the index of coordination (IdC) and propelling efficiency (ep) and the active drag (D). Thirteen national level male swimmers realised two incremental speed tests swimming front crawl with arms only in free condition and using a Measurement of Active Drag (MAD) system. D was measured using the MAD-system; ep was assessed by the ratio v3free / v3MAD; IdC was obtained from arm stroke phases evaluation using video device. The results showed that inter-arm coordination was linked to active drag and not propelling efficiency. Significant quadratic regression between IdC and v ($0.91<R^2<0.99$), power regression between D and v ($0.93<R^2<0.98$) and linear regression between IdC and D ($0.64<R^2<0.98$) were established for each swimmer.

O-045

Fatigue Analysis of 100 Meters All-out Front Crawl Using Surface EMG

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INTRODUCTION: EMG amplitude increases and mean power frequency decreases during fatiguing muscle contractions. The aim of the study was to estimate fatigue of selected propulsive muscles by analysing EMG signals during 100 meters all-out front crawl in amplitude and frequency domain. METHODS: Eleven male competitive swimmers (age 22.0 ± 2.9 years) performed a 100 m all-out crawl. EMG signals from pectoralis major (PM), latissimus dorsi (LD) and triceps brachii (TB) muscles were recorded. Amplitude (ARV) and mean power frequency (MNF) were calculated. Lactate concentration was measured and stroke length (SL), stroke rate (SR) and swimming speed (SS) were extracted from the video recordings. RESULTS: The highest blood lactate values were measured 5 min after the swim.14.1 ± 2.93 mmol.l-1. SL and SR decreased from 2.00 ± 0.13 to 1.89 ± 0.18 m and from 50.56 ± 4.15 to 47.12 ± 5.33 stroke.min-1 respectively, from the first to the last 25-m lap. SS decreased in every lap by 6.18%, 5.4% and 4.2%, the total average decrease of the speed was 15%.The ARV calculated for LD2 and TB increased, while MNF decreased significantly from 20.5 ± 9.1% to 24.6 ± 8.4% in all observed muscles at the end of the swimming with respect to the beginning of swimming. No differences in the relative decrease of MNF between the muscles were found DISCUSSION: The average ARV calculated at the end increased with respect to the beginning of the swim for the lower part of LD and TB muscle. The increased amplitude might be the result of the activation of additional motor units during the swimming and/or their increased synchronisation as suggested by some previous studies. MNF decreased by 20.5% to 24.6% in all muscles under observation. MNF decrease of 11.41% and 8.55% for the wrist stabilisation muscles were previously reported by Caty at al. (2006). More propulsive role and therefore greater work done during crawl by the muscles monitored in our study might be the cause of greater MNF decrease, implying greater fatigue accumulated in these muscles REFERENCES: 1. Caty VY, Rouard AH, Hintzy F, Aujouannet YA, Molinari F, Knaflitz M (2006) Time-frequency parameters of wrist muscles EMG after an exhaustive freestyle test. Revista Portuguesa de Ciencias do Desporto 6:28-30

O-046

Relationship between Arm Coordination and Energy Cost in Front Crawl Swimming

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INTRODUCTION: The capacity to reach high swimming velocities (v) is greatly dependent on biomechanical and physiological parameters. Additionally, the stroke temporal organization is also important to characterise highly skilled swimmers. Ten years ago Chollet et al. (2000) presented the Index of Coordination (IdC), a tool that assesses arm coordination. The assessment of the energy cost (C) is also well reported in the literature. Thus, it was aimed to assess the relationships between IdC and C at moderate to high intensities front crawl. METHODS: Seven high level swimmers performed a paced incremental protocol of 7x200m (0.05 m.s-1 increments, 30s rest), until exhaustion (Fernandes et al., 2003). Oxygen consumption was measured through direct breath-by-breath oximetry (K4b2, Cosmed) and blood lactate concentrations were assessed at rest, during the intervals, and immediately after each step (YSI1500LSport auto-analyser). C was assessed with data obtained both from aerobic and anaerobic energy pathways. Video analysis, obtained from two synchronized video cameras (JVC GR-SX1 SVHS) fixed on the lateral wall of the pool, was used in order to obtain the IdC value in all stages. RESULTS: During the incremental protocol, IdC and C increased, presenting very high relationships with v (r=0.99 and r=0.98, p<0.01, respectively. Despite InC and C were very highly correlated (r=0.99, p<0.01), when removing the effect of v (through partial correlation method), this relationship was not significant (r=0.42, p=0.40). DISCUSSION: The increase in swimming v implied a changed from a catch-up to an opposition mode (near to the VO2max intensities), which is in agreement with the literature (Chollet et al., 2000). Equally, C values also increased with v, as described before, seeming to be justified by the increasing power output necessary to overcome drag. The main finding was the very high direct relationship between IdC and C (r=0.99, p<0.01), which is in accordance with previous studies in terrestrial locomotion. However, the simple analysis of the r value shows that C increase with the increased continuity of technique (higher IdC), which seems to be paradoxal, being probably explainable by the fact that both parameters are strongly influenced by v. When it was removed the effect of v, it was observed that IdC and C do not correlate significantly. REFERENCES: 1. Chollet D et al. (2000). Int J Sports Med, 21(1): 54-9 2. Fernandes RJ et al. (2003). Int J Sports Med, 24(8): 576-81

O-047

Front Crawl and Backstroke Arm Coordination in Swimmers with Down Syndrome

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INTRODUCTION: Recent studies have shown that the evaluation of arm coordination provides new information to the classic analysis (Chollet et al., 2008). Studies focusing specifically on swimmers with Down syndrome (DS) are very scarce. In that perspective, the aim of this study was to characterize the Index of Arm Coordination (IdC) in swimmers with Down syndrome. METHODS: Six international level swimmers with DS participated in this study (age: 20.2 ± 4.8 years, height: 154.3 ± 12.1 cm, weight: 58.4 ± 14.1 kg and fat mass: 16.4 ± 11.6 %). All swimmers performed 2 x 20 m swims at maximal intensity. The IdC was considered as the time gap between the propulsion of the two arms and expressed as a percentage of the duration of the complete arm stroke cycle. The level of significance was established at 5%. RESULTS: The IdC for the front crawl was -11.3% ± 5.2% and for the backstroke -13.5 ± 4.8%. For front crawl, a significant relationship was found between IdC and the relative duration of the push phase (r = 0.88), as well as with the propulsive phase (r = 0.92). An inverse relationship was found between IdC and the non propulsive phase (r = -0.92). In backstroke, there was a significant inverse relationship between IdC and velocity (r = -0.89). DISCUSSION: The international level swimmers with DS of this study presented a catch-up arm coordination mode in front crawl, which may be associated with less proficient arm coordination (Seifert et al., 2008). Trained swimmers usually change from catch-up to superposition with increasing velocities. The catch-up coordination mode was also found in all swimmers for the backstroke, which is in concordance with the literature on less skilled swimmers and for skilled swimmers at low velocities (Chollet et al., 2008). This instrument can be very helpful to coaches in better understanding underwater stroke phases. The findings also emphasize the importance of augmenting the propulsive phases of the arms and, with this, diminishing the lag time of the swimmers. Technical mistakes can also be detected through the

study of the arm coordination. REFERENCES: 1. Chollet D, Seifert L, Carter M (2008). Arm coordination in elite backstroke swimmers. J Sports Sci, 26(7): 675-82. 2. Seifert L, Chollet D, Chatard JC (2008). Kinematic changes during a 100-m front crawl: effects of performance level and gender. Med Sci Sports Exerc, 39(10):1784-93. Erratum in: Med Sci Sports Exerc, 40(3):591.

O-048

Coordination Changes during a Maximal Effort 100 m Short Course Breaststroke Swim

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INTRODUCTION: There are three general patterns of co-ordination used in breaststroke swimming known as continuous, glide and overlap. Investigation of co-ordination changes during a race could provide a better understanding of the swimmer's personal co-ordination and how changes in that co-ordination relate to stroke rate, stroke length and swimming speed (Pelayo et al., 2007) The aims of this study were to: (1) investigate co-ordination changes during a 100 m short course breaststroke swim and (2) compare kinematic variables between each of the four laps as the swimmers progresses through the100 m swim. METHOD: With institutional ethical approval trained breaststroke swimmers (females n=8; males n=18) performed a maximal effort 100 m swim from a water start, in a 25 m pool. Each lap was recorded underwater using three 50Hz video cameras (1 at each end of the pool and a 3rd mounted to a trolley [sagittal plane]). The last three strokes of each length prior to the turn were analysed to determine the duration of arm recovery, arm propulsion, leg recovery, leg recovery and transition phases. Stroke rate, stroke length and clean swim speed were analysed within a 10 m section of the pool that was not affected by starting, turning or finishing. RESULTS: Twenty four of the swimmers showed a decrease in clean swim speed from the 1st to the 4th lap with an overall significant mean decrease in clean swim speed of 8.3% (P=0.002). There was no significant (P>0.05) change in either mean stroke rate or mean stroke length from the 1st to the 4th lap. Changes in transition time from the 1st to 4th lap approached statistical significance (p=0.06) DISCUSSION: As swimmers became fatigued they decreased the transition time between the end of the leg kick and the start of arm pull phases in an attempt to maintain clean swim speed. A better understanding of the changes in co-ordination could assist coaches in the design of training interventions to delay the effects of fatigue. REFERENCES: Pelayo P, Alberty M, Sidney M, Potdevin F, Dekerle J. (2007) Aerobic Potential, stroke parameters, and co-ordination in swimming front-crawl performance. Int J Sports Phys Performance, 2, 347-359.

O-049

Muscular Request of Different Fin Uses

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The purpose of the present study was to examine the muscular request of different practices using different fins. We focused on three different fin uses: body-board, swimming, and snorkelling. We used inverse dynamics to estimate the muscular power of the lowers body joints (knee and hip). For each practice we recorded the three-dimensional kinematics of lower limbs with underwater camcorders. The input forces and torques measurement, necessary for bottom-up inverse dynamic, were measured by a twice fin robot which reproduced mean foot kinematics of each practice recorded before. The three kinematics and joint power computed at knee and hip were analysed. Kinematics differs for each practice but joint powers are statically the same (1,87±1,54 W/Kg). This method has the main advantage to allow us to characterize precisely effect of fin blade on human joints.

O-050

Markerless Analysis of Front Crawl Swimming

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INTRODUCTION: Although underwater swimmers video recordings are widely diffused, swimmers' kinematics is usually reconstructed only on a single sagittal view, relying on manual digitization of specific features' position. In this study, 3D kinematics of the right arm in front crawl swimming is analyzed employing a markerless, automatic and repeatable method [1], based on multi-view video recordings of the subject. METHODS: An elite swimmer performing front crawl was acquired employing 5 subaqueous CCTV colour cameras and Canopus ADVC-55 A/D converters (PAL interlaced video, 25frames/sec). Cameras were synchronized automatically by means of an ad-hoc application, and calibrated with Bouguet method. Silhouette extraction was performed employing a Gaussian mixture algorithm (Intel OpenCV library), which creates an adaptive model of the background; a priori information, in terms of an extra "white" Gaussian component of the model, was included in order to deal with the presence of the foam. From the intersection of these silhouettes' back-projections in space, a visual hull of the subject was obtained at each frame. The joints' position was reconstructed by means of matching the visual hull with a subject-specific mesh model (obtained from a dry and static visual hull of the subject), based on rigid-segments, employing the articulated-ICP algorithm. Only a manual initialization step is required, in which the initial position of the wrist is determined by digitizing its positions on all the views, and triangulating them. Correlation coefficients were evaluated for the three components of shoulder, elbow and wrist joints among three trials. RESULTS: The 3D joint trajectories repeatability analysis reported intra-method correlation coefficients between trials ranging from 0.948 to 0.997 for the antero-posterior component, from 0.751 to 0.998 for medio-lateral and from 0.2578 to 0.9975 for vertical. In the latter case, poor correlation was found for the elbow joint, while wrist and shoulder showed a good correlation (mean: 0.91±0.1SD). DISCUSSION: The application of a fully automatic markerless technique for analysis of swimmers' kinematics has been investigated. Good results were achieved in terms of intra-method repeatability of joint trajectories. Although this method has not been validated yet due to the lack of a gold standard, it is very promising for quantitative, wide-scale studies on swimmers' motion. REFERENCES: 1. E. Ceseracciu et al. ISBS Conf Proc. 2009

O-051

50m Race Components Times Analysis Based on a Regression Analysis Model Applied to Age-Group Swimmers

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Training loads and methods should be adapted to swimmer's age and performance level. International age-group records times of 50m freestyle showed a progressive improvement in performance of this event. This event could be used as an evaluating tool of the race components (RC). RC should be modified with the age, growth and physical conditioning development. Some forms of regression analysis have been applied to RC studies during international competitions (Absaliamov &

Timakovoy, 1990; Nomura, 2006), but this kind of analysis has not been applied to age-group swimmers. Our research purpose was to estimate and use a sophisticated statistical model of the RC performance evolution during the age-group development based on a 50m freestyle test. METHODS: 280 regional age group swimmers (162 males and118 females) participated in the study (age range: 9 - 22 years). Detailed swimming competition video analysis procedure was applied to obtain the RC. Regression analysis was used to discover the tendency and model of the partial times. Inverse function approximation of the RC [start time (ST), stroking time (STT), turning time (TT) and finishing time (FT)] by age and gender was carried out. RESULTS: The type of generic equation obtained by age and gender was as follows: ymen= a1+ b1/age: y woman= a2 + b2/age. Furthermore, different equations were obtained for gender, RC and 50m times. Significant differences between genders in %ST, %TT, %FT were obtained. A crossing trend was found between both models with the crossing age around 12-14 years. The percentage of RC times of these age-group swimmers were compared with percentages of RC times of international swimmers and showed significant differences. DISCUSSION: Race Component times during a 50m freestyle test improved with age and physical conditioning development. The results obtained in percentages of RC times were different between genders. The results showed significant differences between RC percentages in the final 50m time between the study participants and international level swimmers. REFERENCES: 1.Absaliamov, Timakovoy. (1990). Aseguramiento Científico de la Competición. (A.I. Zvonarev, Trans.).(1 ed.). (Vol.1). Moscow: Vneshtorgizdat. 2.Nomura, T. (2006). Estimation of the lap-time of 200m freestyle from age and the event time. Revista portuguesa de ciências do desporto. Vol. 6, Supl. 2. (pp. 239-241).

O-052

The Altitude Project: An International Collaborative Research Project on Altitude Training in Elite Swimmers

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INTRODUCTION: : Altitude training (AT) is a common practice among swimmers although scientific evidence of its benefits is scarce and controversial, particularly in elite athletes. The Altitude Project aims to: 1) determine the effectiveness of AT using the Hi-Hi (living and training at moderate altitude), or the Hi-Lo (high intensity training performed at lower altitude) models, in comparison with sea level training; 2) establish the physiological mechanisms involved; 3) ascertain whether altitude training affects swimming technique; 4) uncover any negative impact on athletes' health and performance; and 5) identify markers of individual response and adaptation to AT. METHODS: An international group of researchers belonging to universities and sports organizations of different nations, supported by the IOC and FINA among others, will develop a major international study starting at October, 2010. About 40 male and female elite swimmers from various countries and their coaches will participate in a controlled, matched-paired, balanced experiment with three interventions: Hi-Hi (2320 m), Hi-Lo (high intensity training at 690 m, Granada), and Lo-Lo (sea level, Barcelona). After the first set of tests, subjects will be matched by gender, competitive level, and VO2max, and to one of the three groups. Initial and repeated measurements along the study will include: 1) performance testing, 2) swimming economy and metabolic testing (including VO2max and MAOD), 3) swimming technique and kinematics, 4) hematology (including flux cytometry and total Hb mass), 5) pro-oxidant/antioxidant balance, 6) immunological status, 7) heart rate and arterial blood pressure variability, 8) echocardiography, and 9) clinical monitoring. RESULTS: Individual and group results will be presented to and discussed with participating scientists, coaches and athletes. Thereafter, they will be presented in international congresses and submitted to high impact scientific journals. DISCUSSION: The project is open to sports and scientific national organizations from all countries willing to contribute with recruiting and funding athletes, coaches and scientists. REFERENCES: 1. Rodríguez FA and Levine BD (2009) The Altitude Project: A Scientific Outline. 2. Rodríguez FA and Levine BD (2010) The Altitude Project: A Summary for Coaches and Athletes. *Brochures available from the authors upon request (*thealtitudeproject@gmail.com).*

O-053

A New Method to Evaluate Cross-Sectional Area Based on Computer Animation of Swimming

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INTRODUCTION: Reducing cross sectional area (CSA) during starts and turns is a key part of performance optimisation. Different methods have been used to obtain this parameter without any standard: total human body volume to the power 2/3, wetted area or frontal area based on planimetry technique (PT) (Toussaint, 1990). These different methods can lead to discrepancies in drag values (Cappaert, 1994). Recently, Nicolas et al. (2009) used two synchronized camcorders to evaluate drag parameters during the different phases of an undulatory stroke cycle. However, such a technique needs accurate synchronization and calibration of the different camcorders views. The aim of this study is to provide a new method based on animation of virtual characters to obtain instantaneous cross-sectional area in an undulatory stroke cycle. Its main advantage is to obtain cross-sectional area as well as biomechanical analysis with a single camcorder in a sagittal plan and without space calibration. METHOD: A camcorder placed side-on to the swimmer recorded the undulatory movements in the sagittal plane of eight swimmers. This information provided the angles between limbs. These data were then used by our animation engine to animate a virtual swimmer whose anthropometric data came from the real swimmer. A specific algorithm has been developed to automatically obtain the CSA using body outlines. In order to validate our method, we also calculated the CSA using PT with a frontal camcorder view of the same undulatory movements. RESULTS/ DISCUSSION: Our results show similar values of maximum CSA using PT and the frontal camcorder view (0.012±0.003m^2) and our algorithm based on 3D animation (0,014±0.004m^2). The mean coefficient of variation between the results obtained from the two methods is 7.3%. This difference could be related to the level of details of the mesh used to model the avatar. One prospect to this work is to take resistive and propulsive body segments into account in CSA calculation. From this method, we intend to better understand swimming hydrodynamics and the way CSA influences active drag. More generally, this approach has been designed to provide new practical insights into swimming analysis protocols. REFERENCES: Cappaert, J.M., Gordon, B.J. (1998) Sports Eng, 1(1): 51-55. Nicolas, G., Bideau, B. (2009). Hum Mov Sci, 28 (4): 480-493. Toussaint, H.M., de Groot, G., Savelberg, H.H.C.M., et al. (1988). J. Biomech, 21: 435-4

O-054

Assessing Mental Workload at Maximal Swimming Intensity Using the NASA-TLX Questionnaire

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INTRODUCTION: The NASA-TLX questionnaire [1] assesses six independent dimensions (mental, physical and temporal demand, own

performance, effort, frustration) composing mental workload. Its sensitivity was tested according to the magnitude of effort, gender, age expertise and progress. METHODS: Fifty subjects divided according to gender (27 men, 23 women), expertise (33 experts, 17 recreational), and age (34 adults, 16 youths) performed a maximal 400-m front crawl. Experts also performed 100-, 200- and 300-m trials at the velocity of the previous 400-m, and retested on the maximal 400-m after three months of aerobic training. ANOVAs examined age, gender, expertise, distance and training effects on total workload (TWL) and other dimensions of the NASA-TLX. RESULTS: Women had lower TWL (48±9 vs. 54±2, p<.05) and effort (59±13 vs. 70±21, p<.05) level than men. No difference based on expertise was observed for any dimension of the TLX. Youth had lower TWL (47±6 vs. 53±10, p<.05) and temporal demand (36±20 vs. 57±20, p<.05) than adults. From 100- to 400-m, a significant increase was recorded in TWL (32±28 vs. 50±28, p<.05), physical demand (21±22 vs. 65±29, p<.05) and effort (32±16 vs. 63±19, p<.05). After three months of training, no significant difference in TWL was noted, although swimmers with improved performance exhibited lower scores in frustration (50±25vs30±15, p<.05) and own performance (64±22 vs. 35±19, p<.05) and higher scores in effort (46±25 vs. 64±16, p<.05). DISCUSSION: The TLX-NASA questionnaire is sensitive to the objective task demand rather than to the participant's level, although some variations were seen in gender and age groups. The retest condition indicated its overall reliability, and analysis of its dimensions allows subtle changes to be highlighted. It thus seems to be an interesting tool for coaches and scientists alike. REFERENCES: 1. Hart, S. and L. Staveland, Development of the NASA-TLX: Results of empirical and theoretical research. Amsterdam: North Holland. p. 139-195. 2. Koltyn, K.F., P.J. O'Connor, and W.P. Morgan, Perception of effort in female and male competitive swimmers. Int J Sports Med, 1991. 12(4): p. 427-9.

O-055

Whole Body Observation and Visualized Motion Analysis of Swimming

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INTRODUCTION: It is an efficient mean to film swimmer's swimming motion of their whole body in order to grasp swimmer's technique. However, it is difficult to understand differences in detailed motion such as twisting arms or paths of arm strokes from the actual motion images. In order to understand the detailed motion of the forearm in swimming, Ohgi [1] used 3D accelerations and 3D angular velocities obtained by a data logger. Synchronizing the actual motion images with the acquired logger data makes the detailed swimming motion more understandable. Furthermore, the top view over the swimmers was observed by a camera for wave resistance against the swimmers. The wavelet transform, which is chronological frequency analysis, was also performed on these logger data and the dominant frequency was grasped chronologically in different swimming styles. METHODS: Underwater and overwater cameras were attached with a cart on pipe rail trucks at a poolside. Two motion images were combined into an unified image by a video mixer. The data logger with 3D accelerometer, 3D gyro sensor and depth sensor built in was used for acquisition of stroke motions. This device was attached on the forearm. The assessment experiment of swimming stroke operations was conducted. Swimming motions were recorded visually and digitally simultaneously. The logged data were analyzed by wavelet transformation in order to distinguish the minute differences graphically. RESULTS:Motion images of swimming were obtained like watching through plexiglas wall by the observation device. The swimming motions and 3D acceleration and 3D angular velocity signal waves were synchronized into a motion picture. Analysis of swimming motion signals becomes easier because of references of the synchronized motion pictures. In graphical patterns of swimming stroke motion, a deep stripe patterns appear in a main stroke period (2.0sec). Each of a quarter (0.5sec) and a half (1.0 sec) periods of fundamental stroke were also obtained as a stripe pattern in S-shaped free-style stroke. It is possible to discuss the different patterns with each player in the same swimming style. DISCUSSION: The author developed whole body observation apparatus in swimming. The motion pictures were synchronized with 3D acceleration and 3D angular velocity data which recorded the forearm actions. Furthermore, wavelet transform of swimming stroke was carried out and the swimming motion was visualized. REFERENCE: Ohgi, Y.(2006), Swimming X, 69-70.

O-056

The Validity of a Procedure for Competition Analysis in Swimming Based on Individual Distance Measurements

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INTRODUCTION: During competition analysis, individual distance swam during different race segments have been scarcely measured in competition (Pai et al., 1984). The aim of the study was to check the accuracy and reliability of a system for competition analysis in swimming based on individual distance measurements, comparing it with the most commonly used scaling technique. METHODS: 128 swimmers participants in 100 meters events of all four strokes were filmed in the 50x25 meters pool. Two competition analyses were performed simultaneously, based 1) on a linear scale system and 2) on 2D-DLT photogrammetry. RMSE accuracy of the position and intra-control point's distance was assessed. Repeated digitization of hand entry and head emersion was checked for consistency by mean of the coefficient of variation. Race segment times using both procedures were compared with Bland and Altman's 95% limits of agreement. RESULTS: RMSE when reconstructing the 2D-DLT position of 32 control points was 0.050 meter, less than 0.5% of control space in x axis. The reconstruction of intra-control point's distance showed RMSE=0.046 meter, less than 1.2% of the total distance. The repeated digitization of the freestyle turn's total distance in each lane of the pool showed coefficients of variation less than 1%. Maximum systematic differences between 2D-DLT and scaling technique occurred during freestyle and backstroke turn time (0.05 s). Maximum random error occurred always in breaststroke being 0.17 s during start time, 0.21 s during swim time and 0.23 s during turn time. DISCUSSION: 2D-DLT showed great accuracy values in the present study with errors similar to other studies utilizing the same technique (Challis, 1998). Two technical actions successfully tested during the digitization process allow measurements of any variable during competition. However, no other studies had previously applied DLT techniques to swimming competition analysis. Differences between 2D-DLT and scaling technique (no longer than a frame of standard-speed video (0.04 s.) could be acceptable for its practical use in competition analysis; however, precautions must be taken when measurements are made during underwater parts of the race. REFERENCES: 1. Challis, J. H. (1998). An investigation of the influence of bi-lateral deficit on human jumping. Human Movement Science, 17(3): 307. 2. Pai, Y., Hay, J. G., Wilson, B. D. (1984). Stroking techniques of elite swimmers. Journal of Sports Sciences, 2(3): 225-239.

O-057

Bronchial Hyper-Responsiveness, Physiological and Psychological Recovery Among Adolescent Swimmers: A Preliminary Investigation

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INTRODUCTION: Many endurance sports require a hard training

regime, and swimming is one of the most physically and mentally demanding of all sports as they have a hard in-water and out-of-water training program. For many swimmers breathing problems cause additional stress in the recovery process. The prevalence of exercise induced asthma (EIA) and bronchial hyperresponsiveness (BHR) is especially high amongst elite endurance athletes and has markedly increased over the last three decades. In addition for swimmers, the inhalation of chlorine is thought to be an airway provoking factor during training and competitions (Drobnic et al., 1996). The aim of this preliminary investigation is to test if there are any links between breathing problems, physiological and psychological recovery for swimmers. METHODS: 15 male and 9 female adolescent swimmers performed one Methacholine challenge and two Eucapnic voluntary hyperventilation (EVH) tests. In addition, the swimmers also filled in a questionnaire package that consisted of scales measuring perfectionism, burnout, recovery and motivational climate. RESULTS: 15 of 24 swimmers had at least one positive test result to either one of the EVH tests or to the methacholine challenge (PD20 ≤2 µmol). When coding the swimmers as responsive or not responsive, we were able to correlate BHR with psychological variables which gave some significant and meaningful results even though low number of participants. BHR correlated negatively with accomplished recovery (-.44, p<.05), and positively with perfectionism (parental criticism: .48, p<.05). DISCUSSION: This preliminary investigation emphasize that the prevalence of bronchial hyper responsiveness (BHR) among elite adolescent swimmers is alarmingly high. Breathing problems may lead to underperformance, though; BHR is rarely mentioned as a physiological marker for e.g. overtraining (Richardson et al., 2008). Hence, parental pressure, massive training load, unsuccessful recovery is vital issues with applied consequences both for training and competition. In conclusion, there is evidence that we need more research about this possible (breathing) stress-recovery imbalance in order to identify underrecovery. REFERENCES: Drobnic F, Freixa A, Casan P, Sanchis J, Guardino X. Assessment of Chlorine exposure in swimmers during training in swimming pools. Med Science Sports Exerc 1996; 2: 271-274. Richardson S. Overtraining athletes. Champaign, IL: Human Kinetics, 2008.

O-058

Immune Status Changes and URTI Incidence in the Initial 7 Weeks of a Winter Training Season in Portuguese Swimmers

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INTRODUCTION: Despite of different periodization strategies there is a known trend for a substantial increasing in training volume in the initial mesocycle of the training season. Few studies address this initial adaptation period. The impact of this phase is generally overlooked by coaches, given the low intensity and gradual increment of training load. This study analysed the variation of hormonal and immunological parameters and the incidence of URTIS, during the first 7 weeks of a winter training season. METHODS: The sample of this study consisted of 13 male swimmers of Portuguese national level. Training volume, intensity and dry land activities were controlled. Blood samples were collected in the beginning of the season, after an off training period of 6 weeks and after 7 weeks of training, by venopuncture, always at the same time of the day. Total leukocyte counts, % and lymphocyte populations and subsets were accessed by flow cytometry. Serum concentrations of cortisol and free testosterone were determined by chemiluminescence (Immulite 2000). The URTIS were accessed by self report in daily log books. Statistical analysis using non parametric Wilcoxon test was conducted (p<0.05). RESULTS: The volume of training increased gradually until the weekly distance swum doubled (20 to 42 km) at a rate of 17,5% increase/week. The higher rate of URTIS occurrence of all the season was observed during this 7week period. Leukocyte counts increased corresponding to an elevation of counts and % of granulocytes. The total number of lymphocytes remained unchanged but the CD4+ and CD8+ cells counts decreased. The number of CD56+ cells decreased. A decrease in the NKCD56dim and an increase in the NKCD56bright cells were also found. Serum cortisol increased leading to a decrease in the testosterone to cortisol ratio. DISCUSSION: Although the increment of training was thought to be prudent, our results show a real impact on hormonal and immunological parameters with the nº of URTI episodes being the highest of the season. The decrease observed in lymphocyte cell count subsets could explain a lower immune competence associated with the elevation of cortisol. These findings point to an impact in immune function of progressive and light training loads at the initial phase of preparation after long periods of rest, which must be taken into account by coaches when adopting recovery strategies. REFERENCES: 1. Gleeson, M. (2007). J Appl Physiol, 103(2), 693

O-059

Postexercise Hypotension and Blood Lipoprotein Changes following Swimming Exercise

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INTRODUCTION: An acute bout of exercise evokes changes in a variety of risk factors for cardiovascular disease. Most of the acute exercise studies to date have focused on running and cycling as exercise modes (Tanaka et al. 2009). It is not known whether swimming exercise results in similar changes in risk factors for coronary heart disease. METHODS: To address this question, a total of 20 young (29±2 years) apparently healthy sedentary and recreationally-active subjects were studied. Each subject performed 3 experimental sessions (time control, running exercise, and swimming exercise) separated at least one week apart. Exercise protocol consisted of five 10-min bouts of exercise at 75% of heart rate reserve with 1 min of rest between each bout. RESULTS: Baseline (pre-exercise) values were not different between the three sessions. Brachial blood pressure did not change after the 3 sessions. However, both running and swimming produced significant decreases in ankle blood pressure compared with the time control (P<0.05). The reductions in ankle blood pressure appear to be mediated by reductions in total peripheral resistance because cardiac output did not decrease and arterial stiffness, as assessed by both carotid-femoral and brachial-ankle pulse wave velocity, did not change. There were no significant changes in total, HDL-, LDL-, VLDL-cholesterol, or triglycerides after the swimming or running sessions although HDL-cholesterol tended to increase after both swimming and running sessions. DISCUSSION: We concluded that postexercise responses in blood pressure and blood cholesterol are not different between running and swimming and that both exercise modes induced significant postexercise hypotension in the leg but not in the arm. REFERENCES: Tanaka H. (2009). Swimming exercise: impact of aquatic exercise on cardiovascular health. Sports Med 39, 377-387.

O-060

Strategy for the Prevention of Shoulder Pains in the Case of Competitive Swimmers

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INTRODUCTION: Between 20 and 80% of all competitor swimmers encounter shoulder pain during their career. Following a study relevant

to the causes of such shoulder pain, we developed a strategy in order to minimize the problem as much as possible. METHODS: Since 1998, we examined the athlets during the pre-season and regularly report to the trainers and swimmers a selected program of exercices. RESULTS: Between 2000 and 2007, we examine 59 athlets of Genève-Natation 1885. All 59 swimmers (27 female, 32 male, average age 18 years old, the youngest 13 and oldest 24) trained for over 10 hours per week. In this group, 39 swimmers presented a hyperlax morphology, 27 had shoulder pain, of these 11 swimmers continued suffering during the time. In 2000, 5 swimmers had to give up swimming, the 6 swimmers which we followed between 1998 and 2007 were able to have a regular « non pain » season. The main clinical problem was a painful shoulder with winging of the scapula, which can be resolv quick by a non invasive selected treatment. DISCUSSION: Different reasons can cause shoulder's pain with swimmers. In our opinion the anterior symptomatic instability seem to be the major reason of this problem with the swimmers. The mean fact is muscular fatigues that induce a muscular compensation. Fatigue of the subscapularis and serratus anterior muscle induce a compensative overfunction of the rhomboid and infraspinatus muscles, this generate a global dysbalance of the shoulder's biomechanics involving a painful anterior instability. We create in 1998 a preventive strategy to avoid this problem; the basis of the prevention is to report a program of exercises and a regular in situ presence. This report is done after training once a year, our regular presence at the field allow controlling the good realization of the program, in case of problem a quick clinical examination and the beginning of accurate treatment is fast done. This allow for 6 swimmers which we followed between 1998 and 2007 to have a regular « non pain » season, Our active presence in the swimming pool seem to allow to minimize this problem of painful shoulder, without precisely quantify this reduction. REFERENCES: -Weldon E.J.,Richardson A.B.: Clinics in sports medicine, 20:423-438,2001 - Scovazzo,an electromyographic and cinematographic analysis of 12 muscles, Am J Sports Med 19:581,1991 -C.A. Rockwood,Jr, conservative management of rotator cuff tears. 258-267, in Rotator cuff disorders, W..Z. Burkhead (1996)

O-061

The Effect of Hydrotherapy on Some Selected Parameters Related to Kyphosis in Kyphotic Girls

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The effect of hydrotherapy on some of the selected parameters related to Kyphosis in kyphotic girls Masoumeh Azizi1* , khadijeh Asadi Saravi2* , Prof Yahya sokhangouee , Prof Mansour Eslami and Prof MehrAli Hemati nejad 1 M.S, Department of Sport Science.Islamic Azad University of Abadan and 2 M.S, Department of Sport Science.Islamic Azad University of Sari Abstract The purpose of the present study was to detemine the effect of 6-weeks hydrotherapy on the some selected parameters related to Kyphosis in kyphotic girls.After sampling and diagnosing the kyphotic girls at the Azad University, 10 subjects were selected. All subjects participated in 18 sessions, three times a week and each time half an hour per session. The dependant variables were involved: back muscles power, spine flexibility, chest expansion, shoulder abduction movement extension which they were measured by dynamometer, goniometer, and strip meter before and after exercise. Data was analyzed by descriptive statistic and dependent T-test at the significant level of (¦Á=0/05) and following results were concluded:The result showed that there was a significant difference between post-test in comparison with pre-test for the back muscles power (p¡Ü0 /05) , shoulder abduction movement (p¡Ü0 /05), spine flexibility and the chest expansion (p¡Ü0 /05). In comparison with pre-test, it has been shown an increase in value of all dependent variables after the hydrotherapy. Keywords: kyphosis, hydrotherapy, selected parameters .

O-062

The Relationship of Respiratory Symptoms and Bronchial Responsiveness in Competitive Swimmers

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INTRODUCTION: The prevalence of exercise induced asthma and bronchial hyperresponsiveness (BHR) is reported high among elite endurance athletes. Of the summer sports, swimmers show a high incidence of BHR and respiratory symptoms. From the winter Olympic Games 2002 and later the international Olympic Committee-Medical Commission (IOC-MC) required objective measurements of BHR or reversibility to bronchodilators to obtain approval for the use of β2-agonists in sports. The aims of the study were therefore to evaluate the relationship between respiratory symptoms in young elite swimmers and two different tests of BHR; Eucapnic voluntary hyperventilation (EVH) and the dose of inhaled methacholine causing 20% decrease in FEV1 (PD20 methacholine). Secondly we aimed to define the repeatability of the EVH test. METHODS: 15 male and 9 female adolescent elite swimmers, 15 to 25 years old, performed one measurement of PD20 methacholine and two EVH tests in randomised order. Dry air containing 5% CO2 was inhaled with a target ventilation of ≥85% MVV (minimum 65%) for 6 min. PD20 methacholine ≤ 2 µmol and EVH ≥ 10% decrease in FEV1 were considered positive according to the limits given by IOC-MC. The athletes reported their respiratory symptoms and medication use in the modified AQUA2008 questionnaire. RESULTS: Twenty swimmers (83%) reported respiratory symptoms, 15 of these (75%) had a positive provocation test. Fourteen (58%) of the 24 swimmers had at least one positive test result to either one EVH test or to PD20 methacholine. The sensitivity for PD20 methacholine ≤ 2 µmol in relation to respiratory symptoms was 50% versus 60% and 47.37% for the two EVH tests, respectiveley and 75% for PD20 methacholine ≤ 4 µmol. Bland-Altman plot of the two EVH tests showed a consistent distribution with only one subject outside the limits of agreement CI (-5.5, 6.8). DISCUSSION: The prevalences of BHR and respiratory symptoms among adolescent elite swimmers are very high. PD20 methacholine ≤ 2 µmol and EVH ≥ 10% agree but PD20 methacholine ≤ 4 µmol shows the best sensitivity in relation to respiratory symptoms. . This may infer that the symptoms occurring in swimmers may to some extent be unspecific and not always related to BHR, alternatively that the requirements set up by IOC-MC may be too strict. The EVH test has a high repeatability, but is very expensive and uncomfortable to perform.

O-063

Performance Level Differences in Swimming: Relative Contributions of Strength and Technique

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INTRODUCTION: The drag equation explains swimming performance as: v ≈√(F/Cd), where v is swimming velocity, F is force, and Cd is the active drag coefficient. Consistent with this equation, previous research found that v increases with √F (Havriluk, 2004), and that faster swimmers have a lower Cd than slower swimmers (Havriluk, 2003). The purpose of this study was to determine how faster swimmers perform better than slower swimmers due to the relative contributions of strength (F) and technique (Cd), so that coaches can implement the most appropriate interventions for continued improvement. METHOD: Male (n=40) and female (n=40) swimmers were tested with Aquanex+Video swimming four trials (one of each stroke) over a

20 m course (e.g. Havriluk, 2003). Underwater video, hand force data, and swim time were collected over the last 10 m. The Cd was calculated. The swimmers were stratified into faster and slower groups based on the v for each stroke. RESULTS: Regression analyses found significant ($p<.05$) curvilinear relationships with v for both F and Cd for all strokes for both genders. The magnitude of the difference between faster and slower swimmers in both F and Cd was calculated as an effect size for all 8 combinations of gender and stroke. In 7 of 8 gender/stroke combinations, the effect size for Cd was greater than for F. The mean effect size was .54σ for the F values and .90σ for the Cd values. DISCUSSION: The mean Cd effect size was almost double the F effect size, indicating that the advantage faster swimmers have over slower swimmers is derived more from technique than strength. Coaches can help slower swimmers improve by emphasizing technique instruction and regularly measuring their Cd. Because of the large gains in v that result from small decreases in Cd, even the fastest swimmers can continue to benefit from improving technique. Faster swimmers can also gain a greater advantage from a more effective use of strength. A detailed hand force analysis is necessary to help coaches identify wasted motion and provide options that increase average force to achieve maximum performance potential. REFERENCES: Havriluk, R. (2004). Hand force and swimming velocity. Paper presented at the XVth FINA World Sports Medicine Congress, Indianapolis, IN. Havriluk, R. (2003). Performance level differences in swimming drag coefficient. Paper presented at the VIIth IOC Olympic World Congress on Sport Sciences, Athens.

O-064

The Effect of Restricting the Perceptual Task in Temporal Organization of Crawl Swimming: Surface Characteristics

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INTRODUCTION: Researches on motor control have been trying to understand temporal organization of motor skills and the nature of their representations. However, there have not been studies that manipulate perception keeping surface characteristics constant. This study aimed to observe how restricting the ability to swim can influence superficial parameters of front crawl. METHODS: There was mixed random-systematic sampling among 5% of high-ability swimmers from São Caetano do Sul, enrolled with DETUR in 2008 (n=106). Disturbing was carried out by light shone onto the retina, forming a configuration according to the degree of complexity. Subjects swam at a natural rhythm. Data were analyzed using Mauchly's Test of Sphericity and repeated measures ANOVA (Contrast). Probability was 5% ($p\leq0.05$). RESULTS: We observed significant differences in the flexible parameters of front crawl after perception manipulation, even when keeping swimming distance and considering a normal swimming rhythm. Upper field, foramen convergence e foramen divergence presented higher values for time, when compared to without restriction (21.68±2.69; 21.51±2.5; 22.73±3.31 s vs. 20.33±1.92 s, respectively) and lower values for speed, when compared to without restriction (1.17±0,15; 1.18±0.14; 1.12±0.15 m.s-1 vs. 1.24±0,12m.s-1, respectively, $p<0,05$). No significant differences were observed in stroke frequency due to restrictions (Without Restriction - 0.93±0.08; Lower Field - 0.9±0.08; Upper Field - 0.89±0.09; Breathing Against - 0.89±0.10; Foramen Convergence - 0.91±0.10; Foramen Divergence - 0.90±0.10 s.s-1, $p<0,05$). CONCLUSION: Concerning to synchronization (Movement control), these results corroborate the idea that front crawl temporal organization, in its variable aspects, depends on the perceptual structure (Visual field). So, it exerts its function in perceptual representation in a conscious manner, different from data shown by previous studies on motor behavior(1;2). REFERENCES: 1. Manoel, E. de J.; Connolly, K. J. (1995). Variability and the development of skilled actions. International Journal of Psychology, 19: 129-47. 2. Freudenheim, A. M.; Basso, L.; Xavier Filho, E.; Madureira, F.; Silva, C. G. S.; Manoel, E. J. (2005). Organização temporal da braçada do nado crawl: iniciantes "versus" avançados. Revista Brasileira de Ciência e Movimento, 13 (2): 75-84.

O-065

Effect of Target Sound Made by One Swimmer's Dolphin Kick Movement on another Swimmer's Dolphin Kick Performance

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INTRODUCTION: The purpose of this study was to determine the effect of a target sound produced by one swimmer's dolphin kick movement on another swimmer's dolphin kick performance. METHOD: Fifteen competitive swimmers participated in this study. We created a target sound that was converted from coordinates of the toe of a target swimmer's dolphin kick depth expressed as sound scales. This mean the target sound indicates the other swimmer's movement. Subjects were required to swim using a dolphin kick while listening to the target sound and close to toward a target movement. Tasks were to see whether the sound scale would affect the depth of a swimmer's dolphin kick, and whether without the sound, the swimmers dolphin kick would retain any improvements. RESULTS: After listening to the target sound, no significant difference in Timing Error (0.017 ± 0.01 s to 0.018 ± 0.01 s) and Depth Error (10.74 ± 1.00 % to 10.87 ± 0.61 %) was observed in pre and post. After listening the sound a few minutes later with no sound, There was no significant difference between trials in Timing Error (0.02 ± 0.01 s to 0.02 ± 0.03 s, 60 s later was 0.01 ± 0.02 s, 120 s later was 0.02 ± 0.01 s, and 300 s later was 0.01 ± 0.02 s), but a significant difference was found 300 s later ($p< .01$) in Depth Error (12.1 ± 0.9 % to 12.3 ± 0.9 %, 60 s later was 13.0 ± 2.7 %, 120 s later was 11.3 ± 1.9 %, and 300 s later was 10.45 ± 0.6 %). DISCUSSION: This study indicates that an auditory model can be useful to set a swimming pace or to immediately coordinate timing. The dolphin kick, however, is but one parameter of movement. In the real world of training, the coordination and timing of strokes is based upon a number of parameters. In this study, movements were expressed on a sound scale. This target sound had no immediate effect on the swimmers movement because retention and the reproduction of movement are sequential steps in the learning process. At the same time, the cognition of sound and kinesthetic sensation are different modes of receiving information that are difficult to process for a swimmer who is underwater.

O-066

Technology and Innovation in Educating Swimming Coaches and Teachers

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INTRODUCTION: The main aim of this project is to improve the quality of swimming coach/teacher training and assessment in a manner that is cost effective. This project is funded by the Leonardo da Vinci, Programme. It is a 'transfer of innovation' programme for the Swimming Association of Iceland (SSI). To increase the effectiveness of delivery while minimising cost and inconvenience to participants, this programme will be transferred to a 'blended' delivery model taking ad-

vantage of video and web-based technologies that have been developed at Edinburgh University (UE) and CAPDM, specialists in development of on-line educational products. The necessary practical components of the current programme will be retained and revamped to synthesise with the on-line components. UI will set up, manage, and implement the teaching qualification of the SSI to its specifications. The on-line components of the courses will be delivered through the international e-learning delivery and coach information website CoachesInfo.com to participating coaches and teachers. METHODS: Educational units for swimming teachers and coaches will be upgraded to 'on-line' delivery for the SSI with a view to implementation throughout Europe. The refinement of the units will benefit from involvement and complementary expertise of the three university partners. Progressive surveys and pilots are used to 'fine-tune' the content, delivery and assessment mechanisms, and to achieve appropriate synthesis of on-line and practical course components. RESULTS: The primary beneficiaries are the coaches in Iceland. Improvements in instructional effectiveness of the swimming teachers will have a significant 'knock on' effect to increase swimming ability of all swimmers, whether recreational or competitive. Feedback from swimming coaches has been generally very positive. and ensured that material is optimally effective and at levels suited to the requirements and abilities of the participants. DISCUSSION: This project is successfully adopting the latest technology to develop effective learning material for swimming coaches and teachers for global use in a cost effective manner. This will have a beneficial impact at three levels – the SSI; the Nordic Swimmer Education Network; and coaches and teachers throughout Europe. The project is a good example of cooperative endeavour to transfer complementary knowledge and experience, possessed through academic, business, and coaching activity, to practicing educators.

O-067

Using a Scalogram to Identify an Appropriate Instructional Order for Swimming Items

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Scalogram, first proposed by Guttman (1950), is a descriptive ordering technique used in the social sciences to investigate how heterogeneous behavioral items may temporally relate to one another. In the present study, we explored whether there was a predictable temporal order of acquisition among selected swim skill items used in the instruction of swimming to identify whether the preferred order suggested preferences for the order in which to teach the same swim skills. A convenience sample of thirty-one college students enrolled in University instructional swimming classes performed each of the items in random order while each performance was videotaped by the investigators. After establishing acceptable inter-observer objectivity exceeding $P \geq 0.80$, the investigators observed each of the video trials and scored each item for each participant as pass-fail using pre-established criteria based on the American Red Cross Swimming and Water Safety learn-to-swim program (2004). The Red Cross order for teaching the tested skills was confirmed as the best order identified by the scalogram for young adult participants with a coefficient of reproducibility of CR = 0.93. Limitations in the procedures and results suggested the need for several future studies to identify whether the order could be applied to other ages and ability levels as well as to how susceptible the scalogram technique is to idiosyncratic instructional experiences of participants.

O-068

Learning and Improving a Swimming Technique within an Inter-Disciplinary and Experience Based Teaching Approach with two 7th Grade School Classes

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INTRODUCTION: The aim of the study is to investigate in how far the school subjects swimming and physics can benefit from each other when teaching them together in an inter-disciplinary and experience based context. It was expected that a comprehensive background knowledge about the biomechanics of swimming help improving a swimming technique. On the other hand, teaching physics in the context swimming was supposed to be an advantage regarding improving interest in physics as school subject. Gained experiences in the context of swimming should make it easier for the students to deal theoretically with the respective topics as well. METHODS: Two parallel school classes (7th grade) of a German Gymnasium were taught separately over six weeks. In the experimental group (N=25), physics and swimming were taught as a unit in the context of "moving efficiently through the water". In the control group (N=26), physics and swimming were taught separately. Besides the different arrangement and teaching method, it was tried to keep the aims and contents similar in both groups. Standardized tests were conducted in order to evaluate different factors such as knowledge, interest in physics, and swimming technique (Noethlichs and Schulz 2007). RESULTS: Results showed that both groups improved their breast stroke technique significantly but with an advantage for the experimental group. The knowledge test indicated a significant increase of the experimental group in comparison to the control group. DISCUSSION: Within the experimental group, learning the physics of swimming were directly linked to personal experiences and experiments in the water. The students experienced for instance different forces in the water with their own body and they tried to investigate how they could take advantage of those forces regarding an efficient movement through the water. Subsequent theoretical reflections gained an experience-based background knowledge, which seemed to enable improving their breast stroke technique autonomously. The control group students depended more on the teacher's instructions and feedback. In addition, the experience-based method supported the understanding of the physics of swimming significantly which can reasonably be related to the specific teaching design. REFERENCES: Noethlichs, M. & Schulz, A. (2007). Physik und Schwimmen gleichzeitig. Ein Beispiel für eine fächerverbindende Unterrichtsreihe, Praxis der Naturwissenschaften (56), 8, 35-43.

O-069

Stability and Prediction of 100-m Breaststroke Performance During Elite Swimmers Career

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INTRODUCTION: Longitudinal performance assessment is important to help coaches defining realistic goals and training methods. The purpose of this study was to analyze the 100-m Breaststroke performance stability throughout the elite swimmer's career, from children to adult age. METHODS: An overall of 35 Portuguese male swimmers and 905 race times were analyzed for seven consecutive seasons between 12 and 18 years old. Portuguese male top-50 ranking in the 100-m

Breaststroke event, in the 2007-2008 season was used to identify the swimmers included in it. Best performances were collected from ranking tables provided by the Portuguese National Swimming Federation, and when appropriate were also collected from a public swimming database (www.swimrankings.net). Performance progression was analyzed based on two approaches: (i) mean stability; (ii) normative stability. For mean stability assessment, descriptive statistics and ANOVA repeated measures for each season and event followed by a post-hoc test were computed. Normative stability was analyzed with the Pearson Correlation (Malina, 2001) and the Cohen's Kappa tracking index (Landis and Koch, 1977). RESULTS: ANOVA repeated measures revealed significant variations in the 100-m Breaststroke swimming performance [F (1,34) = 353.57; P < 0.01]. Bonferroni post-hoc tests verified significant differences (P < 0.01) between all seasons analyzed. The only exception was for the pair wise comparison between the sixth and the seventh seasons which was not significant. The K value, expressing the stability throughout the overall swimmer's career, was low (K = 0.38 ± 0.05). Self-correlations were significant in all situations (P < 0.05), except between the 16 and 17 years. Stability becomes high (r = 0.644) from 14 until 18 years old. DISCUSSION: There was an obvious 100-m Breaststroke performance enhancement from children to adult age. Stability and prediction of swimmer's performance based on overall career is low. When more strict time frames are used, swimming performance stability and prediction increases starting at the age of 14. The change from 13 to 14 years can be a milestone, where the ability to predict the final swimmer's performance level strongly increases. REFERENCES: 1. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977; 37:439-446 2. Malina RM. Adherence to physical activity from childhood to adulthood: a perspective forma tracking studies. Quest 2001; 53:346-355

0-070

Performance Decrease Following Summer Break in Youth Swimmers

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INTRODUCTION: Children in Germany have 6 weeks of school break. During this time usually no swim training is performed leading to a decrease in performance which was built up before the school break. The aim of the study was to evaluate the amount of performance loss following 6 weeks of summer break in youth swimmers. METHODS: 26 competitive swimmers between 9 and 11 years (MW 11.5 ± 1.4 yrs) participated in the study. Seven weeks before the summer break the kids performed a 100m all-out swim and a 2000m all-out swim. After five weeks of training the two tests were performed again. After the second test day the summer break occurred (6 weeks) without any swim specific training. Two and eight weeks after the summer break the tests were repeated again. RESULTS: The swimmers achieved a time of 35:31.2 ± 5:14.5min (2000m) and 1:25.4 ± 0:10.8 min (100m) during the first tests. After five weeks of training the times decreased without statistical significance (2000m 34:52.8 ± 4:35.0 min; 100m 1:24.3 ± 0:10.4min). Two weeks after the summer break the performance level in both tests decreased significantly (2000m 36:11.6 ± 5:01.4 min; 100m 1:26.7 ± 0:09.7min). After a short period of training, the performance increased significantly and the swimmers nearly reached their level of the time before the summer break (2000m 35:10.7 ± 4:34.4 min; 100m 1:24.3 ± 0:10.3min). DISCUSSION: We could show that junior swimmers between 9 and 11 years of age are able to rebuild their performance level in six weeks of training. Therefore the summer break of six weeks is very important in competitive junior swimming. From a physiological and psychological point of view, young athletes need a break from daily training to regenerate and motivate again for the next season.

0-071

Talent Prognosis in Young Swimmers

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INTRODUCTION: Neural networks are able to predict the future success of talents by revealing distinct patterns in the individual set-up of the sport specific disposition (Philippaerts, Coutts & Vaeyans, 2008). The purpose of this paper is to compare linear and nonlinear talent prognoses in the crawl sprint. METHODS: The Magdeburg Talent Study on Elite Sport Schools (MATASS) is a six year longitudinal study. The data were collected from 1997 to 2001 from a total of 729 male (age: M = 171.2 months, SD = 42.5) and female swimmers (age: M = 159.3 months, SD = 39.0). The final competition performance data were recorded in 2006 for all male (n = 130) and female swimmers (n = 113). RESULTS: 33 performance prerequisites were measured at three different time points, and reduced by factor analyses: (1) body stature, (2) maximum and explosive strength, (3) general and (4) sport specific speed strength, (5) technique and coordination, and (6) elementary speed. In a second step, the factor values of the six juvenile talent criteria, together with the (7) speed of performance development, (8) utilization of performance prerequisites, and (9) psychological stress stability were used to predict three final talent groups at adult age. For the cross-validated prognosis two methods were used: a linear discriminant analysis (DA), and a nonlinear operating Self-organizing Kohonen Feature Map (SOFM). The comparison of the real adult performance groups with the modeled outcome led to far better predictions in the SOFM. The percentages of correctly predicted cases (females = 87.9 percent; males = 68.3 percent) are much higher than those delivered by the DA (females = 69.0 percent; males = 50.0 percent). DISCUSSION: The quality of the predictions of the linear DA was comparably lower than that of the nonlinear SOFM. Thus, the results of the study show that neural networks are excellent tools to model and to predict future competitive performances on the basis of juvenile talent makeup. Besides that, the better results of the neural network modeling support the interpretation that the development of talented young athletes is a nonlinear complex problem that should be addressed by a dynamic systems approach. REFERENCES: Philippaerts, RM, Coutts, A, Vaeyens, R (2008). Physiological Perspectives on the Identification and Development of Talented Performers in Sport. In Fisher, R, Bailey, R (eds.). Talent Identification and Development. The Search for Sporting Excellence. Berlin: ICSSPE: 49-67.

0-072

Reproducibility of Pacing Strategies in High Level Junior Swimmers

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INTRODUCTION: Recently, the analysis of pacing strategies has gained importance in sports medicine research. Up to now, there is little data available in swimming. Three different ways of pacing have been described in swimmers: even, fast-slow and slow-fast pacing (Maglischo, 2003). This classification was mainly developed from observations in races at Olympic Games or World Championships. The aim of this study was to determine the reproducibility of pacing strategies in high level junior swimmers during 200, 400 and 800 m tests. METHODS: 16 competitive front crawl swimmers (7 ♀, 9 ♂, age: 16.9±2.2 years, training history: 6±1.8 years) performed 200, 400 and 800 m tests, each dis-

tance twice, within one week. All 100m split as well as total times were recorded for the 800 and 400 m test (50m split times for the 200m test). Furthermore blood lactate concentrations [bLa] were measured after each test. Training and nutrition on test days and the day before were tightly controlled. RESULTS: Pearson correlations as well as Bland-Altman analyses were used to determine reproducibility. Correlation coefficients (r) for the 800 m were between r = 0.83 and 0.97 for all split times, except for the last section (r = 0.79). Mean bias was between 0.13 and -0.81s, the limits of agreement [LoA] were between ± 1.7 and 5.0 s for all 100 m sections except the final one (mean bias = -1.05 s, LoA = 5.8 s). During the 400 m race r was above 0.90 for each section (mean bias = -0.16 to -0.60 s, LoA = ± 1.6 to 4.7 s). Results were similar during the 200m (r > 0.90, mean bias = -0.35 to -1.14 s, LoA = ± 1.1 and 2.6 s). For [bLa] was r was 0.88 during 800m and 0.80 during 400 m, whereas for the 200 m it was 0.32. DISCUSSION: The reproducibility of pacing profiles of junior swimmers seems acceptable, although the last section shows greater variability. Thus it might be speculated that anticipatory control of intensity is dominant during the race with actual sensory feed-back information getting more important during the end spurt of the race. However, the physiological rational behind pacing strategies is mostly unknown and further research is needed. REFERENCES: Maglischo (2003): Swimming fastest, Human Kinetics, USA.

O-073

A Competition-Based New Research Design to Assess an Intervention Affecting Performance of a Squad of Elite Athletes

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INTRODUCTION: Performance of elite athletes is difficult to study with conventional experimental designs, because sample sizes are usually small, coaches are often unwilling to randomize athletes to treatments, and performance in tests may not reflect performance in competitions. We present here a more practical powerful competition-based research design for sports in which a squad of athletes competes frequently as individuals and the coach is prepared to implement an intervention for a competition. METHODS: We developed and evaluated the competition-based design by analyzing US competitive swimming performance times, assuming an intervention affecting performance in all strokes and distances had been applied to swimmers in one or more arbitrarily chosen squads for one or more competitions. The swim times were downloaded from USAswimming.org for the period September 2008 through August 2009 (post Beijing Olympics through Rome World Championships and US Open Championships). We analyzed data for swimmers who achieved >900 Hy-Tek points at the World Championship selection trials and who were in squads of >2 swimmers at the trials. Each swimmer's best points score was then used to select their best event, and only competitions with >14 best-event swims were included. Times for the resulting 365 swims in 7 competitions by 146 athletes in 19 squads were then analyzed with a mixed linear model. Fixed and random effects were included in the model to estimate the intervention effect in a design equivalent to a parallel-groups controlled trial. RESULTS: Uncertainty in the estimate of the mean effect of an intervention in a given competition with a squad of ~13 swimmers was a minimum of ±0.7% (expressed as 90% confidence limits) when there were at least 50 other swimmers in that competition and all swimmers entered at least four other competitions. The same intervention applied to an extra squad (~25 swimmers in total) in a different competition reduced the minimum uncertainty to ±0.5%. DISCUSSION: The competition-based research design for interventions on athletic performance appears to provide outcomes that are more precise and trustworthy than those of conventional research designs, but clear outcomes with interventions producing trivial or smallest important effects for swimmers (~0.3%[1,2]) will require use of multiple squads in multiple competitions. REFERENCES: 1. Pyne, D.B. et al., J Sports Sci 22, 613-620, 2004 2. Hopkins, W.G. et al., Med Sci Sports Exerc 41, 3-12, 2009

O-074

Overall Trends and Individual Trajectories of Swimming Performance in a Decade of New Zealand National Championships

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INTRODUCTION: The progression of an athlete's competitive performance is an important element in the development of talent and selection of events, but little is known about changes in swimmers during their formative years. Here we report effects of calendar year and age on performance of swimmers at an annual national championship and an approach to prediction of future performance of individual swimmers. METHODS: The data were the official performance times of swimmers who had entered at least three New Zealand Age Group and Open Championships in 2000-2009 (65-194 swimmers with 261-769 entries in the 16 stroke and distance combinations for each sex). Each swimmer's best time in a given event was log-transformed for analysis of changes in performance as percents using a mixed linear model that included a quadratic trend to adjust for gradual overall yearly changes in performance and individual quadratic trends or "trajectories" for the effect of age on each swimmer's times. Each swimmer's trajectory was used to estimate age of best performance and to predict performance for several years following the last swim. RESULTS: Most boys' events showed practically linear improvements in mean performance time of 1-3% between 2000 and 2009; girls' breaststroke and butterfly showed similar improvements, but there was little change in most other girls' events. After adjustment for these trends, plots of each swimmer's times and their individual fitted trend showed that quadratics are appropriate to model age-related changes in performance. Age of best performance was similar for boys and girls but showed greater variation between girls (18.9 ± 1.5 and 18.7 ± 2.8 y respectively, mean ± SD); the range in best age for different strokes and distances was ~2 y. There was adequate precision for most estimates and for prediction of most individuals' performances. A change of coach or location for some swimmers was apparent as a substantial deviation of one or more swims from their quadratic trajectories. DISCUSSION: The overall progression statistics will help coaches and swimmers set realistic goals for race times at the National Championships. Annual implementation of the analysis to update the individual performance trajectories should provide guidance for event selection and talent identification.

O-075

A Full Body Computational Fluid Dynamic Analysis of the Freestyle Stroke of a Previous Sprint Freestyle World Record Holder

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INTRODUCTION: It has long been accepted that understanding fluid flow patterns in swimming should lead to performance enhancements. Unfortunately, the ability to quantify the effects of these flow patterns experimentally when swimming is limited and is typically only able to provide approximations of total body effects at best. Computational Fluid Dynamics (CFD) can be used to model and solve complex problems of fluid flow and is ideally suited to analysing drag and pro-

pulsion across the body when swimming.METHODS: A case-study approach was undertaken to examine the propulsion and drag forces across the body experienced during full body freestyle swimming using CFD. The swimmer used held the 50m and 100m freestyle World Record at the time of the testing and a full 3D surface scan of the swimmer was used for the CFD simulations. Manual 3D digitising was used to provide the 3D kinematics to animate the model. A realisable K-epsilon turbulence CFD model was used in the analysis.RESULTS: The overall changes in forces throughout the stroke were characterised by six clear cycles, containing four small peaks and two large peaks. These peaks represent the six beat kick pattern that was adopted, with the two large peaks correlating with the peak propulsion of the left and right arm strokes; which occurred simultaneously with two of the kick cycles. These peaks, and in particular the peaks associated with the arm stroke propulsion, were reflected in increases in the swimmer's instantaneous velocity. An examination of the breakdown in the distribution of forces revealed that the arms and legs create a significant amount of the total propulsion, with the trunk contributing to the majority of the drag force. The hands provided a total propulsive momentum of 23.8Ns while the combined contribution of the wrist, forearm and elbow was 27.6Ns. This highlights that the forearm position during the underwater arm stroke is as critical as that of the hands. Likewise the thighs, knees and shanks also contributed a greater percentage of the propulsion than the feet. DISCUSSION: The current study provided insight into how propulsion and drag forces are generated throughout a full freestyle swimming stroke through the use of CFD analysis. The resultant outcome of the analysis is both an increased level of foundational knowledge related to the production of propulsion and drag forces, as well as the provision of practical points that may be used to improve freestyle performance.

0-076

Computational Fluid Dynamics Applied to Competitive Swimming: The Role of Finger Position

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INTRODUCTION: The best fingers' relative position during the underwater path of the stroke cycle in swimming seems to be an unclear issue. Even in elite level swimmers, different relative positions of thumb and finger spreading can be observed. The aim of the current abstract was to present the hydrodynamic characteristics of a true model of a swimmer's hand with different fingers' positions using computational CFD. METHODS: Scans of the right hand of a male elite swimmer were obtained using a computer tomography scanner. The hand was scanned with fully abducted (68º), partially abducted (30º) and adducted thumb positions (Marinho et al., 2009). Furthermore, scans were made with fingers closed together, fingers with little distance spread (0.32 cm) and fingers with large distance spread (0.64 cm) (Marinho et al., 2010). Steady-state CFD analyses were performed using the Fluent® code. The measured forces on the hand models were decomposed into drag and lift coefficients (CD and CL). Attack angles of hand models of 0º, 45º and 90º, with a sweep back angle of 0º were used. RESULTS: The position with the thumb adducted presented slightly higher CD values compared with thumb abducted positions (0º, CD=0.25; 45º, CD=0.61; 90º, CD=1.09). The position with the thumb fully abducted presented higher CL values at attack angles of 0º (CL=0.24 vs. CL=0.21, partially abducted; CL=0.18, abducted) and 45º (CL=0.65 vs. CL=0.62, partially abducted; CL=0.60, adducted). The model with little distance between fingers (0º, CD=0.24; 45º, CD=0.68; 90º, CD=1.13); presented higher CD values than the models with fingers closed (0º, CD=0.25; 45º, CD=0.61; 90º, CD=1.09) and fingers with large distance spread (0º, CD=0.26; 45º, CD=0.57; 90º, CD=0.93). The values for the lift coefficient presented little differences between the three models, for a given attack angle (0º, CL≈0.20; 45º, CL≈0.60; 90º, CL≈0.20). DISCUSSION: For hand positions in which the lift force can play an important role (e.g. insweep phases), the abduction of the thumb may be better, whereas at higher angles of attack, in which the drag force is dominant, the adduction of the thumb may be preferable. Moreover, these thumb positions should be associated to fingers slightly spread, allowing the hand to create more propulsive force during swimming. REFERENCES: 1. Marinho DA et al. J Sports Sci and Med 2009; 8(1): 58-66. 2. Marinho DA et al. J Appl Biomech 2010; in press. Supported by FCT (PTDC/DES/098532/2008)

0-078

Hydrodynamic Characterization of the First and Second Glide Positions of the Underwater Stroke Technique in Breaststroke

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INTRODUCTION: The gliding constitutes a non-negligible part of the swimming races. The aim of this work was to experimentally study the first and second gliding positions of the breaststroke underwater stroke used after starts and turns at several gliding velocities by characterizing: gliding velocity (v); body cross sectional area (S); drag coefficient (CD); passive drag (D). METHODS: Six national level male swimmers participated in this study. A methodology similar to that described in Vilas-Boas et al. (in press) was used, namely determining S using planimetry while D and CD were assessed through inverse dynamics based upon the velocity to time curve of each glide, monitored through a swim-meter (Lima et al. 2006). RESULTS: The first glide presented higher mean values of v (1.50 ± 0.22m/s and 1.15 ± 0.24m/s) while the higher values of acceleration were verified in the second glide. D increased with v while CD decreased. Swimmers showed a smaller S in the first glide position than in the second (759.95 ± 124.12cm2 vs 814.46 ± 111.23cm2). DISCUSSION: The first glide obtained higher v values, as it follows wall impulse and has a better hydrodynamic position. For both glides, D increases with v, while CD decreases. The first one is characterised by lower D and CD values for all v, probably due to a parallel and concurrent effect of S and CD caused by the increased body length and slenderness associated with the flexed shoulders and extended arm position. Therefore, swimmers and coaches should stress the need for body position control during the glides, and the need of technical evaluation, control and advice to allow drag reductions during swimming performance, and not only emphasising propulsion increase capabilities. REFERENCES: 1. Lima, A.B.; Semblano, P.; Fernandes, D.; Gonçalves, P.; Morouço, P.; Sousa, F.; Fernandes, R.; Barbosa, T.; Correia, M.V.; Tani, G.; Vilas-Boas, J.P. (2006). A kinematical, imagiological and acoustical biofeedback system for the technical training in breaststroke swimming Portuguese Journal of Sport Sciences, 6 (Suppl.1): 22. 2. Vilas-Boas, J.P.; Costa, L.; Fernandes, R.; Ribeiro, J.; Figueiredo, P.; Marinho, D.; Silva, A; Rouboa, L.; Machado, L. (in press). Determination of the drag coefficient during the first and second gliding positions of the breaststroke underwater. Journal of Applied Biomechanics

O-079

3D Computational Fluid-Structure Interaction Model for the Estimation of Propulsive Forces of a Deformable Monofin

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INTRODUCTION: The current paper contributes to the investigations of biomechanical aspects of propulsion of swim fins. Indeed, we describe a new method that is devoted to computation of propulsive forces generated by flexible monofin. From this method, we calculate the added mass and show the great impact of this parameter. METHODS: A 3D fluid-structure model with inertial coupling is developed. The monofin is assumed to be a deformable elastic structure. The fluid is described with the acoustic pressure. The coupling results in an added mass charcterizings the energy transmission between the fin and the water. A numerical computation with the Finite Element Method (FEM) is conducted. The transient propulsive force end torque are investigated. RESULTS: The added mass of surrounding water affects significantly the eigenfrequencies and modal shapes. It can be observed that taking into account for 3D effects leads to decrease (27.71 to 40.21%) the vibration frequency of the fin. Moreover, the influence of the elasticity has been investigated and shows that he flexibility of the fin blade increases the thrust. A significant variation of the frequency of the non-harmonic thrust evolution is observed with regards to the applied stroke kinematics that are harmonically varying. DISCUSSION: To our knowledge it is the first fluid-structure interaction model for the whole monofin-water system solved by 3D FEM approach. It is based on a monolithic resolution of the whole system fluid and solid. REFERENCES: Bideau N, Mahiou B, Monier L, Razafimahery F, Bideau B, Nicolas G, Razafimahery F, Rakotomanana L (2009). 2D dynamical efficiency of a swim-fin: a fluid-structure approach. Computer Methods in Biomechanics and Biomedical Engineering, 11: 53-54.

O-080

Human Undulatory Swimming: Kinematics, Flow and Mechanical Model

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INTRODUCTION: We have learned that athletes in high level swimming try to copy successful strategies from fish locomotion. They use underwater undulatory motion, also called dolphin kicks, to reach an optimum motion by filed kinematics. Due to the absence of systematic studies intensive training phases are necessary to check in the trial-error-principle the advantages and disadvantages of different variations of the motion. The aim of this study is to understand the motion in its fluid mechanical impact and to develop a motion pattern for optimum and efficient propulsion with the help of modern experimental and numerical flow analysis. METHODS: Time resolved particle image velocimetry (PIV) was used to visualize the flow around a swimmer during underwater undulatory swimming in still water in an indoor pool. The principle of PIV is to calculate the displacement of a large number of small levitating particles (diameter: 100 ìm, typically illuminated using green laser light) of two consecutive pictures. The path of the particles was monitored at 250 fps with a high speed video camera (PHOTRON Ultima APX). Local flow velocities and the velocity field were calculated by a cross-correlation algorithm. Swimmers kinematics were recorded using active LED marker at the joints and a video camera system (BASLER A602fc, 30 fps). RESULTS: Vortex generation is monitored in the head region and mainly in the region of the legs. The human swimmer shows a highly complex flow pattern along the body and in the wake. Vortices are generated either at edges like the chin or in regions of high angle acceleration, e.g. dorsal of the knee due to knee flexion or ventral of the knee due to knee extension. These vortices are generated already cranial but are reused pedal for propulsion (vortex re-capturing [1]). DISCUSSION: Although the human body is limited by movement asymmetries and far from the flexible streamlined body of fish high level swimmers partly copy successful strategies from fish locomotion. It remains to show the differences in kinematics and flow pattern due to swimming with maximum thrust and swimming effectively and the advantage of using flow preformation. Flow tunnel experiments of a segmented mechanical model should verify the obtained flow pattern around the human swimmer. REFERENCES: [1] Hochstein, S. et al. (2009) *Swimming like a fish? First evidence of vortex re-capturing.* In: A. Duarte, J. Cabri, J. Barreiros (Eds.), European Workshop on Movement Sciences, Lisbon, p. 89

O-081

The Development of a Component Based Approach for Swim Start Analysis

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INTRODUCTION: Research on swimming starts has included information on the block, flight, underwater and free swimming phases using a variety of technologies. This study examined variables contributing to overall starting performance. A system developed to better understand these phases comprised video, force and acceleration information. Testing demonstrated system reliability and the impact of intervention with an elite athlete. METHODS: The aim of the research was to fuse vision, force plate data and acceleration data to enhance quantitative feedback to coaches and swimmers. A platform incorporating four tri-axial force transducers was integrated into a starting block. Data was synchronised with video and wireless acceleration data for various levels of competitive swimmers. RESULTS: Measurements included horizontal and vertical force throughout the block phase, first movement, overall block and flight times and distance as well as time to the first stroke and number of strokes to 15m. Arellano et al. (2005) and Mason et al. (2007) suggested that horizontal force results in better starts. An elite swimmer had 1.2% variation in timing and peak forces between trials while the equivalent variability for a University level swimmer was 16% and 14% respectively. The intervention study showed no changes in the horizontal forces but 6% reduction in the vertical forces for an elite athlete. However, data from our studies is too limited to determine the best variables associated with overall start performance. DISCUSSION: Individual components have been developed that enable the start to be quantified throughout various phases. Results in pilot examples have highlighted the reliability of the data and the impact of intervention. The synchronisation of the data provides accurate and timely feedback. Future work will develop a more complete understanding of force and acceleration data. REFERENCES: Arellano, R., Llana, S., Tella, V., Morales, E., Mercade, J. (2005). A Comparison CMJ, Simulated and Swimming Grab Start Force recordings and their Relationships with the Start Performance, XXIII ISBS, China. Mason, B., Alcock, A., Fowlie, J. (2007). A Kinetic Analysis and Recommendations for Elite Swimmers Performing the Sprint Start, XXV ISBS, Brazil.

O-082

Influences of the Back Plate on Competitive Swimming Starting Motion in Particular Projection Skill

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INTRODUCTION: For the swimming, an important factor is motion on the block to start fast. The starting platform with a back plate has been approved by FINA. The purpose of this study was to identify the influences of the back plate to swimming starting motion in particular projection skill. METHODS: Ten male college swimmers were used as subjects. They performed the track start from the conventional platform (CON) and from the platform with the back plate (BKP). The back plate was used a pedal for a track and field starting equipment. Digital video camera was used to record the performance of each trial from side view. The projective motion was divided into set position, acceleration phase, take-off and flight phase. Kinematic variables were calculated using 2D-DLT method. These variables for the projective motion consisted of the 15 items. RESULTS: At the set position, the horizontal coordinates of CM were BKP;-0.205(0.054) m, CON;-0.253(0.054) m. The CM position of BKP was significantly forwarder. The knee angles of rear leg were respectively BKP;84.3(11.3) degree, CON;97.1(11.4) degree. Knee of BKP were extended significantly narrower. During just before the take-off, the mean pre-projection angles of CM were BKP;-6.7(4.4) degree, CON;-8.2(4.3) degree. BKP was significantly more horizontally. At take-off, projection angles of CM were BKP;-8.2(5.2) degree, CON;-10.5(4.9) degree. BKP was more horizontally near and significantly larger. Vertical velocities of CM at the take-off were BKP;-0.65(0.45) m/s, CON;-0.81(0.45) m/s. BKP was near the zero and significantly lager. Other items for the take-off and for flight was not seen significantly difference. DISCUSSION: At the set position, the CM of BKP displaced to anterior. It was in agreement with study of squatting-to-standing movement that heel elevation primarily influenced postural adjustment as anterior displacement of the hip.In BKP, the rear knee angle was about 90 degree. Isometric force-angle relationship of knee extension had reported that larger force was at 105 to 120 degree than other degree condition. Therefore, the rear knee of BKP should be more extend a little more. It seemed that the pre-projection angle of BKP approached horizontally was a preferable effect with back plate. There were a few influences of the back plate at take-off and during flight phase. As subjects did not have an enough skill for using a back plate yet, they could not keep the domination on the starting block.

O-083

A Biomechanical Comparison of Elite Swimmers Start Performance Using the Traditional Track Start and the New Kick Start

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INTRODUCTION: The international governing body for swimming (FINA) has approved the use of a new starting block (Omega, OSB11) with an inclined kick plate. This has required the development of a kick start technique. The kick plate is angled at 30° to the surface of the block and can move through five different locations on the platform. To date, no study has examined the biomechanical factors associated with a start using the OSB11. Hence, the purpose of this study was to determine the effects of the new start platform on performance, relative to that of the track start. METHODS: The study utilised 14 elite swimmers (nine male aged 20.8 ± 3.0 years, five female aged 21.4 ± 2.8 years) all of which had personal best times which attained a minimum of 850 FINA points. Each completed six dive and glide starts (three kick starts and three track starts) in a randomised sequence. The analysis system calculated the overall force profile of the start. It utilised an instrumented start block including the measurement of the rear foot through a second instrumented incline plate. The system included a series of calibrated high speed digital cameras, one above water to capture the start and three underwater to obtain vision from 0 m to 15 m. A video camera timing system was used to obtain the times to 5 m and 7.5 m. RESULTS: The mean time on block was 0.77 s for the kick start, which was significantly less ($p<0.01$) than the track start 0.80 s. The kick start was also significantly faster ($p<0.05$) to 5 m and 7.5 m than the track start (1.62 s & 2.69 s compared to 1.66 s & 2.73 s, respectively). The kick start produced a significantly higher ($p<0.01$) horizontal take-off velocity (4.48 $m.s^{-1}$) compared to the track start (4.41 $m.s^{-1}$) and a higher average horizontal force (0.60 N/kg compared to 0.57 N/kg). The average velocity between 5 m and 7.5 m was not significantly different ($p>0.05$) between the two techniques. DISCUSSION: The results of this study indicate that the kick start on the new OSB11 start platform was significantly faster than the track start. Despite the participant's own bias towards their preferred technique being the track start, the kick start was significantly faster off the block; with a higher horizontal velocity and an increased on block horizontal force. This advantage was maintained through the time to 5 m and 7.5 m. This preliminary research indicates that coaches and athletes should spend time adapting to the new block and the new starting technique.

O-084

Comparison among Three Types of Relay Start in Competitive Swimming

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INTRODUCTION: Step start techniques in relay events could generate higher horizontal velocity at the take-off from starting block (McLean et al. 2000). However, the relay time was not considered in the relay start performance in their study. The purpose of the present study was to evaluate effectiveness of no-step (NS), single-step (SS) and double-step (DS) relay start. METHODS: Eight collegiate male swimmer participated in the present study. Swimmer performed relay start trials with maximum effort 6 times in each relay start trials. Ground reaction force were measured by Kistler force plate and calculated the take-off velocity and take-off angle from force date. The relay time were measure by counting video image of high-speed camera (250Hz). RESULTS: Relay times significantly were shorter in order of No-step start (0.018 ± 0.029sec), Single-step start (0.052 ± 0.044 sec) and Double-step start (0.087 ± 0.060 sec) ($P < 0.05$). Horizontal velocity by legs driving in the no-step start (3.50 ± 0.34m/s) was significantly faster than that of the double step start (3.22 ± 0.25m/s) ($P < 0.05$). There was no significant difference in horizontal take-off velocity (NS: 4.09 ± 0.34m/s, SS: 4.09 ± 0.31m/s, DS: 4.13 ± 0.32m/s) and take-off angle (NS: -11.92 ± 6.15°, SS: -13.18 ± 5.27°, DS: -13.70 ± 4.80°). There were eight trials in total each step start trials of all subjects by determined missed trial for feet placements from the video image. DISCUSSION: The eight trials of missed feet placements in total trials of each start indicated that the degree of difficulty of the step start was higher than the no-step start. Therefore, no-step start is better for achieving constant and higher performance at actual relay event of competition from the results in the present study. However, a step start may has a possibility to generate higher horizontal take-off velocity. REFFERENCES: 1.McLean SP, Holthe MJ, Vint PF, Beckett KD, Hinrichs RN (2000). Addition of an approach to a swimming Relay Start. Journal of Applied Biomechanics, 16: 342-355.

O-085

Influence of Swimming Start Styles on Biomechanics and Angular Momentum

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INTRODUCTION: Mc Lean et al. in 2000 calculated kinetic momentum generated during block phase for relay's starts to analyze the quantity of rotation. It was shown that use steps before leaving the block make more steeper takeoff and entry angles. Pike trajectory or arms swing during flight phase can thus have an incidence on body rotation and by consequence on aerial part of the start. The aim of this study was to make a relationship between angular momentum generated during the start and the different start styles. METHODS: Elite swimmers performed 3 times a 25-m at 50-m race pace with preferential start technique. Durations of the block and flight phases, the body angles at take-off and entry, kinetic momentum and standard deviation of it, kinetics and 15m time, were assessed. The sample was classified according to Seifert et al.. Correlations between variables and 15-m time were calculated and ANOVA tests assessed differences between start styles. RESULTS: Performance to 15m were similar between groups. Concerning start variables, take off angle, flight distance, total and standard deviation of angular momentum were significantly lower for flat start by report to the two other start styles. Entry angle was significantly greater for pike start. Vertical impulse was significantly negatively correlated with time to 15m (r=-0.507) and ΔH was positively (r=0.461). DISCUSSION: Lower angular momentum and shorter flight phase for flat start suggest a strategy of reducing aerial phase to go more quickly in the water. Swimmers in flat style reduced temporal deficit instead of trying to travel a higher distance in the air and store higher velocity at water entry for following phases for other styles. Expertise can't thus be reduce to the accession to a unique technique but optimising with own personal characteristics. Different ways were used: reduce temporal deficit and start to swim early (flat style) or generate high velocity and go farer in the air to travel longer distance and compensate the relative loss of time in following parts of the start (pike and Volkov starts). REFERENCES: 1. Seifert, L., Vantorre, J., Lemaitre, F., Chollet, D., Toussaint, H.M., Vilas-Boas, J.P. (2009). Different profiles of the aerial start phase in front crawl (under press), Journal of Strength and Conditioning Research 2. McLean, S.P., Holthe, M.J., Vint, P.F., Beckett, K.D., Hinrichs, R.N. (2000). Addition of an approach to swimming relay start.

O-086

Learning Flat and Pike Entries during Swim Start from the Block

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INTRODUCTION: A study with two randomly assigned subgroups was conducted to examine to effects of feedback information (entry angle) on the dive-in performance. While one group was instructed to perform a pike entry the other subgroup had to exercise a flat entry (i.e. Mills & Gehlsen, 1996; Maglischo, 2003). METHOD: Ten male elite swimmers participated in the study. Five starts were performed for each of four separate learning interventions. While the take-off phase was examined by an above-water video camera and portable starting block equipped with 2D-force strain gauges, the dive-in phase was examined with an under-water video camera. The starting performance was examined by the time elapsed between the starting signal and the passage of the head at 7,5 m. After each start, subjects received feedback information on their entry angle (angular displacement of the interconnecting line: finger tip vs. hip joint to the horizontal alignment). In addition, subjects were presented a slow motion video sequence of their take-off and dive-in behaviour. For the flat entry a entry angle of less than 35° was required. For the pike entry, subjects were asked to keep their entry angle above 40°. For the statistical analysis, kinematic parameters were used representing the take-off phase as well as the dive-in phase. For the latter, a new model was applied to reliably detect body landmarks despite air particles swept along the body surface during the dive-in phase and distorting clear vision. Dynamic parameters (maximal horizontal and vertical force values) completed the data analysis. The three best starts were included in the statistical analysis. An analysis of variance was used to identify statistical correspondences. RESULTS: Both subgroups improved their starting performance significantly. Subjects changed their take-off angle according to their required entry angles. Changes in the take-off angle, in the entry angle, and in the horizontal take-off velocity were statistically explained by the intervention factor and by the group factor. While the flat entry group improved their horizontal take-off velocity, no change in this parameter was observed for the pike entry group. However, the higher horizontal take-off velocity in the flat entry group was associated with less pronounced horizontal velocity during dive-in. The opposite effect was true for the pike entry group.

O-087

Do Fastskin Swimsuits Influence Coordination in Front Crawl Swimming?

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INTRODUCTION: Fastskin suits (FS) have been greatly contested over the past several months, and the numerous studies on them have reported contradictory findings. The aim of this study was to compare the effects of FS on spatio-temporal parameters and the Index of Coordination (IdC) developed by Chollet et al. [1]. METHOD: In the first part of this study, 15 swimmers (6 females and 9 males) were asked to carry out a series of glide, buoyancy and passive torque tests and to swim a series of 25-m trials at four velocities (800, 400, 100 and 50 m), with and without FS. In the second clinical part of the study, a French international swimmer, specialized in short distances, carried out the same tests in SS condition and with three different FS. RESULTS: The results showed no significant differences in buoyancy, glide or passive torque with and without FS. A significant difference in IdC ($p<.01$): with FS: -9.562±5.87 versus without: -8.323±6.83 and propulsive phase ($p<.01$): with FS: 40.289±5.59 versus without: 41.609 ±6.81 was detected by looking at the average values of the four velocities. DISCUSSION: IdC was affected by wearing an FS, with a reduction in drag constraints for the same given speed, making each propulsive movement more effective. The compressive effect of these new FS, by reducing body volume and then damaging floatation, is offset by an improvement in the Cx. This compression is thus more useful for higher swim speeds. The case study of a real sprinter confirmed this change in coordination logic and further showed that, thanks to FS, he did not have to stack his actions to reach his highest speed. This study also suggested that the same FS could have different effects for other swimmers, each swimmer being unique: the same swimmer using a different swimsuit might be differently affected. The newest generation of FS, which did not improve buoyancy, did improve the glide and reduce drag. The swimmer thus had fewer constraints and was perhaps able to swim higher on the water, without needing to stack his actions. His coordination at a given speed when wearing an FS corresponded to coordination at a slower speed without an FS. REFERENCES: Chollet D., Chalies S., Chatard JC. (2000). A new index of coordination for the crawl: description and usefulness. Int J Sports Med, 21(1): 54-59.

O-088

A Comparison of Characteristics of High Functional Swimwear for Competitive Swimming

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INTRODUCTION: The purpose of this study was to clarify factors of the high functional swimwears had made a lot of new world records recently, and to suggest design improvements for a new swimwear suitable for the new regulation by FINA. METHODS: Two elite swimmers participated in this study. LZR Racer (L), Aqua Force (F), and X-Glide (X), as the high functional swimwears, and Aile-Bleue (B) as a comparative swimwear were used. L has high wearing pressure, F was made by rubber, X has both peculiarity of L and F. To evaluate of characteristics of the swimwears, we measured 1) the passing velocity under the water after starting, 2) the cross sections (CS) of a leg, and 3) the passive drag by using a swim mill. RESULTS: The mean passing velocity (m/s) of the subjects after starting with the X was higher than others (X:2.1±0.5, L:2.0±0.4, F:2.0±0.4, B:1.9±0.5). The relative values (%) which indicate a constriction of a thigh with L was smaller than others (X:149.3±16.1, L:147.4±19.4, B:152.7±18.8). The passive drag with L was larger than others. The passive drag (N) with X and F were small at lower velocity but became larger at higher velocity (velocity 0.6-1.4m/s ; X:10.2±10.4, L:14.7±11.8, F:6.5±10.3, B:10.0±12.2, velocity 1.6-1.8m/s ; X:62.5±18.3, L:63.5±14.1, F:49.3±13.1, B:45.0±10.9). It was observed the legs f position with X or F became closer to the horizontal line. DISCUSSION: The results of passive drag reveal that rubber swimwears (X and F) indicated a different tendency between the lower and higher flow velocity. It is thought that the drag decreased due to the body position became close to the horizontal because the rubber swimwears might have an effect for lifting the legs, but the effect induced an increase of the wave drag at higher velocity, then the passive drag inverted between the rubber swimwears and others. For an effect of constriction by the swimwears, it was observed the CS of a thigh was decreased by wearing the L and X. As all findings of the research, it is concluded F has an effect for reducing the drag due to lift legs, L has an advantage to restrain vibration of legs by a strong compression, and X gets both benefits of the two swimwears. According to the new regulation, a rubber material was not forbidden. So it was important to investigate a new material instead of a rubber and to achieve an appropriate wearing pressure. REFERENCES: 1, Federation Internationale de Natation (2009) FINA Requirements for swimwear approval

O-089

Effects of Swimwear Developed in 2008 on Drag During Front Crawl Swimming

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INTRODUCTION: Last 2 years (2008-2009), numerous new world records were made in competitive swimming races. The great success seems to be caused by a reduction in drag with an improvement of quality of swimwear, however the prediction has not been clarified, yet. Therefore, the present study investigated the effect of new types of swimwear developed in 2008 on drag during front crawl swimming. METHODS: The subjects were 8 well-trained male college swimmers (age: 21±1 yrs). For this experiment, 4 different swimwear were used; one was a conventional swimwear (pants-short) and the others were 3 different pants-long swimwear that were developed in 2008. The subjects swam 25m more than 10 times at different but constant swimming velocity wearing each swimwear, in order to establish drag-swimming velocity relationship. The active drag force was directly measured during arm stroke of front crawl swimming using a system of underwater push-off pads instrumented with a force transducer (MAD system) (Toussaint 1988, Ogita 2006). RESULTS: The mean drag values that were estimated for a range of swimming speed (1.2, 1.5, and 1.8 $m \cdot s^{-1}$) were lower by 1-5 N (2-6%) in 3 new types of swimwear than those in conventional wear, but those differences were not statistically significant (conventional vs others; P>0.7). There were no significant differences in drag among 3 new types wear, either (P>0.9). However, when race times in 100m to 400m were estimated based on the drag, metabolic power of each subject, and assumed mechanical (9%) and propelling efficiency (60%), time reductions in 1 to 4 s would be expected by wearing new types of swimwear. DISCUSSION: These results suggest that on a group level, although no significant reduction in drag during front crawl swimming were found between conventional and newly developed swimwear, the observed small reduction in drag might be provide a considerable competitive advantage. REFERENCES: 1. Ogita F, Tanaka T, Tamaki H, Wagatsuma A. Hamaoka T, Toussaint HM (2006). Metabolic and mechanical characteristics of Olympic female gold medalist. Biomechanics and Medicine in Swimming X, eds., J.P. Vilas-Boas, F. Alves, A. Marques, Porto; Portuguese journal of sport sciences 6, Suppl 2: 194-197. 2. Toussaint HM, de Groot G, Savelberg HHCM, Vervoorn K, Hollander AP, van Ingen Schenau GJ (1988). Active drag related to velocity in male and female swimmers. J Biomech, 21: 435-438.

O-090

Shaving and Perceptual Sensory Threshold

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INTRODUCTION: For more than half a century, competitive swimmers have performed the act of shaving hairy skin prior to a championship. However, scientific evidence explaining the mechanism by which shaving down enhances performance is minimal. The objective of this study was to quantify sensory perception before and after shaving. METHODS: Before shaving, sensory perception threshold force was identified in ten neurologically normal men (26±3.6 yrs). Semmes-Weinstein monofilaments were applied perpendicular and in triplicate to a 1 cm2 skin area overlaying the gastroc, and a single verbal response of "yes" was sufficient to qualify as positive perception. The mean of four alternating ascending and descending threshold tests were used to establish a perceptual threshold force for each condition. All perceptual tests were performed with no visual input from the subject. These procedures were performed for each of the randomized conditions of no wind and wind. After the pre-shave trial, both legs were completely shaved between transverse planes at the lowest point of the torso and the lateral malleolus. Sensory threshold procedures were repeated 24 hours post-shave. A thermistor was used to measure calf skin temperature for each experimental condition. A two-way repeated measures ANCOVA was used to determine differences between the factors of shave and wind with skin temperature as a covariate. RESULTS: A significant two-way interaction between treatments of shave and wind [$F(1,9)= 14.48$, $p<0.01$] was observed. Pre-shave sensory threshold force was significantly greater ($F(1,18)= 20.27$, $p<0.001$) with wind than that without wind (3.91±2.67g vs. 1.79±1.5g). However, post-shave sensory threshold force was not significantly different with or without wind. Without wind, sensory threshold force before and after shaving did not differ. However, in the presence of wind, pre-shave sensory threshold force was significantly greater than post-shave [$F(1,18)= 7.03$, $p<0.05$]. Skin temperature was not different from pre- to post-shave. DISCUSSION: Shaving hair of the legs did not result in an altered sensory perception. However, under the wind condition, shaving resulted in an improved ability to perceive a cutaneous stimulus, with skin temperature being constant. Therefore, when perturbed by wind, hairy skin may attenuate sensory perception. If this change is due to changes in peripheral input to the motoneurons, then the resultant motor output (swim performance) may also be affected.

O-091

The Acute Effect of Front Crawl Sprint-resisted Swimming on the Direction of the Resultant Force of the Hand

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INTRODUCTION: For effective propulsion the resultant force produced by a swimmer's hand should be aimed as much as possible in the swimming direction (Toussaint et al., 2000). Moreover, it is suggested that in-water resistance training methods, such as sprint-resisted swimming, would be more effective for the improvement of the swimming performance. However, there is a lack of data regarding the acute effect of the sprint-resisted swimming on the direction of the resultant force of the hand, which was the aim of the present study. METHODS: Five female swimmers swam 25 m front crawl with maximal intensity, without and with added resistance. A bowl with a capacity of 6 l was used as added resistance. The underwater motion of the right hand was recorded using 4 cameras (60 Hz) and selected points were digitized using the Ariel Performance Analysis System. The hydrodynamic coefficients and the methodology presented by Sanders (1999) were used for the estimation of the drag, the lift and the resultant force of the swimmer's hand. Moreover, the angle between the resultant force and the axis of propulsion was calculated. For the statistical treatment of the data the t-test for dependent samples was used. RESULTS: During resisted swimming the magnitude of the drag, the lift, the resultant and the effective propulsive forces were not altered significantly. However, the angle between the vector of the resultant force and the axis of swimming propulsion in the pull phase was decreased significantly (t4= 2.877, p< 0.05) during resisted swimming (13.26 ± 15.37 deg), in comparison with free swimming (36.31 ± 14.73 deg). DISCUSSION: During sprint-resisted swimming, the angle formed between the resultant force vector and the axis of the swimming propulsion was decreased significantly in the pull phase and thus the resultant force was steered more in the forward swimming direction. Consequently, it could be speculated that front crawl sprint-resisted swimming probably could contribute to the learning of a more effective application of the propulsive forces. REFERENCES: 1. Sanders R. (1999). Hydrodynamic characteristics of a swimmer's hand. J Appl Biomech, 15: 3 – 26. 2. Toussaint HM, Hollander AP, Berg Cvd, Vorontsov AR. (2000). Biomechanics of swimming. In: Garrett WE, Kirkendall DT (eds.). Exercise and Sport Science. Philadelphia, Lippincott: Williams & Wilkins, 639-660.

O-092

Mechanical And Propulsive Efficiency Of Swimmers In Different Zones Of Energy Supply

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INTRODUCTION: The goal of the research was experimental studying of regularities for metabolic energy transformation into velocity of human's swimming by sports strokes in different zones of energy supply on the basis of the mathematic model of this process: v0 = Pai•eg•ep / Fr(f.d.), in which v0 is mean swimming velocity at the competitive or training distance {m·s^{-1}}; Pai is power of active energetic metabolism {W}; eg is dimensionless coefficient of mechanical efficiency; ep is dimensionless coefficient of propulsive efficiency; Fr(f.d.) is frontal component of active drag force {N} (Kolmogorov, 1997) METHODS: To define experimentally variables of the mathematic model, a complex of physiological and biomechanical research methods has been applied (Kolmogorov, 2008). 29 female and male university swimmers took part in the research in the three zones of energy supply: below the threshold of anaerobic metabolism (AT), above the zone of maximal oxygen consumption (VO2 max) and in the zone between AT and VO2 max. RESULTS: In human's water locomotion, eg (for women it ranges from 0.0592±0.0022 to 0.0659±0.0015, for men – from 0.0685±0.0029 to 0.0792±0.0026) is much lower than ep (for women it ranges from 0.647±0.009 to 0.704±0.009, for men – from 0.670±0.010 to 0.721±0.012). The highest values of eg and ep female and male swimmers have shown in the zone between AT and VO2 max. In all the zones of energy supply, male swimmers have higher values of eg. At the same time, the values of ep are equal for female and male swimmers. DISCUSSION: Effective and safe ways to improve swimmers' sports results in the process of training meso-cycle are, first of all, connected with decreasing of unavoidable losses at both stages of metabolic energy transformation into useful activity result, which is quantitatively reflected in dynamics of values of mechanical and propulsive efficiency. REFERENCES: 1. Kolmogorov, S.V. (1997). Transformation effectiveness of elite swimmers metabolic and mechanic energy. In: Eriksson, B. & Gullstrand, L. (ed.). Proceedings XII FINA Wold congress on sports medicine. Goteborg: Chalmers Reproservice, 453–462. 2. Kolmogorov, S.V. (2008). Kinematic and dynamic characteristics of steady-state non-stationary motion of elite swimmers. Russian Journal of Biomechanics, 12(4): 56-70.

O-093

Physiological and Performance Characteristics of 200 m. Continuous Swimming and 4X50m "Broken" Swimming with Different Interval Time.Demands

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INTRODUCTION: The purpose of this study was to investigate: 1) the physiological demands of "broken" swim (4X50m) with different interval and the physiological demands of continuous method (200m) during free-style swimming of maximum intensity and 2) which interval in broken swimming, contributes to the development of higher swimming speed with similar physiological demands to continuous swimming. METHODS: Twelve swimmers (aged: 14-17 years) with at least five years of training age were tested in 4 conditions: in 200m and in 4X50m of free-style swimming with 5, 10 and 20 s interval time between sets. In the beginning, a VO2max test was performed. In all sets, oxygen consumption (VO2000 Breeze Lite, MedGraphics, USA), blood lactate concentration (Accusport, Boehringer, Germany), heart rate (Polar, Vantage NV, Finland), performance time, mean speed and hands frequency, rate of perceived exertion (Borg scale), were measured. One way ANOVA for dependent samples was used to define the overall differences in each variable. One way ANOVA also, for dependent samples with repeated measurements was used to define differences in each variable between 50m sets. A Tukey test was employed to assign specific differences in the analysis of variance. Statistical significance was set at P<0.05. RESULTS: Significant differences between continuous and "broken" swimming with 20 s interval were observed in performance (2:29.33±9.27 vs 2:17.12±7.78 sec, P=0.004), in mean speed (1.35±0.073 vs 1.46 m.sec-1, P=0.004) and in heart rate (184.00±5.42 vs 195.08±12.34 beat.min-1, P=0.01). No differences were observed in performance time and in hands frequency between sets of 50m with 20 s interval time. On the contrary, these parameters were significantly different in conditions of smaller interval time (10 and 5 s) and in continuous swimming of 200 m. DISCUSSION: Continuous swimming of maximum intensity and "broken" swim with 5 and 10 s interval time did not differ in performance characteristics and physiological responses. Higher intensity and greater performance were achieved in "broken" swimming compared with continuous swimming, when the interval time was 20 s. However, no differences were observed in

physiological responses. Collectively, it seems that high swimming speed training with similar physiological demands to continuous training needs a short interval that allows athletes to swim at higher intensity and to improve performance.

O-094

Crucial Findings from the 4W Model of Drowning for Practical and Teaching Applications

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This study aimed to suggest practical and teaching applications of the 4W model of drowning. A major literature review of quantitative research was undertaken to identify potential risk factors of drowning, qualitative content analysis was used to analyze publicly available drowning incident videos (n = 41, M = 345.0, SD = 2.8), and 34 individuals involved in drowning incidents were interviewed (30 males age 16–65 years, M = 28.4, SD = 11.3; 4 female age 19–65 years, M = 37.5, SD = 19.5). Results confirmed that test criteria such as a 100 m run–50 m swim–100 m run for open water and a 50 m run–20 m swim–50 m run for pool/water parks could be more useful for assessing speed combined with an 'early approach' to the victim than any currently in operation. The 'early approach' criterion would be established to test the ability of the lifeguard to be able to remain alert, to have good vision, to recognize the casualty's instinctive drowning response, to initiate a rescue ignoring the bystander's lack of response and to reassure the drowning victim. Drownings and their rescue interventions should be perceived as 3-dimensional problems.

O-095

Real and Perceived Swimming Competency, Risk Estimation, and Preventing Drowning among New Zealand Youth

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INTRODUCTION: Drowning as a consequence of aquatic activity is a significant cause of unintentional death among New Zealand youth. The ability to swim has long been promoted by water safety organisations as a critical asset in drowning prevention. However, little is known about youth real or perceived swimming competency or of their perceptions of their risk of drowning. This study reports the New Zealand preliminary findings of an international project entitled the Can You Swim Project? METHOD: The subjects were a cohort of beginning undergraduate students of Physical Education (n = 68) assessed in a two-part study using an initial questionnaire survey to provide self estimates of swimming competency and risk perception, followed by a practical test of seven swimming-related competencies. RESULTS: One third of the students estimated that they could swim less than 100 m (n = 21; 32%), compared with 34% when tested. Similar proportions were obtained for those who thought they could swim more than 300m non-stop (estimated 41%; actual 43%). No significant gender differences in either real or perceived swimming competency were found. However, significantly more males estimated lower risk of drowning associated with a series of aquatic scenarios. Most females rated falling into a deep river fully clothed as an extreme/high risk situation (females 69%, males 6%), most males considered this to be a low/no risk situation (males 94%, females 31%). DISCUSSION: Student self-estimates of competency compared well with actual measurement. No significant gender differences were found in self-estimated or actual swimming competencies, but males significantly estimated lower risks of drowning across a range of drowning scenarios. The implications of these findings on drowning prevention and the need for further investigation are discussed. REFERENCES: 1. Moran K. (2006). Re-thinking drowning risk: The role of water safety knowledge, attitudes, and behaviours in the aquatic recreation of New Zealand youth. Unpublished doctoral dissertation, Massey University, New Zealand. 2. Stallman R.S., Junge M. and Blixt T. (2008). The teaching of swimming based on a model derived from the causes of drowning. Int J of Aquatic Research and Education, 2(4), 372-382.

O-096

Keeping the Safety Messages Simple: The International Task Force on Open-Water Recreational Drowning Prevention

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International Task Force Members: Beerman S (Canada), Bennett E (USA), Bierens J (Netherlands), Brewster BC (USA), Connelly J (Ireland), Farmer N (Australia), Franklin R (Australia), George P (Australia), Kania J (Kenya), Matthews B (Australia), Moran K (New Zealand), Quan L (USA), Rahman A (Bangladesh), Stallman R (Norway), Stanley T (New Zealand), Szpilman D (Brazil), Tan RMK (Singapore), Tipton M (UK). Secretariat: Tansik M (USA).

INTRODUCTION: Globally, many organizations have attempted to address the risk of drowning associated with aquatic recreation by promoting a diverse plethora of drowning prevention messages. This diversity reflects the multifaceted nature of the drowning problem but preliminary discussion among drowning prevention advocates suggested that messages could be contained within simplified generic messages applicable to all settings. The Task Force was formed to establish guidelines for the promotion of key messages related to open water drowning prevention. METHOD: The consensus process consisted of teleconference calls and ongoing e-mail debate over a period of 18 months, as well as informal discussion at international conferences. Messages were subdivided into those that focused on Care of self and those that focused on the Care of others in open water recreation. Using a modified Delphi technique, these recommendations were then prioritized. RESULTS: From an original compilation of over 60 messages, the Task Force agreed on 16 key messages that would foster open water drowning prevention. Learning swimming and water safety survival skills was the preferred option in both Care of self and Care of others categories. Other strongly supported messages related to swimming with lifeguard supervision, the use of lifejackets (PFD's), and the close and constant supervision of others in your care. DISCUSSION: The recommendations have established informed, consistent, and concise messages that promote safe recreational use of open water. It is hoped that they will improve the clarity of communication between drowning prevention organizations and the public they serve as well as provide a framework for safety messaging that is applicable to a range of communities and settings with the ultimate goal of saving lives. REFERENCES: Bierens JJLM, (Ed) (2006). Handbook on drowning-prevention, rescue, and treatment. Heidelberg: Springer

O-097

Movement Economy in Breaststroke Swimming: A Survival Perspective

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The goals of swimming instruction are numerous. One, however, should

be common to all programs; the preservation of life. Historically, attempts have been made to justify one stroke above others, both as the first stroke to be learned and as the most important stroke. It is well known that N. America has a long tradition of teaching crawl early if not first, and that Europeans generally favor breaststroke in the same way. It has been argued that breaststroke is the easiest stroke to swim with the head up for those who prefer not to place the face in the water. While this may in some ways be true, it is irrelevant and in many ways contradicts the goals of water safety. When adopting a head up position in swimming the breaststroke, the Cof G is displaced backward, farther from the Cof B. This causes a tendency for the legs to sink, increasing the angle of the body and concurrently, resistance. Increased resistance or decreased economy theoretically reduces survival possibilities. The purpose of this study was to quantify the difference in energy expenditure for breaststroke with the head and face held constantly above the surface and for breaststroke performed with normal breathing. Classic Douglas bag respirometry was used in a flume setting. During submaximal swimming (0.5m/sec), the volume of O2 uptake was significantly higher (p= <0.001) when swimming with the face constantly above the surface than with normal breathing. Average values for head up vs normal breathing were 90.4ml/meter (S.D.=20.7) and 84.6ml/meter (S.D.= 19.6). Both HR and blood lactate levels were also significantly higher when swimming "head up" (p=<0.01, N=8 and p=<0.05, N=10, respectively). The average values for HR and La were 147/min vs 135/min and 5.4mM vs 3.9mM, respectively.

0-098

A Model for Drowning Prevention in Lake Victoria; A Case Study from East Africa

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INTRODUCTION: Five thousand (5000) people drown every year in Ugandan lakes and rivers, also the number per year for only Lake Victoria (Uganda, Tanzania and Kenya). Fishing boats and inland ferrys are often not seaworthy or are simply overcrowded. The ability to swim is also at a low rate in Africa. The International Marine Rescue Federation (IMRF), the successor to the International Lifeboat Federation, promotes water safety around the world and encourages initiatives by coast guards and rescue organisations. The National Lake Rescue Institute is the rescue organisation dealing with safety on the lakes of Uganda. IMRF and NLRI have cooperated since 2003. The board of NLRI demonstrated that the number of drownings on African lakes was excessive. The aims of this study were thus to, a) examine the efficacy of initiatives to launch rescue stations along the coast of the major lakes of East Africa, b) to examine the potential sustainability of these rescue stations, and c) to examine the possibility of strengthening such an approach by participating actively in the local community. METHODS: In an IMRF board meeting in 2008 in Kampala, Uganda, the decision was made to take IMRF responsibility to raise funds, advise and to supply a paid CEO to manage NLRI. Fund raising has been difficult. Limited funds are now coming in. RESULTS: Five main goals have been set: a) teach people to swim, b) produce life jackets locally, c) train local people in water safety, d) train crew to man locally made boats and apply appropriate rescue techniques, e) attemt to improve local economy. The focus is on LV and to open 5 rescue stations in 5 years time. Two stations are already in operation on Northern Lakes. NLRI has a head office and a training facility. DISCUSSION: Improving fishing and agriculture, may create the financial freedom to execute rescue work voluntarily. An oil company paid for equipment and training on Lake Albert. There is mutual interest of oil companies and saving lives on the lakes, because the oil companies need a safety guarantee. CONCLUSIONS Promising trials have been carried out together with telecom companies to locate people in distress with their mobile phones. Mobile phones can technically be equipped with a distress button. Discussions have begun regarding an East African common program for Lake Victoria. REFERENCES: 1.IMRF Board Meeting (2008). Minutes of meeting from Kampala 2.Vervaecke H., (ed) (2002). ILS World Drowning Report. ILS, Leuven

0-099

Swimming Ability, Perceived Competence and Perceived Risk Among Young Adults

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The question 'why do good swimmers get into difficulty?', is often asked. Do they over estimate their ability or underestimate the risk, or both? And who is a good swimmer? Eighty one (n = 81) university physical education students completed a questionnaire and performed practical tests of swimming ability. The questionnaire covered a) perception of their ability, b) perception of whether or not these skills would be more difficult in open water and c) their perception of risk in five specific scenaria. The practical tests covered seven swimming skills. Both questionnaire and practical tests were conducted at the beginning of the student's first year. Gender differences were tested by the Mann-Whitney U test. On the practical tests, the women out performed the men on 4 of 7 tests. Regarding perceived competence, their were few gender differences. The women were highly confident about floating in open water while the men were certain they could not do the same. In contrast, the men predicted 100% success on surface diving to the bottom of the pool (4m) with 80% believing it would be easy, while the women were less certain (88%) and only 62% felt it would be easy. In reality, the women outperformed the men on surface diving. Lastly, on 5 scenaria depicting risk, there were no gender differences.

0-100

Dietary Thiamin and Riboflavin Intake and Blood Thiamin and Riboflavin Concentrations in Collegiate Swimmers under Intensive Training

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INTRODUCTION: The purpose of this study was to provide quantified data to find relationship between high physical activity by swimming training and biochemical thiamin and riboflavin status. METHODS: Thiamin and riboflavin concentrations in the whole blood of a group of 19 collegiate swimmers (6 males and 13 females) were measured during a low-intensity preparatory period and compared with measurements taken during a high-intensity training period. Additional variables included anthropometric characteristics; estimated energy expenditure during swimming training; distance covered; resting energy expenditure; estimated energy requirement per day; and dietary intake of energy, thiamin, and riboflavin. RESULTS: No major changes were observed in anthropometric characteristics or dietary intake, while energy expenditure during swimming training per day significantly increased in the intensive training period (496 ± 0 kcal in the preparation period versus 995 ± 96 kcal in the intensive training period for males [P < 0.001] and 361 ± 27 kcal versus 819 ± 48 kcal, respectively, for females [P < 0.001]). Blood thiamin concentration decreased significantly during the intensive training period compared to the preparation period (41 ± 6 ng/mL decreased to 36 ± 3 ng/mL for males [P = 0.048], and 38 ± 10 ng/mL decreased to 31 ± 5 ng/mL for females [P = 0.004]); however, the concentration of riboflavin was unchanged. DISCUSSION: Thiamin is more sensitive to an increase in carbohydrate metabolism whereas riboflavin is more sensitive to changes

in fat metabolism. Because the percentage of carbohydrates utilized as an energy resource increases along with the increase in intensity of physical activity, blood thiamin concentration is considered more sensitive than riboflavin concentration to an increase in energy expenditure brought about by intense training. REFERENCES: 1. Belko, A. Z., Obarzanek, E., Kalkwarf, H. J., Rotte,r M. A., Bogusz, S., Miller, D., Haas, J. D., Roe, D. A. (1983). Effects of exercise on riboflavin requirements of young women. American Journal of Clinical Nutrition, 37, 509-5172. 2. Fogelholm, M., Rehunen, S., Gref, C. G., Laakso, J.T., Lehto, J., Ruokonen, I., Himberg, J. J. (1992b). Dietary intake and thiamin, iron, and zinc status in elite Nordic skiers during different training periods. International Journal of Sport Nutrition, 2, 351-6.

0-101

Does Immersion Affect Cortical Activation in Humans? :Functional Near Infrared Spectroscopy Study

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INTRODUCTION: Previous studies have shown that immersion and exercise in water improves the functioning of frail elderly and stroke patients. Simmons et al. (1996) reported that the balance ability of elderly was improved by sitting in water twice a week, suggesting that immersion influences cortical activation. Thus, this study aimed to examine the effect of immersion on the sensorimotor cortex (SMC), the premotor area (PM) and the supplementary motor area (SMA) using functional near infrared spectroscopy (fNIRS).METHOD: Healthy students participated in this study. Using fNIRS (OMM-3000, Shimazu Co.), we measured changes in cortical oxygenated hemoglobin (oxyHb) while subjects sat down on land and in water for five minutes each. We specified the location of SMC, PM and SMA according to Suzuki et al. (2004) and compared the results between land and water. Ambient and water temperatures were 34°C for both conditions. We also measured blood pressure, heart rate (HR) and skin temperature. RESULTS: We found that oxyHb in SMC, PM and SMA significantly increased in water (0.02±0.01 mMmm, 0.02±0.01 mMmm, 0.01±0.01mMmm) than on land (0.00±0.01 mMmm, 0.00±0.01 mMmm, 0.00±0.01mMmm) ($p < 0.05$); however, there were no significant differences in mean blood pressure, HR or skin temperature between the two conditions. DISCUSSION: Our results indicated that tactile and pressure stimuli from water increased the activation of SMC and SMA. It has been reported that the primary somatosensory area (S1) and the primary motor cortex (M1) engages while receiving tactile and pressure stimuli through the spinal cord and thalamus (Bodegard et al., 2003). Moreover, SMA activation is enhanced by receiving projections from S1 during tactile stimuli (Numminen et al., 2004). Our results indicated that PM was activated more in water than on land. It is possible that it received input not only from the thalamus but also from the parietal lobe (Van de Winckel et al., 2005). Furthermore, we speculate that activation of PM might be the reason why the immersion evoked a swimming image. CONCLUSION: These results suggested that tactile and pressure stimuli from water increases activation of SMC, SM and PM areas in humans. REFERENCE: Simmons, V. et al. J Gerontol A Bio Sci. 1996:51;M223-8. Suzuki, M. et al. Neuroimage 2004:23(3);1020-1026. Bodegard, A. et al. Hum Brain Mapp 2003:20(2);103-115. Numminen, J. et al. Neuroimage 2004:22(2);815-821. van de Winckel et al. Neuroimage 2005:26(2);441-453.

0-102

Is Sight the Only Deterrent to Breaststroke Performance in Visually Impaired Paralympic swimmers?

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INTRODUCTION: Swimmers with visual impairment complete in 3 classes. In the 100-m free these swimmers followed a similar race pattern of stroke rate and length to Olympic swimmers. Class S11 with greatest impairment swam slowest and were least competitive, classes S12 and S13 did not differ. It was suggested that fewer classes are needed. Breaststroke races are also organised under the same system but little study has been made of visually impaired swimmers in this stroke. METHODS: The only large scale race analysis data of Paralympic swimmers available dates from the Sydney 2000 Games. Participants were 32 male 100-m breast finalists in classes SB11 to SB13 for visually impaired and class S14 for intellectually disabled (ID). Able-bodied reference data were obtained for an identical analysis (n=8) at the Olympic Games. Start, turn, finish and mid-pool speeds were measured on video tape along with stroke rate(SR) and length(SL). RESULTS: There was no significant difference in end race result between swimmers with limited vision (SB12 & SB13) (M=75.5s) and with ID (SB14) (M=76.14s). Speed decreased as the race progressed with loses of 7% to 8% in segment 2-3 (turning) in Paralympians compared to 4% for Olympic swimmers. ID swimmers lost the most speed over the race (15.2%). There were no differences among Paralympic swimmers in start speed but class SB13 finished significantly faster and SB11 was slower in this race segment. There was no difference among groups in SR and only Olympic swimmers showed significantly longer SL (+0.4m/stroke). Olympic swimmers used a different race pattern for SR and SL. Together with the smallest speed decreases they also showed the largest SR decrease at the beginning of the race (-5.5%) followed by very large rate increases (>7.0%). This was combined with the largest SL increases (+3.3%) followed immediately by the largest SL decreases (<-10%). The SR of visually impaired swimmers decreased significantly following turn and was very low SL following start. Only ID swimmers could not increase SR at the end of the race. DISCUSSION: Visually impaired use poor race speed patterns in breaststroke perhaps due to insufficient conditioning. They are slow in start and turn due to the poor underwater pulling action, start swimming too early and show large speed drops after turning losing both SR and SL. The degree of visual impairment does not seem to be the main distinguishing factor of race performance in breaststroke.

0-103

Influence of Swimming Speed on the Affected- and Unaffected-Arm Stroke Phases of Competitive Unilateral Arm Amputee Front Crawl Swimmers

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INTRODUCTION: Presently, no examination of arm stroke phases has been undertaken for swimmers with a single-arm amputation. It is likely that the roles of their affected- and unaffected-arm within the stroke cycle may differ. Understanding these would be of great practical importance. The aim of this study was to determine if the arm stroke phases used by competitive unilateral arm amputee crawl swimmers differed between their affected and unaffected sides and whether these phases altered with an increase in speed. METHODS: Thirteen (3 male & 10 female) highly-trained swimmers (age 16.9 ± 3.1 yrs) consented to participate. All were elbow level, single-arm amputees. Mean 50 m crawl best time was 32.7 ± 3.1 s. Participants completed five 25 m crawl trials, counterbalanced from slow to maximum swimming speed (SSmax). Trials were video-taped underwater from both sides using tracking camera systems. Three consecutive, non-breathing stroke cycles were analysed. Arm stroke phases for both the unaffected- and affected-arm were determined at 80%, 85%, 90%, 95% and 100% of SSmax. General linear modelling tests were used to compare the changes in arm stroke phases between the affected and unaffected arms across swimming speeds. Statistical significance was set at $p < .05$. RESULTS: Across swimming speeds, the affected-arm spent relatively longer ($p < .05$) in

all arm stroke phases, with the exception of the Pull phase, compared to the unaffected-arm: Entry and Glide (38.3 ± 9.5% vs. 23.2 ± 8.0%); Pull (10.9 ± 2.8% vs. 23.1 ± 5.9%); Push (18.4 ± 6.4% vs. 13.8 ± 2.7%); Recovery (39.9 ± 3.5% vs. 35.9 ± 3.2%). With increasing speed: 1) the affected-arm's Entry and Glide phase decreased significantly ($p < .05$), while the unaffected-arm's Entry and Glide phase remained unchanged; 2) the unaffected-arm's Pull phase decreased significantly ($p < .05$), while the affected-arm's Pull phase remained unchanged; 3) both arms' Push phase increased significantly ($p < .05$). DISCUSSION: With an increase in swimming speed the stroke phases of the affected and unaffected arms differed significantly. Such differences might be linked to how these swimmers organised the motor skills necessary to swim crawl. As swimming speed increased the relative durations of certain arm stroke phases changed. The single-arm amputees used a coordination strategy that asymmetrically adjusted their arm movements to maintain the stable repetition of their overall arm stroke cycle when swimming at different speeds.

O-104

Effect of Buoyant Torque on Body Roll of Unilateral Arm Amputee Front Crawl Swimmers

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INTRODUCTION: Rotation about the body's longitudinal axis in front crawl swimming or 'bodyroll' may serve many useful functions including: facilitating the breathing action, aiding arm recovery and reducing drag. The torque exerted by the buoyant force about the longitudinal axis, as the arm is recovered over the water, is an important mechanism for driving bodyroll. A single arm amputation may limit a swimmer's ability to generate bodyroll. The purpose of this study was to quantify the buoyant torque experienced by single arm amputee front crawl swimmers about their longitudinal axis and its effect on their bodyroll. METHODS: The buoyant torque acting about the longitudinal axis depends on the positions of the whole body centre of mass (CM) and centre of buoyancy (CB) relative to this axis, and the magnitude of the buoyant force. These variables were calculated from body segment masses and volumes, and the position-time histories of each segment. Six female single arm (at-elbow) amputees performed non-breathing front crawl trials at sprint pace. Trials were recorded above and below water with six video cameras. A thirteen-segment full body model of the swimmer was defined. One complete stroke cycle was digitised and 3D coordinates obtained. Body segment data were calculated from digital photographs of the participants, using the elliptical zone method. Bodyroll was described by the angular displacements of the upper trunk (shoulder roll) and lower trunk (hip roll). Buoyant torque was obtained from the cross product of the whole body CM— CB position vector and the buoyant force vector. RESULTS: Swimmers experienced significantly higher peak buoyant torques during recovery of the unaffected arm (8.1±1.4 N.m) than during recovery of the partially-amputated arm (3.5±0.9 N.m). Maximum body roll angles during the unaffected-arm recovery (shoulder: 41±8°; hip: 30±5°) were higher than those during recovery of the partially amputated arm (shoulder: 32±6°; hip: 23±6°). DISCUSSION: The buoyant torque always acted to decelerate the bodyroll from arm exit to mid-recovery and then to accelerate it from mid-recovery to arm entry. The considerable bilateral asymmetry in the buoyant torque could not account for the bodyroll patterns displayed by any of the swimmers. This indicates that the swimmers were utilising mechanisms other than the buoyant torque, such as external torques from non-propulsive fluid forces, to control their bodyroll.

O-105

The Effect of Higher Ambient Air Temperature on Thermoregulatory Responses and Thermal Sensation during Lower Body Immersion in Cool Water

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INTRODUCTION: The non-uniform thermal environment condition surrounding the human body will be observed during water exercise exposes upper body to the air. Although the effect of water on thermal responses is expected to be greater than air due to the higher thermal conductance of water, the combined effect of water and air temperature condition has not been sufficiently studied, and it will be useful information to conduct a water exercise program. This study investigated the effect of hot air temperature on thermoregulatory responses and thermal sensation during lower body immersion in cool water. METHODS: Nine male subjects were immersed in water to their chest level for 60 min at three water temperature conditions (Tw: 23, 26 and 33.5°C) with a neutral and hot ambient temperature (Ta: 27 and 31°C). Rectal temperature (Tre), skin temperatures, oxygen consumption (VO2), skin blood flow (SkBF) on the forearm and thigh, thermal sensation (TS), and thermal comfort (TC) were measured. RESULTS: No difference was observed in Tre, VO2, SkBF on forearm and thigh between hot and neutral Ta conditions during 23°C water immersion. In 26°C water, the SkBF on the forearm was significantly higher, and VO2 was significantly lower in hot Ta condition ($p<0.05$); Tre decrease was significantly greater in hot Ta condition compared to neutral Ta ($p<0.05$). TS and TC was significantly warmer and more comfortable in hot Ta condition than in neutral Ta condition during 26°C immersion ($p<0.05$), while the difference between Ta conditions was small in 23°C water, though colder TS and uncomfortable TC were observed in 23°C water compared to 26°C water. DISCUSSION: During lower body immersion in 23°C water, there was no difference in thermoregulatory responses and Tre between hot and neutral Ta condition. It suggests that cold stimulus from the lower body in 23°C water was large enough to induce thermoregulatory responses regardless of the effect from the upper body in the air. Although it was expected to maintain higher Tre if only the heat exchange on the skin surface was considered, in 26°C water, lower Tre was observed in hot Ta condition. Thermal input from the upper body in slightly hot Ta might suppress the shivering thermogenesis that led to lower Tre than in neutral Ta. The importance of Ta condition effects on shivering thermogenesis and Tre as well as thermal sensation was indicated during immersion, especially in a cool water environment of 26°C, as in this study.

O-106

Front Crawl Technique at and Around Maximal Lactate Steady State

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INTRODUCTION: The aim of the present study is to determine how the arm coordination in front crawl can explain the changes in Stroke Rate (SR) during sub-maximal constant-pace exercise swum below vs above Maximal Lactate Steady State (MLSS). It is hypothesized that the non propelling action would decrease, and the time allotted to propulsion for 15m to be covered would increase as fatigue develops under the non-sustainable condition to compensate for a loss of force (i.e. above MLSS). METHODS: Seven trained competitive male swimmers performed a four maximal efforts to model the d-t relationship (slope: Sd-t) and three constant-speed efforts to exhaustion (TTE; Sd-t, Sd-

t-5%, and Sd-t+5%). Blood lactate concentration ([La]) was measured at minute 10 and at exhaustion. Two cameras were placed on a side plan (one above / one below the water surface) for the measure of the duration of four distinct arm stroke cycles phases and determination of the Indices of coordination (Chollet et al., 2000). The time allotted to propulsion for covering 15m was estimated (Tprop = 15 x (tB+C) / SL). RESULTS: Sd-t was 1.26 ± 0.06 m.s-1. The accumulation of [La] between minute 10 and 30 of Sd-t (TTE=25.8 ± 7.8 min) would have been 2.21 ± 2.35 mmol.L-1 if all swimmers could swum for so long (>MLSS). No significant change in [La] was found during Sd-t -5% (TTE=49.8 ± 13.6 min; < MLSS). Sd-t +5% was maintained for 8.9 ± 3.4 min. At the end of each trial, SR was greater and SL lower. The non propulsive phases were shorter but the propulsive phases longer within each stroke's cycle (in % of the total duration of the cycle). Since SR increased throughout each trial (~16%), the strokes' cycles were shorter by the end of the trials. The actual time of the non propulsive phase (in sec) was still shorter at the end of each trial but the propulsive phases were not significantly different at Sd-t-5% and Sd-t (shorter at Sd-t+5%). Tprop was significantly increased at the lower speeds but did not change significantly during Sd-t+5%. DISCUSSION: Catch-up was the coordination adopted by the swimmers during the TTE. Swimmers do change their motor organisation during fatiguing exercise, with less time dedicated to the non propulsive phases, but more time to the propulsive phases, but the later only at very severe intensities. REFERENCES: Chollet, D., Chalies, S. & Chatard, J.C. (2000) A new index of coordination for the crawl: description and usefulness. Int J Sports Med 21(1), 54-9.

0-107

Determination of Lactate Threshold with Four Different Analysis Techniques for Pool Testing in Swimmers

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INTRODUCTION: Pool testing using blood lactate (BLa) versus swimming velocity (V) relationship is a standard in performance diagnostics of swimmers. We determined lactate threshold (LT) using common analysis techniques hypothesizing that the results will repeat with acceptable accuracy in both test-retest and analysis-to-analysis comparisons. METHODS: The subjects were 30 male and female swimmers. Mean±SD for age was 16.7±3.3 y, stature 1.70±0.08 m and body mass 61.8±6.6 kg. They performed n*100-m swims twice in three days. Four different approaches were applied to define the LT and analyzed from BLa / v curves by two experienced analysts. RESULTS: Linear regressions (R2), Intraclass correlation coefficients (ICC) connected with two-way ANOVA, and t-test showed that both test-retest reliability and comparability between Dmax and Linear Estimation modes was very high (R2 = 0.85-0.96; ICC = 0.96-0.99; t-tests = N.S.). Differences existed when comparisons were made between modes with fixed BLa. DISCUSSION: We conclude that the test-retest reliability of the n*100-m swimming test was high indicating that the method itself was repeatable and is a useful means of monitoring changes in indicators of physical fitness in swimming. Also the analysis methods were noticed to offer reliable results to be used for prescription of training. In analysis-to-analysis comparisons some significant differences existed pointing out the necessity to understand their specific characters. The original speed at which the LT and or the LTind appear depends specifically on the pool test protocol being used. REFERENCES: Cheng B, Kuipers H, Snyder AC, Keizer HA, Jeukendrup A, Hesselink M (1992) A new approach for the determination of ventilatory and lactate threshold. International Journal of Sports Medicine, 13, 518-522. Gullstrand L, Holmer I (1980) Fysiologiska tester av lands¬lagssimmare: Anaerob energi-leveransmätningen av blodmjölk¬syra [Physiological tests for national team swimmers: Measurement of anaerobic energy metabolism by blood lactate] Simsport, 3, 15 17. Stegmann H, Kindermann W, Schnabel A (1981) A lactate kinetics and individual anaerobic threshold. International Journal of Sports Medicine, 2: 160 – 165.

0-108

Can Blood Glucose Threshold be Determined in Swimmers Early in the Swimming Season?

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INTRODUCTION: A recent study reported that blood glucose threshold (GT) could be observed during an incremental exercise test and that GT was correlated with blood lactate threshold (LT) (1). The relationship between GT and LT during a running exercise was discussed, however, no study has investigated GT during swimming. The purpose of the present study was to investigate whether GT could be determined in swimmers early in the swimming season. METHODS: Seven university swimmers participated in this study and performed an incremental swimming test in a swimming flume. The test was conducted at 4-5 weeks after the beginning of the winter swimming season. Swimming velocity was increased incrementally from 55% to 85% of the individual's 400 m freestyle average swimming speed. Each stage included swimming for three minutes with two minutes rest for blood sampling. Blood glucose (Glu) and blood lactate (Bla) was measured after each swimming stage, and the velocity corresponding to GT and LT was analyzed. The subjects were instructed to finish their last meal 3 h before testing. RESULTS: LT was determined in all swimmers (1.24±0.05 m/sec). Glu did not increase during the high intensity stage and GT was not determined. DISCUSSION: The present study investigated whether GT could be determined in swimmers early in the swimming season. Our results showed that GT could not be determined during an incremental swimming test. GT is thought to occur by the elevation of catecholamine and glucagon activity during running, thus, a difference in hormonal response during swimming may explain the present result. Flynn et al. (2) reported that Glu and Glucagon:Insulin ratio reacted differently between continuous 45 min (75%VO2max) swimming and running. The low Glu observed during high intensities may be due to high glucose uptake by the working muscle. However, since the experiment was conducted early in the swimming season, the low endurance capacity of the swimmer may also affect the Glu response in this study. Further study investigating the hormonal responses and carbohydrate oxidation rate during an incremental swimming test is warranted. REFERENCES: 1. Simões et al. (2003) Blood glucose threshold and the metabolic responses to incremental exercise tests with and without prior lactic acidosis induction. Eur. J. Appl. Physiol., 89: 603-611. 2. Flynn et al. (1990) Fat storage in athlete: Metabolic and hormonal responses to swimming and running. Int. J. Sports Med., 11: 433-440.

0-109

Evaluation of Force Production and Fatigue Using an Anaerobic Test Performed by Differently Matured Swimmers

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INTRODUCTION: Delaying the fatigue is probably a desire of all swimming coaches. In what means anaerobic function and high power production resisted exercises, we still doesn't know when fatigue signifi-

cantly emerges and how to get and use information that allow us to better control and plan anaerobic swimming training. In a previous study of our group (Soares et al., 2006) it was possible to study fatigue and to determine fatigue thresholds on velocity-to-time curves obtained in a 30 sec maximal effort. The purpose of the present research is to study fatigue and determine fatigue thresholds in force-to-time curves produced during 30 sec tethered swimming efforts. METHODS: Ninety swimmers of three maturational groups took part in the study. Values of maximal, mean, and minimum force were determined, as well as the variation coefficient of the mean force. The anaerobic fatigue thresholds were determined on the individual force-to-time curves. Typical force cycles were produced and quantitatively analysed considering the fatigue thresholds predetermined. RESULTS: It was possible to conclude that force tends to increase with maturation in males (Fmax pre-pub: 0.74±0.27; pub: 1.50±0.14; post-pub: 1.82±00.23). In females, tethered force tends to stabilize after puberty (Fmax pre-pub: 0.66±0.21; pub: 1.34±0.40; post-pub: 1.31±0.23). It is possible to determine one to two fatigue thresholds in F(t) curves and to define typical stroke cycles before and after the fatigue occurrence. DISCUSSION: Swimmers of both genders have similar levels of force. That force tends to increase in males with maturation. In females, tethered force tends to stabilize after puberty. The variation of the Fmean tends to decrease with maturation, probably due to the eventually better swimming technical competence. It is possible to determine changes in F(t) curves that may be associated to the idea of "fatigue thresholds". The number of curves with two fatigue thresholds tends to be higher. It is possible to define typical stroke cycles before and after the fatigue threshold occurrence. REFERENCES: Soares, S.; Machado, L.; Lima, A.; Santos, I.; Fernandes, R.; Correia, M.; Maia, J.; Vilas-Boas, J. P. (2006). Velocimetric characterization of a 30 sec maximal test in swimming: consequences for bioenergetical evaluation. In: J. P. Vilas-Boas, F. Alves, e A. Marques (eds.). Biomechanics and Medicine in Swimming X. Revista Portuguesa de Ciências do Desporto, 6(supl. 2): 265-268.

0-110

Stroke Phases and Coordination Index Around Maximal Lactate Steady State in Swimming

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INTRODUCTION: Alberty et al. (2009) verified decrease of non-propulsive phases and maintenance increase of the propulsive phases during exhaustive tests (95, 100 and 110% of maximal 400-m swim speed test). There is no data referring to the stroke strategies to maintain the speed during long-distance swims, which are found during some swim training sessions and long-distance events. The aim of this study was to analyze changes in stroke parameters (i.e., stroke length - SL and stroke rate - SR) and arm coordination (i.e., propulsive and non-propulsive phases and IdC) when swimming at and above (102.5%) maximal lactate steady state (MLSS). METHODS: Twelve endurance swimmers (21 ± 8 yr.) performed in different days: 1) 200 and 400-m all-out tests to determine critical speed (CS), and; 2) two to four 30-min sub-maximal continuous tests at imposed swim pace, to determine the MLSS. Video analysis was used to determine the SR, SL, stroke phases and IdC. The IdC was determined using the lag times between the propulsive phases of each arm (Chollet et al., 2000). Blood lactate and stroke technique variables were analyzed at 10th and 30th minute of each imposed speed test. RESULTS: There was significant difference among MLSS (1.22 ± 0.05 m.s-1), 102.5% MLSS (1.25 ± 0.04 m.s-1) and CS (1.30 ± 0.08 m.s-1). SR and SL was maintained during the test swum at MLSS and have modified at 102.5% MLSS (SR - 30.98 ± 3.44 and 32.26 ± 3.56 cycles.min-1 and SL - 2.47 ± 0.22 and 2.38 ± 0.24 m.cycle-1). All stroke phases maintained during the test swum at MLSS. However, the propulsive phase B (pull) increased at 102.5% MLSS (21.7 ± 3.4% and 22.9 ± 3.9%). There was no significant effect of exercise intensity and time on IdC. CONCLUSIONS The changes in stroke parameters (i.e., reduction in SL and increase in SR) and arm coordination (i.e., increase in propulsive phase B) of well trained swimmers during long distance imposed speed tests performed at heavy intensity domain (ie., below CS), occurs only at condition of non-metabolic equilibrium. These changes are important to increase the duration over which the propulsive force acted per distance unit as the force capacity was reduced. REFERENCES: Alberty M, Sidney M, Pelayo P, Toussaint HM. Stroking characteristics during time to exhaustion tests. Med Sci Sports Exerc 2009; 41: 637-644 Chollet D, Chalies S, Chatard JC. A new index of coordination for the crawl: description and usefulness. Int J Sports Med 2000; 21: 54-59

0-111

Quantitative Data Supplements Qualitative Evaluations of Butterfly Swimming

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INTRODUCTION: Previous analyses of thousands of trials of synchronized underwater video and hand force data show a dramatic increase in force at the beginning of the butterfly pull immediately following two events: 1) when the hands first submerge below the level of the shoulders and 2) when elbow flexion begins. As both of these events are usually observable by a coach on a pool deck, quantitative data about these events may help coaches to better qualitatively assess technique. As the mechanical advantage increases with both shoulder extension and elbow flexion at the beginning of the pull, it is hypothesized that hand force will significantly increase with these events. METHOD: Four events were selected for analysis: 1) when the hands first submerge below the level of the shoulders, 2) when elbow flexion begins, 3) when the hands first become medial to the elbows, and 4) when the hands pass perpendicularly below the shoulders. Female swimmers (n = 23) from three university teams were tested with Aquanex+Video swimming butterfly over a 20 m course (as in Becker & Havriluk, 2006.) Underwater video and hand force data were collected over the last 10 m. The average hand force over a .1 sec interval before and after each event was calculated. RESULTS: As hypothesized, there was a significant ($p<.01$) increase in force for two events; when the hands first submerged below the level of the shoulders (18.0 N) and when elbow flexion began (14.6 N). There was no significant change in force when the hands first became medial to the elbows (.4 N) or when the hands passed perpendicularly below the shoulders (-.2 N). The swimmers required .36 sec to submerge the hands below the shoulders out of the .81 sec total time that the hands were underwater generating force. DISCUSSION: The large increases in force when the hands first submerged below the level of the shoulders and when elbow flexion began emphasize the importance of a mechanically advantageous angle at both the shoulder and elbow. Based on the quantitative results, coaches can qualitatively evaluate swimmers to ensure they eliminate the wasted time that their hands are above the shoulders by adjusting the entry angle. Coaches can also encourage swimmers to begin elbow flexion as soon as the entry is complete. In addition to improving performance, these technique adjustments will be helpful in reducing the onset of shoulder injury.

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The Usefulness of the Fully Tethered Swimming for 50-m Breaststroke Performance Prediction

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Propulsive force is well recognized as an important component of swimming performance, but most of the studies was focused on crawl-stroke and it is still unclear whether tethered swimming can be used to evaluate others strokes. The present study aimed to identify the relationship between 50-m breaststroke performance and force-time variables obtained from a 30-s maximal tethered swimming test. Fourteen high-competitive male breaststrokers from Brazil and Serbia age: 22.50 ± 5.00 years, height: 1.83 ± 0.09 cm, weight: 76.3 ± 7.4 kg, percent from 50-m breaststroke long pool World Record: 91.91 ± 1.91%) accomplished a 30-s self-chosen cycle frequency maximal breaststroke effort in tethered swimming. The mean value of peak force (Fpeak), average force (Favg), impulse force (ImpF), rate o force development (RFD) and full stroke duration (DUR) was retained for analysis as independent variables. Time in 50m breaststroke was converted in average swimming velocity (VEL50m) to be used as dependent variable. The mean (±SD) values of VEL50m, Fpeak, Favg, ImpF, RFD and DUR were 1.72 ± 0.04 m/s, 469.82 ± 94.61 N, 136.92 ± 17.54 N, 156.52 ± 14.37 Ns, 1147.61 ± 464.55 N/s, 1157.65 ± 125.89, respectively. Multiple regression analysis with the backward method was employed to construct the model, which was statistically significant ($F=29.933$, $p<0.001$), explaining 82.1% of sample size adjusted variance (adjusted $r^2=0.821$) with a standard error of ±0.015 m/s and represented the equation: VEL50m = 3.401 - 0.002*DUR + 0.015*ImpF - 0.015*Favg. The present results showed a high significant relationship between 50-m breaststroke performance and tethered swimming test, corroborating to previous study, which observed the same for high competitive crawl-strokers (Dopsaj et al., 2000), and confirming the initial hypothesis that the fully tethered swimming can be used for breaststroke performance evaluation and/or prediction. Besides, these results also allow to understand how much different each propulsive force variable is involved with swimming performance, what variables are needed to be improved for getting better results and, after testing swimmers at different moments of the periodization, identify deeper how the different training loads administrated are influencing performance in 50m breaststroke. Therefore, the fully tethered swimming can be used as a valid tool for breaststrokers' performance and evaluation.

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Characteristics of Pressure Distribution and Flow Patterns around the Hand during Sculling Motion

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INTRODUCTION: Sculling motion is one of the basic propulsive movements of the hands in swimming. The hands move simply figuring 8, but it is actually complicated movement like repeating acceleration and deceleration. Propulsive mechanism of sculling motion has not been clearly explained yet. Thus, the purpose of this study was to investigate the propulsive mechanism of sculling motion from the characteristics of pressure distribution, flow pattern around a hand and kinematics information. METHODS: One ex-competitive male swimmer participated in this study and was instructed to swim with sculling motion in a swimming flume (0.5m/s). Three experiments were executed and synchronised. The first experiment was the pressure measurement by the small pressure sensors placed at 12 distinct parts of the swimmer's left hand to calculate the fluid force acting on the hand. The second was the flow visualization around the left hand by 2C-PIV to describe the flow pattern, and the other was the motion analysis (3D-DLT) by high speed camera (250fps) to calculate the attack angle of the hand. All experiments were synchronized by a pulse generator for starting each data acquisition. RESULTS: The variations in pressure distributions showed the interesting changes being accompanied by changing the leading edge of the hand. The pressure differences between palm and back of the hand near the leading edge were larger than that of the other edge during each travelling phase. The peak fluid force calculated from the pressure data was about 50 N during continuous sculling motion. The flow patters around the hand were showed as the velocity-vorticity maps. There were at least a pair of vortices, and the vectors directed to the main flow direction in a flow field. Also, the fluid force reached the peak when the hand passed through the shed vortex at the transition phase. The attack angle of the hand was changing between 20 to 90 degrees and the peak attack angle was observed at each transition phase (out-in/in-out scull). DISCUSSION: The pressure distribution results varied interestingly along with the hand movements. From the comparison of the three experimental results, it was suggested that the generation of vortices was associated with the pressure distribution and the attack angle. It was also suggested that the generation of the fluid force was correlated with the vortex capturing by the hand. This phenomenon was similar to the propulsive mechanism of the flying insects.

0-114

100m Freestyle: Factors Affecting Performance

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INTRODUCTION: 100m freestyle has been subject to rapid development for the last few years. Although much focus has been directed towards the swimming suit, it remains an eligible wish that the performance within it have also evolved. Few studies have established statistical models designed to predict swimming-performance, partly as powerful multivariable analyses demand high numbers of participants. Unable to accommodate to those demands, this study aimed at investigating performance determining factors in 100m freestyle. METHODS: Data were from 13 female and 11 male Norwegian national-level swimmers, aged 15 to 24. Sprint velocities, time trials, oxygen uptake and in-water force measurements were measured according to Aspenes et al. (2009). After controlling for normality, distribution was calculated as mean±standard deviation and linear regressions as standardized β and p-value with 100m performance as the dependent variable. RESULTS: Mean 100m time was 65.5±3.7 seconds in females and 58.7±2.1 seconds in males. In females, maximal 50m freestyle performance ($\beta=0.96$, $p<0.001$), maximal velocity in 25m sprint ($\beta=-0.93$, $p<0.001$), maximal 400m freestyle performance ($\beta=0.83$, $p<0.001$), maximal swimming force ($\beta=-0.82$, $p=0.001$), velocity at VO2peak ($\beta=-0.71$, $p<0.01$) and VO2peak ($\beta=-0.55$, $p=0.05$) was associated with 100m performance in order of significance. In males, maximal 50m ($\beta=0.96$, $p<0.001$) and 400m ($\beta=0.83$, $p<0.001$) freestyle performance, maximal swimming force ($\beta=-0.82$, $p<0.01$), maximal velocity in 25m sprint ($\beta=-0.74$, $p<0.01$), supine reaching height ($\beta=-0.70$, $p<0.05$), weight ($\beta=-0.66$, $p<0.05$) and height ($\beta=-0.63$, $p<0.05$) were associated with 100m performance. Factors that did not associate with 100m performance in either gender were age, maximal land strength, swimming economy, and stroke length and -rate during maximal swimming. DISCUSSION: Our analyses showed that the strongest associates of 100m swimming performance were performance in other swimming events, and surprisingly, 400m freestyle was the second strongest associate. Other studies have shown that performance to a high degree relies on favourable anthropometric features, but in our small sample this was only valid for males. In contrast to established knowledge, we did not find any asso-

ciation between stroke length or - rate and performance in any gender. Aspenes, ST, Kjendlie, PL, Hoff, J, Helgerud, J. Combined strength and endurance training in competitive swimmers, JSSM, 8:357-365. 2009.

0-115

Shoulder and Hip Roll Differences between Breathing and Non-Breathing Conditions in Front Crawl Swimming

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INTRODUCTION: The effect of breathing on body roll has been the topic of only a few studies, with body roll calculated for the whole trunk based on the assumption that the trunk moves as a rigid segment in front crawl. However, Psycharakis and Sanders (2008) indicated that the shoulders roll significantly more than the hips and reported differences in the temporal characteristics of shoulder roll (SR) and hip roll (HR) during non-breathing cycles. The purpose of this study was to examine the influence of breathing on SR and HR during front crawl swimming. METHODS: Six competitive male swimmers swam two maximum 25m front crawl trials under different conditions: non-breathing (NBr) and breathing on the preferred side (Br). Six video cameras (50Hz) and three-dimensional analysis methods were used as described by Psycharakis et al. (2005) and Psycharakis and Sanders (2008). The total SR and HR were calculated as the sum of the roll to both sides. SR and HR were also calculated separately for the breathing side (SR-BS; HR-BS) and the non breathing side (SR-NBS; HR-NBS). Statistical analysis was done with paired samples t-tests and significance was accepted at $p<0.05$. RESULTS: Swimming velocity was not significantly different between trials (Br: 1.76±0.09m/s; NBr: 1.80±0.08m/s). Total SR was significantly higher in the Br (120.3±7.7°) than the NBr trial (107.4±6.9°). No significant differences were found in the total HR (Br: 44.1±5.9°; NBr: 41.8±6.7°). SR was significantly higher than HR in both trials. SR-BS increased significantly in the Br trial, but there were no significant differences between the Br and NBr trials in HR-BS, SR-NBS and HR-NBS. No significant differences were found in the Br or the NBr trials between SR-BS and SR-NBS, and HR-BS and HR-NBS. DISCUSSION: Swimmers increased SR when breathing by increasing mainly the roll of the shoulders towards the breathing side. HR and swimming velocity did not seem to be significantly affected by the breathing action. These preliminary data need to be expanded to larger sample sizes to confirm and generalise the findings. REFERENCES: 1. Psycharakis SG & Sanders RH. (2008). Shoulder and hip roll changes during 200-m front crawl swimming. Med Sci Sports Exerc. 40(12): 2129-2136. 2. Psycharakis SG, Sanders R & Mill F. (2005). A calibration frame for 3D swimming analysis. In Q. Wang (Ed.) Proceedings of the XVII International Symposium on Biomechanics in Sports, Beijing, The China Institute of Sports Science, 901-905.

0-116

Lactate Concentration Comparison Between 100m Freestyle and Tethered Swimming of Equal Duration

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INTRODUCTION: Maximum capacity of anaerobic lactic mechanism is proportional to the production of lactic acid. One of the most common test is the 100 meters freestyle. Many researchers have used tethered swimming to measure aerobic and anaerobic capacity (Maglischo, 2003). The question created is with which test of 100m freestyle or the tethered swimming, both at the same time, can achieve maximum accumulation of lactic acid in blood. The aim of this research is to compare lactic acid production in both tests of maximum effort and equal time: a) in 100 meters freestyle and b) in tethered swimming. METHODS: In this study participated 12 swimmers of national level (age=21.5±0.67 years, Body stature =181.8±7.24 cm and Body mass=80.75±7.99). At the beginning, they swam 100 meters freestyle with maximum intensity and time performance and blood lactate accumulation were measured. Afterwards, in two days time the same athletes were tested in tethered swimming, in equal time to that they achieved in 100 meters (Bonen et al.,1980). In order to determine maximum concentration of lactic acid in the two different tests, samples of blood were taken in 3rd, 5th, and 7th minute of recovery time. RESULTS: The average maximum accumulation of lactic acid in 100 meters freestyle was 11.09 ±4.22 mmol/l, while in tethered swimming 10.27 ±3.29 mmol/l. The average time performance in 100 meters freestyle as well as in tethered swimming was 58.74 ±2.33sec. There was statistical significant correlation between performance time of 100m freestyle and mean strength in tethered swimming ($r= -0.63$, $p< 0.05$), while no significant correlation was found between performance time in 100m freestyle, mean strength in tethered swimming and maximum accumulation of lactic acid. DISCUSSION: From the results it is obvious that both tests are adequate for the evaluation of maximum capacity of anaerobic lactic mechanism, with a difference as far as it concern the maximum accumulation of lactic acid. The tethered swimming test comes behind the 100 meters freestyle test in lactic acid production, probably because it influences the technique of legs in freestyle and as a result the rhythm and the intensity of the effort are reduced. REFERENCES: 1. Bonen, A., Wilson, B. A., Yarkony, & M., Belcastro, A. N. (1980). Maximal oxygen uptake during free, tethered, and flume swimming. Journal of Applied Physiology, 48, 232-235 2. Maglischo, E. W. (1993): Swimming Even Faster, Mayfield Publishing Companu, U.S.A.

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Biophysical Analysis of the 200m Front Crawl Swimming: a Case Study

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INTRODUCTION: Propulsive and drag forces acting on the swimmer's body are major performance determinants, being affected by technique, motor organisation and control. The muscular activity, as the energy expenditure, are also swimming influencing parameters. It was studied the 200m maximal front crawl of an elite Olympic swimmer, analysing the intracyclic velocity variation of the centre of mass, arm coordination, energy expenditure and neuromuscular activity. METHODS: A male swimmer (21 yrs, 71kg and 180cm), national record holder, swam 200m for the assessment of the intracyclic velocity variation (IVV) in x, y and z axes (2 surface and 4 underwater cameras, Sony® DCR-HC42E, digitised with APASystem and determined through the coefficient of variation of the velocity of the centre of mass), arm coordination (Index of Coordination - IdC - Chollet et al., 2000, using the digitised model), oxygen uptake (K4b2) and neuromuscular activity (surface electromyography - EMG) of the flexor carpi radialis, biceps brachii, triceps brachii, pectoralis major, upper trapezius, rectus femoris, biceps femoris and tibialis anterior muscles. A spectral index (cf. Dimitrov et al., 2006) was calculated for one stroke cycle for each 25m. Afterwards, swimmer performed 50, 100 and 150m at the 200m pace for blood lactate kinetics analysis (Lactate Pro), which allowed the assessment of the total energy expenditure (Ė). Linear regression was assessed on muscle EMG parameters ($p < 0.05$). RESULTS: It was observed a decay of velocity, stroke length and stroke rate through the 200m, with a slightly increase of this last parameter in the last lap. IVVx maintained stable and larger magnitudes of IVV were found for y and z

than in x axis. IdC kept in the catch-up mode, increasing in the last 100m. Ë increased in the 1st 50m, resulting from an exponential increase of the VO2 kinetics, reaching the VO2 peak in the 2nd 50m. In 4th 50m, the glycolitic contribution was found to be higher, which lead to high values of Ë. It was also found a significant increase of the fatigue indices for the most studied muscles. DISCUSSION: It was observed an interaction of important coordinative, biomechanical, electrophysiological, and bioenergetical performance influencing parameters. Changes in some factors imply other changes or offer the stability needed for a better performance. REFERENCES: 1. Chollet et al. (2000). Int J Sports Med, 21(1): 54-9 2. Dimitrov et al. (2006). Med Sci Sports Exerc, 38(11): 1971-79

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Graphic Removal of Water Wave Impact on the Pool Wall during the Flip Turn

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INTRODUCTION: When the swimmer approaches the wall for the turn, part of the water volume displaced hits the wall before the swimmer's contact, causing the acquisition of an "anticipatory" force curve (Lyttle, 2000; Roesler, 2002). The aim of the present study was to develop a graphical technique to remove the wave that precedes the contact of the swimmer with the wall during the front-crawl flip turn, characterizing and quantifying it. METHODS: A extensometric underwater force platform was used, and two video cameras were attached to record the contact and monitor the contact time of the swimmer's feet on the wall. A male swimmer held 8 turns with maximum speed, but without touching the platform to characterize the wave kinetics. Afterwards, a sample of 17 swimmers performed 154 valid flip turns. To eliminate the wave signal interference in the force signal produced by the swimmer at the wall, a graphical solution was used during the signal processing performed using the Matlab software. Based on the trend of symmetry of the wave around its peak value, the program eliminated the water wave effect out of the original signal by reconstructing the curve from the time of the initial contact. RESULTS: The comparison of the impulse (time integral of the force / time curve) with and without the water wave effect showed, respectively, values of 314.48 ± 62.75, and 288.57 ± 51.79 Ns, pointing out a reduction of 10.87 % of the original force to time curve after the wave effect was removed. DISCUSSION: The comparison of the characteristics of the force to time curve of the wave produced by a swimmer during a flip turn, with and without touching the wall, support satisfactorily the solution proposed to remove the water wave effect from the swimmers' kinetics. It is accepted that the error associated with the wave data elimination with this procedure is not relevant, ensuring data integrity and increasing accuracy of the swimmer's kinetics evaluation at the wall contact. REFERENCES: 1. Lyttle, A. (2000). Hydrodynamics of the human body during the freestyle tumble turn. The University of Western Australia. 2. Roesler, H. (2002). Turning force measurement in swimming using underwater force platform. Paper presented at the International Symposium on Biomechanics and Medicine in Swimming, Saint-Etienne, France.

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A Study of Apnea Turn, A New Underwater Turning Method for Butterfly and Breast Stroke Races

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INTRODUCTION: The present study designed the Apnea turn that carried on the whole body under water to pivot operation and push the wall. This turning method has possibility because it decreased of the wave drag to pivot at under water previously. In addition, the research paper concerning the development of a new turning method like current the Apnea turn is not found. The purpose of this study was to clarify a characteristic of the Apnea turn and to consider about possibility a new turning method for competitive swimmers. METHODS: The subjects were elite competitive swimmers, whose specialties were butterfly and breast stroke. This study calculated that each phase time (turn-in, pivot, glide, turn-out) in the turn phase, push off velocity from the wall, the distance from the wall and the center of gravity, the distance from the water surface to the center of gravity when the wall contact by foot. After the experiment, we implemented subjectively evaluated about the Apnea turn. RESULTS: Average of 5m-RTT was 5.62±0.33s at open turn, 5.55±0.27s at the Apnea turn. The push off velocity from the wall was 2.92±0.06m/s at open turn, 3.02±0.11m/s ($p<0.01$). Then, nine in ten subjects whose distance of the wall and the center of gravity in the Apnea turn neared than open turn ($p<0.01$). All subjects whose the water surface and the center of gravity in the Apnea turn was depth than the Open turn ($p<0.01$). DISCUSSION: The results suggest that the Apnea turn will be able to contribute to improve the swimming performance and then it may become prospective a new turning method. In addition, the Apnea turn has issue to more improve the swimming performance. REFERENCE: 1. Lyttle A., Blanksby B., Elliot B. and Lloyd D. (1999): Investigating kinetics in the freestyle flip turn push-off. Journal of Applied Biomechanics, 15, 242-252.

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A Study About the Cognitive Interplay Between Sensory and Biomechanical Features While Executing Flip Turns Wearing Different Swim Suits

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INTRODUCTION: A flip turn is a motor action due to a combination of the established competence matching features of postures and situational influences. In general, movements are organized at different cognitive levels including their sensory effects. Every movement is formed by cognitive units, so called Basic Action Concepts (BAC). These BACs are integrated in a hierarchical cognitive architecture of regulation and control levels for a motor action. In this context, movements are realizing action goals evoked by motivation, cognition, and emotion, which are grounded on auditory, visual, or kinaesthetic cues (Schack, 2004). The purpose is to study the influence of sensory effects on flip turns under two different conditions: wearing a regular or a full swim suits. METHODS: Eight elite swimmers, 19.9 ± 3.4 years, participated in this study. They were asked to bring their regular and competition swim suits. From each swimmer 10 turns swimming freestyle at each condition were video taped by using an underwater camera. After each set the swimmers answered a questionnaire for examining the strength of sensory effects; a comparison was based on t-Test. Next they executed two tests for structure dimension analysis–motorics (SDA-M) to test the cognitive representation of the flip turn technique and the sensory effects related to that technique, respectively using cluster analysis. A biomechanical analysis of the videos was executed to determine speed data, compared by Wilcoxon-Test. RESULTS: The results revealed that turns while wearing full suits are executed significantly faster (.012) (the approach and the gliding verlocity were higher), three of 27 sensory effects were rated significantly ($p < .05$) different (e.g. estimation of distance to the wall). The technique was mentally represented significantly different ($\lambda = .52 < 0.68$ due to suit conditions). The mental representation per condition, however, was structured alike when based on sensory allocations ($\lambda = .71 > \lambda crit = 0.68$). CONCLUSION: The study demonstrated that different swim suits changed a) the representation of the same ac-

tivity and the sensory effects but the (appropriate) cognitive representation reveal a close connection between of the sensory based effects and their biomechanical structure. Thus in technique training sensory based hints must not be separated from biomechanic

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Effect of Specific Training on Swimming Start Performance

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INTRODUCTION: The swimming start is a significant performance component for success in competitive swimming, especially in short events. The purpose of the study was to determine how the swimmers start improvement could be related to a specific training providing accurate information about the start duration at different distances (10 and 15m). METHODS: Differences between manual timing and times obtained through video analysis were previously set. Results highlighted the importance of an accurate evaluation. The system developed allowed swimmers and coaches to know the starting times as they know in competitions. The system consisted in an electronic touchpad placed on the pool's lateral lane. A group (n=42) of regional swimmers and P. E. students participated on the study. The group was divided equally into experimental and control groups. Each group practiced during 10 sessions. The experimental group (EG) received accurate information about their starting times (Terminal Knowledge of Results [TKR]). Meanwhile, control group (CG) did not receive any information after each trial. RESULTS: We did not find statistical differences in start times measured at 10 and 15m, between groups. Nevertheless, both groups significantly improved their starting times. However, greater improvements were produced within the EG (more than 5% vs less than 2% at the CG). To check the significance of the improvement within each group, a related samples t-Test was performed. Results showed greater significance levels in the EG than in the CG ($p<0.001$ vs $p<0.005$). In addition, when an individual intra-subject analysis was applied, performance tended to be more consistent within the EG (differences between best trial and average time were reduced up to 0.05s in some subjects). DISCUSSION: Due to the short start times, accurate evaluation must be performed, to avoid false improvements due to erroneous measurements. Results suggested that the systematic and controlled repetition of the swimming starts, leads to performance improvement. This should be taken into account to increase the start practicing time within a whole year's planning. In addition giving the swimmers accurate KR produces greater performance improvements than only systematic repetition with manual timing (not accurate enough). Moreover, the system seems to be individually more effective, making the start performance more consistent. This is important when considering the anticipated performance at important competitions.

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Relay Start Strategies in Elite Swimmers

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INTRODUCTION: The few studies in the literature concerning the efficiency in relay starts in swimming have focussed mainly on differences in take-off movement techniques (e.g. Gambrel et al., 1991; McLean et al., 2000). Although, trends could be identified, the results are still somewhat inconclusive. In contrast, no study has examined yet whether a reduction of changeover-time in between wall-contact of the income swimmer and the take-off of the outgoing swimmer is a useful relay start strategy as advocated by various swimming experts (e.g. Maglischo, 2003). Two studies were conducted to evaluate the effects of different feedback sources on relay start performance. METHODS: Study 1: Twenty-six junior elite swimmers were examined during a 4-day learning experiment with three relay-starts on each day. Two experimental groups were randomly assigned to two different feedback categories. While one group received feedback on the maximum in the horizontal take-off force the other group received feedback on the changeover-time. Study 2: Sixteen elite swimmers participated in a one-day learning experiment concerning feedback for two different take-off movement techniques. While one group practised the traditional armswing start the second group learned two perform a single-stepstart. Both groups received feedback on the maximum in horizontal force as well a video presentation on their changeover performance. In both studies the time between wall-contact of the income swimmer on the time at for the first 7,5 m of the outgoing swimmer was used as criteria for the relay start performance. RESULTS: Study 1: Swimmers receiving feedback on their horizontal force clearly showed higher improvements in their relay start performance as compared to swimmers receiving changeover-time feedback ($F=4,4$; $p < 0,05$). Individual improvements in the force feedback groups could be as much as 0,5 s. While both groups showed similar improvements in the changeover-time only the force feedback group yielded increases in their horizontal force. Study 2 showed that both groups reduced their changeover-time within one day by up to 50 percent ($F = 46,7$; $p < 0,01$). While no significant differences between the two take-off movement techniques were found there was a tendency for the single-stepstart to outperform the armswing start. However, despite considerable improvement in the changeover-time no improvements were found in the relay start performance.

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Analysis of Swim Turning, Underwater Gliding and Stroke Resumption Phases in Top Division Swimmers Using a Wearable Inertial Sensor Device

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INTRODUCTION: Improving swimming performance is a difficult task especially for élite athletes. A possibility is to investigate how optimising the timing of turning, underwater gliding and stroke resumption phases (Lyttle et al, 1999) by studying the relevant kinematics. Common video analysis is often inadequate to investigate motor tasks such as the swim turning. Swimming research recently started to include wearable accelerometers in their experimental setups (Slawson et al, 2008). This work aimed at describing the mentioned phases in top division swimmers using a wearable inertial device composed of a triaxial accelerometer and gyroscope. METHODS: Eight élite swimmers (4M, 4F) volunteered to participate in the study; they were part of a top division Italian team and were selected so as to cover all the four styles. A wearable inertial device (Sensorize, Italy) was used to measure 3D accelerations and angular velocities. The device was positioned on the lower trunk and a 50m trial at the maximum velocity was executed. Only angular velocities ωL, ωS and ωV about the three axes of the device frame of reference (lateral, L; sagittal, S, vertical, V) were post-processed. Phase durations, angular velocity peaks, stroke rate "sr" and the ratio "r" between gliding and stroke duration were analysed. RESULTS: Highest ωL (565 deg/s) was found in freestyle, highest ωV (354 deg/s) in backstroke flip-turn. Highest ωS (330 deg/s and 260 deg/s), conversely, were found in both breaststroke and butterfly. The sign of the rotation depended upon the turning technique. Sr was 62±3 and 54±6 for M and F; both sr and r lowered in the last lap. Consistently, higher r were found for backstroke (0.7±0.1), the lower for freestyle (0.3±0.1). DISCUSSION: The feasibility to use inertial sensors to characterise turning, gliding and stroke resumption in swimming was verified. Strength points of the approach are: simple description of the

turning kinematics; possibility to extract performance-related parameters; simplicity of use for the operator; the minimal encumber for the athlete. Future steps are the inclusion of further athletes, the definition of further parameters, eventually specific for each swimming styles. REFERENCES: 1. Lyttle AD et al, 1999. Optimising kinetics in the freestyle flip turn push-off. Journal of Applied Biomechanics, 15: 242-52. 2. Slawson SE et al, 2008. Accelerometer Profile Recognition of Swimming Strokes. The Engineering of Sport 7, 1: 81-8

0-124

Applications of Wireless EMG Measurements in Water

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INTRODUCTION: EMG measurements have been used for many years in competitive swimming to describe muscle recruitment and relate it to dry land training and potential problems such as shoulder impingent and muscle fatigue. In the past, most measurements have been done with systems needing direct wire connections to power and amplification. More recently, new wireless equipment has been developed, permitting full freedom of movement for swimmers. METHODS: Small independent surface units (EMU) (50mm*40mm*15mm, 28g) including muscle electrode, ground and a sender are attached to the skin in a normal way. The signal is transmitted directly to the receiver over a distance of up to 50m. In case of transmission failure or interference due to the water, the EMU has onboard memory for up to 7 minutes recording and seamless transmission occurs after the activity has been completed. The electrodes and EMU can be made waterproof with elastic plastic film if the edges of the film are secured with sport tape. BENEFITS Wireless EMG systems put little restraint on the swimmer, his/her movement, or the environment in which measurements can take place. Recordings have been done not only in controlled situations but during actual competition and even in outdoor pools. Further the EMG signal has less noise than most wire systems. RESULTS: Measurements with this system have demonstrated bilateral muscular imbalance in single leg amputee swimmers and diversity in muscle recruitment patterns for competitive swimmers with visual impairment and swimmers with mild and severe cerebral palsy. It has also been used to examine muscle activity during therapeutic applications such as in the Bad Ragaz Ring Method. The muscle use patterns of specific stroke specialists compared to non-specialists have also been investigated with the equipment. DISCUSSION: This equipment can be used to investigate the International Paralympic Committee swimming functional classification system in more details than has been possible to date. It also makes the application of EMG measurements almost coach friendly.

0-125

User-Friendly Portable Poolside Video Analysis

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INTRODUCTION: Video based analysis of swimming technique has been limited by a lack of portability of camera and playback systems, difficulties of setting stable camera views, poor quality of images, cumbersome file management and playback, and affordability. The aim of this project was to develop a portable coach friendly system that empowers coaches to conduct qualitative analysis at their own pools. A second aim was to enable data collection for quantitative 2D and 3D analysis in any location to reduce costs and disruption to swimming programmes. METHODS: To address the limitations of other systems the minimum operational requirements of the following components of the system were specified: Cameras; waterproof holding boxes; control and storage PC; 'touch screen'; software integrating control of camera functions and camera views, capture, playback of one or two camera views concurrently; portable storage in a case. Testing of the requirements was conducted. A prototype system was demonstrated and the system subsequently modified to improve the software and portability. RESULTS: The system developed has the following main features: High quality wide-angle lens with up to 12x optical zoom; integrated pan and tilt; low distortion throughout the zoom range; remote controlled camera functions including aperture, shutter speed, and gain; waterproof holding boxes with low distortion perspex window, simple and effective mechanism for attaching to pool walls or floor, stable for use in 3D analysis, neutral buoyancy to enable ease of underwater positioning, dimensions optimal for pan and tilt, waterproof cable exit; control and storage PC enabling control of either one or two cameras, large file storage, and file management; 'touch screen'; user-friendly software that integrates control of camera functions and camera views, capture, playback of one or two camera views concurrently, real time video preview, playback with slow motion, simple data base entry and file retrieval; simple file management, retrieval and download; portable storage in a standard size travel case with hard exterior, handle, and wheels. The errors in 3D reconstruction using two systems in combination (four cameras) compared favourably with similar systems. DISCUSSION: This system developed meets the requirements specified. As a consequence coaches have an affordable qualitative analysis system that can be used readily in any pool. The system is also suitable for 2D and 3D quantitative research.

0-126

Advanced Biomechanical Simulations in Swimming Enabled by Extensions of Swimming Human Simulation Model "SWUM"

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INTRODUCTION: There are many mechanical problems to be solved in human swimming. For these problems, the authors have developed a simulation model, "SWUM," (Nakashima et al., 2007) and a free software "Swumsuit" as the implementation of SWUM. Since SWUM was reported in the last symposium, major extensions have been successively made on it, such as optimizing calculation, musculoskeletal simulation, and multi agent/object simulation, in order to extend the capability of analysis. In this paper, these extensions are explained and the various recent results from their implementation are presented in order to show their validity and usefulness. METHODS: All analyses in this paper were carried out using SWUM. The first extension of SWUM was for the optimizing calculation. In the optimizing calculation, a single simulation of time integration is repeated changing the various design variables until a given objective function is maximized. The second extension was the musculoskeletal simulation. The whole body musculoskeletal model with 458 muscles was employed. The third extension was "multi agent/object simulation." "Multi agents" means multiple swimmers and "multi objects" means implements for swimming such as fins, a starting block, the pool wall, and so on. RESULTS AND DISCUSSION: A simulation example of the optimization of arm stroke in freestyle swimming was presented in the paper. It was found that the thrust by the hand had two clear peaks when pulling (t = 0.29, t is nondimensional time) and pushing (t = 0.54) the water. For the musculoskeletal simulation, an example of the simulated and experimental results for the breaststroke was shown. It was found that the upper limb muscles were activated at the hand stroke, and that the lower limb muscles were

activated at the kick in the simulation. As the examples of the multi agent/object simulation, simple synchronized swimming by three swimmers, monofin swimming, and the shooting motion in water polo were presented respectively. In the simulation of shooting motion, the velocity of the shot ball was 13.5m/s. In future studies, various mechanical problems in swimming and aquatic activities will be analyzed by the present extensions. REFERENCES: 1. Nakashima, M., Satou, K., Miura, Y. (2007). Development of swimming human simulation model considering rigid body dynamics and unsteady fluid force for whole body. J Fluid Sci & Tech, 2(1): 56-67.

P-001

Comparison of Manikin Carry Performance by Lifeguards and Lifesavers When Using Barefoot, Flexible and Fiber Fins

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INTRODUCTION: Fins use is fundamental in aquatic rescue activities, either for sport or saving purposes. There is a large variety of fin models available in the market, and a common concern of lifesavers and lifeguards is to choose the best fin model. The main purpose of this study was to compare these two groups performing a manikin carry effort using barefoot, flexible and fiber fins. METHODS: Twenty subjects (10 licensed lifeguards and 10 lifesavers) performed 3 x 25 m maximal swim trials carrying a manikin, barefoot and with flexible and fibre fins. Each 25 m bout was divided in three parts for a detailed analysis. Instantaneous velocity to time curve (v(t)) was obtained using a cable speedmeter. Slops and Fatigue Index (FI) were assessed over the v(t) curve. RESULTS: Subjects obtained lower v values in the barefoot condition, comparatively with flexible and fiber fins (lifesavers: 0.77±0.08; 1.12±0.1; 1.31±0.11, respectively and lifeguards: 0.67±0.06; 1.03±0.10; 1.09±0.12). Lifesavers performed faster in any of the three effort segments of the 25 m effort when using fiber fins. There were no differences in the total carrying time of lifesavers and lifeguards in any of the conditions studied. The use of fiber fins by the lifesavers allowed the rise of the v and increase fatigue delay during the first half part of the test. The v decline and the FI were similar for both groups. DISCUSSION: The higher v obtained with the use of fins could be explained by the higher propulsive area of these materials. The higher observed v attained by lifesavers during the 25 m effort when using fiber fins could be due to their common use in training and competition. The absence of differences in v by lifeguards using four different fin models was already pointed out by Abraldes et al. (2007). It is possible that the eventually lower training level of lifeguards compared to lifesavers did not allow for a specialized use of any of the tested fin models. The absence of differences in fatigue indicators among the carrying effort could be a consequence of the short total effort duration. In syntheses, fiber fins seams to allow for a higher v of lifesavers when compared with flexible fins. The effect of the use of flexible or fiber fins is not evident in fatigue for both lifesavers and lifeguards. REFERENCES: 1. Abraldes, JA, Soares, S, Lima, AB, Fernandes, R, Vilas-Boas, JP. (2007). The Effect of Fin Use on the Speed of Lifesaving Rescues. Int J Aquat Res & Ed 1(4): 329-340.

P-002

Swimming Forces: A Review

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INTRODUCTION: Several studies have investigated the drag force (Zamparo et al, 1996; Sheenan & Laughrin, 1992) in various forms, while others researched the lift force as another variable of producing propulsion in swimming. Aim: To review research based on the forces in swimming in an attempt to better understand the desirability of generating maximum forward lift force and minimum forward drag force on the body seg-ments as the most efficient combination to be used for propelling the body. METHOD: A review of literature was employed for identifying the role of the 'forces' in swimming. The terms "forces" and "swimming" were used as key words. More than 72 journal articles provided by electronic libraries (e.g., Sport Discus) and textbooks were available in the literature libraries. The selection process of references was based on the following criteria: articles referring to the influence of forces in swimming, review articles and other publi-cations, focusing on literature having origin from countries where swimming is well researched (e.g. USA, Australia). DISCUSSION: The internal and external forces acting on a human body and the effects produced by these forces (Hay, 1978), that were examined are described in figure 1. CONCLUSIONS: Significant correlations exist between selected anthropometric variables and drag of the ac-tively propelling swimmer. Future examination of the active drag needs to appreciate the individual biomechanical technique and the size of the examined sample. Body position changes influence resistance. Re-search needs to report to whom those results refer to (e.g. elite, non swimmers, etc), the estimated errors in their hydrodynamic data and the procedures used to reduce them. Computational Fluid Dynamics, can work as database of drag and lift coefficients for use in unsteady flow conditions for the evaluation and the im-provement of the technique. Swimming propulsion is the result of subtle and changing combinations of lifts and drag forces.

P-003

Kinematical Characterisation of a Basic Head-Out Aquatic Exercise during an Incremental Protocol

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INTRODUCTION: The aim of this study was to analyze the relationships between musical cadence and kinematical characteristics of a basic head-out aquatic exercise, when immersed to the breast. METHODS: Six women with at least one year as head-out aquatic instructor were assessed. Subjects performed five bouts of 16 repetitions of the "rocking horse" at the "water tempo". Bouts intensity were 80% (120 b.min-1), 90% (135 b.min-1), 100% (150 b.min-1), 110% (165 b.min-1) and 120% (180 b.min-1) of the cadence reported by Barbosa et al. (2009) to achieve a 4 mmol.l-1 of blood lactate. The protocol was videotaped in sagital plane with a pair of cameras providing a dual projection from both above and underwater. The study comprised the kinematical analysis (f=50Hz) of the full cycles (Ariel Performance Analysis System, Ariel Dynamics Inc., USA). It was evaluated the: (i) cycle period; (ii) 2D linear position ranges (foot, hand and centre of mass); 2D linear velocity ranges (foot, hand and centre of mass). RESULTS: There was a decrease of the cycle period throughout the experimental protocol ($R2=0.83$; $P<0.01$). There were any significant relationship between horizontal ($0.01<R2<0.31$) class

P-004

Kinematic Analysis of Take-Off Performance in Elite Swimmers: New OSB11 Versus Traditional Starting Block

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INTRODUCTION: Recently, a new starting block (OSB 11 from Omega Swiss Timing, Ltd.) was introduced to FINA international swimming competitions. While the distributor of this new block advertises its product to result in shorter race times studies to examine the kinematic changes associated with the new construction are scarce. A study was conducted to compare the kinematic take-off profiles of german elite swimmers from the new starting block (surface area 74x50 cm, 9° surface angle to the ground) and from the traditional starting block (surface area 50x50 cm, 5° surface angle to the ground). METHOD: Seven male swimmers (3 grab starters and 4 track starters) participated in the study. Their take-off performances were videotaped and later on examined for selected kinematic parameters. The last ten frames during the block phase and the first five frames in the flight phase were analyzed (take-off angle and take-off velocity related to the centre of mass trajectory). A second video camera was used to measure the starting performance by the time elapsed between the starting signal and the passage of the head at 7,5 m. Each subject performed three track starts on the new OSB 11, three track starts on the traditional starting block, and three grab starts on the new OSB 11. The best two trials for each condition were used for the statistical analysis. RESULTS: For the track starts, starting performance was significantly reduced by 0,2 s in the new OSB 11. In addition, a shorter block time and a higher horizontal take-off velocity were found for the new block. For the comparison between the two starting techniques on the new block, track starters showed significantly shorter starting times and block times as well as a significantly higher horizontal take-off velocity. While significantly a better starting performance was found for the new OSB 11, our results also indicate that a modification of the dive-in behaviour may be necessary to fully utilize the possibilities of the new starting block.

P-005

Application of CAST Technique to 3D Motion Analysis of Front Crawl Swimming

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INTRODUCTION: Although underwater swimmers video recordings are widely diffused, swimmers kinematics is usually reconstructed only on a single sagittal view. Some authors performed a 2D kinematics analysis of the front crawl by means of multi-cameras underwater acquisition systems, relying on manual digitization of specific features' position. Thus in this study an automatic and repeatable method to assess 3D kinematics of front crawl swimming is presented. This combines both the Calibrated Anatomical Systems Techniques technique (CAST) [1] and a semi-automatic feature tracking technology. METHODS: 4 out of several front crawl trials performed by an elite swimmer and recorded by means of 5 underwater color analog cameras were selected. The latter were synchronized automatically by means of an ad-hoc application, and calibrated with Bouguet method. A set of 25 features was drawn on the body, to reconstruct the 3D kinematics of the right trunk and arm. The 3D trajectories of the following 4 anatomical landmarks were reconstructed by applying CAST: the incisura jugularis (IJ), the acromion (ACR), the center of the elbow joint (EJ) and of the wrist joint (WJ). The features were tracked in each video sequence by using an application based upon the registration technique proposed by Lucas and Kanade [2]. A comparison with the manual tracking technique, assessed by two trained experts, was also performed. RESULTS: The 3D joint trajectories repeatability analysis for CAST reported intra-method correlation coefficients between trials ranging from 0.936 to 0.999 and from 0.801 to 0.996 for EJ and WJ, respectively, along the 3 axes. A good correlation was found also for the IJ and the ACR (0.947 to 0.999 and 0.766 to 0.999) between trials along medio-lateral and antero-posterior axis, however along the vertical axis a poor correlation was found, especially for the ACR. Without applying CAST, the trajectories of the IJ and the ACR were determined during 10% of the acquired motion, reaching the 80% when CAST was applied. Further, the comparison with manual tracking showed good consistence of the proposed technique in terms of variability. DISCUSSION: The use of a combined methodology which employs both the semi-automatic tracking and CAST provides more objective and consistent results than direct manual video digitization. REFERENCES: 1. A. Cappozzo et al. Clinical Biomech, 4 171-178, 1995 2. B.Lucas, T. Kanade. Intl Joint Conf on Artificial Intelligence, 674-679, 1981

P-006

Which is the Recommended Duration for the Tethered Swimming Test?

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INTRODUCTION: The tethered test is one of the most widely used methods for estimating the swimming force. (Dopsaj, 2003). However, tethered test results were debatable for the low correlation with the swimming performance and for the test's duration. In this work we investigate which is the duration of the tethered test that allows to obtain results highly correlated with the swimming performances. METHODS: We defined four types of tethered test that differ only for them duration (15s for T15, 30s for T30, 45s for T45, 60s for T60). Six female national ranked swimmers (age 16±0; 1.64±0,02 m; 58.0±5kg.) performed 4 tethered tests with maximum intensity for T15, T30, T45, T60. The force was recorded with a load-cell (Globus, Italia). Blood lactate measurements were performed 1 m after the end of each trial (L15 for T15, L30 for T30, L45 for T45, L60 for T60). We investigated the correlation between the value of strength (N) recorded by the load-cell and the best-time performance of the athletes for each type of tethered test. These performances result from the official competitions in distances of 50m (V50), 100m (V100) and 200m (V200) crawl. RESULTS: The significant correlations between the best-time of swimmers and the load cell measurements were: V50/T15= 0.95 (<0.05), V50/T30= 0.95 (<0.05), V100/T15= 0.87 (<0.025), V100/T30= 0.96 (<0.05), V100/T45= 0.79 (<0.05). The average blood lactate produced increased linearly with increasing duration of the test (5.15 mml/l for L15, 7.13 mml/l for L30, 8.72 mml/l for L45, 9.65 mml/l for L60). DISCUSSION: This study shows a good correlation between the best-time performance on the distances of 50 m and 100 m and the values of force measured using the tethered test with duration 15 s and 30 s. Data are less related in the test of longer duration and distance of 200 m. These findings, in part yet submitted by other authors, seem to confirm the link between the tests with short time duration and the performances with greater use of power and predominance of anaerobic energy. T15 and T30 tethered test are probably the best to highlight capacities of the young sprinters in swimming. REFERENCES: Dopsaj M., Matkovic I., Thanopoulos V., Okicic T., (2003) Realibility and validity of basic kinematics and mechanical characteristics of pulling force in swimmers measured by the method of tethered swimming with maximum intensity of 60 seconds. Facta Universitatis, 1(10), 11-22.

P-007

The Effect of Wearing a Synthetic Rubber Suit on Hydrostatic Lift and Lung Volume

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INTRODUCTION: In the Swimming World Championships 2009 swimmers utilized suits produced entirely, or partially, with industrial polymers. The effect of technical suits in determining the increase in swimming speed is still not fully understood, their advantage could be related to an increase of buoyancy (Benjanuvatra, 2002). The aim of this work was to evaluate the differences in hydrostatic lift and lung volume in swimmers wearing (or not wearing) a suit made of polyurethane/neoprene. METHODS: In the first test, the hydrostatic lift 6.96 kg) were measured 0.03 m; 75.45± of 9 male swimmers (age 23.25±3.01; 1.80± while wearing a "standard" swim suit (S) or a full body technical suit (X-glide Arena Italy= Xg). After a maximal inspiration, the subjects were kept in position for 10 s under the water surface throughout a cable connected to a pulley system positioned on the swimming pool floor. The cable was also connected to a load cell (Globus, Italy) positioned on the pool's edge that allowed to measure the subject's hydrostatic lift (the force with which their body tended to rise towards the water surface). In the second test, chest circumferences (maximal inspiration and maximal expiration) and lung volumes (VC: Vital Capacity, ERV: Expiratory Reserve Volume, VT: Tidal Volume, IRV: Inspiratory Reserve Volume) were measured in both conditions of suit. RESULTS: 3.99 N for S and 14.33± 4.53 The average values of hydrostatic lift were 14.51± N for Xg (R=0,94, P<0.05), for the chest circumferences during max. expiration (R=0,86) and max. inspiration (R=0,99) were 88,6±3,70 / 97,3±3,26 cm for S and 86,6±3,39 / 95,6±2,48 cm for Xg. The average values of lung volumes were: VC 6,31/6,14 L (<0,01), ERV 2,12/1,79 L (<0,01), VT 0,94/0,88 L, IRV 3,26/3,47 L (<0,05), respectively for S and XG. DISCUSSION: Hydrostatic lift was found to be smaller in Xg. A strong thoracic or abdominal compression caused by the technical suits could be tentatively related to the observed reduction in the chest circumferences during maximal inspiration and expiration as well as to the reduction in the lung volumes and in the hydrostatic lift. The improvement in performance obtained by wearing Xg is not related with a better static buoyancy. REFERENCES: Benjanuvatra N., Dawson G., Blanksby B.A., Elliott B.C., (2002) Comparison of buoyancy, passive and net active drag forces between Fastskin and standard swimsuits. Journal of Science and Medicine in Sport, 5(2), 115-23.

P-008

Kinematical Analysis of Butterfly Stroke: Comparison of Three Velocity Variants

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INTRODUCTION: Stroke mechanics are continuously emphasized on competitive swimming in order to minimize intracyclic velocity variation (IVV). However, nonetheless butterfly specific training series are conducted in different intensity zones, few is known about the behavior of biomechanical parameters, and their implications on IVV, at different training regimens. We aimed to compare the butterfly kinematical changes during 100m (between the 1st and 4th laps) at 3 swimming velocities and in-between these intensities. It was hypothesized that higher IVV is observed at the 4th lap of each 100m, and, when comparing the 100m performed at different intensities, lower IVV will occur at higher velocities. METHODS: Seven female swimmers performed a protocol of 3x100m butterfly at sub-maximal (60 and 80%, v60 and v80, respectively) and at maximal velocities (v100), with a 30min interval. Two above and below water cameras, positioned in the sagittal plane, were used for movement analysis. APASystem was used to calculate and analyze the velocity (v), stroke length (SL), stroke rate (SR) and IVV of the centre of mass. Kinematic analysis was conducted at the first (1st) and fourth (4th) lap of each 100m test. Significance was considered for p<0,05. RESULTS: Comparing swimming v between the 1st and 4th lap of each 100m, differences were only observed at v100 (with higher v values in the 1st 50 m split: 1.47±0.13 vs 1.23±0.08). When comparing the v60, v80 and v100, differences were found in the 1st lap between all the trials (1.47±0.13, 1.30±0.21 and 1.27±0.06, respectively for v100, v80 and v60). Considering SR, higher values were observed for the 1st lap comparing with the 4th lap in v60 (48.0±1.22 vs 46.8±3.03) and v100 (57.0±7.20 vs 52.8±2.40). When comparing swimming intensities, SR in the 1st and 4th step was always lower in v60 than in v100. SL tends to follow an inverse behaviour than SR, but without statistical significance. Regarding the IVV parameter, no differences were observed. However, a tendency for higher values at v60 comparing to v100 in the 1st lap (24.9±11.60 vs 16.40±8.50) and in the total 100m effort (17.5±5.00 vs 14.8±7.00) was perceived. DISCUSSION: The behavior of the v and stroking parameters observed followed the traditionally described when comparing different front crawl intensities. The non existence of differences regarding the IVV seems to evidence that the lower v and SR values observed in the v60 were not of sufficient magnitude to affect it.

P-009

Biomechanical Characterization of the Backstroke Start in Immerged and Emerged Feet Conditions

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INTRODUCTION: The start is accepted as an important element for success in competitive swimming, especially in the short events. Concerning the backstroke start, the number of studies is scarce, none of which has yet dealt with the technical adjustments allowed by the new rules that authorize the swimmers to position their feet above water level. The aim of this study was to describe and compare two variants of the backstroke start technique, one with the feet parallel in complete immersion (BSFI) and the other with the feet parallel in complete emersion (BSFE) METHODS: Six male high-level swimmers performed two sets of 4 maximal intensity backstroke starts using the two variants: BSFI and BSFE (with intervals of 2 min between repetitions and 1 h between sets). Dual-media video images (Vilas-Boas et al., 1997) were recorded using two cameras (DCR-HC42E and SVHS-JVCGR-SX1) positioned in the sagittal plane of the movement and afterwards digitized (APAS). Kinetic data were obtained using an underwater extensometric platform. The handgrip system was adapted allowing keeping the same body elevation regarding water surface. The backstroke start was divided into three phases (adapted from Hohmann et al., 2006): hands-off, take-off and flight. Several temporal and kinematical parameters were assessed. RESULTS: Findings registered higher flight time and higher horizontal displacement of the centre of mass (Dx) at BSFI. BSFE seems to imply higher impulse, and higher time of hands-off, foot take-off and total start. DISCUSSION: As a performance parameter, the total time spent during the start was lower for BSFI than BSFE, allowing concluding that the first being faster than the second should be preferred for competitive use. This observed superiority of the BSFI may be at least partially justified by the higher flight time and Dx. These findings seem to confirm the hypothesis that lower feet position can determine the Dx by constraining the orientation of the resultant wall reaction vector. It is recommended that coaches begin monitoring the backstroke start variants strategies to improve tech-

nique, which can be determinant of the start success. REFERENCES: 1. Hohmann A, Fehr U, Kirsten R., Krüger T (2006). Emg-model of backstroke start technique. Port J Sport Sci, 6 (1), 37-40. 2. Vilas-Boas JP, Cunha P, Figueiras T, Ferreira M, Duarte J (1997). Movement analysis in simultaneously swimming techniques. In: K Daniel, U Offman, J Klauk (Eds), Kolner Swimmsporttage. Bericht, 95-103

P-010

Tethered Force Production in Standard and Contra-standard Sculling in Synchronized Swimming

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INTRODUCTION: Sculling is a common used technique in synchronized swimming and, although its importance is undeniable in this sport, very few studies were implemented to date. In fact, no study seems to have quantified the force produced by the swimmer performing this technique. As the appearance of fatigue during sculling was also not yet studied, it was aimed to measure the force production and the fatigue induced by standard and contra-standard sculling. METHODS: A 30 s maximum intensity tethered synchronized swimming test was applied over a total of thirteen synchronized swimmers, in order to determine individual force (F) to time curves - F(t) -, in two conditions: (i) standard sculling, and (ii) contra-standard sculling. Fatigue was assessed through the fatigue index (FI) computed using the F(t) extreme values and time. RESULTS: The absolute mean ± SD values for maximal force (Fmax) and FI in standard and contra-standard sculling were 40.77 ± 12.39 N and 34.58 ± 5.41 N, and 46.88 ± 17.62 % and 37.87 ± 11.26 %, respectively. Almost all the synchronized swimmers reached higher absolute and relative Fmax in standard sculling. The higher observed values of Fmax in standard and contra-standard sculling were 62,59N and 43,64N, respectively. The values of FI evidenced that the F values, despite all the variations observed, declined during the 30 s effort in all participants and in both sculling conditions. With the exception of Fmax values, none of the variables studied were different between standard and contra-standard sculling. DISCUSSION: Almost all the synchronized swimmers reached higher values of Fmax in standard sculling, which can be related to the possibility of this action to be a more "natural" movement from the anatomical point a view. Additionally, swimmers who reached higher Fmax values were, in general, the oldest, taller, heaviest and with a higher arm span, which is in line with the swimming related literature (Sidney et al., 1996). The synchronized swimmers who reached higher Fmax in standard and contra-standard sculling do not present the higher values of FI, which may be explained by differences in maturation, anthropometric characteristics and training background. However, it was observed an inverse relationship between FI and the average of minimum forces. In conclusion, there were differences in Fmax production between standard and contra-standard sculling in synchronized swimmers. REFERENCES: 1. Sidney M et al. (1996). J Hum Mov Stud, 31: 1-12.

P-011

Pulling Force Characteristics of 10s Maximal Tethered Eggbeater Kick in Elite Water Polo Players

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INTRODUCTION: In water polo, duel play is the players' basic technical and tactical (TE-TA) position in both offense and defense. The position essentially enables players to block the opponent by holding their arms so as to perform the TE-TA elements, using the eggbeater kick technique simultaneously. This paper aimed to define the basic kinematical and mechanical characteristics of 10s maximal tethered eggbeater kicks in elite water polo (WP) players. METHODS: The study involved 14 male elite WP players (Age=21.5±5.1yrs, BH=187.2±6.1cm, BM=84.5±11.9kg, training experience=11.7±3.6yrs). The tests were conducted in the middle of the national premiere league preparation period for the 2006/07 competition season. A standard procedure was used, applying the tethered puling force methods, and the players had to realize the maximal pull force of 10s duration only by eggbeater kicks while in the chest-forward position. The following measurements of the kinematical and mechanical characteristics of pulling force were taken: the duration of a single eggbeater kick (TimeEBK), in ms; the maximal (peak) force value realized by a single eggbeater kick (FmaxEBK), in N; the average force value realized by a single eggbeater kick (FavgEBK), in N; the impulse of force (ImpFEBK), in Ns; the single eggbeater kick explosive force (RFDEBK), in N/s; and the single eggbeater kick frequency (HzEBK), expressed in the numbers of kicks per minute. All data were treated in absolute and relative values with the descriptive statistical method. RESULTS: The descriptive variable results yielded the following absolute values: TimeEBK=497.78±56.95 ms; FmaxEBK=190.52±36.04; FavgEBK=140.44±21.12; ImpFEBK=72.95±14.32; RFDEBK=336.73±98.89; HzEBK=120.08±14.70 Kicks/min. The descriptive variable results yielded the following relative values: FrelEBK=2.295±0.534 N-kgBW; FavgrelEBK=1.689±0.327 N-kgBW; ImpFrelEBK=0.880±0.214 Ns-kgBW; RFDrelEBK=4.105±1.610 N/s-kgBW. DISCUSSION: The results indicated the descriptive values of the kinematical and mechanical characteristics of the 10s maximal tethered eggbeater kick in elite water polo players with regard to the absolute and relative values. Also, the resulting models could help towards the development of the water polo training technology, as well as the establishment of a new method to test the specific leg fitness in elite senior water polo players.

P-012

Motor Coordination During the Underwater Undulatory Swimming Phase of the Start For High Level Swimmers

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INTRODUCTION: In swimming event, start is determinant to achieve a good race performance. During the underwater undulatory swimming phase, swimmers have to find the optimal leg motor coordination to produce the highest propulsive forces without increasing the hydrodynamic resistances. The aim of this study is to determine the motor coordination that high level swimmers are able to produce during the underwater undulatory swimming phase of the start. METHODS: 12 high level male swimmers participated in this study. Swimmers were asked to performe the most efficient grab start. Swimmers were filmed during the whole underwater phase of the start by 4 mini-DV camcorders. Nine anatomical landmarks were identified on the swimmer's body. To minimise the error during the digitising process, both sides of the swimmers were supposed to be symmetric. Landmarks space coordinates have been calculated using a modified 2D DLT technique (inspired from Drenk et al., 1999). Space reconstruction accuracy was 6.2 mm. Ankle, knee and hip angles and positions were calculated. Motor coordinations and synergies were identified by computing cross correlation functions. RESULTS: Results show significant cross correlation between: the hip angle and the ankle angle, the hip angle and the trunk angle, the hip angle and the thigh angle of attack, the knee angle and the thigh angle of attack, the knee depth and the thigh

angle of attack, the knee depth and the hip angle, the knee depth and the knee angle, the hip angle and the leg angle attack, the knee angle and the leg angle attack, the ankle depth and the hip angle, the ankle depth and the knee angle, the toes depth and the hip angle, the toes depth and the knee angle, the toes depth and ankle angle. DISCUSSION: During the underwater undutory swimming, swimmers have to find the optimal leg amplitude. It seems that high level swimmers control leg amplitude thanks to a strong joint synergy between the hip action and the ankle action. Knee action is also important but seems to have an independent effect on leg amplitude. REFERENCES: 1. Drenk, V., Hildebrand, F., Kindler, M., & Kliche, D. (1999). A 3D video technique for analysis of swimming in a flume. In R.H. Sanders, & B.J. Gibson (Eds.), Proceedings of the XVII International Symposium on Biomechanics in Sports (pp. 361-364). Perth, Edith-Cowan University

P-013

Evaluation of the Validity of Radar for Measuring Throwing Velocities in Water Polo

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INTRODUCTION: Many studies have been published being interested in the meas-urement of velocity of balls, implements and corporal segments in sports where those skills are basic for performance. Skill in passing and throwing is vital in Water Polo because accuracy and the ability to produce high velocities are also valuable during the game for shots at goal. The aim of the present study was twofold; firstly to evaluate the validity of the radar measurements versus high velocity 2D photogrammetric analysis, in two different situation, and secondly, to establish a valid methodology to asses throwing velocity in Water Polo. METHODS: The participants carried out 48 throws at maximum intensity from the penalty position (24 throws), and from an oblique position to the goal (¥è ~ 20¨¬) in the same penalty line (24 throws) with and without goal-keeper. They executed throws by alternating manner with a 3-min rest between each. The ball maximum velocity was measured with radar placed ten meters behind the goal, and aligned with the penalty line. Simultaneously; a 2D photogrammetric study was accomplished. The camera was mounted on a rigid tripod at a height of 1.0 m and placed at a distance of 10 m from the middle of the athlete¡¯s lane. The optical axis of the camera was perpendicular to the direction of throwing for each different situation. One trial by each participant for each throw condition was analyzed. After the throws were analyzed, Pearson correlation coefficients (SPSS 15.0) were used to determine the interrelationship among the maximum velocity obtained by the radar gun and the 2D analysis. The alpha level was set to p ¡Â 0.05. RESULTS: For frontal throws with-out goalkeeper the ICC was 0.96, and with goalkeeper was 0.84. If we analyze throws in oblique situation (¥á ~ 20¨¬), the ICC was 0.94 without goalkeeper and 0.96 with goalkeeper. When we analyzed all throws in frontal situation the Pearson correlation coefficient obtained was 0.91 and in oblique position was 0.94. In all situations p value was ¡Â 0.001. CONCLUSION: Radar is a valid method to measure throwing velocity in Water Polo, so for frontal throws as well for oblique throws

P-014

A Kinematic Study on the Dive-In Behaviour During Swim Start Performance From the Block

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INTRODUCTION: While dive-in performance after swim start from the block is considered to be essential for swim start performance in general (e.g. Bonnar, 2001; Guimaeres & Hay, 1985), there are only few studies in the literature related to an examination of underwater kinematic profiles in elite swimmers. This deficit might be due to apparent methodological problems involved when detecting body landmarks as air particles swept along the body surface distorting a clear vision. A new procedure was developed to identify body landmarks despite visual restrictions during the dive-in phase. A study was conducted to examine the kinematic differences in elite swimmers. METHOD: Sixteen male elite swimmers participated in the study. Starting performance was studied in the course of a 50m speed test and measured by the time elapsed between the starting signal and the passage of the head at 7,5 m. Three video cameras were used for data acquisition. While block performance and head passage at 7,5 m were analyzed by two above water cameras, an under water video system was used to examine the dive-in behaviour. Since body landmarks are hard to be identified because of air particles carried along the body surface during dive-in, segment mid-lines were evaluated by a linear regression model (Fischer & Kibele, 2007). Traditional body landmarks (segment end-points) were identified as intersections of two adjacent segment mid-lines. RESULTS: Significant statistical correlations were found between the starting performance and the hip angle at water entry of the centre of mass ($r=-0.72^{**}$), the mean horizontal velocity during the dive-in phase ($r=-0.72^{**}$), and the maximal dive-in depth ($r=-0.69^{**}$). Accordingly, significant differences in these parameters were found between good starters and poor starters. No differences were found in the mean horizontal velocity between starting signal and water entry, angle of the centre of mass trajectory at first water contact. There are indications that good starters minimize their loss in horizontal velocity during dive-in by the use of a dolphin-kick. Moreover, good starters perform deeper dives during the transition to the horizontal body position. Our results indicate, that good starters also show higher angular impulses about the transverse body axis.

P-015

Comparison Between two Different Types of Instruments: an Encoder and an Inertial Sensor Device

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INTRODUCTION: The measurement and analysis of the kinematics of the swimmer is difficult and complex due to the environment in which it occurs. The research and development of new technologies aim to give the coach the opportunity to obtain more immediate information. In this work, the performances of two different instruments, that can be used as field tools by coaches, were compared. METHODS: The instruments used were the SpeedRT (ApLab Rome), measuring distance and time through the extraction of a wire coil placed in a rotating sensor, and FreeSense (Sensorize Rome), measuring triaxial linear acceleration and angular velocities based on the technology system 3D MEMS. 8 swimmers (180 ± 8.7 cm, 77 ± 9.7 kg) wore simultaneously the two devices. The Freesense has a belt with a back support, and the SpeedRT was connected to the belt. The subjects performed 3 trials of 25 m in 3 different swimming styles (crawl = T1, butterfly = T2, breaststroke = T3). The recorded signals were exported in spreadsheet format to identify the starting time instants, to overlap the acceleration curves and to perform the comparison. RESULTS: The average correlations between the instruments was high and homogeneous: for T1 R = 0.77 ± 0.08, for T2 R = 0.88 ± 0.02, for T3 R = 0.88 ± 0.02. The difference between the average values of signals for SpeedRT vs FreeSense was -0.19 (± 0.61) m/s*s. Considering the positive acceleration this value was 0.53 (± 0.22) m/s*s, while for the negative acceleration was -0.63 (± 0.35) m/s*s. DISCUSSION: Morouço (2006) compared data of acceleration

acquired by the video system and SpeedRT. In this work, the signals showed good temporal overlapping and relationship. The average difference, in our view, reflected the specific features of the tools and their applications. For symmetric styles, characterized by higher accelerations, the signals' correlation is high, while a smaller correlation was found for the crawl. The wire accelerometer allows to get "on-line" indication of space that allows analysis of speed of movement in different phases of the trials, while the sensor accelerometer is not bound to linear measurements and considers three reference planes. REFERENCES: Morouço P., Lima A.B., Semblano P., Fernandes D., Gonçalves P, Sousa F., Fernandes R, Barbosa T., Correia M.V., Vilas-Boas j.P., (2006) Validation of a cable speedometer for butterfly evaluation. Revista Portuguesa de Ciências do Desporto, Vol. 6, Supl. 2, 236-239

P-016

The Mechanical Power Output in Water Polo: a Case Report

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INTRODUCTION: The coaches use normal swimming parameters as reference to develop the plan training activities even if the water polo player does not move as a swimmer in the best hydrodynamic position. The purpose of this work is to compare the mechanical power required to play a game as computed with a new model based on the specific analysis of the swimming's technique of water polo. METHODS: Two indices of passive drag were measured with the method of towing at different speeds (1.2-1.4-1.6-1.8-2 m/s) in a water polo player (27 years, 1.77 m, 79 kg). The first index was obtained in the position of "best glide" (Swim), the second index was obtained in a "head-up" position of the subject (Wp). The active drag in the two conditions was estimated (Kjendlie, 2008) as 1.5 times the value of passive drag. To calculate the drag in acceleration, the maximum acceleration reached by the typical water polo starting in "trudgeon" was measured. Then, that value (m/s*s) was reproduced in the tow Ben-Hur by measuring the drag value in the specific condition. The value of the mechanical power required to the water polo was computed multiplying the drag by speed: Power-drag = k*vn*v. The data of game model is obtained from a video analysis of the individual distances and velocity on a international water polo match in World Championship 1994. The total swimming time was defined for four steps of velocity and the values of mechanical power were calculated for all steps. RESULTS: The average mechanical power of a water polo game in Swim model was 150489J/2400s=62.70W, in WP model is 481375J/2400s=200.57W. DISCUSSION: The crawl technique used by water polo players involves a higher energy cost compared to the crawl technique used in swimming due to the need to keep the head out of the water. The players perform a series of swimming sprints with starts from standstill alternated to stationary phases. The mechanical power required to the water polo players could be more than three-fold higher than that required for freestyle swimming at the same velocities. Our study highlights the importance of developing specific training programs for water polo, addressing the higher requirements of mechanical power, taking into account the specific movement techniques and comparing the distances travelled using different swimming techniques. REFERENCES: Kjendlie P.L., Stallmann R:K., (2008) Drag characteristics of competitive swimming children and adults. Journal of Applied Biomechanics, 24(1), 35-42.

P-017

Attack Angle, Resultant Speed and Acceleration of the Hand and Vertical Acceleration of the Greater Trochanter during Sculling Motion: a Case Study

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INTRODUCTION: Synchronised swimmers need to be able to maintain a steady height in the water by performing controlled sculling motion, in which constant vertical resultant force (VRF) is applied. This study aimed to analyse the attack angle, the resultant speed and acceleration of the hand during sculling motion in order to relate these variables with the vertical acceleration of the greater trochanter (VAGT), which is proportional to the VRF. METHODS: One synchronised swimmer was asked to perform sculling motion in a stationary, vertical position (head above the water surface and with the water at chin level). Three-dimensional kinematic data from underwater video analysis was used to calculate the VAGT, the average attack angle and the hand's average resultant speed and acceleration during 11 consecutive cycles of sculling motion. Each cycle was divided into four phases: in-sweep, transition phase from in-sweep to out-sweep, out-sweep and transition phase from out-sweep to in-sweep (Arellano et al., 2006). Each variable was compared between the phases through a series of paired t-tests (α=0.05). RESULTS: Greater attack angles were found during the transition phase from out-sweep to in-sweep (51.8±6.8°). This phase also presented higher average resultant acceleration of the hand (27.4±4.8 m/s2). Higher average resultant speeds of the hand were found during the in-sweep and out-sweep (1.8±0.2 m/s). The lowest average attack angle (1.2±9°) and resultant speed of the hand (1.4±0.1 m/s) occurred during the out-sweep and transition phase from in-sweep to out-sweep respectively. The highest positive values of the VAGT occurred during the transition phase from out-sweep to in-sweep (0.8±0.2 m/s2), while the highest absolute negative values occurred during the other transition phase (-0.7±0.2 m/s2) and the lowest absolute average occurred during the in-sweep (-0.1±0.2 m/s2). DISCUSSION: Comparing in-sweep and out-sweep, greater VRF was applied during the out-sweep, which also showed the lower attack angle. Greater negative VRF was found during the transition phase from in-sweep to out-sweep, which may be explained by the lower average attack angle, while greater positive VRF was found during the other transition phase in which average attack angle was higher. REFERENCES: Arellano, R., Terrés-Nicoli, J., Redondo, J. (2006) Fundamental Hydrodynamics of Swimming Propulsion. In: Biomechanics and Medicine in Swimming X, Portuguese Journal of Sport Sciences, Porto, Portugal.

P-018

Comparison of Combinations of Vectors to define the Plane of the Hand in order to Calculate the Attack Angle during the Sculling Motion

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INTRODUCTION: Studies into swimming propulsion describe different combinations of vectors (different methods) to define the hand plane, which may alter the attack angle. The purposes of this study, which involved synchronized swimmers and swimmers in a real situation, were (i) to verify the agreement between the attack angles calculated using different methods, described in the literature and proposed by this study, to define the plane of the hand and (ii) to verify the variation in vector length of the methods found to be agreement in order to establish which method is most recommended when estimating the attack angle during sculling motion. METHODS: The sample consisted of 16 female participants (10 synchronized swimmers and 6 swimmers, all familiar with

sculling actions). They performed sculling motion in a stationary vertical position (head above the water surface and with the water at chin level). Three-dimensional kinematic data from underwater video analysis was used to calculate the attack angle using different methods described in the literature, such as Schleihauf (1979), Berger et al. (1995) and Lauder et al. (2001) (Lauder 1-5), and a new combination (NC) proposed by this study to define the plane of hand. The degree of agreement was established between the attack angles calculated using different methods and the variation was verified in vector lengths of the methods that were found to be in agreement. RESULTS: The attack angles calculated from Schleihauf, Lauder 1 and NC methods were in agreement. The variation in length of two vectors of these methods was 12% and 17.9% for Schleihauf, 7.2% and 17.9% for Lauder 1 and 7.8% and 8.4% for NC. DISCUSSION: While Schleihauf, Lauder 1 and NC methods are in agreement, the vectors used in the NC presented a smaller variation in their lengths. We suggest using the NC method to calculate the attack angle when analyzing the sculling motion, as these results were obtained in a real situation as opposed to a model. REFERENCES: 1. Berger, M, Groot, G, Hollander, P. (1995). Hydrodynamic drag and lift forces on human hand/arm models. J Biomech, 28(2):125-133. 2. Lauder, MA, Dabnichki, P, Bartlett, RM. (2001). Improved accuracy and reliability of sweepback angle, pitch angle and hand velocity calculations in swimming. J Biomech, 34(1):31-39. 3. Schleihauf, R. (1979) A Hydrodynamic Analysis of Swimming Propulsion. In: Swimming III, Terauds end Bedingfield, Edmonton, Canada.

P-019

Relative Contribution of Drag and Lift Forces in the Separate Phases of the Front Crawl Swimming

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INTRODUCTION: The resultant force produced by a swimmer's hand is a combination of drag and lift forces. The optimal combination of these forces is important, in order as much as possible of the resultant force to be aimed in the swimming direction (Schleihauf, 2004). Although both drag and lift forces are important for the swimming propulsion, it is suggested that, it is more effective when swimmers rely more on drag, rather than on lift forces (Maglischo, 2003). However, there is a lack of data regarding the relative contribution of drag and lift forces in the separate phases of the underwater stroke in front crawl swimming, which was the purpose of the present study. METHODS: Ten female swimmers swam 25 m front crawl with maximal intensity, with pull-buoy and without breathing in the middle of the pool. Four camcorders (60 Hz) were used to record the underwater motion of the right hand, and the digitizing of selected points was undertaken using the Ariel Performance Analysis System. The underwater stroke was divided in three phases: a) entry and catch b) pull and c) push. The hydrodynamic coefficients and the methodology described by Sanders (1999) were used to estimate the propulsive forces of the hand. Two-way analysis of variance for repeated measures was used for the statistical treatment of the data. RESULTS: During the pull phase the mean drag force (7.27 ± 1.89 Í) was significantly (F1,9= 7.590; p < 0.05) greater than lift force (5.37 ± 1.33 Í), while during the push phase no significant (F1,9= 3.829; p= 0.082) differences were found between drag (7.85 ± 1.16 N) and lift forces (8.81 ± 1.84 N). Furthermore, the drag force was not significantly different (F1,9= 0.591; p= 0.355) between the pull and push phases, while the lift force was significantly higher (F1,9= 29.142; p< 0.05) during the push vs. the pull phase. DISCUSSION: Both drag and lift forces are important for appropriate propulsion. However, the drag force is decisive for the propulsion in both propulsive phases of the underwater motion of the hand, while the contribution of lift force was increased during the push phase. REFERENCES: 1. Maglischo EW. (2003). Swimming fastest. Champaign IL., Human Kinetics. 2. Sanders R. (1999). Hydrodynamic characteristics of a swimmer's hand. J Appl Biomech, 15: 3 – 26. 3. Schleihauf RE. (2004). Biomechanics of Human Movement. Authorhouse. Bloomington, Indiana.

P-020

Kinematics Analysis of the Undulatory Underwater Swimming during a Grab Start of National Level Swimmers

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INTRODUCTION: Few information clearly present the important factor that the swimmer should achieve to limit the loss of velocity during the underwater phase of a start. The aim of this study is to estimate the most important factors that the swimmers would use to improve his performance. METHOD: Twelve swimmers were asked to perform a competitive start. The underwater area was recorded using three cameras. A modified double plane direct linear transformation method was used to calculate the landmark coordinates in space. The following variables were defined: the horizontal velocity of the center of mass (Vxg) and hip (Vxh); the angle of attack of trunk (átr), thigh (áth), leg (ále), foot (áfo); the mean kick frequency (f); the mean kick amplitude (A); the phase time of the knee (Pk) and the ankle (Pa). The effect of the independent variables (átr, áth, ále, áfo, f, A, Pk,Pa) on the dependent variables Vxg and Vxh was analysed using stepwise linear regression. RESULTS: The regression equations show that different parameters influence Vxg and Vxh at different phase of the underwater undulatory swimming. Between 5.5 to 6.5 m, the stepwise regression analysis show that the decrease of angles of attack of different segments (átr at 5.5 m, áfo at 6 m, áth at 6.5 m) are selected variables to improve the horizontal velocity Vxg and Vxh. Between 6 to 7.5 m, the stepwise regression analysis show that the increase of the phase time (Pk and Pa) are selected variables to improve the horizontal velocity Vxg and Vxh. At 6.5 m, the stepwise regression analysis show that the decrease of the angles of attack of thigh (áth) and the increase of the phase time of the knee (Pk) are the best predictors to improve horizontal velocity Vxg and Vxh (R2=0.79 for Vxg and R2=0.89 for Vxh). At 7.5 m, the stepwise regression analysis show that increase of phase time of the knee (Pk) and mean kick frequency (f) are the selected variables to improve respectively Vxg and Vxh DISCUSSION: At 6.5 m, the decrease of the angle of attack of the thigh (áth) and the increase of the phase time of the ankle (Pa) predicts the improvement of the horizontal velocity Vxg and Vxh. The stepwise regressions enable to propose principles to improve the underwater phase of the swimmer of the present study: to adopt streamline position with linear adjustment of the trunk and the bottom segments, to move like dolphins using only foot and leg for propulsive segment in underwater undulatory swimming.

P-021

Comparison of Front Crawl Swimming Drag between Elite and Non-Elite Swimmers Using Pressure Measurement and Motion Analysis

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INTRODUCTION: The hydrodynamic force exerted on a swimmer is changing from moment to moment during swimming. It is important to understand the dynamics of swimming to discuss the swimming

technique and performance. The purpose of the study is to suggest a methodology to quantify the drag force, which was changing during front crawl swimming, and to compare the swimming drag between elite and non-elite swimmers. METHODS: The subjects were a well-trained male competitive swimmer (49.6 sec/100mFr.) and a male triathlete (82.0 sec/100mFr.). The trial was the front crawl swimming using arm only in a swim-mill, which was set the flowing velocity to 1.3 m/s. The estimation of the drag force was based on the equation of motion, that is "ma = Fp + Fd", along with swimming direction. The twelve small pressure sensors were attached on the subject's both hands in order to measure the pressure distribution and to calculate the hydrodynamic force exerted on the hands. The attitude of both hands during underwater phase was calculated by the videography and 3D-DLT method. The propulsive force Fp was calculated as a component along with swimming direction of the hydrodynamic force on the hands, assuming that the swimmers produced the propulsive force by the hands only. The swimming acceleration a in the inertial term of the equation was calculated from the position of the umbilical part, as an alternative point of the center of gravity, which was recorded using a high speed camera with 250 fps. All measurements in the experiment were synchronized. RESULTS: The inertial term, the propulsive force and the drag force during 5 seconds were obtained in each trial. The mean drag forces were 21.3 N in elite swimmer and 50.3 N in non-elite, respectively. The maximum drag forces were 90.3 N in elite and 189.4 N in non-elite. The non-elite swimmer kept producing propulsive force with high stroke frequency. The mean propulsive force of the non-elite swimmer was higher than that of the elite swimmer (25.5 N in elite and 51.4 N in non-elite). DISCUSSION: The non-elite swimmer had to keep producing the propulsive force in order to maintain the swimming velocity, because of the larger drag force and de-acceleration. The smaller drag force in the elite swimmer would make it easy to keep the swimming velocity. It was suggested that our methodology to quantify the drag force during front crawl swimming would be useful to understand the dynamics and to discuss the performance of swimming.

P-022

The Study on the Properties of Power Output of Lower Limbs in Collegiate Swimmers During Vertical Jumping Performance

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INTRODUCTION: The injuries such as muscle strain or ankle sprain of swimmers often occurred during activities on the ground. It suggests that the injuries may be caused by their hyper mobility of the ankle joint or the reduction of the performance with the antigravity movement, but the real causes have not been elucidated yet. The measurement of jumping performance is widely used to evaluate the physical condition and trainability of athletes, but not so much of swimmers. The purpose of this study is to investigate the differences in the vertical jumping performance between Swimmers (SW) and Track and Field athletes (TF) in order to elucidate their properties of power output of lower limbs and to prevent the injuries of swimmers. METHODS: 12 male SW and 9 male TF in N university were participated. All subjects performed counter movement jump (CMJ) and squat jump (SJ) on the portable force plate. The changes in jumping height, displacement and velocity of center of mass (COM) were derived from the time series of the ground reaction force (GRF) collected with sampling frequency at 400 Hz. The same measurements were performed before (Pre) and after (Post) 6 months routine training. RESULTS: For SW, a significant increase in jumping height was observed in SJ (Pre;0.36±0.04m, Post;0.44±0.05m), but not in CMJ (Pre;0.46±0.05m, Post;0.49±0.05m), as a result of 6-months routine training. In contrast, for TF, no significant changes were observed in SJ (Pre;0.43±0.09m, Post;0.48±0.08m), but their COM displacement and the time from lowest COM displacement (t0) to the time when COM velocity reached maximum (t1) were significantly smaller in the CMJ (Pre;0.27±0.02s, Post;0.23±0.03s). DISCUSSION: CMJ requires the ability to convert the eccentric contraction to concentric contraction quickly (i.e., stretch-shortening-cycle; SSC), but SJ does not require it. Therefore it is conceivable that the performance of SJ was specifically related to the muscular strength of lower limbs. For TF, who performed daily antigravity training, the parameters in CMJ were improved, while, for SW, who lacked antigravity training, the parameters only in SJ were improved during six months. Since the above difference is caused by the lack of antigravity training, the results indicate that the antigravity training is essential to improve SSC function. When SW perform activities on the ground, it might be necessary for SW to prevent in

P-024

Relationships Between Entry Skill and 15m Time in Competitive Swimming Start

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INTRODUCTION: The purpose of this study was to examine the relationships between skill in entry phase and the glide speed. METHODS: Fourteen collegiate elite male swimmers performed maximal efforts competitive swimming start followed by 25m freestyle swim. The mean value of the swimmer elapsed time at 15m was 6.81±0.17 sec. The motions above and under water were recorded by synchronized two high speed video cameras (250 fps), and two CCD video cameras (60fps), respectively. The two-dimensional analysis was used to calculate the kinematic variables, such as entry speed, angle of projection, attitude angle and angle of attack. These angles were calculated about entry and glide phase. And, also acceleration in glide phase and angular variation about angle of projection, attitude angle and angle of attack during entry phase were calculated. A correlation analysis was conducted to examine the relationships between performance of start phase (15m time) and the kinematic variables. RESULTS: About kinematic variables in entry phase, angle of projection was 34.4±2.9deg. Attitude angle was 39.5±4.9deg. Angle of attack was -4.6±6.5deg. About kinematic variables in glide phase, angle of projection was 31.0±3.0deg Attitude angle was 11.1±5.8deg. Angle of attack was 19.9±3.8deg.There was a significant negative correlation between 0-15m time and angle of attack ($p<0.05$; $r=-0.534$). Also, there was a significant positive correlation between 15m time and acceleration in entry phase ($p<0.05$ $r=0.593$). Also, there was a significant negative correlation between angle of attack and acceleration in entry phase ($p<0.05$ $r=-0.599$). There was no correlation between angular variation about angle of attack and acceleration in entry phase ($p=0.158$ $r=-0.277$). DISCUSSION: The result of this study showed that the angle of attack and acceleration in entry phase influence 15m time. From these result, it is consider that the entry skill explained by angle of attack influence acceleration in entry phase, and therefore 15m time is shorten. But there was no correlation between angular variation about angle of attack and acceleration in entry phase. These results suggest that angular variation about angle of attack do not influence deceleration during entry phase in expert competitive swimmers.

P-025

Effects of new Hightech-Swim-Suits on Passive Drag

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INTRODUCTION: Which influence do Hightech-Swim-Suits have on swimming performance was the main question during the Olympic Games 2008 and World Championships 2009. Therefore the purpose of the present study was to investigate the effects of new generation Hightech-Swim-Suits compared to conventional swimwear on passive drag. METHODS: Eight national league swimmers (4 male, 4 female) participated on repeated gliding-tests with a Semi Tethered Machine (STM). The participators wore either conventional swimwear, shoulder-to-ankle Speedo LZR Racer, bluesenventy nero comp or Arena R-Evolution. For each condition athletes were towed in a 50m pool three times at water surface (s) and 0,5m deep (uw) in randomised order. Thereby velocity was measured. After smoothing the velocity-curves the means of steady state velocity were compared with ANOVA repeated measures with Fisher post-hoc test ($p<0.05$). RESULTS: Under both conditions (s and uw) swimsuits reached higher velocities compared to conventional swimwear. Thereby Speedo LZR always reached the highest velocities (s: 1,95ms-1 ± 0,01; uw: 2,14 ms-1± 0,01), followed by blueseventy (s: 1,91 ms-1 ± 0,01; uw: 2,10 ms-1 ± 0,01) and Arena (s: 1,91 ms-1± 0,01; 2,09 ms-1± 0,01). The lowest speeds were reached with conventional swimwear (1,87 ms-1± 0,01; 2,02 ms-1± 0,01). Significantly higher velocities at the surface were found for Speedo LZR compared to normal swimwear and Arena R-Evolution. Under water blueseventy and Speedo achieved significantly higher velocities compared to normal swimwear. DISCUSSION: Drag is an important phenomenon, because its reduction improves swimming speed. Passive drag is smaller than active drag. Anyway measuring passive drag allows exposing the effects of swimsuits without any influence of swimmers skills. Former studies measured the effects of "previous" swimsuits on active and passive drag and found different results. The present study showed advantages in wearing one of the tested suits while gliding through water. Even if the results cannot be transferred to a real situation of swimming, it can be expected, that long gliding phases under water after turns and wearing a swimsuit might improve swimming performance.

P-026

Different Frequential Acceleration Spectrums In Front Crawl

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This study analyzes the three different spectrums that define the acceleration produced by front crawl swimmers during a high speed test. These swimmers (n=79) performed 25 meters at maximum speed. The acceleration was obtained from the position–time data recorded using a position transducer. The amplitude in the time domain was calculated with the root mean square (RMS); while the peak power (PP), the peak power frequency (PPF) and the spectrum area (SA) were calculated in the frequency domain with Fourier analysis. An ANOVA to establish differences between groups (spectrums) was applied. Results show three different spectrum types (type 1: 27,85%, type 2: 30,38% and type 3: 41,77%). Our work shows that type 1 frequential spectrum is related to more coherence and might discriminate to the swimmers with better RMS.

P-027

The Gliding Phase in Swimming: The Effect of Water Depth

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INTRODUCTION: Aiming to achieve higher performances, swimmers should maximize each component of swimming races. During starts and turns, the gliding phase represents a determinant part of these race components. Thus, the depth position allowing minimizing the hydrodynamic drag force represents an important concern in swimming research. The aim of this study was to analyse the effect of depth on drag during the underwater gliding, using computational fluid dynamics (CFD) METHODS: The 3-D domain representing part of a swimming pool was 3.0m depth, 3.0m width and 11.0m length. CFD simulations were applied to the flow around a 3-D model of a male adult swimmer in a prone gliding position with the arms extended at the front (Marinho et al., 2009). General moving object model was used to model the body as the moving object. During the gliding, the swimmer model's middle line was placed at different water depths: 0.20m (just under the surface), 0.50m, 1.0m, 1.50m (middle of the pool), 2.0m, 2.50m and 2.80m (bottom of the pool). The coefficient of drag and the hydrodynamic drag force were computed using a steady flow velocity of 1.60m/s for the different depths run for 3 seconds in each case. RESULTS: The coefficient of drag was 0.67, 0.62, 0.53, 0.44, 0.36, 0.30, 0.28 and the drag force was 100.20N, 92.30N, 80.50N, 65.40N, 53.40N, 44.70N and 42.0N when gliding at a water depth of 0.20 m, 0.50m, 1.0m, 1.50m, 2.0m, 2.50m and 2.80m, respectively, at the time of 2 seconds when the swimmer was approximately at the middle of the computational pool. DISCUSSION: The water depth seems to have a positive effect on reducing hydrodynamic drag during the gliding. Moreover, gliding near the bottom of the pool also presented lower drag values compared to gliding at a water depth, for instance, in the middle of the swimming pool. This finding could suggest that the positive effects of water depth are more powerful than the possible negative hydrodynamic effects of turbulence near the bottom of the pool, expected when the simulations are not carried-out with a moving model. Reducing the drag experienced by swimmers during the glide off the wall can enhance start and turn performances. Therefore, a commitment between decreasing drag (by increasing water depth) and gliding travel distance should be a main concern of swimmers and an important goal to be studied in future investigations. REFERENCES: Marinho DA et al. J Appl Biomech 2009; 25(3): 253-257. Supported by FCT (PTDC/DES/098532/2008)

P-028

Regression Analysis Model Applied to Age-Group Swimmers: Study of Stroke Rate, Stroke Length and Stroke Index

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INTRODUCTION: Training loads and methods should be adapted to swimmer's age and performance level. International age-group records times of 50m freestyle showed a progressive improvement in performance of this event. This event could be used as an evaluating tool of the race components (RC). RC should be modified with the age, growth

and physical conditioning development. Some forms of regression analysis have been applied to RC studies during international competitions (Absaliamov & Timakovoy, 1990; Nomura, 2006), but this kind of analysis has not been applied to age-group swimmers. Our research purpose was to estimate and use a sophisticated statistical model of the kinematic characteristic, stroke rate (SR), stroke length (SL) and stroke index (SI) performance evolution during the age-group development based on a 50m freestyle test. METHODS: 280 regional age group swimmers (162 males and118 females) participated in the study (age range: 9 - 22 years). Detailed swimming competition video analysis procedure was applied to obtain the RC. Regression analysis was used to discover the tendency and model of the 50m times, SR, SL and SI. Inverse function approximation of the 50 m time by age and gender was carried out. Quadratic function approximation of the SL and SI by aging was carried out. Lineal function by aging was defined for ST. RESULTS: Different equations were obtained for gender, 50m times, SR, SL and SI. Significant differences between genders in were obtained. 50 m times were different between genders. There is a tendency to improve the parameters SL and SI with age in both genders. SR don´t get a clear trend and has an irregular behaviour. DISCUSSION: Kinematics components SL and SI change with the development of many physical fitness factors. With growth, the 50m times of the swimmers studied have a tendency to improve with the development. SR, SL and SI have the same generic equation for boys and girls but there are two different models according to gender. The inverse function by age and gender was the better approximation carried out in this training test of 50m freestyle. SR don´t get a clear trend. REFERENCES: 1. Absaliamov, Timakovoy. (1990). Aseguramiento Científico de la Competición. (A.I. Zvonarev, Trans.).(1 ed.). (Vol.1). Moscow: Vneshtorgizdat. 2. Nomura, T. (2006). Estimation of the lap-time of 200m freestyle from age and the event time. Revista portuguesa de ciências do desporto. Vol. 6, Supl. 2. (pp. 239-241).

P-029

Free Simulation Software "Swumsuit" to Learn and Research Biomechanics in Swimming

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INTRODUCTION: The authors have developed a simulation model "SWUM" (Nakashima et al., 2007) and its implementation software "Swumsuit". Since the software was reported on the last symposium, it has been updated successively in order to extend its possibility. In this pool side demonstration, its technical description as well as the basic usage will be presented in order to show its usefulness for learning and researching the biomechanics in swimming, while the scientific results will be presented in another oral presentation (Nakashima et al., 2010). METHODS: Swumsuit was written in two programming languages. For the main simulation program, the programming language FORTRAN was employed because of its high computing performance in numerical calculation. For the graphical user interface, the script language Tcl/Tk was employed because of easiness for constructing the graphical user interface. RESULTS AND DISCUSSION: Swumsuit is an open source free software and available on the website (http://www.swum.org/swumsuit/). It runs on Windows, Macintosh and Linux. The current version is 4.0.2. From the version 2.0.0, 3.0.0, and 4.0.0, the optimizing calculation, musculoskeletal simulation, and multi agent/object simulation have been enabled, respectively. For optimizing calculation, the user can describe freely the design variables and objective function by writing scripts. For the musculoskeletal simulation, the user can invoke the musculoskeletal software from Swumsuit directly. For the multi agent/object simulation, the user can describe the mechanical interaction between the agents/objects. Participants for this session are recommended to bring their own laptop computers since the software and sample data of the above results will be distributed by CD-R or USB memory in the session in order to enable the participants to use the software by themselves. REFERENCES: 1. Nakashima, M., Satou, K., Miura, Y. (2007). Development of swimming human simulation model considering rigid body dynamics and unsteady fluid force for whole body. J Fluid Sci & Tech, 2(1): 56-67. 2. Nakashima, M., Kiuchi, H., Maeda, S., Kamiya, S., Nakajima, K., Takagi, H. (2010). Advanced biomechanical simulations in swimming enabled by extensions of swimming human simulation model "SWUM". Biomechanics and Medicine in Swimming XI: (to be presented).

P-030

Measurement of Unsteady Fluid Force Acting on Limbs in Swimming Using a Robot Arm and Its Modeling Using the Swimming Human Simulation Model "SWUM"

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INTRODUCTION: Thrust generated by the limbs is one of the most important issues in the biomechanics of swimming. Many studies to date have been conducted in order to investigate the fluid force acting on the limbs, especially for the hand, by experiments and numerical simulations. However, most of them were confined to the steady condition although the swimming motion is completely unsteady. Some recent studies have conducted experiments and simulations for unsteady motion. However, such studies have investigated the unsteady motion only in one or two degrees-of-freedom (DOF), which are still far away from the real swimming motion. Therefore, the objective of this study was to investigate the unsteady fluid force during swimming in more realistic situation. For this objective, a robot arm which can perform 5DOF motion, and can represent both the upper and lower limb motions during swimming was developed. METHODS: The joint torques and the resultant thrust acting on the robot arm were measured by the force sensors attached to the robot. In a circulating water tank, an experiment to measure the fluid force was conducted for four swimming strokes of the upper and lower limbs. In order to model the unsteady fluid forces, the swimming human simulation model "SWUM", which has been developed by the authors (Nakashima et al., 2007), was employed. RESULTS: AND DISCUSSION: From the experiment, it was found that even the slight difference of the fluid forces between slightly different swimming motions can be quantified by the developed experimental system. The measured thrust of the crawl stroke reached the maximum value of 50N. With respect to the modeling, fluid force coefficients, which are the parameters in the fluid force model, were identified using optimizing calculation, so that the discrepancy of the forces and moments between the experiment and simulation was minimized. Good agreement between the experiment and simulation with the determined fluid force model indicated validity of the determined model. The averaged discrepancy between the simulation and experiment was 11%. The identified fluid model will be useful for mechanical analyses of various swimming motions by SWUM in the future studies. REFERENCES: 1. Nakashima, M., Satou, K., Miura, Y. (2007). Development of swimming human simulation model considering rigid body dynamics and unsteady fluid force for whole body. J Fluid Sci & Tech, 2(1): 56-67.

P-031

Estimating the Added Mass and the Active Drag Force During Push-off in Flip Turns

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INTRODUCTION: While swimming, the swimmer moves his/her

body mass and transfers momentum and energy to the surrounding water, setting it into motion. The same occurs at the flip turns, however the swimmer is now contacting the wall. We may thus register the force applied by the swimmer by placing an underwater force platform at the wall. If we simultaneously video record the turns, we have also access to the position of its center of mass. Similarly to Lyttle et al. (1999), we have merged video and force data in order to estimate the active drag force and the added mass during flip turns. The study of the force production in the flip turns has also been studied numerically by Klauck (2005). Lyttle et al. (1999) used the F=m.a law, obtaining the acceleration from a 2nd order derivative, a numerically unstable procedure; we used the I=m(Vf-Vi) law, obtaining the velocity from a first numerical derivative (numerically unstable) and the impulse by an integration of the force (a numerically stable procedure). METHODS: An extensometric underwater force platform, two above water and four underwater fixed cameras (50Hz) were used, all synchronised. With a sample of 10 swimmers, six males and four females, all participants at the Absolute Portuguese National Championships, 89 valid turns were analysed. Using the APAS software to analyze the video and a MATLAB routine to analyze data from the force plate and combine it with the kinematic data, it was possible to estimate the active drag force and the total mass (swimmer mass + added mass) during contact time. RESULTS: The results (mean ± SD) obtained for the total sample were 0.5 ± 0.14 N/BW, 1.10 ± 0.22 N/BW, 1.58 ± 0.30 kg/BM and 2.38 ± 0.77 kg/BM, for the mean and maximum active drag force, and the mean and maximum total mass, respectively. DISCUSSION: From the results it is possible to conclude that during the flip turns the swimmer moves itself plus over its body mass of water on average, while the peak values may exceed three times its body mass. Putting all this water in motion adds to the drag force experienced by the swimmer. The results suggest that this method is suitable to compute the drag force and the added mass during flip turns. REFERENCES: Lyttle A, Blanksby B, Elliott B, & Lloyd D (1999). Investigating kinetics in the Freestyle flip turn push-off. J Appl Biomech, 15, 242 Klauck J (2005). Push-off forces vs kinematics in swimming turns: model based estimates of time-dependent variables. Hum Mov Sci, 6(2), 112

P-032

Efficiency Analysis of Swimmers' Start Using Starting Block With Adjustable Raised Foot in Competitions

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INTRODUCTION: The aim of this work was to determine the influence of the use of starting block with adjustable raised foot on the start efficiency. METHODS: In this research 16 international level sportsmen took part. The specialization of swimmers was distances of 50, 100 and 200 meters in butterfly and freestyle. Comparative data was obtained in the sportsmen's competitive activity analysis at the international competitions of the World cup lap in Moscow and the European championship in Istanbul on the short water during one month in the November and December 2009. Also finalists' results on the first 15-meters section of the distances in both competitions were analyzed. On the first start in Moscow the usual starting blocks without adjustable raised foot were used, on the second start in Istanbul the same swimmers used the starting block with adjustable raised foot. Athletes were in the same swim suits, that means that the constituent of the frontal component of active drag depending on the swim suit type was constant. In the research digital video cameras were used, the beginning of the start was synchronized with the flash and it was taken into account in the video file processing. The time fixation was made by the swimmer's head while they passed the 15-meters of the start section. RESULTS: The data analysis of finalists of the World cup lap and the European championship showed a high correlation of the time of passing the 15-meters start section and the sport result: on the distance of 50 meters (men and women) r=-0,65-0,70; on the distance of 100 meters r=-0,60-0,65; on the distance of 200 meters r=-0,50-0,55; on the distance of 400 meters r=-0,25-0,30. The average time of start section passing using the starting block with adjustable raised foot decreased on the distance of 50 meters by 2,25%* and the sport result time decreased by 0,63%*; on the distance of 100 meters – by 2,20%* and 1,34%*, respectively; on the distance of 200 meters – by 2,22%* and 1,72%*, respectively (* p>0,01). DISCUSSION: Swimmers of high qualification have the capability to make stably the start section of the distance. Considering that the swimmers participated in both competitions in the same typical swim suits and the external conditions did not change the start section result improvements can be explained with the influence of the use of starting block with adjustable raised foot.

P-033

Biomechanical Factors Influencing Tumble Turn Performance of Elite Female Swimmers

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INTRODUCTION: Turns represent an important factor in determining the final performance of a swimming race. A successful turn results from a multitude of factors. The freestyle tumble turn can be divided into the approach, rotation, wall contact, glide, underwater propulsion, and stroke resumption phases. The aim of this study was to analyse relations with both kinematic and dynamic factors of each phases and the 3mRTT as measure of turning performance. METHODS: Eight elite female swimmers participated in this study (22.3 ± 4.1 years, 62.2 ± 6.2 kg, 174.7 ± 5.8 cm). They were monitored during a crawl tumble turn at maximum speed. 5 stationary video cameras were located underwater on a semi-ellipse centred on the calibrated turn place. An underwater 3D force platform was mounted on the turning wall. Every interesting anatomical reference point was digitized manually at a frequency of 50 Hz. Image coordinates were transformed to 3D object-space coordinates using the DLT algorithm. The principal kinematic data were horizontal velocities of the head (e.g. VGUP at the end of the glide) and the duration of each phase (e.g. glide duration GD). The major dynamic data was the time between the beginning of the push-off and the maximum horizontal force peak (%PFHM in % and PFHM in s). The tumble turn performance criterion (PERF) was the time taken to swim from 3 m in to 3 m out the turning wall (3mRTT in s). RESULTS: High correlation coefficients values were observed between PERF and %PFHM (r = 0.84, p = 0.017), PFHM (r = 0.82, p = 0.024) and GD (r = 0.79, p = 0.035). The best model was PERF = 0.741 x %PFHM + 0.842 x GD + 0.334 x VGUP + 1.532 ($F = 49.9$, $r^2adj = 0.95$, $p = 0.001$). PFHM explained 80 % of PERF, GD explained 12 % and VGUP 3 %. DISCUSSION: The major result of this study was that best female swimmers were able to develop soon her maximal horizontal force during the push-off phase. The time of peak force and the glide phase were preponderant. Further studies with an extended population (elite male and less-skilled female swimmers) would analyse the effects of more dynamic factors. REFERENCES: 1. Blanksby, B.; Gathercole, D. & Marshall, R. (1996) Force plate and video analysis of the tumble turn by age-group swimmers. J Swimming Research 11, 40-45. 2. Lyttle, A. D.; Blanksby, B. A.; Elliott, B. C. & Lloyd, D. G. (2000) Net forces during tethered simulation of underwater streamlined gliding and kicking techniques of the freestyle turn. J Sports Sci 18(10), 801-807.

P-034

Identifying Determinant Movement Sequences in Monofin Swimming Technique

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INTRODUCTION: The aim of this study is to identify errors in leg and monofin movement structure, lowering the effectiveness of swimming. With this information on errors, the crucial sequences in monofin swimming were identified. METHODS: Six high level monofin swimmers conducted a progressive trial (900m at increasing speeds). One cycle of each swimmer was filmed and analyzed (SIMI). Results were obtained in the form of time dependent series for: angle of foot bending in relation to the shank and proximal part of the fin in relation to the foot and for angle of attack: the distal part and entire fin surface. The choice of parameters was based on a devised monofin swimming model (Rejman, 2009). The errors were quantified by calculating the difference of the fields estimated by registered and model series. The range of errors were illustrated by the movement sequence registered, which were compared with sequences that accomplished the model or were slightly different. RESULTS: Based on information related to the scale and structure of errors committed by swimmers the following suggestions were formulated: the errors in angular displacement studied mostly exceeded the pattern of model, with the exception of the dorsal flexion of feet in the upbeat, performed by the slowest swimmer; the most difficult element of monofin swimming is the proper range of motion in the ankle joints; the parameter most differentiating the swimmers, is the angle of bend of the feet: the errors estimated were high correlated to swimming velocity. The information related to errors creates a basis for isolating crucial sequences of leg movements and monofin, which allows the description of key elements in the swimming technique. DISCUSSION: Controlling foot movement allows use of the torque of transfer to initiate propulsion through the bending of the tail and changing of the structure of waterflow over the of the fin. Correct crucial sequences allow for use of the monofin to achieve maximum swimming speed. That is why the identification and of key elements in the movement structure, and the quantification of their quality, is justified within the aim of anticipating and eliminating errors. REFERENCES: Rejman M. (2009). Modeling of monofin swimming technique: optimization of feet displacement and fin strain. J. App. Biomech, 25:340-350

P-035

Patterns of Behavior in the Crawl Technique of the Elite Portuguese Swimmers

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INTRODUCTION: The purpose of this study was to find the applicability of the monitoring system based on the crawl technique. Louro et al. (2009) found that the existence of motor patterns contributes for the implementation of this technique, from an appropriate observed methodology. When used in swimmers training, analysis can reduce the variability of behavioral tuning swimming technique (CampaniÃ§o, et al. 2006). The behavior was studied through the analysis of temporal patterns (T-pattern) of five elite swimmers and a sequence of five cycles (swimming at submaximal (75%) and maximum speed). METHODS: Five elite Portuguese swimmers (Mean Â± SD; age 20,87 Â±1,55; FINA Points at 100m crawl: 815,62 Â±65,09), performed the distance of 25 meters, at submaximal (75%) and maximum speed. A digital video camera Sony Mini DV (25 Hz) was placed about 30 centimeters deep, near the edge of the pool. The instrument of observation was prepared Ad-Hoc qualitative analysis, enables the study of stability of technical implementation. This study was ensured through the index of intra-observed reliability (95%) and inter-observed accuracy (96%). The Theme 5.0 software was used to detect patterns of 5 cycles in each swimmer. This allowed the identification of stable structures in technical performance, within a critical interval of time (P<0.05) - T - patterns. RESULTS: The mean index values of stability in the sub-maximum speed were 0.45 Â± 0.16, and the relative to the values of stability at maximum speed was 0.43 Â± 0.12. DISCUSSION: The swimmers with best times have an improved stability of swimming in the two executions, although this is higher in sub-maximum speed, we deduce that itÂ´s because the sub-maximal speeds are closer to the training speed. REFERENCES: CampaniÃ§o, J., Santos, J. & Silva, A. (2006). Breaststroke Swimming Patterns From VÃdeo Sequences Analyzes, produced by specific field formats. Book Of Abstracts Biomechanics and Medicine in Swimming. Revista Portuguesa de CiÃªncias do Desporto, vol. 6. supl.1,76. Louro H., ConceiÃ§Ã£o,A., Matos T., Nilton J., Franco R., Camerino O., CampaniÃ§o J. (2009) Characterization of Temporal Patterns of Behavior of the Crawl Technique Journal of Sport Science & Medicine (8) Suppl. 11 2009, 95.

P-036

Evaluation of the Gliding Capacity of a Swimmer

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INTRODUCTION: The capacity to move its own body through the water with the lowest resistance should be included among the most important qualities of a swimmer. In his advance through a liquid, evacuates water and occupies its place, causing the hydrodynamic resistance that acts in the same swimming direction but in the opposite sense. Diminishing resistance is probably the fastest way to improve performance and the most efficient to reduce energetic cost. It is for this reason that a double goal is pursued: To give advise to coaches to re-orient their training sessions towards reduction of resistance forces by suggesting exercises for its improvement and to develop and apply a new test for the evaluation of gliding. METHODS: The proposed gliding test is an adaptation of the one developed by Klauck et al. (1976) and evaluates the maximum speed reached by the swimmer after push-off from the wall and the passive hydrodynamic resistance when gliding through the water. Video image and values from velocity meter are simultaneously recorded. This device, attached to the swimmer's hip, displays the instantaneous speed during the exercise. The gliding resistance coefficient Gc includes frontal area (A) and friction and shape coefficient (Cd) in a single parameter. The formula to be used for its calculation is Gc = 20 / dT * (1 / VFinal – 1 / VInitial), where dT=selected gliding time, Vinitial=max. speed at push-off and Vfinal=instant velocity after dT. RESULTS: ObsF (154,64) is higher than CritF (4,05), meaning that both coefficients, Klauck's Resistance Factor Rf and Gc evaluate lost of speed and are linearly related by equation Rf = 0,0403 * Gc + 0,089 with n=48, R2=0,771, SEE=0,0213 and CritT=2,3172. Best gliders obtained the lowest values of Gc, because of either a higher initial velocity or a small lost of speed. Lower initial velocities and/or higher decelerations lead to higher values of Gc of worst gliders. DISCUSSION: This methodology eases the complex process of technique learning by letting the swimmer to establish a direct relation between "what he feels" (sensations from recent execution) with "what he does" (visual feedback from video images) and "the result of what he does" (speed curve and Gc as a gliding performance). REFERENCES: 1. Klauck J and Daniel K (1976). Determination of man's drag coefficients and effective propelling forces in swimming by means of chronocyclography.In: P V Komi (ed.) Biomechanics V B. Human Kinetics Pubishers. pp 250-257

P-037

Modelling Arm Coordination in Front Crawl

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Regularly, arm coordination of front crawl swimmers switched from catch-up to superposition mode when speed was found to increase. The aim of this study was to model the relationships between the index of coordination (IdC) and speed (V). Twenty male swimmers of various skill level and specialty (sprint vs. distance) realised an incremental speed test of 8 × 25-m steps. After checking the change of arm coordination with speed, 5 models of regression were tested: power, logarithmic, exponential, linear and quadratic. The model was done by averaging the individual coefficient; then percent of error with the model was determined for each swimmer. The quadratic modelling ($IdC = aV^2+bV+c$) showed the highest coefficient of determination ($0.81<R^2<0.99$) and the lower inter-individual mean error with the model (21%). Arm coordination modelling enabled to relate motor control with the performance (V), the stroking parameters (stroke rate and stroke length) and the stroke efficiency (stroke index)

P-038

Creating the Best Physical Resources for Performing the Underwater Undulatory Swimming, a Case Study

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INTRODUCTION: Underwater undulatory swimming (UUS) has progressed in speed over an Olympic cycle faster than surface swimming times (1). In 2008 we (NSF and OLT) started a project in order to catch up with this development. We planned to create the best physical resources in our swimmers for performing the UUS. Kinematic analysis of world class swimmers (WCS) showed they are able to maintain a high frequency and a small difference between the down and upsweep. METHODS: We conducted a case study on a norwegian top-level female swimmer (IS). We compared the video analysis of a WCS and IS using the same kinematic measurements as Loebbecke et. al 2009 (2) Based on these data we designed and implemented in training on land and water a set of exercises for improving stability, strength and flexibility especially for core and ankle. This training was performed 3 days a week. The progress of USS speed was tested: a. 15m start speed during competition, b. kicktest during training of 15m max speed test from a push-off . RESULTS: 15 m time during competition showed the most significant improvement, pre 2,01 m/s and posttraining 2,35 m/s. The push-off test has increased with 0,05 m/s. The kinematic measurements showed improvement in the ability to kick with higher frequency over time, 2,14 kicks/s pre and 2,38 kicks/s post. The frequency is 2,78 kicks/s for WCS. The difference between the down and upsweep is reduced from -0,07s to -0,05s. Plantar flexion on land improved, but during kicking is still less than observed in WCS, 86 and 72 degrees. DISCUSSION: The observed differences between the fastest male UUS and IS in kickspeed, upsweep kick and dynamic ankle flexibility were the reasons why we intensified the effort to improve the physical basis for the swimperformance. The results improved on those elements we considered important for UUS likewise did the swimperformance. Obviously there could be other explanations for this improvement like the new swimsuits. Nevertheless it seems the specific exercises for strength and flexibility designed on the basis of the observed difference in crucial techniqual elements contributed to improve these elements. Perhaps the greatest advantage seems to be the swimmers ability to use a big plantar flexion of the ankle. REFERENCES: 1. Haljand R. www.swim .ee. 2. von Loebbecke A, Mittal R, Fish F, Russell M. (2009) A comparison of the kinematics of the dolphin kick in humans and cetaceans. Human Movement Science, 28, 99–112.

P-039

Observation of Standard Breaststroke Technique Stability

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INTRODUCTION: The aim of this study was to create an instrument to collect data for analysis of the technical stability in swimming. This instrument will serve as a base for the observed behavior during the cyclic execution in the breaststroke technique. In this context, using qualitative analysis through the observational methodology, the study focused on the characterization of the motor patterns of behavior in the breaststroke technique on elite athletes. METHODS: The instrument consisted of a system of field formats, based on references of observational methodology and biomechanical models of swimming, giving special emphasis to six taxonomic criteria that aggregate in the form of alpha-numeric codes the crucial information to describe behaviors that define the breaststroke technique. The quality of the instrument was analyzed using the kappa Cohen the software-GSEQ_SDIS (Bakeman & Quera, 1996), based on the records of seven trained observers, and, for accuracy effects, another expert. RESULTS: The kappa Cohen results ranged between 0.94 and 0.98, guaranteeing the accuracy and objectivity when describing technical approaches with this instrument. The behavioral stability changes accordingly to the swimmer and also between the stages and observed moments, however each swimmer fits the technical model. DISCUSSION: We can consider that, given the high values of agreement between the expert and the seven observers, the instrument is appropriate to observe the conduct of technical Breaststroke swimmers in context situations. REFERENCES: Louro, H., Silva, A., Anguera, T., Camerino, O., Oliveira, C., Conceição, A., Campaniço, J. Stability of Patterns of Behavior In the Butterfly Swimmers Journal of Sport Science & Medicine (8) Suppl. 11 2009, 195

P-040

Effects of a Blueseventy™ Bodysuit on Spatial-Temporal and Coordinative Parameters During an All-Out 50-M Front Crawl Stroke

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INTRODUCTION: Considering that there is not enough research on the effects of using bodysuits on swimming performance, the purpose of this study was to verify the effects of using a shoulder to ankle bodysuit (Blueseventy™) on spatial-temporal and coordinative parameters during an all-out 50m front crawl. METHODS: Six subjects (16.6 ± 2.0 yrs) performed two all-out 50m trials (with and without bodysuit), starting in the pool. Two sub-aquatic video cameras (30 Hz) were used to acquire images from both laterals sides of the pool. The cameras were carried manually using a chariot and trails. The arm stroke phases (entry-catch, pull, push and recovery) and index of coordination were determined frame-by-frame by two experienced researchers. To measure the kinematic variables, a video camera (25 Hz) positioned in the middle of the pool was used. A repeated measures ANOVA was performed (mixed model 2 x 2 – two suits and two 25 m splits), with main effects verified using LSD post-hoc for an $\alpha < 5$ %. Using the software SPSS v. 15.0. RESULTS: Using the bodysuit swimming speed was higher ($p = 0.004$) and stroke length was also higher ($p = 0.023$). In the first split there was no difference in the duration of the stroke phases. However, on the second 25 m split, the duration of the entry and catch phase ($p = 0.041$) and non-propulsive phase ($p = 0.033$) were shorter. No statistical differences in index of coordination were found. DISCUSSION: Using the bodysuit enabled the subjects to swim in average 4.7 ± 2.2

% faster, which is more than found on a study by Chatard and Wilson (2008), who reported a 3.2± 2.4 % increase in swimming speed using the FastSkin™ bodysuit. It is likely that the larger increase in speed found in our study is due to the fabric composition of the suits from Blueseventy™. The increase in speed was due to an increase in stroke length, since there was no difference in the stroke rate, which means improved swimming economy (Chatard and Wilson, 2008). The shorter entry and catch phase, during the second split of the trial, results in a significant decrease in the non-propulsive duration. Indeed no differences were found in the index of coordination. REFERENCES: 1. Chatard JC, Wilson B (2008). Effect of Fastskin Suits on Performance, Drag, and Energy Cost of Swimming. Med Sci Sports Exerc, 40(6): 1149-1154. 2. Seifert L, Chollet D, Rouard A (2007). Swimming constraints and arm coordination. Hum Mov Sci, 26(1): 68-86.

P-041

Relationship Between High Elbow Technique and Motion of Shoulder Joint in Front Crawl Swimming

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INTRODUCTION: In general, their observed distinctive differences between unskilled and skilled swimmers for the arm stroke motion. Especially, the difference is elbow position from the entry to pull phase. We reported that skilled swimmers are maintaining higher elbow position than unskilled swimmers (Suito et al., 2008). However, it is not known exactly how the skilled swimmer is maintaining high elbow position. The present study, therefore, aims to illustrate the nature of shoulder joint motion of underwater stroke motion for unskilled and skilled swimmers. METHODS: Five skilled swimmers and five unskilled swimmers volunteered to participate in this study. All swimmers performed the full-exertion 25-m front crawl swimming. Two electrically synchronized video cameras were used to capture the right upper limb at 60 Hz. To assess the high elbow technique, this study used the high elbow index (Ihe) reported by Suito et al. (2008). The shoulder angular velocities were computed from entry to pull phases. Mean and standard deviations were calculated for the measured parameters. Comparison between the Ihe of the skilled and unskilled swimmers was made using unpaired t-test. Pearson correlation was also used to estimate the relationship between the Ihe and the peak angular velocity of the shoulder. The criterion for statistical significance was $P < 0.05$ for all analyses. RESULTS: The Ihe of the skilled swimmers was lower compared with the unskilled swimmers ($P < 0.001$). The angular velocities of the shoulder adduction and horizontal abduction were a similar between the skilled and unskilled swimmers. On the other hand, the differences between the skilled and unskilled swimmers of the angular velocity of the shoulder joint were found the angular velocity of internal rotation. Moreover, a significant correlation was obtained between the Ihe and the peak angular velocity of internal rotation ($r = 0.85$, $P < 0.01$). DISCUSSION: It is likely that the skilled swimmers are increasing the shoulder internal rotation angular velocity in the entry phase to maintain a high elbow position. In contrast, the unskilled swimmers seems to be not able to maintain a high elbow position, because the shoulder inter rotation angular velocity in the catch phase is not increased. Thus, to keep the high elbow position is more likely effective to improve movement of the internal rotation of shoulder joint. REFERENCES: 1. Suito H, et al. Proceedings of XXVI ISBS, Seoul, Korea, 613-616, 2008.

P-042

A Study About The 3D Acceleration In Front Crawl And Its Relation With Performance

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The objective of this study was to analyze the acceleration generated during front crawl. The swimmers (n=70) performed 25 meters at maximum velocity. 3D accelera-tion (ms-2) was registered. Root Mean Square (RMS) was calculated in the anterior-posterior (X), medium-lateral (Y) and upper-lower (Z) direction. RMS indexes were calculated to relate the directions in twos. One-way ANOVA was performed. Relations between variables have been calculated with Pearson's r. The results show differences ($p<0,01$) between RMSX (1,71±0,05), RMSY (4,92±0,17) and RMSZ (2,30±0,12). Velocity correlated positively RMS values ($p<0,01$) and the indexes that relate the RMSX with RMSY ($p<0,01$) and RMSZ ($p<0,01$). To conclude, 3D acceleration analysis might indicate the efficiency during front crawl.

P-043

An Analysis of the Underwater Gliding Motion in Collegiate Competitive Swimmers

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INTRODUCTION: The underwater gliding motion during start and turn phases are important for the total race time in modern swimming [1]. The purpose of this study was to analyze the underwater gliding motion in collegiate competitive swimmer. METHODS: Twelve healthy male collegiate swimmers volunteered to participate in this study. The subjects performed underwater gliding motion as fast as possible after the start wall kicking. During the underwater gliding motion, the swimmers were to hold the streamlined position. The subjects were monitored with an underwater video camera (SK-2130, SONY, Japan) with a sampling frequency of 60Hz in the sagittal plane to measure the angular displacement of their different joints. In this study, the subjects were asked to wear two different models of swimsuits: one is made of the conventional fabrics; the other is a newly developed, so-called high speed swimsuit (Fastskin LZR racer, Speedo, England). RESULTS: The swimming velocity of the subjects wearing a conventional swimsuit decreased when the flexion-extension movement in the knee and the hip joints were performed during underwater gliding motion. On the other hand, the swimming velocity of those wearing an LZR swimsuit showed that the highest speed was maintained during the gliding motion when the knee and the hip joint angles of 180 degrees were maintained from the start to 0.8sec. DISCUSSION: During the underwater gliding motion, the swimmers have to hold a streamlined posture. To stay in the best streamlined position, and to minimize the hydrodynamic resistance, the return to the water surface should rather be initialized by a progressive and synchronize action of the three joints [2]. The result of this study was that the highest speed was maintained during the gliding motion when the knee and the hip joint angles of 180 degrees were maintained from the start to 0.8sec. In other words, during the underwater phase such as a start and a turn, it was clearly important that the swimmer maintained his body in a streamline posture. REFERENCES: 1. Marinho D.A., V.M. Reis, F.B. Alves, J.P. Vilas-Boas, L. Machado, A.J. Silva, A.I. Rouboa. 2009. Hydrodynamic drag during

gliding in swimming. J Appl Biomech, 25(3): 253-257. 2. Elipot M., P. Hellard, R. Taiar, E. Boissiere, J.L. Rey, S. Lecat, N. Houel. 2009. Analysis of swimmers velocity during the underwater gliding motion. J Biomech, 42(9): 1367-1370.

P-044

Investigations into Strength Endurance Exercises for Swimmers

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INTRODUCTION: Training at specific power training devices plays a crucial role with the increase of drive power in cyclic motions. Similar to the competition movement the intensity is increased by an enhanced frequency. The temporal relationship of the driving phase and the break changes to the disadvantage of the break. We could show that the duration of the relative breaks is related positively to breathing economy. Thus in this study the behavior of muscle activity in the main drive muscles in case of increased frequency was analyzed. METHODS: 12 age-group swimmers performed both the classical pulling movement of swimmers (butterfly, front crawl) at a rope pulling ergometer as well as the single and double pole skiing techniques. In each case the frequency was increased by 30 to 50 reps/min . At the rope pulling ergometer (FES Berlin) we monitored the force-distance curves of intra-cyclic power, frequency, stroke length and duration as well as the activities of several arm and shoulder muscles (Myo 2000, Noraxon). From the EMG the mean relative activity (% MVC) as well as the activity duration (tM) was calculated. RESULTS: In all kinds of movement the intra-cyclic power increased with the frequency, with higher values in the synchronous pulling techniques compared to the alternating techniques just like in the comparison of the ski pulling techniques with the swimming techniques. The duration of the break decreased in relation to the stroke time with all kinds of movement. The highest relative activities were monitored for m. pectoralis major (PM) and m. latissimus dorsi (LD), their muscle activity increased simultaneously with intra-cyclic power during frequency increase. Altogether muscle activity in swimming was higher than in skiing. The relative duration of muscular activity increased simultaneously with the relative duration of the pulling phase during the higher frequencies, with some muscles showing higher activity duration during lower frequencies. Table: Relative duration of the recovery phase of PM and LD in relation to the stroke duration during different stroke rates (SR): SR [1/min] 30; 35; 40; 45; 50; PM [%] 61 ± 10,6; 59 ± 11,6; 58 ± 10,2; 53 ± 13,0; 47 ± 15,8; LD [%] 46 ± 15,4; 48 ± 16,0; 51 ± 10,8; 47 ± 9,8; 40 ± 8,6; DISCUSSION: The LD and PM could be identified as main drive muscles for all kind of techniques. Thus the ski pulling techniques represent a suitable training exercise for the power endurance development of the swimmers.

P-045

Head Out Swimming in Water Polo: a Comparison with the Front Crawl in Young Female Players

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INTRODUCTION: In water polo, when swimming forward, players keep the elbows high (in order to stop opposing players from gaining possession of the ball) and this probably decreases the arm stroke efficiency (ηp); moreover they keep their head out of the water (to see the rest of the pool and make the appropriate play) and this probably increases the trunk incline (TI) and the hydrodynamic resistance (Wd). Both factors, are expected to increase the energy demands of head out swimming (HOS) in comparison with front crawl swimming (FCS). METHODS: Two groups of young female water polo players (G-12, N = 11, 11.9 ± 1.4 years; 3.3 ± 0.5 years of practice and G-16, N = 10, 16.5 ± 1.3 years; 4.8 ± 0.6 years of practice) participated to the study, they were requested to swim with the two styles (HOS and FCS) at 4 self selected speeds (V, m . s-1: slow, moderate, fast and maximal) while their stroke frequency (SF, Hz), kick frequency (KF, Hz) and stroke length (SL, m) were assessed. The arm stroke efficiency (ηp) was calculated according to the simple model proposed by Zamparo et al. (2005). During the experiments video records were taken in order to measure trunk incline (TI, degrees); the subjects were equipped with a waterproof heart rate monitoring system to record their heart rate (HR, bpm). RESULTS: The comparison between styles indicates that all parameters are significantly different in the two conditions (HOS and FCS). Swimming with the head out leads to a small (2%), albeit significant, reduction of the self select speed in comparison to FCS. During HOS the players have a larger (32%) TI and a higher HR (7%) compared to FCS. Moreover, in HOS, SL and ηp are significantly reduced (21% in both cases) whereas SF is increased (17%) in respect to FCS. Finally, KF is 10% lower during HOS than during FCS. DISCUSSION: HOS is characterized by relevant differences in the biomechanics of swimming in comparison with FCS. The need of keeping the head out of the water does indeed lead to an increase of TI whereas the need of keeping the elbows high does indeed lead to a reduction of ηp. Finally, both needs determine, as hypothesized, an increase of the energy requirement of this peculiar "form of locomotion in water" as confirmed, albeit indirectly, by the higher HR in HOS than in FCS at any given speed. REFERENCES: Zamparo P, Pendergast DR, Mollendorf J, Termin B, Minetti AM (2005). An energy balance of front crawl. Eur J Appl Physiol, 94: 134-14

P-046

The Interplay Between Leg Kick Efficiency and Pushing Phase Acceleration in Determining the "Turning Speed" in Front Crawl Swimming

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INTRODUCTION: Several factors are expected to determine the swimming speed after a turn (before resuming the arm stroke at the surface level). We focused our attention on the contribution of the acceleration during the pushing phase and of the efficiency of the underwater undulatory movement in determining the time taken to cover the first 5 m after the turn in a simulated 100 m race conducted in a 50 m swimming pool. METHODS: Thirteen subjects participated to the study: 5 (4M/1F) elite swimmers of the Italian National Swimming Team and 7 (3M/4F) swimmers competing at local/national level. They were asked to swim the 100 m distance as fast as possible; during this simulated race we recorded their speed in the first 5 m after the turn (v50-55). In a separate series of experiments, the average acceleration during the push (apush, an index of the force exerted during the push) was calculated based on kinematic data collected by means of an underwater video camera; in these experiments the subjects were asked not to kick after the pushing phase, just to glide. In a further series of experiments the subjects were asked to swim underwater by using the dolphin kick while passing in front of an underwater video camera in order to calculate the Froude efficiency of the leg kick (ηF) as proposed by Zamparo et al. (2002). RESULTS: Average speed in the first 5 m after the turn (v50-55) was 3.09 ± 0.78 m . s-1 (range: 1.98-4.63); average acceleration during the push (apush) was 2.80 ± 0.69 m . s-2 (range: 1.76-3.85); Froude efficiency of the dolphin kick (ηF) was 0.67 ± 0.02 (range: 0.65-0.70). A good relationship was observed between v50-55 and ηF (R = 0.704, P = 0.011) as well as between v50-55 and apush (R = 0.680, P = 0.015).

A multiple regression analysis indicates that these two factors, explain 73% of the variability of v50-55 after a turn (P = 0.035). DISCUSSION: As hypothesized apush and ηF are well related to the "turning speed" (v50-55) in a simulated 100 m race. Hence both "factors" should be taken into account for a proper training of this "phase" of a swimming race. REFERENCES: 1. Zamparo P, Pendergast DR, Termin B, Minetti AM (2002). How fins affect the economy and efficiency of human swimming. J Exp Biol 205: 2665-2676.

P-047

Technical Monitoring and Application of Swimming Competition

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INTRODUCTION: At present, Swimming on the technical and tactical basic methods of analysis used to analyze the above water video and conduct mainly some sub-timing and technical and tactical statistics-based in the international arena. METHODS: on-site data collection and analysis are mostly used for technical and tactical statistics of the video analysis in the major international swimming events (see reference [1-8]). However, this statistical analysis is not enough and complete from the perspective of biomechanics (see reference [6]). Its main limitation is that it cannot provide technical details of technical analysis acquiring athletes in the race to use. But details of these technologies can provide a scientific basis for improving the swimming skills of athletes. Therefore, we study a test method that will be more comprehensive and complete analysis of competition. RESULTS: Our study a test method is easy to install and use software and hardware equipment under the conditions of the competition and training to complete the critical section of the above and under water camera technology. It can further analysis the key technology of players in addition to statistical analysis of video. The video acquisition and analysis system for technical analysis include (see Figure 1) a surface camera, underwater camera, image synthesis, video-signal switcher, video recorders, computers and analysis software in this study. It was applied in March 2006 Asian Swimming Championships in Singapore. DISCUSSION: Described in this article are used in swimming competition of real-time video capture, and further kinematic analysis of swimming technique video collection and analysis methods. It can get a variety of swimming skills for two-dimensional kinematic data. The accuracy of the data depends on the image quality, calibration methods and accuracy.Practical application shows that these data can basically meet the needs of the present technical analysis of swimming. This test method required fewer operations staff and equipment to the above in the application used in the test system. They have:(1) a more comprehensive measurement and feedback parameters. (2) Installation of a simple, time-saving. (3) its small size, light weight, easy to carry, easy to operate.(4) Low-voltage DC battery-powered, Security is good. (5) low cost, suitable for all kinds of swimming pools, especially those that do not use the swimming pool underwater observation equipment.

P-048

Technology and Swimming: 3 Steps Beyond Physiology

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INTRODUCTION: In 2008, the polyurethane made its first appearance in swimming with the use of a new generation of swimsuits. The result was a sudden improvement of performances, repelling the imminent physiological limits (Berthelot et al., 2008). The aim of this study is to quantify the gain provided by the 3 different swimsuits generations introduced in 1999, 2008 and 2009 respectively. METHODS: We collected the best performance of the first 10 world swimmers every year in 34 swimming events from 1990 to 2009. The number of significant values (ANOVA test, p < 0.05) was then summed each year for both sexes. The relative improvement or "gain" between the mean m of the 10 best from one year to the next was computed for all years and all events. RESULTS: Three variation peaks are observed in 2000, 2008 and 2009 corresponding to the year of INTRODUCTION: of each swimsuit. The 1st peak has a higher number of significant variations recorded for women vs. men (13 vs. 9). The 2nd peak presents the highest number of variations, with an equal repartition of significant progressions between men and women (13). The 3rd peak shows a high number of variations for men (9) and fewer variations for women (3). The mean gain values are: 0.74% ±0.26% (2000); 1.16% ±0.48% (2008); 0.68% ±0.55% (2009) for men events and 1.00% ±0.37% (2000); 0.97% ±0.57% (2008); 0.27% ±0.70% (2009) for women events. DISCUSSION: Body shape is one the factors altering drag resistance (Vorontsov and Rumyantsev, 2000). The large impact of the first generation swimsuit on women events suggests that compression of women's body may have been a major factor reducing hydrodynamical resistance as soon as 2000. This may be the first innovative parameter explaining recent women's swimming performances. The second generation swimsuit introduced in 2008 provided large gains in both men and women, while the third generation impact is less homogeneous: women showed a lower performance progression, while men experienced a relative improvement. With a period of prohibited swimsuits, we expect a rapid return to physiological thresholds in 2010, which will be partially limited by the allowance of new technology such as starting blocks. REFERENCES: Berthelot, G., Thibault, V., Tafflet, M., Escolano, S., El Helou, N., et al. The Citius End. PLoS ONE 3:e1552, 2008. Vorontsov, A.R., Rumyantsev, V.A. Resistive forces in swimming. pp. 184–204. Oxford, UK: Blackwell, 2000.<

P-049

The Difference in Red Blood Cell Indices between Elite Female Distance and Sprint Swimmers

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INTRODUCTION: Previous investigations suggest that training intensity and duration can affect the hematology of athletes. As differences exist between distance and sprint swimmers in regards to training methods and metabolic demands, the purpose of this study was to determine whether or not there were differences in red blood cell indices when comparing elite female distance and sprint swimmers. METHODS: Twenty-two elite female swimmers were classified into two groups: a distance group (Dis) (n=11) whose primary events were 400m or 800m and a sprint group (Spt) (n=11) whose primary events were 100m or 200m. All swimmers were trained at the same facility. Red blood cell count (RBC), hematocrit (HCT), hemoglobin (HGB), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and red blood cell volume distribution width (RDW), were measured weekly, every Monday morning, before the first training session over a one-year period from August, 2007 until July, 2008. Due to the objective limits (such as subjects unavailable or technical error of instruments), the number of samples obtained was 477 in Dis and 459 in Spt. RESULTS: Compared to Spt, Dis had higher values of HCT (0.40¡À0.04L/L vs. 0.38¡À0.03L/L), HGB (132.41¡À10.10L/L vs. 128.66¡À9.31L/L), MCV (87.70¡À5.66 fl vs. 84.75¡À6.20fl), and MCH (29.06¡À1.35pg vs. 28.54¡À1.88pg)(P<0.05), but lower val-

ues of MCHC (331.97¡À15.31g/L vs. 338.19¡À17.06g/L) and RDW (13.67¡À0.94% vs. 14.25¡À0.97%)(P<0.05). No differences in RBC between Dis and Spt (4.57¡À0.34¡Á1012/L vs. 4.52¡À0.41¡Á1012/L) (P>0.05) were observed. DISCUSSION: RBC values in both groups were at an advantageous level for oxygen transportation in blood. Higher values of HCT, HGB and MCH in Dis indicate a potential for greater oxygen flow to meet the presumably greater use of oxygen in active skeletal muscles during distance swimming. Higher values of MCV in Dis were indicative of a larger proportion of young red blood cells, which had more deformability for red blood cells to pass through capillaries. Higher value of MCHC demonstrated that a larger proportion of red blood cells in Spt were aging and atrophic. Besides, atrophy varied the shapes of red blood cells; as a result, Spt had a higher value of RDW. REFERENCES: 1. Wang R. (2002) Exercise Physiology (in Chinese). Beijing: People's Sports Publishing House. 2. Stager JM, Tanner DA. (2003) Swimming. Oxford: Blackwell Publishing.

P-050

Modelling the Slow Component in Elite Long Distance Swimmers at the Velocity Associated with Lactate Threshold

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INTRODUCTION: It is known that continuous exercises performed at the lactate threshold have the greatest effect upon the body's oxygen transport system (Billat, 2001). This type of training enables swimmers to attain max by restoring the slow component of and by reducing the amplitude of the slow component after a period of training (Carter et al., 2000). Restoration of the slow component of appears to be more frequent among athletes having a high fractional at the lactate threshold (Billat, 2001) which is typical of ultra-endurance athletes (Billat et al., 2001). We hypothesized that in high-level long-distance swimmers, long interval training at LT, induce a large slow component of . METHODS: Seven elite male long-distance swimmers performed in a 6x300-m incremental swimming exercise to exhaustion in order to determine lactate threshold (LT = 3.1 ± 1.2 mmols.l-1), and the velocity associated with LT (v LT = 1.45 ± 0.01 m•s-1 = 97.3 ± 5.6% of v max). Secondly, the parameters of kinetics were calculated for the first 500m of one interval training set: 6 x 500-m using a double exponential model. RESULTS: The fit for the two-term exponential model was (r^2= 0.62 ± 0.18). All seven subjects displayed a slow component of during the first 500m of IT6*500 with values measured at 401.7 ± 129.9 mlO2.mn-1 and 5.69 ± 1.96 ml.mn-1.kg-1. DISCUSSION: Elite Long-distance swimmers exhibit exceptionally high levels of peak oxygen uptake and peak swimming velocity at the lactate threshold. All of the swimmers tested exhibited a large amplitude slow component of oxygen uptake. REFERENCES: Billat V, Demarle A, Slawinski J, Paiva M, Koralsztein JP. Physical and training characteristics of top-class marathon runners. Med Sci Sports Exerc 33(12): 2089-2097, 2001. Carter H, Jones AM, Barstow TJ, Burnley M, Williams C, Doust JH. Effect of endurance training on oxygen uptake kinetics during treadmill running. J Appl Physiol 89: 1744-1752, 2000.

P-051

The Impact of Tension in Abdominal and Lumbar Muscluature in Swimmers on Ventilatory and Cardiovascular Functions

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INTRODUCTION: Pulmonary function does not appear to place a limit on maximal exercise in most physical activities. However; in competitive swimming, the postures and movements that are required to properly execute many different strokes often impedes the ventilatory muscles and the ability of the body to properly ventilate the lungs and consume oxygen. Some theorists have proposed that contracting abdominal muscles and other lower trunk muscles will reduce resistance on the swimmer's body and increase performance while swimming the Crawl Stroke. METHODS: Thirteen participants involved in swimming activities (8 Males, 5 Females) ages 22-60 years of age volunteered for evaluation of their VC, MVV, FVC1 and resting VO2 and VCO2 under the two differing postural conditions. The participants were studied under both conditions, which were with muscles at rest Control Condition (CC) and participants with their abdominal muscles and erector spinae statically contracted Experimental Condition (EC). Each participant was measured on a Spirometrics Flowmate III Spirometer for pulmonary functions and a metabolic cart for RVO2 and RCO2. There was a 3 minute rest between counter-balanced trials for all measurements. All participant pulmonary functions and resting RVO2 were expressed relative to their age, body weight and height. RESULTS: An ANOVA revealed significantly lower differences in VC, MVV and FVC1 during EC compared to CC. The EC also resulted in significantly higher oxygen consumption values for these participants. There were no significant differences observed in CO2 between EC and CC. DISCUSSION: Since there is no proof that these muscle contractions actually decrease resistance on the swimmers' body and that ventilatory functions were significantly diminished while oxygen utilization requirements were significantly increased, we suggest these alterations in body mechanics are not conducive to improving performances during Crawl Stroke swimming.

P-052

Relationship between Propelling Efficiency and Swimming Performance in Elite Swimmers

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INTRODUCTION: The propelling efficiency (ep) has been suggested as a important determining factor of competitive swimming (Toussaint, 1990). However, although there are several studies that investigated with respect to the metabolic capacity and drag in elite swimmers, propelling efficiency of elite swimmers has not been examined, and the relationship between propelling efficiency and swimming performance in elite swimmers has not been clarified, either. Therefore, this study aimed to examine the relationship between propelling efficiency and swimming performance in elite swimmers. METHODS: The subjects were 9 elite Japanese swimmers (age: 23±1 yrs) including a gold medalist and a finalist in Olympic Games. By the use of an extended version of the measurement of active drag which was developed by our laboratory, Pd was measured directly. Simultaneous measurement of oxygen uptake (VO2) enabled the establishment of the relationship between the rate of the energy expenditure (PVO2) and Po (since when swimming on the MAD system, Po=Pd). These individual relationships describing the

mechanical efficiency (eg) were then used to estimate Po in free swimming from measurements of VO2. Since Pd was directly measured at each velocity studied by use of the MAD system, ep could be calculated according to the equation ep= Pd/(Pd+Pk)=Pd/Po. Also, a swimming performance of each subject was evaluated by swimming velocities which were calculated from the performance time of 50m, 100m, 200m and 400m maximal swimming. RESULTS: Mean value of swimming velocity of each distance was 1.82±0.05m.s^{-1} in 50m, 1.70±0.04m.s^{-1} in 100m, 1.58±0.06m.s^{-1} in 200m and 1.52±0.06m.s^{-1} in 400m, respectively. The mean values of eg and ep were 10±1% (range; 6 to 11%), and 71±6% (range; 56 to 80%), respectively. The individual ep values were significantly related to individual swimming performance in 200m and 400m (200m; r=0.72, P<0.05, 400m; r=0.80, P<0.01), but not to those in 50m and 100m. DISCUSSION: The findings of this study indicated that that ep observed in elite swimmer exceeds 70%, which is comparably higher than those reported previously. Also, the results suggest that ep is more important factor to determine swimming performance for middle and long-distance event rather than for short-distance event. REFERENCES: 1. Toussaint HM (1990). Differences in propelling efficiency between competitive and triathlon swimmers. Med Sci Sports Exerc. 22: 409-415.

P-053

The Effect of Snorkel Breathing During Front Crawl Swimming on Respiratory Muscle Fatigue

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INTRODUCTION: The use of snorkels has become a popular training aid for competitive swimmers. However, the narrowed external airflow path associated with snorkel breathing (SB) presents an inspiratory and expiratory flow limitation, which has the potential to induce respiratory muscle fatigue (Rohrbach et al., 2003). The aim of the current study was to explore the influence of SB on inspiratory and expiratory muscle fatigue (IMF and EMF, respectively) during front crawl (F/C) swimming. METHODS: Following institutional ethical clearance, 6 competitive University swimmers were recruited (mean ± SD: age 20 ± 1.0 years; body mass 74.6 ± 8.6 kg; stature 175.2 ± 10.5 cm) to undertake 3 x 200m F/C swims of different breathing conditions in a swimming flume: 1x: ad libitum (ALB), controlled frequency breathing (CFB) and SB. The order of the swims was randomised, and following a standardised 500m warm-up, were completed at a swimming velocity equivalent to 90% of each swimmer's season best time. Inspiratory and expiratory mouth pressure (MIP and MEP, respectively, RPM, Micro Medial, UK) were recorded pre and post each 200m swim. RESULTS: Two way repeated measures ANOVA revealed no significant differences in MIP between conditions (p = 0.265), although baseline MIP (149 ± 36 cmH2O for ALB, 153 ± 30 cmH2O for CFB and 160 ± 32 cmH2O for SB) was significantly higher (p = 0.014) than post swim MIP (124 ± 33 cmH2O for ALB, 126 ± 39 cmH2O for CFB and 138 ± 27 cmH2O for SB). Similarly, baseline MEP (173 ± 50 cmH2O for ALB, 157 ± 38 cmH2O for CFB and 177 ± 33 cmH2O for SB) was significantly higher (p = 0.045) than post swim MEP (150 ± 49 cmH2O for ALB, 146 ± 37 cmH2O for CFB and 163 ± 40 cmH2O for SB) but not different between conditions (p = 0.294). DISCUSSION: IMF and EMF both occur in response to sub-maximal 200m F/C swimming, but the magnitude of IMF and EMF is similar between SB, ALB and CFB in trained University swimmers. Whether SB creates a respiratory muscle training stimulus remains to be seen. REFERENCES: Rochrbach, M., Perret, C., Kayser, B., Boutellier, U. & Spengler, C. M. (2003). Task failure from inspiratory resistive loaded breathing: a role for inspiratory muscle fatigue? European Journal of Applied Physiology, 90, 405-410.

P-054

Can High Intensity Workloads be Simulated at Moderate Intensities by Reduced Breathing Frequency

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INTRODUCTION: Reduced breathing frequency (RBF) is often used during regular swimming training. Due to athlete's distress reported after the exercise with RBF, it has been speculated that high intensity workloads can be simulated at moderate intensities by RBF (West et al., 2005). Therefore, the purpose of this study was to compare some respiratory and metabolic responses during constant load exercises with different breathing conditions (spontaneous and RBF), performed at different absolute intensity. METHODS: Eight healthy male subjects performed an incremental cycling test twice: first, with spontaneous breathing and second, with RBF at 10 breaths per minute. A constant load test with RBF (B10) was then performed to exhaustion at the peak power output obtained during the incremental test with RBF. Finally, the subjects performed constant load test with the spontaneous breathing (SB). This test was performed to exhaustion at peak power output obtained during the incremental test with spontaneous breathing. Respiratory parameters (VE, PETO2, PETCO2), metabolic parameters (Vo2, Vco2) and oxygen saturation (SaO2) were measured during both constant load tests. Capillary blood samples were taken before and every minute during both constant load tests for measuring lactate concentration ([LA]) and parameters of blood acid-base status (pH, Pco2,). RESULTS: Regardless of the type of comparison (the data obtained at the defined time or maximum and minimum values during the exercise), there were significant differences between SB and B10 in all respiratory parameters, metabolic parameters and SaO2 ($p \leq 0.01$ and 0.05). Furthermore, there were significant lower [LA-] and Pco2 during B10, when compared to SB ($p \leq 0.01$). However, there were no significant differences in pH during the exercise between different breathing conditions. DISCUSSION: Due to obtained results it could be concluded that RBF during exercise at lower absolute intensity did not produce similar conditions as they were during the exercise with spontaneous breathing at higher absolute intensity. REFERENCES: 1. West SA, Drummond MJ, VanNess JM, Ciccolella ME. (2005). Blood lactate and metabolic responses to controlled frequency breathing during graded swimming. J Strength Cond Res, 19(4): 772-6.

P-055

Swimming and Respiratory Muscle Endurance Training: A Case Study

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INTRODUCTION: Immersion in water increases thoracic pressure, causing ventilatory constraints both at rest and during effort. Until lately, ventilation was not considered a limiting factor for submaximal or maximal work. However, a ventilatory limitation was shown to decrease maximal performance in healthy subjects and athletes. The results on respiratory muscle endurance training (RMET) are contradictory, with reports of some or no effect on physical performance. It was suggested that this training could delay respiratory muscle fatigue and permit better distribution of blood flow to the working muscles. METHOD: This case study investigated whether RMET would increase performance, respiratory muscle force and endurance in a long-distance swimmer. An expert in long distances (21 years, 183cm, 71 kg) trained for 10 weeks in a RMET program, plus his usual swim training. He was evaluated twice: before (1 week) and just after the RMET program. Maximal swim time trials (50 m and 200 m), ventilatory function tests, maximal inspiratory and expiratory pressure (MIP and MEP), and respiratory endurance tests were

done. Lactate and perceived exertion responses were also measured. Respiratory training was performed with a device (SpiroTiger®) to ensure normocapnic hyperpnea and consisted of 30 minutes a day, 5 days a week. RESULTS: Ventilatory parameters were not improved post-training, but MIP, MEP, endurance test duration and swim performances were all increased (+19%, +33%, +7 minutes; 50m: -5.4%; 200m: -7.2%). Lactate concentrations were lower after the swim trials (50m: -0.7mmol.l-1; 200m: -4.4mmol.l-1). Rates of perceived exertion also showed large effects. DISCUSSION: The main finding was the improved performance in the swim trials after RMET training, with improved endurance, respiratory muscle force, and perceived exertion. We compared our findings with those of other respiratory muscle training studies and noted greater changes in the performance and respiratory muscle force of our swimmers than that observed by Kilding et al. (2009). The difference may be due to our longer training period (10 weeks vs. 6 weeks), increasing the respiratory training impact. REFERENCES: 1. Kilding AE, Brown S, McConnell AK (2009). Inspiratory training improves 100 and 200 m swimming performance. Eur J Appl Physiol E-Pub.

P-056

Comparison of Respiratory Muscle Fatigue Between Swimming Strokes in National Standard Age-Group Swimmers

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INTRODUCTION: Inspiratory muscle fatigue (IMF) has been reported following 200 m front crawl (F/C) swimming in national and international standard masters' swimmers (Lomax & McConnell, 2003). Whether the magnitude of IMF varies between strokes and whether expiratory muscle fatigue (EMF) occurs in highly trained age-group swimmers was addressed in this study. METHODS: Following institutional ethical clearance, 11 national standard British age-group swimmers were recruited (mean ± SD: age 14 ± 1.4 years; body mass 55.9 ± 7 kg; stature 151.5 cm ± 5.1 cm) to undertake four ((1 x: F/C, back stroke (B/K), breast stroke (B/R) and butterfly (fly)) maximal 200 m swims from a push start. Each swim was undertaken on a separate occasion, at the same time of day, in the same swimming pool and followed a standardised 600 m warm-up. Inspiratory and expiratory mouth pressure (MIP and MEP, respectively; RPM Micro Medical, UK) were recorded pre and post each 200 m swim. In addition, breathing frequency (fr) and stroke count (SC) were recorded per swim. RESULTS: Two-way repeated measures ANOVA revealed similar MIP values ($p = 0.590$) between strokes pre- (F/C 110 ± 21 cmH2O; B/K 112 ± 18 cmH2O; B/R 112 ± 24 cmH2O; Fly 110 ± 17 cmH2O) and post- (F/C 88 ± 22 cmH2O; B/K 93 ± 23 cmH2O; B/R 86 ± 19 cmH2O; Fly 96 ± 23 cmH2O) swim, although MIP did decline ($p < 0.001$) following each 200 m swim. No differences were observed in MEP either pre- (F/C 99 ± 31 cmH2O; B/K 98 ± 31 cmH2O; B/R 95 ± 27 cmH2O; Fly 99 ± 31 cmH2O) or post- (F/C 100 ± 39 cmH2O; B/K 99 ± 35 cmH2O; B/R 96 ± 35 cmH2O; fly 90 ± 28 cmH2O) swim at any time point ($p = 0.727$) or between strokes ($p = 0.744$). No relationship ($p > 0.05$) was observed between fr and the percentage change in MIP (F/C r = -.456; B/K r = .218; B/R r = .218; Fly r = .312) or between SC and the percentage change in MIP (F/C r = .458; B/K r = .496; B/R r = .520; Fly r = -.161). DISCUSSION: IMF occurs in response to maximal 200 m swimming in each of the four strokes but EMF does not. Although the magnitude of IMF was not significantly different between strokes, there was a trend for IMF to be higher in F/C and B/R (~20-23%) compared to Fly and B/K (13-17%). Furthermore, the magnitude of fatigue was not related to breathing frequency and had no effect on stroke count. REFERENCES: Lomax, M. E. & McConnell, A. K. (2003). Inspiratory muscle fatigue in swimmers after a single 200 m swim. Journal of Sports Sciences, 21, 659-664.

P-057

Effect of Systemic Arterial Stiffness on Underwater Blood Pressure in Middle-Aged and Elderly Japanese Women

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INTRODUCTION: It is thought that systolic hypertension is caused by an increase of systemic arterial stiffness which increases with age. We examined the relationship between underwater blood pressure and arterial stiffness in middle-aged and elderly women. METHODS: Eighteen middle-aged and elderly women participated in this study. We divided subjects into two groups; a lifestyle related disease (LSRD) group and a non-lifestyle related disease (NLSRD) group. We measured their blood pressure, pulse beat and systemic arterial stiffness. Blood pressure and pulse beat were measured in a sitting position on land (LSi), a standing position on land (LSt) and an underwater standing position (WS) in succession. Systemic arterial stiffness was measured with pulse wave velocity between brachial and ankle in the supine position on land. RESULTS: In the NLSRD-group, systolic blood pressure and pulse beat were significantly different in all positions (SBP: LSi; 110+/-11mmHg, LSt; 100+/-18, WS; 118+/-18. PB: LSi; 12.5+/-1.4beats/10seconds, LSt; 13.3+/-1.6, WS; 11.7+/-1.6, $p<0.05$). However, these differences were opposite each other. Diastolic blood pressure was no significant difference in every position. On the other hand, in the LSRD-group, systolic blood pressure was significantly different in every position (SBP: LSi; 129+/-15, LSt; 114+/-16, WS; 140+/-13, $P<0.05$). Regarding diastolic blood pressure, it was higher in the LSi-position (76+/-8) than in the Lst-position (67+/-10, $p<0.05$). Pulse beat were higher in the LSt-position (14.6+/-1.5) than in the other two positions (LSi; 13.6+/-2.1, WS; 13.0+/-1.9, $P<0.05$). In the relationship between underwater systolic blood pressure and arterial stiffness, in the NLSRD-group, underwater systolic blood pressure positively correlated with systemic arterial stiffness ($r=0.7$, $P<0.05$). However, the LSRD-group had no correlations ($r=0.3$, NS). DISCUSSION: In healthy middle-aged and elderly women, systemic arterial stiffness associated with underwater systolic blood pressure. However, in the lifestyle related diseases people had no relation. They are also higher underwater systolic blood pressure and systemic arterial stiffness than healthy people. It was suggested that the prediction of the blood pressure in the water is different than in the lifestyle related disease people. REFERENCES: Onodera S, et al. (2001): Safety and validity of aquatic exercises for the aged considering from a viewpoint of blood pressure. Desant Sport Science, 17: 53-61

P-058

Markers of Cardiovascular Health in Physically Active Masters Swimmers

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INTRODUCTION: The risk of cardiovascular disease increases with age. Though increased age is a leading risk factor, physical activity is modifiable. Since the general population (GP) does not meet the minimal recommendations for physical activity, aging is confounded by inactivity. The purpose of this study was to investigate activity and health in an older population habitually involved in swimming. METHODS: Cardiovascular assessment was conducted on 31 highly active (1288±1095 min/wk) swimmers competing in the 2009 USMS Long Course Nationals. Subjects self-reported physical activity using a modified IPAQ survey and were divided into younger (MSY; 50.9±3.4 yr; 5 m, 10 w) and older (MSO; 59.4±3.1 yr; 4 m, 12 w) groups. Blood pressure (BP), large (C1) and small (C2)

arterial elasticity indices, cardiac output (Q) and stroke volume (SV) were measured with the HDI/Pulsewave™ CR-2000 Research CardioVascular Profiling System. For comparison, members of a collegiate swim club (SC) (23.0±3.6yrs; 9 m, 5 w) were similarly assessed. USMS groups were also compared to published values (GP) (36.0±8.7 yr) defined as "healthy" (Prisant et al, 2002). RESULTS: C1 (MSY: 19.79±4.58 mL.mmHg-1x 10; MSO: 14.71±4.75 mL.mmHg-1x 10) was not different between: a) MSY and SC (20.59±3.49 mL.mmHg-1x 10) b) MSO and GP (14.4±4.0 mL.mmHg-1x 10) but c) was higher in the MSY than in the GP and d) was lower in MSY than the SC. C2 (MSY: 6.05±4.05 mL.mmHg-1x 10; MSO: 4.07±2.38 mL.mmHg-1x 10) was not different between MSY and GP (6.5±4.0 mL.mmHg-1x 10) but was greater in MSY compared to SC (9.49±2.24 mL.mmHg-1x 10) and in MSO compared to GP and SC. Systolic BP (MSY: 122.1±9.8mmHg, MSO: 137.3±16 mmHg) did not differ in MSY compared to GP (120.8±12.1 mmHg) or SC (121.9 ±9.7 mmHg). MSO was higher than both. Diastolic BP (MSY: 74.4±5.5mmHg; MSO: 78.1±10 mmHg) was higher in MSY than GP (69.4±7.6 mmHg) and SC (67.8±8.3 mmHg) and higher in MSO than in GP and SC. Q was less in MSY (4.8±.6 L.min-1) & MSO (4.8±.6 L.min-1) compared to both GP (5.5±.9 L.min-1) and SC (5.6±.4 L.min-1). SV was greater in MSY (92±14 mL.bt-1) and MSO (88±15 mL.bt-1) compared to GP (78±16 mL.bt-1). DISCUSSION: These data suggest that a lifetime of physical activity, such as swimming, can attenuate age associated declines in cardiovascular integrity. Active lifestyles illustrate positive training effects and allow maintenance of cardiovascular function throughout the lifespan.

P-059

Heart Rate Responses During Gradual Increasing and Decreasing Exercise in Water

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INTRODUCTION: The purpose of this present study was to determine the effects of heart rate responses during and after arm cranking exercise by gradual increase and decrease work load in water and on land. METHODS: Eight healthy Japanese males volunteered for this study. Subjects performed arm cranking exercise for 32 min and recovered for 1 min at standing position. Subjects underwent exercise types both calibration test and triangular tests. The calibration test was 20%, 60% and 40% levels of peak oxygen uptake at a 4-min period for 12-min. The work load varied triangular between 20% and 60% levels of peak oxygen uptake at a 4-min period for 20-min. Both experimental tests were performed on land (L-condition) and in water (W-condition). Water temperature and level were 30 degrees Celsius and iliac crest, respectively. Heart rate and cardiac autonomic nervous system activity (MemCalc) were continuously measured under both conditions. The maximal and minimal values, amplitude (difference between maximal and minimal values), and phase lags at the top and bottom of the work rate were measured in each exercise cycle for heart rate. T30 reflecting the reactivation in cardiac parasympathetic was calculated by the rate of decrease in RR interval for 30 sec after exercise. RESULTS: Heart rate in the W-condition was significantly lower than the L-condition ($p < 0.05$). The ln HF in the W-condition was significantly higher than the L-condition during triangular exercise ($p < 0.05$). The phase lags to the top and bottom the work rate in the W-condition was significantly shorter than the L-condition (respectively, $p < 0.05$). The amplitude was no significant difference between in the W-condition, as compared with on the L-condition. The T30 in the W-condition was significantly lower than on the L-condition ($p < 0.05$). During 1 minute after exercise, the ln HF in the W-condition was significantly higher than the L-condition ($p < 0.05$). DISCUSSION: The results in the present study suggest that activation of cardiac parasympathetic nervous system caused by water immersion may affect attenuation of phase lags response to gradual increase and decrease exercise. This attenuation of phase lags in the water exercise may contribute to reactivation of cardiac parasympathetic nervous system after exercise. Thus, exercise and its recovery in the water may enhance the stability of autonomic nervous activity not only during exercise but also after exercise.

P-060

Relationship between Heart Rate and Water Depth during Standing in Water

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INTRODUCTION: We already clarified that heart rate of young and old persons significantly decreased during standing in water, and that the decreases of heart rate depended on the water depth (Onodera S. 2001, 2006). We speculated that the changes in heart rate could agree with same water depth, not only increase of water depth but also decrease of water depth. Purpose: The purpose of this study was to clarify the relationship between the heart rate and the water depth during increase and decrease of water depth. METHODS: Seven volunteers participated in this study (Age: 23 yrs old).All subjects had an informed consent. A posture was standing in a test tank. It was nine conditions of water depth (on land, knee joint, greater trochanter, xiphoid process, under the collarbone, xiphoid process, greater trochanter, knee joint, on land). Each condition of water depth was kept for a minute. Heart rate was always measured using waterproof electrocardiograph. Water temperature was thirty-four degrees Celsius. Room temperature was twenty-eight degrees Celsius. RESULTS: Heart rate was significantly decreased during increase of water depth (on land: 80 (SD: 9) bpm, knee joint: 73 (SD: 7) bpm, greater trochanter: 70 (SD: 7) bpm, xiphoid process: 63 (SD: 7) bpm, under the collarbone: 62 (SD: 9) bpm). On the other hand, heart rate was significantly increased during decrease of water depth (xiphoid process: 62 (SD: 4) bpm, greater trochanter: 64 (SD: 9) bpm, knee joint: 68 (SD: 5) bpm, on land: 77 (SD: 8) bpm). The changes in heart rate were like a U-curve and were statistically difference (ANOVA, $P<0.05$). DISCUSSION: It was considered that the main factor of decrease of heart rate was the increase of stroke volume and venous return induced by water pressure. The increase of venous return could be interpreted in imported cell sap from cell to blood. However, as the heart rate did not agree with the same water depth, it could be another functional mechanism of the human body. It could estimate that the autonomic nervous system participated in this phenomenon. REFERENCES: 1. Onodera Sho, et al. (2001): Effects of water depth on abdominals aorta and inferior vena during standing in water. J Gravitational Physiology, 59-60 2. Onodera Sho, et al. (2006): Changes in cross sectional area of inferior vena cava during arm cranking exercise in water. Biomechanics and Medicine in Swimming X, 161-163

P-061

Body Composition Differences in Elite Waterpolo Players

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INTRODUCTION: The aim of the present study was to investigate body composition differences in three different group elite water polo

players. METHODS: All players representative of Turkiye National Waterpolo Team, totaly 163 waterpolo player investigated. First group consists of 18 senior water polo player age of 24.3±4.9 (SGRP), second group consists of 73 junior water polo player age group of 15-16 (JGRP) and the third group consists of 62 youth waterpolo player age group of 13-14 (YGRP). Body composition analysis made with Tanita BC-418 Segmental Body Composition Analyzer (Tanita Corp., Tokyo, Japan) by BIA. All players analyzed at the begining of the national teams preparation period at 2009-2010. Data analyzed with PC using statistic software program SPSS for Win, 11.0.0 – SPSS Inc., 1989-2001) and the p value set at 0.05 significant level. RESULTS: At the results, differences were found between these three waterpolo player group at the following body composition parameters ($p<0.05$); height, body mass, basal metabolic rate, fat mass, fat free mass, total body water, right leg fat free mass, right leg predicted muscle mass, left leg fat free mass, left leg predicted muscle mass, right arm fat ratio, right arm fat free mass, right arm predicted muscle mass, left arm fat ratio, left arm fat free mass, left arm predicted muscle mass, truncal fat mass, truncal fat free mass and truncal predicted muscle mass. DISCUSSION: The present study provides baseline physiological data that have been used in the prescription of individual training programs (weight loss programs or strenght training) for these waterpolo players and this information is also available to the coaches.

P-062

Oxygen Uptake Kinetics Around the Respiratory Compensation Point in Swimming

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INTRODUCTION: The upper boundary of the heavy domain is the highest intensity in which oxygen uptake (VO2) and blood lactate concentration can be maintained at an elevated but steady level. The purpose of this study was to describe VO2 kinetics throughout the heavy and severe domains during front crawl swimming, considering respiratory compensation point (RCP) as the transition parameter. METHODS: Nine male swimmers (68.6±9.2kg, 178.2±6.4cm, 21.0±7.2 years, and 3,999.2±726.1 ml.min^{-1} VO2max) were submitted to the following tests, using portable breath-by-breath system connected to a snorkel and valve: 1) incremental test with 300m stages ranging 85 to 100% of maximal swimming velocity at 400m (Dekerle et al., 2003), to determine the velocity at ventilatory threshold (VT), RCP and VO2max (vVO2max); and 2) square-wave test performed twice, from rest to one of two velocities set at 2.5% below and above RCP, to describe VO2 kinetics using a bi-exponential model. Difference between two means was checked by a paired t-test. Significance level was set at 0.05. RESULTS: The trial below RCP was performed at v36.8±8.5%$1 (% of the difference between the velocity at VT and VO2max) (91.5±2.3%vVO2max), with a slow component (391.2±236.6 ml.min^{-1}), eliciting only a sub-maximal rate (91.6±5.7%VO2max). The trial above RCP (v71.1±17.2%δ; 96.2±2.4%vVO2max) also presented a slow component (399.4±270.4 ml.min^{-1}) leading to its maximum (104.6±9.5%VO2max). DISCUSSION: The main VO2 responses observed were: a) patterns in the time constant for the primary and slow components kept unchanged; b) time delay was significantly shorter during exercising at severe domain only for primary component; and c) slow component is kept unchanged between heavy and severe domains, but it led to the attainment of VO2max when swimming above RCP. Thus, some of trends reported to Carter et al. (2002) for changes of the VO2 response profiles on treadmill across heavy and severe domains were also present in this study. Then, the major finding is that VO2 kinetics around RCP gathers the pulmonary VO2 responses reflecting the heavy and severe domains. REFERENCES: 1. Carter H; Pringle JSM; Jones AM; Doust JH. (2002) Oxygen uptake kinetics during treadmill running across exercise intensity domains. Eur J Appl Physiol, 86: 347–354. 2. Dekerle J; Baron B; Dupont L; Vanvelcenaher J; Pelayo P. (2003) Maximal lactate steady state, respiratory compensation threshold and critical power. Eur J Appl Physiol, 89: 281–288.

P-063

Hormonal, Immune, Autonomic and Mood States Variation at the Initial Preparation Phase of a Winter Season, in Portuguese Male Swimmers

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INTRODUCTION: In this study we aim to analyse the variation of hormonal, immune autonomic and mood states after the first mesocycle of a winter swimming season, through the behav-iour of well established fatigue markers markers. METHODS: The sample of this study is constituted by 13 male swimmers of national Portuguese level (17,2± 1,3 years old, 174,9 ±5,8 cm, 65,8±6,8 kg of height and weight respectively). Training volume and intensity were registered Blood and saliva samples were collected in the beginning of the winter season, and after 7 weeks of training, by venopuncture, at the same time of the day (between 15 and 17h). A 48 hours rest after the last training session was respected. Serum cortisol and free testosterone were de-termined by Electrochemiluminescent immunoassay and salivary cortisol e testosterona and salivary IgA determined through ELISA. The HRV assessment analysis was done with the Kubios HRV Analysis Software (Kuopio, FIN). The Portuguese version of the Profile of Mood States POMS short form was used for psychologic assessment of the impact of training. RESULTS: The volume of training increased gradually until it doubled the week distance swum with a mean increasing rate of 17,5% per week. Significant higher values of serum and salivary cortisol were found. Although the free testosterone remained stable during this period the testosterone / cortisol ratio decreased significantly. The HRV analysis in the frequency domain revealed an elevation of LF / HF due to the large increment of LF and the decrease of HF. The total score of POMS also showed an alteration towards significant worst score. DISCUSSION: Our results highlight the interest of the use of cortisol as a marker of the impact of chronic training effect, showing higher sensibility when compared to testosterone.. Autonomic imbalance associating increased sympathetic activity and reduced vagal tone has been proposed as a marker of excessive fatigue and impaired performance. The higher LF / HF ratio found in this study seems to confirm this. The results of the POMS demonstrate as reported previously, first signs of the training stress were of psychological nature. CONCLUSION: The sudden increase of the volume of training induced significant alterations the stress hormone cortisol, in the autonomic balance and a deterioration of mood states. REFERENCES: 1. Pyne, D., McDonald, W., Gleeson, M., Flanagan, A., Clancy, R., & Fricker, P. (2001). Med Sci Sports Exerc., 33(3), 348-353.

P-064

Oxygen Uptake Kinetics in All-Out Arm Stroke, Leg Kicking and Whole Stroke Front Crawl 100-m Swims

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INTRODUCTION: Arms and legs are often trained separately to obtain specific muscle adaptations along with whole body training. However, studies of VO2 kinetics have been conducted only in whole stroke (Rodríguez et al., 2003). This study examined VO2 on-kinetics during all-out 100-m front crawl arm stroke, leg kicking and whole body swimming. METHODS: 36 swimmers (26 M, 10 F) performed three all-out 100-m swims in random order (A: arms stroke, L: leg kicking, S: whole stroke). Breath-by-breath VO2 values were measured using a swimming mask attached to a portable gas analyzer (MetaMax 3B, Cortex). Phase I (cardiodynamic component) was computed as a time delay (TD) for Phase II (primary component) and the latter was then described using single [$VO2(t) = A0+A1(1-e^{-(t-TD)/\tau})$] and double exponential models. VO2 parameters were compared using paired (A/L/S) and unpaired (M/F) t-tests ($p \leq \alpha = 0.05$). RESULTS: There were no differences between single and double exponential curve fitting convergence parameters. Mean ± SD values for main parameters during A, L, and S, respectively, were as follows. TD (Phase I): 13.7±4.2, 14.0±4.2, 13.8±4.7 s (M), and 15.9±5.1, 19.5±5.3, 15.1±4.9 s (F). Total amplitude: 2.506±0.613, 2.681±0.538, 3.084±0.712 mL/min (M), and 1.817±0.229, 2.161±0.161, 2.431±0.2512 mL/min (F). Time constant (τ): 12.6±4.4, 9.9±2.8, 9.0±2.9 s (M), and 11.9±5.4, 10.6±4.1, 9.7±4.0 s (F). DISCUSSION: In either sex, VO2 kinetics attained higher amplitudes at S, followed by L and A. M reached higher amplitudes in all swims as compared with F. Time constants for S were lower than in a previous report (Rodríguez et al. 2003), although in that study the cardiodynamic component was not isolated. During A and L, 81 and 87% (M) and 75 and 89% of VO2 (F) of respective S amplitude was attained, similar to previously reported values during a 6-min flume swim (Ogita et al. 1996), thus confirming that the aerobic energy release in the active muscle groups involved in A plus L cannot be fully reached during S because of cardiorespiratory limitations. REFERENCES: Ogita F., Hara M., Tabata I. (1996) Anaerobic capacity and maximal oxygen uptake during arm stroke, leg kicking and whole body swimming. Acta Physiol Scand 157(4):435-441. Rodríguez F.A., Keskinen K.L., Keskinen O.P., Malvela M. (2003) Oxygen uptake kinetics during free swimming: a pilot study. Biomechanics and Medicine in Swimming IX, pp. 379-384. Saint-Étienne: Université de Saint-Étienne.

P-065

Determination and Validity of Critical Velocity in Front Crawl, Arm Stroke and Leg Kick as an Index of Endurance Performance in Competitive Swimmers

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INTRODUCTION: Wakayoshi et al.1, 2 have suggested that critical swimming velocity (vcri), defined as a swimming velocity which could be theoretically maintained forever without exhaustion, could be adopted as a simple and valuable index for swimming endurance performance and might correspond to the exercise intensity at maximal lactate steady state (MLSS). The purposes of this study were to determine the respective Vcri in whole crawl stroke (swim, Vcri-s), arm stroke (pull, Vcri-p) and leg kick (kick, Vcri-k), and also to examine whether Vcri-s, Vcri-p and Vcri-k correspond to the exercise intensity at MLSS for each stroke. METHODS: Fourteen male trained college swimmers volunteered for this study. All swimming tests were performed in a specially designed swimming flume. For the determination of Vcri, five constant water flow velocities were used, which ranged from 1.2m/s to 1.7m/s for Vcri-s and Vcri-p, and from 0.8m/s to 1.3m/s for Vcri-k. Exhaustion was defined by the subject not being able to maintain the water flow velocity (i.e. moving 1 m back from the initial position). For MLSS-test, the swimmers were asked to perform, by swim, pull and kick for 20 min (5 min x 4 stages) at the velocity corresponding to Vcri-s, Vcri-p and Vcri-k, and the 20 min swim was interrupted by three short rest periods (<60s) for blood sampling. Blood lactate concentration (BL) was determined before, during the three rest periods, immediately after, and 3 and 5 min after each trial. RESULTS: The relations between distance (D) and time (T) in swim, pull and kick were expressed in the general form, $D = a + b \times T$, with r2 value (goodness of fit) showing higher than 0.998 ($p<0.001$) in all subjects. In MLSS-test, all subjects could maintain the Vcri for 20 min in respective strokes. In addition, no significant differences were found in BL measured after 4 stages among swim, pull and kick. DISCUSSION: These data suggest that Vcri can be determined by the relationship between D and T, not only in swim but also in pull and kick, and Vcri obtained by each stroke would correspond approximately to the exercise intensity at MLSS. REFFERENCES 1. Wakayoshi K., et al.; Determination and validity of critical velocity ad an index of swimming performance in the competitive swimmer, Eur. J. Appl. Physiol., 64, 153-157, 1992. 2. Wakayoshi K., et al.; Does critical swimming velocity represent exercise intensity at maximal lactate steady state?, Eur. J. Appl. Physiol., 66, 90-95, 1993.

P-066

Differences in Methods Determining the Anaerobic Threshold of Triathletes in the Water

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The goal of this research is to determine whether statistically significant differences exist between three various methods for determining the anaerobic threshold, i.e. differences in heart frequencies with regard to the anaerobic threshold (FSanp-1, FSanp-2, FSanp-3) pertaining to a swimmers' progressive test. The variable sample consisted of basic anthropometric variables, as well as a set of variables for the evaluation of functional abilities in 13 Croatian triathletes: maximum heart frequency, maximum speed, maximum lactates, anaerobic threshold FS (intersection method „4mmol/l", „D-max method"), anaerobic threshold lactates (intersection method „4mmol/l"„D-max method"). The subjects swam a progressive discontinuous test of 7 x 200 meters, the same being used to measure cardiovascular and metabolic responses to swimming speed increase applying the front crawl technique. In order to determine statistically significant differences between various methods used to establish the anaerobic threshold of the subjects, the t-test was used for dependent samples. In the course of this research, the "Intersection" method and the "D-max method" have proven to be a reliable means in assessing the anaerobic threshold.

P-067

Water Training Effect in Shoulder Rotator Strength in Young Swimmers

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INTRODUCTION: The purpose of this study was to evaluate the effect of 18 weeks water training on the rotator cuff strength of young swimmers. METHODS: Twenty Portuguese national level male swimmers (age: 14.60±0.67 years old, height: 170.79±6.48 cm, body mass: 61.73±4.68 kg) and 16 sedentary male students (age: 14.88±0.72 years, height: 168.38±6.19 cm, body mass: 60.84±11.69 kg) participated in this study. The peak-torque of shoulder internal (IR) and external rotators (ER) was measured in the beginning of the season and after 18 weeks. Concentric action at 60º/s (3 rep) and 180º/s (20 rep) were measured in a seated position, using an isokinetic dynamometer (Biodex System

3–Biodex Corp., Shirley, USA). Anova with repeated measures was adjusted by baseline data and used to determine significant main effects in shoulder rotators strength and unilateral ratios (concentric ER/IR). The level of significance was set at 0.05. RESULTS: Significant differences were found in all variables that measure the IR shoulder strength, at 60º/s in dominant(DT) (P=0.000) and non-dominant(NDT) shoulder (P=0.002), and at 180º/s, both in DT (P=0.000) and NDT shoulder(P=0.001). At 180º/s ER we only found differences in the NDT shoulder (P=0.007). In respect to ER/IR ratio, significant differences were found between baseline and 18 weeks in both shoulders at 60º/s (DT: P=0.000; NDT: P=0.001). At 180º/s only in the DT ER/IR ratio significant differences were found (P=0.002). DISCUSSION: The main results are similar with previous studies [1]. After a exclusive water training period, the IR strength gains were significant higher when compared with the ER. These results are attributed to the repetitive shoulder IR and arm adduction motions involved in swimming techniques. As a consequence of the differences in strengths gains, the ER/IR ratio decrease from baseline to 18 weeks water training. The present data show specific adaptations in shoulder strength and identify a relative muscular imbalance between the IR and ER on the DT and NDT arm of young swimmers. Since the ratios describe the quality of muscular balance/imbalance, we can conclude that 18 weeks water training period induces muscular imbalances in both shoulders. REFERENCES: 1. Ramsi, M., Swanik, K. A., Swanik, C., Straub, S. & Mattacola, C. (2004). Shoulder-Rotator strength of High School swimmers over the course of a competitive season. Journal of sport rehabilitation. Human Kinetics Pub. USA. Vol 13: 9-18.

P-068

General Indexes of Crawl Swimming Velocity of Junior Water Polo Players at Match

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INTRODUCTION: In the course of a match a water polo player spends around 37% of overall playing time in horizontal position, and crawl technique is used for about 90% of sections. The task of this research is to define swimming velocity of players in horizontal position, i.e. crawl technique swimming velocity, realized by a junior water polo player during a match, since it is the most represented competitive swimming technique. METHODS: 35 water polo players were analyzed by using video recordings. The following variables were investigated: average swimming velocity during the match and during each quarter, distribution of swimming velocity during the match and per quarters. Additionally, the structure of swimming velocities was defined compared to the following intensities: maximal, sub maximal, high, medium and low. The results were elaborated by descriptive statistical analysis and ANOVA in order to establish differences of the observed variables between the quarters. RESULTS: The average swimming velocity of players at match was 1.356±0.353 m/s, and per quarters: I quarter 1,385±0.350 m/s; II quarter 1,343±0.362 m/s; III quarter 1,353±0.357 m/s and IV quarter 1.331±0.328 m/s. With regard to swimming velocities structure at match, the players perform 2.3% of the sections at maximal velocity, 30.6% at great velocity, 43.9% at medium velocity, 15% at moderate velocity and 8.1% at low velocity. It was established that there were no statistically significant differences of crawl technique swimming velocities between the quarters (F=1,903, p =0,127). It was also determined that there were no differences in swimming velocity distribution with regard to quarters (F=5,269, p = 0,153). DISCUSSION: The results of the research indicate that over 70% of sections in which a player used crawl technique were realized at high and medium intensity. Non-existence of difference in swimming velocities, as well as in swimming velocity structure between the quarters in junior age water polo players can indicate that players at this age and level of fitness are not capable of significantly changing the rhythm during the game. This can be a consequence of adaptation to the applied training load of dominantly aerobic type, but also due to tactical way of playing deployed by the junior age players. REFERENCES: 1. 1. Dopsaj, M., Matkovic, I. (1994): Motor activities during the game, Physical Culture, 48, 4:339 – 347, Belgrade.

P-069

Correlation Between Dry Land Strength Measurements and In Water Force Generation

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INTRODUCTION: USA-Swimming supports the use of a specific dry land force measurement (Vasa Trainer) relative to in-water force generation. Imbalances between the measurements indicate the need to increase strength or enhance efficiency. The purpose of this study was to determine if two standard measurements of dry land strength would correlate with the ability to generate force in water as measured by a timed 22.9m swim or tethered swimming. METHODS: Subjects: N=25 (10 M, 16.6 y; 15 F, 16.3 y). Resistance Training: Bench Press - Subjects completed a barbell chest press with light weight for 10 repetitions. Following a 2 minute rest period, the weight was increased 10 % and another set of 10 repetitions completed. Subjects continued until they were unable to complete ten repetitions. 1RM was estimated using the following equation: Body weight/(1.0278-(.0278 x #reps)). Leg Press - Subjects completed a bilateral seated leg press following the same protocol as the BP. Swim Training: 22.9m Swim - Subjects completed two, 22.9m maximal swims from the starting block. Each swim was separated by 2 minutes. Times were recorded to the 100th of a second and averaged for best time. Tethered swim - Subjects completed two in-water tethered maximal swims (Digital Force Gauge, IMADA, Inc). Each trial was separated by1 minute. Force was recorded in N's and the trials averaged for best effort. Statistics Analysis: Pearson Product Moment Correlation (R > 0.80). RESULTS: A significant correlation existed between BP strength and both the 22.9m swim and TeS for both sessions tested (R = -0.85 & -0.87; R = 0.82 & 0.80). A minor correlation existed between LP and 25 yard swim time (R = -0.70 & -0.77). No significant correlation existed between LP and TeS force generated. DISCUSSION: BP strength significantly correlated with both in-water force measurements. In addition, LP strength was significantly correlated with 25y swim time. Although LP was not correlated with TeS there was a significant difference when males were separated from females. For all measurements taken, males demonstrated a higher level of correlation. The differences observed between males and females could be due to the amount of muscle mass in males. Also, within this age range, males may have had more dry land weight training experience than females. In conclusion, BP strength may be an appropriate alternative to the Vasa Trainer as an indicator of discrepancy between strength and in water force generation.

P-070

Perceived Exertion at Different Percents of the Critical Velocity in Front Crawl

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INTRODUCTION: Concerning that critical velocity (CV) can be used as a parameter of intensity prescription, the aim of the present study was to compare and correlate the perceived exertion (PE) at different percents of the CV in front crawl. METHODS: Ten trained male swimmers (19.4 ± 2.2 years) performed five repetitions of 200 m

at different percents of the CV (90, 95, 100, 103 and 105%), in random order, with 90 s of passive rest, to obtain PE. For statistics analysis Friedman and Wilcoxon tests were used. Correlations among variables were verified by Spearman test. Student t-test was used to compare different percents of the CV, prescribed critical velocity (CVP), and real velocity (SVR). When differences were observed, real CV was compared to the percent immediately above. α <0.05. RESULTS: Differences occurred at 90% (91.9±1.0), 95% (96.2±1.8) and 100% (101.0±1.5) of the CV when compared to SVR and between percents immediately above, indicating that protocol used was validly. PE presented significant difference among percents of the CV. Significant correlation between PE with percents of the CV was observed (rho=0.785, p<0.01). Results suggest that PE increases (from 12 to 17 points) as percent of the CV increases, but it is a non-linear relationship. DISCUSSION: Results are in agreement with others studies that founded correlation between CV and PE during incremental swimming tests (Ueda and Kurokawa, 1995; Lima et al., 2006). Little increases in swimming velocity (5% of the CV) can justify the difference founded in PE. Lowest correlation value observed between CV and PE in the present study compared to the literature could be explained by the PE role in exercise intensity tolerance control. It seems that PE does not necessarily increase when percent of the CV increase throughout short-duration interval training in front crawl. REFERENCES: 1. Lima MCS, Junior PB, Gobatto CA, Junior JRG, Ribeiro LFP (2006). Incremental test proposal based on the rating of perceived exertion to determine metabolic thresholds and mechanical parameters of free style. Braz J Sports Med, 12:1-5. 2. Ueda T, Kurokawa T (1995). Relationships between perceived exertion and physiological variables during swimming. Int J Sports Med, 16:385-9.

P-071

Tracking the 2004-2008 Olympic Cycle Performance in Long Distance Freestyle Events

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INTRODUCTION: As world records are being broken so often, tracking the swimmer's performance is important to analyze its progression between competitions, and help coaches to define realistic goals and training methods. The aim of this study was to track the long distance freestyle events performance during the 2004-2008 Olympic Cycle. METHODS: For the 400-m and 1500-m, an overall of 181 swimmers and 905 race times were analyzed. FINA's male top-150 ranking for long course in the 2007-2008 season was consulted in each freestyle event to identify the swimmers included in it. Best performances during the Olympic cycle seasons (between 2003-2004 and 2007-2008) were collected from ranking tables. This tables were provided by the National Swimming Federations of each swimmer identified, and when appropriate were also collected from a public swimming database (www.swimrankings.net). Performance progression was analyzed based in two approaches: (i) mean stability; (ii) normative stability. For mean stability assessment, descriptive statistics and ANOVA repeated measures followed by a post-hoc test were computed. Normative stability was analyzed with Pearson Correlation (Malina, 2001) and the Cohen's Kappa tracking index (Landis and Koch, 1977). RESULTS: ANOVA repeated measures revealed significant variations in the swimming performance for the 400-m event [F (1,91) = 67.89; P < 0.01] and 1500-m event [F (1,90) = 91.81; P < 0.01] throughout the Olympic Cycle. Bonferroni post-hoc tests confirmed significant performance enhancement (P < 0.01). The K values expressing the stability throughout the Olympic Cycle were moderate [400-m event (K = 0.43 ± 0.05) and 1500-m event (K = 0.44 ± 0.05)]. Self-correlations revealed that high stability is achieved at the third season in the 1500-m event (r = 0.61) and at the fourth season in the 400-m event (r = 0.73). DISCUSSION: World-ranked swimmers performance went through a great improvement during the 2004-2008 Olympic Cycle. Stability and prediction based on overall Olympic Cycle period is moderate. When more strict time frames are used, swimming performance stability and prediction increases, starting at the third season in the 1500-m and at the fourth season in the 400-m. REFERENCES: 1. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977; 37:439-446 2. Malina RM. Adherence to physical activity from childhood to adulthood: a perspective forma tracking studies. Quest 2001; 53:346-355

P-072

Changes of Competitive Performance, Training Load and Tethered Force During Tapering in Young Swimmers

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INTRODUCTION: Training load changes during a taper may have an impact on performance2 and can be estimated using a session-RPE method.3 Moreover, since tethered swimming force is related to performance,1 combined changes of training load and tethered force may explain performance changes. The aim of the study was to examine tethered force and session-RPE load changes before and during a taper. METHODS: During the four-week period before the National Championship (NC), the session-RPE training load of 12 swimmers (age: 14.2±1.3yrs) was recorded daily and summarised for each week. Thirty-four (T1), twenty (T2) and six days (T3) before the NC the swimmers' tethered swimming force (TF) during a 15 s maximum effort test, the hand-grip strength (HG) and percentage of body fat (BF) were evaluated. Backward multiple linear regression analysis was used to examine the relationship of NC performance change with session-RPE training load, TF, HG and BF changes between T3-T1 and T3-T2. RESULTS: Performance was not changed after the taper (0.11±1.6%, 95%CI: -0.9 to 1.1%, p>0.05). The session-RPE load difference of week 4 minus week 1 (W4-W1) was related with the percentage change of performance during the taper (r=0.63, p<0.05). HG, TF and BF were not changed during the T1, T2, T3 and their percentage changes were not related to the percentage change of performance (TF: 112±38, 114±41, 115±41 N, HG-right arm: 35±11, 34±11, 34±12 kg; HG-left arm: 33±9, 32±8, 33±9 kg, BF: 20.1±6.3, 19.1±5.9, 19.5±5.9%, p>0.05). The variation in percentage change of performance was attributed by 40% to changes in session-RPE (W4-W1, multiple r=0.63, r2=0.40, SEE=1.37%, p<0.05). HG, F and BF changes did not contribute significantly to the model. DISCUSSION: Session-RPE estimated training load is a useful parameter affecting changes of performance time. This method of training load calculation may help coaches for a better planning of training before an important competition. REFERENCES: 1. Hooper SL, Traeger L, Mackinnon LT, Ginn E. (1998). Effects of three tapering techniques on the performance, forces and psychometric measures of competitive swimmers. Eur J Appl Physiol, 78:258-263. 2. Mujika I, and Padilla S. (2003). Scientific bases for precompetition tapering strategies. Med Sci Sports Exerc, 35(7):1182-1187. 3. Wallace LK, Slattery KM, Coutts AJ. (2009). The ecological validity and application of the session-RPE method for quantifying training loads in swimming. J Strength Cond Res, 23(1):33-38.

P-073

Ventilatory and Biomechanical Response Analysis in Short vs. Long Interval Training Sessions in Elite Long Distance Swimmers

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INTRODUCTION: It is known that continuous exercises performed at the lactate threshold have the greatest effect upon the body's oxygen transport system (Billat, 2001). This type of training enables swimmers to attain max by restoring the slow component of and by reducing the amplitude of the slow component after a period of training (Carter et al., 2000). Restoration of the slow component of appears to be more frequent among athletes having a high fractional at the lactate threshold (Billat, 2001) which is typical of ultra-endurance athletes (Billat et al., 2001). We hypothesized that in high-level long-distance swimmers, long interval training at LT, induce a large slow component of . METHODS: Seven elite male long-distance swimmers (Mean ± SD, age 21.4 ± 3.5 yrs; weight 71 ± 5 kg ; height 180 ± 5 cm) performed in a 6x300-m incremental swimming exercise to exhaustion in order to determine lactate threshold (LT = 3.1 ± 1.2 mmols.l-1), and the velocity associated with LT (v LT = 1.45 ± 0.01 m•s-1 = 97.3 ± 5.6% of v max). Secondly, the parameters of kinetics were calculated for the first 500m of one interval training set: 6 x 500-m using a double exponential model. RESULTS: The fit for the two-term exponential model was (r^2= 0.62 ± 0.18). All seven subjects displayed a slow component of during the first 500m of IT6*500 with values measured at 401.7 ± 129.9 mlO2.mn-1 and 5.69 ± 1.96 ml.mn-1.kg-1. DISCUSSION: Elite Long-distance swimmers exhibit exceptionally high levels of peak oxygen uptake and peak swimming velocity at the lactate threshold. All of the swimmers tested exhibited a large amplitude slow component of oxygen uptake. REFERENCES: Billat V, Demarle A, Slawinski J, Paiva M, Koralsztein JP. Physical and training characteristics of top-class marathon runners. Med Sci Sports Exerc 33(12): 2089-2097, 2001. Carter H, Jones AM, Barstow TJ, Burnley M, Williams C, Doust JH. Effect of endurance training on oxygen uptake kinetics during treadmill running. J Appl Physiol 89: 1744-1752, 2000.

P-074

Diagnosis of Swimming Technique by Fully Tethered Swimming

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INTRODUCTION: Dopsaj, Matkovic, and Zdravkovic (2000) showed that fully tethered swimming is a worthwhile tool for measuring maximum swimming force (Fmax), and valid to predict 50-m-crawl sprint times. In addition to that, in this study it is assumed that a fully tethered crawl swim test can also be used to measure swimming technique by quantifying the variation of the propulsive force on the rope. Thus, the study aims at the validation of the relative standard deviation (rSD) of the swimming force in a fully tethered 6-s-maximum crawl sprint test. METHODS: 33 male and 27 female elite swimmers of the German junior national team performed 3 maximum crawl sprint trials under fully tethered conditions. The over all swimming force exerted on a steel rope was measured by a load cell. In a first step, the influence of fatigue was eliminated by partializing out the specific variance resulting from the test duration (time) on the dependent force variable by regression analysis. For the residual data of the 6-second stationary force-time curve of each individual the standard deviation was calculated, and then expressed as percentage of the mean force. A small intra- and intercyclic variation of the swimming force is interpreted as a high technical proficiency of the swimmer. RESULTS: Not only the mean swimming force, but also the inter- and intracyclic variation of the swimming force during the 6-seconds all-out test is significantly correlated with the personal best competition time in the 50-m-freestyle swimming. In the boys group, all crawl sprint times below 24.0 s are associated with relative standard variation coefficients of the exerted force in the fully tethered swimming test below 70 percent of the mean swimming force of the individuals. In the girls, no significant correlation (rtc = .08; p = .337; n = 29) between the rSD of the swimming force and the crawl sprint performance could be found. DISCUSSION: The significant correlation between the crawl sprint competition times and a low variation of the propulsive forces exerted in a fully tethered 6-seconds all-out sprint test underline the validity of the test procedure in elite male swimmers. REFERENCES: Dopsaj, M., Matkovic, I., & Zdravkovic, I. (2000). The relationship between 50-m-freestyle results and characteristics of tethered forces in male sprint swimmers: A new approach to tethered swimming test. Physical Education and Sport, 1 (7), 15-22.

P-075

Specific Strength Training and Start Performance in Swimming

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INTRODUCTION: Holthe and McLean (2001) showed that jumping power is a worthwhile parameter for predicting start times in sprint swimming. In this intervention study it is assumed that improving maximum strength and power in squad (SJ), counter movement (CMJ), and drop jump (DJ) leads to better start times in elite swimmers. METHODS: 5 male and 2 female swimmers of different German national swim teams performed a 4-week training intervention to optimize maximum strength and jumping power, as well as the start technique of the athletes. In single case experiments, each athlete performed maximum swim start trials as well as strength and jumping power tests before (pretest) and after (posttest) the 4-week training period. Another 4 weeks later a retention test was administered. The over all start time over a distance of 7.5 m was recorded by video analysis. Kinematic parameters (block time, flight time, and overall start time, angles at take off and water entry, take off velocity) were calculated by motion analysis. Dynamic data were measured as 3-dimensional ground reaction forces (1.000 Hz) by a specific mobile start block with an integrated force plate. The individual performance development in the kinematic and kinetic parameters between the three test dates was analysed by critical differences. Significance level was set by $p < 0.05$. RESULTS: The swimmers improved strength and power, as well as the start time (MPre = 2.70+0.28 s to MPost = 2.63+0.28 s; T = 3.59; n = 5; $p < 0.05$). The best female swimmer, qualifying for the WC 2006, improved maximum strength of the left and right leg, and drop jump (40) index from 136 pts to 166 pts (dkrit: $p < 0.01$) during the training period. Furthermore, in the final qualification competition the best female and male athlete reached personal best start times of 2.82 s (crawl) resp. 2.70 s (backstroke). DISCUSSION: The single case experiments showed that a 4-week training intervention with three weekly training sessions aiming at the maximum and explosive strength of the legs, as well as at the swim start technique is helpful to improve in most of the strength parameters and the overall start performance in swimming in elite athletes. REFERENCES: Holthe, M.J. & McLean, S.P. (2001). Kinematic comparison of grab and track starts in swimming. In J.R. Blackwell & R.H. Sanders (eds.), Proceedings of Swim Sessions. XIX

International Symposium on Biomechanics in Sports (pp. 31-34). San Francisco: University of San Francisco, Exerc. & Sp.

P-076

Relationship Between Eggbeater Kick and Support Scull Skills, and Isokinetic Peak Torque

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INTRODUCTION: Eggbeater kick and support scull are essential basic propulsive techniques in synchronized swimming. The aim of the present study is to ascertain the relationship between muscle strength, and eggbeater kick (EB) skills and vertical position (VP) support skills in elite synchronized swimmers. METHODS: Ten female silver-medalists at the World Championships participated. EB and VP support skills were assessed based on their respective test scores. EB skills were assessed by EB and height (Ht) scores, and VP support skills were assessed by VP and design scores. The isokinetic peak torque for knee flexion and extension (60 or 180˚/s), trunk flexion and extension (60 or 120˚/s) and shoulder internal and external rotations (60 or 120˚/s) were measured using the BIODEX System 3.RESULTS: Both EB and Ht scores significantly correlated with 60˚/s (EB: r=.735, Ht: r=.717) and 180˚/s (EB: r=.711, Ht: r=.749) (left) knee flexion. Ht score significantly correlated with 60˚/s trunk flexion (r=.812). Correlations between EB score and 60 or 180˚/s (left) knee flexion per BW (r=.673), and between height score and 60˚/s trunk flexion per BW (r=.778) were significant. VP scores significantly correlated with 60˚/s (r=.633) and 120˚/s (r=.646) right external shoulder rotations per BW. Design scores significantly correlated with 60˚/s (R: r=.663) and 120˚/s (R: r=.642, L: r=.654) external shoulder rotations per BW. DISCUSSION: From the results, the importance of strengthening the muscles associated with hip flexion such as the hamstrings, rectus abdominis, and psoas major was suggested. These findings are related to the EB techniques for improving skills, which are executed with the knees and heels at higher positions. The significant relationship between external shoulder rotation and VP support skills might have been due to the specificity of support scull movements. The support scull is a rotational movement of the forearms with bent elbows, and it is an unusual movement where a swimmer bends the elbows and externally rotates the shoulder while supinating the forearms. Therefore, rather than individual differences in internal rotation, those in external rotation are closely related to the support scull skills. To improve the support scull skills, upper arm abductors such as the infraspinatus and teres minor should be trained and the muscles around the scapula should be strengthened in proper balance.

P-077

The Effects of Straight Leg Kick on Race Performance in the Sprint Butterfly

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INTRODUCTION: Butterfly swimmers should keep their body as horizontal as possible during the propulsive phases of the arm stroke (Maglischo, 2003). Since 2006, I've coached Kawamoto to change his butterfly technique, employing the straight leg kick, which results in a more horizontal stroke. METHODS: This study compared Kawamoto's performance 2009 and 2005. Each subject performed 25 meter butterfly, from a push start to 15 meter under water butterfly kick. After the 15 meter point, Kawamoto swam all out butterfly stroke until completing a full 25 meters. Swimming Speed Mater (Vine, VMS-003, AC100V, 1/500sec, 0.2mm/pulse) generated the data by an attached wire with movement place. The wire then exports the analogue signals and RS232C signals. These signals calculated are then examined using Microsoft Windows Excel and a Wicoxon Signed Ranked Test. While swimming, the subjects were monitored from the side using an underwater video camera at a sampling frequency of 60Hz (Underwater monitor system 2, YAMAHA, Shizuoka, Japan). The subjects strokes angle of degree was analyzed with DartTrainer in regards to the bending of the knee and upper body movement. RESULTS: Swimming Speed Mater shows the 2009 and 2005 max speed was 2.5m/sec to 2.7m/sec at the second kick phase. The distance pre stroke (DPS) results were different resulting in a, 2.204m±0.131 for 2009 and 1.894m±0.062 for 2005 (DPS (m) Wicoxon.: p=0.006061, 1 stroke (velocity) Wicoxon.: p=0.7748) and DartTrainer showed the upper body movement increased from 61% to 69%. Straight knee considered when the knee bend is 170 degrees to 180degrees (+170 degree), 55% use of straight knee kick for 2009 and 39% for 2005, in the one stroke. DISCUSSION: Based on the above evidence it is clear the most preferred butterfly technique is to use a straight knee kick and to maintain a horizontal body position. Since 2006, we employed the four step training plan in practice and swim meet. First step, we imagined straight kick on the land, second step was to utilize the straight leg fly kick in the pool, third step was to test the technique in a small meet, and fourth step was to utilize the technique in the taper meet. REFERENCES: 1.Maglischo EW (2003). Swimming Fastest. Champaign: Human Kinetics.

P-078

Increased Training Intensity and Reduced Volume for 12 Weeks Increases Maximal Swimming Speed on a Sprint Distance in Young Elite Swimmers

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INTRODUCTION: Training volumes of elite swimmers consists of 40-70 km pr. week depending on the time season and competitive level. Given this volume the average training intensity typically becomes relatively low, compared to the intensity during competition. The training is carried out over a large span of intensities and taxes anaerobic and aerobic energy system. Hence it is reasonable to conduct both anaerobic and aerobic test´s in order to evaluate training effects. METHODS: A group of male (N=20;19±3 yrs mean±SD) and female (N=11, 18±3 yrs) elite swimmers were randomly assigned to an intensity training group (IG; N=16) or a control group (CG; N=15). For 12 weeks, CG continued their normal training of 25-50 km pr week including supra maximal bouts 1-2 times pr. week. IG reduced training volume by 50% and performed at least 4 sets of supra maximal interval training pr week. Before and after a 5x200m progressive step test on a 5 min cycle was performed. On the first 4 steps the speed was controlled and was the same on both occasions. The last level was as fast as possible with an even split. In the pause between repetitions a finger tip sample for analysis of lactate was obtained. After a break lasting at least 3 hrs, a 100 m time trial test was performed with split times for each 5m, obtained by 2 trained observers. RESULTS: A higher max swimming speed was observed (1.67±0.13 m/s vs 1.74±0.17m/s,P<0.05) for IG when comparing pre to post. No differences between groups for any of the split times on the 100m time trail was observed. Furthermore, higher lactate values was observed in CG (5.4±1.6 mmol/l vs 6.4±2.1 mmol/l,P<0.05) after the 4th repetition. No difference in lactate values between groups was noted. DISCUSSION: The major finding of this study is that a 12 weeks training intervention with concomitant doubling of the amount of high intensity training and 50% reduction of the training volume, seems to increase the ability to reach high maximal speed over a sprint distance (100m) without compromising the endurance capacity as judged by the step test. As lactate levels were not changed as a result of training the effect might be related an increase of strength, efficiency or a combination of the two. Surprisingly an increase in the lactate level after the 4th repetition was

observed for CG after 12 week of endurance training. An increase in the transport capacity for lactate out of the working muscles could play a role for this observation.

P-079

Biomechanics and Bioenergetics of 100-m Front Crawl Swimming in Young Male Swimmers

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INTRODUCTION: No studies have investigated the influence of somatic, energetic and technical parameters together to determine sprint swimming performance in boys after reaching puberty. The purpose of the study was to analyze possible relationships between swimming performance, anthropometrical, physiological and biomechanical parameters in male adolescent swimmers. METHODS: 25 male swimmers (15.2±1.9 years; 176.1±9.2 cm; 63.3±10.9 kg) performed 100m maximal front crawl swim in the 25m pool. Oxygen consumption, swimming speed (v), stroke rate (SR), stroke length (SL) and stroke index (SI) were assessed. Blood samples for lactate were taken at the 3rd and 5th minute of recovery and energy cost (Cs) was calculated. RESULTS: The average 100-m performance time was 77.6±9.1 and was significantly related ($p<0.05$) to height, body mass and arm span values from the measured somatic parameters and to ~, SL, SR and SI values, and VO2, ΔLa and Cs values from measured biomechanical and bioenergetic parameters. Biomechanical factors (79%) characterized best the 100m swimming performance in these young swimmers, followed by somatic (49%) and bioenergetic factors (32%). DISCUSSION: The most important finding was that biomechanical parameters characterized best the 100m swimming performance, while the SI was the best predictor of sprint performance in adolescent male swimmers. Therefore, learning the correct swimming technique from the early years of swimming training is important. Cs is a key parameter to evaluate performance in swimming, but there are only a few studies that have investigated the determinants of swimming economy in children and adolescents (Kjendlie et al. 2004; Poujade et al. 2002). By investigating how aerobic and anaerobic performance develops during growth and maturation, it may be possible to identify the capacity for improvement and provide guidelines to coaches for the preparation of specific training sessions for young swimmers. REFERENCES: 1. Kjendlie P et al. (2004) Differences in the energy cost between children and adults during front crawl swimming. Eur J Appl Physiol 91,473-80. 2. Poujade B et al. (2002) Determinants of the energy cost of front-crawl swimming in children. Eur J Appl Physiol 87,1-6.

P-080

Effects Of Applying Different Work Methods At Swimming School Programme For Beginners

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INTRODUCTION: The main aim of this research was to establish any possible differences in learning dynamics of basic swimming skills between two homogeneus groups of children. The first group was experimental group, and this group had learning program divided into five levels. The second group was control group, which worked according to learning program divided into three levels. Both groups were given the same swimming distance. METHODS: The research was conducted on 50 beginners, at the sports camp of Zaostrog, Croatia (n=50, 7-10 yrs). Two groups were formed: the control group and the experimental group. Both groups consisted of 25 participants each. It was previously established that these children have no swimming abilities. The T-test was used in order to establish differences between the two groups. RESULTS: The effects of applying different work methods have given statistically significant differences between the two groups. The experimental group had more significant results than the control group. The Control group results were:sig=0,1; Mean M= -3,76 and the value of the T-test was t= -2,67. DISCUSSION: It can be said that the experimental group was more motivated for success, since this group worked according to five level training program. The program offered faster advancement from the first level to the fifth level. The control group worked according to the three level program; however this group had to overcome the same swimming distance as the experimental group. CONCLUSION: The experimental group has adopted swimming abilities in greater manner and more quickly. REFERENCES: Jürimäe J, Haljaste K, Cicchella A, Lätt E, Purge P, Leppik A, Jürimäe T (2007). Pediatr Exrec Sci, 19, 70-82. Leppik A, Jürimäe T, Jürimäe J (2006). Coll Antropol, 30, 753-76. Torlakovic, A. (2009). Analysis of dynamics of studying basic swimming elements. 11th International Conference of Sport Kinetics (ISBN: 978-960-88403-2-4), Chalkidiki, Greece, p.83-84 (O4).

P-081

13th FINA World Championships: Analysis of Swimsuits Used By Elite Male Swimmers

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INTRODUCTION: The polyurethane swimsuits has become the notice around the pools in the past couple years. A better body position and the reducing of drag are believed to be some of the reasons that allow the swimmers wearing these swimsuits to go faster (Kainuma et al., 2009). The purpose of this study was to verify the distribution of different swimsuits used by male swimmers during the finals at the last world championships being held at Rome in 2009. METHODS: Results databases from the 13th FINA World Championships, in Rome 2009 were used. Only the male swimmers participating in the finals were analyzed, for a total number of 24 individual swimming events. The wearing swimsuits were observed from video recorded of the television broadcast. RESULTS: Male swimmers participating in the finals limited their choice to seven types of swimsuits, of four different brands. Jaked01 Full® was the most used (47%), followed by the Powerskin X-Glide Full® (35%), the Powerskin X-Glide Pants® (7%) and the LZR Racer Full® (5%). Less used were the Jaked01 Pants® (3%), the Hydrofoil Full® (1%) and the LZR Racer Pants® (1%). Powerskin X-Glide Full® was the most used in freestyle events (56%), followed by Jaked01 Full® (29%). In backstroke, male swimmers share a preference between Powerskin X-Glide Pants® and Jaked01 Full® (33% each). All the swimsuits used in the breaststroke finals were distributed by the Jaked01 Full® (79%) and the Powerskin X-Glide Full® (21%). In medley finals, the Jaked01 Full® remained in the preferences (56%) followed by Powerskin X-Glide Full® (25%). We also could verify that 41% of the swimmers wearing Powerskin X-Glide Full® reached the podium, as well as 29% with Jaked01 Full®. DISCUSSION: Male swimmers preferentially used full swimsuits, covering both the torso and legs, probably contributing for a higher drag decrease. We can observe a clear preference for two swimsuits types: the Powerskin X-Glide Full® and the Jaked01 Full®. It seems these swimsuits had greater success rate for achieving podium places. One can speculate that in backstroke swimmers used more swimming pants because they are in a dorsal position, where a full swimsuit could not allow much benefits of the torso cover. The existence of selected preferences by the swimmers highlights the importance of the

swimsuits until the inclusion of the new swimsuit rule and might have on performances in the near future. REFERENCES: Kainuma E et al. Biomed Res 2009; 30(1):69-70.

P-082

Swimsuits Used By Elite Male Swimmers in the 13th FINA World Championships: Analysis of Freestyle Events

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INTRODUCTION: Several world records have been broken in recent years. Swimming community speculates this fact is partly related due to the changes in swimsuits characteristics. To swim faster one need to increase the thrust and reduce drag, which can be achieved wearing the new polyurethane swimsuits (Marinho et al., 2009). The purpose of this study was to verify the distribution of different swimsuits used by male swimmers during all the freestyle finals, according to the different distances swum, at the last world championships being held at Rome in 2009. METHODS: Results databases from the 13th FINA World Championships, in Rome 2009 were used. Only the male swimmers participating in the freestyle finals were observed and analyzed, for a total number of six individual swimming events (50 m, 100 m, 200 m, 400 m, 800 m, 1500 m). The wearing swimsuits were observed from video recorded of the television broadcast. RESULTS: In freestyle swimming events most of the male swimmers participating in the finals choose to wear full body swimsuits. Three different swimsuits brands were used by the swimmers: Powerskin X-Glide Full® (56.25%), Jaked01 Full® (29.17%) and LZR Racer Full® (10.42%). Only 2.08% of the sample used pants. In the shortest event, 50 m, Jaked01 Full® was predominant with 62.50% of the swimmers choices. This value decreases to 25.00% analyzing the 100 m swimming event, and remained similar over the longer distances events. Contrarily, the Powerskin X-Glide Full® was used for 37.50% of the swimmers in 50 m swimming event, and it increased to 62.50% in the 100 m freestyle. This value remained similar over distances up to 1500 m. The maximum value of wearing reached by the LZR Racer Full® was 25.00% in the 400 m, being less used in the other swimming events, even reaching zero values in the 50 m and in the 1500 m events. DISCUSSION: The distribution of swimsuits wearing found in this study leads us to speculate that the Jaked01 Full® was preferred for the shorter distances and Powerskin X-Glide Full® was the choice for longer distances. The LZR Racer Full® was the least suit used and thus it seems it is not a preference for freestyle swimming events at this specific competition. These results seem to demonstrate that swimmers have some preferences regarding swimsuit type according to the distance of the swimming event. REFERENCES: Marinho DA et al. Lecture Notes in Computational Science and Engineering – CFD for Sport Simulation. Berlin: Springer. 2009.

P-083

Effect of Subjective Effort on Stroke Timing in Breaststroke Swimming

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INTRODUCTION: Competitive swimmers require the capacity to change swimming speed to control their output. Nevertheless, controlling their own motion is difficult for athletes. They attempt to control their own motion depending on subjective sensations. This study examined the relation between stroke motion and subjective efforts during breaststroke swimming (BR) in comparison with front crawl swimming (FC). METHODS: In this study, 22 well-trained college swimmers participated after giving their consent. Eight 25-m swim trials were conducted, consisting of two styles (FC and BR) and four levels of subjective effort. The levels were four steps from 70–100% effort with the same clearance for one fs maximal effort. The swimming velocity (SV, m/s) was calculated with each swimming record. The stroke rates (SR, strokes/min) were calculated from videotaped data of the swimmers. A second camcorder was placed underwater to record the swimmers for at least one complete stroke cycle, supporting analyses of the stroke phases (divided into three phases). Data were presented as mean ± standard deviation (SD). A stroke × grading level (2 × 4) repeated measures ANOVA was used to assess the significance of changes with grading level between strokes. Tukey fs post hoc test was used. RESULTS and DISCUSSION: A significant positive correlation was found between subjective effort and SV. The regression equations of FC and BR were, respectively, Y=0.67X+0.335 ($r=0.99$, $p<0.01$) and Y=0.42 X+0.587 ($r=0.97$, $p<0.01$). Increasing and decreasing the swimming velocity depends remarkably upon SR, not only for FC but also for BR. However, a significant interaction ($p = 0.011$) was found for SV. No significant interaction ($p = 0.821$) was found for SR. Both strokes have the same ratio of SR increase as stepping up the subjective effort, but not the same ratio of SV increase. Results show that the degree of SV increase by SR increase in BR is less than in FC, which might be attributed to technical characteristics: the difference between the alternate arm stroke in FC and in the simultaneous arm stroke in BR. CONCLUSION: In conclusion, increasing and decreasing the swimming velocity depends remarkably upon SR, not only in FC but also in BR. However, the degree of the SV increase by the SR increase in BR is expected to be less than in FC. These results suggest that changing SV with subjective effort in race and training is available as a difference of style.

P-084

Technical and Physiological Changes During Continuous vs. Intermittent Swims at and Above Maximal Lactate Steady State

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INTRODUCTION: Most endurance training sessions are prescribed using intermittent exercise, which allow maintaining higher intensities with the same metabolic condition. In swimming, stroke technique (i.e., stroke rate - SR and stroke length - SL) and physiological potential may equally contribute to performance. When exercising above maximal lactate steady state (MLSS), a significant reduction in SL (Dekerle et al., 2005) has been found. Therefore, this study aimed to verify whether MLSS determined using continuous (MLSSc) or intermittent (MLSSi) protocols represent a boundary above which not only physiological but also technical changes occur. METHODS: Thirteen endurance swimmers (23 ± 9 yr) performed four to eight 30-min sub-maximal tests, to determine the MLSSc and MLSSi (12 x 150 s with 30 s of passive recovery). The time to complete 5 stroke cycles was used to calculate one SR value per 100 m. SL was calculated as the ratio between speed and SR. The blood lactate, SR, and SL were analyzed at minute 10 and 30 of each test. RESULTS: The speed at MLSSi (1.17±0.09 $m.s^{-1}$) and MLSSc (1.13±0.08 $m.s^{-1}$) were significantly different (3.2%) while the blood lactate concentration was similar (4.3±1.1 and 4.4±1.5 $mmol.L^{-1}$, respectively). SR increased during MLSSi (32.5±3.2 and 33.8±3.2 $cycles.min^{-1}$, 3.9%), 102.5% MLSSc (32.0±3.7 and 34.2±3.6

cycles.min^{-1}, 7.0%) and 102.5% MLSSi (33.8±3.9 and 35.1±3.9 cycles. min^{-1}, 3.9%). SL decreased during MLSSc (2.22±0.31 and 2.14±0.30 m.cycle^{-1}, 3.6%), MLSSi (2.20±0.27 and 2.11±0.28 m.cycle^{-1}, 4.9%), 102.5% MLSSc (2.19±0.32 and 2.05±0.31 m.cycle^{-1}, 6.3%) and 102.5% MLSSi (2.17±0.28 and 2.08±0.29 m.cycle^{-1}, 4.1%). SR and SL changes from minute 10 to 30 of the exercise were greater during 102.5% MLSSc when compared to MLSSc. There was no significant correlation of the % change in [La] with changes is SR and SL. DISCUSSION: It is concluded that swimming technique is changing over time when swimming not only above but also at MLSS, thus in both continuous and intermittent conditions, despite a steady state in blood lactate concentrations. However, these changes seem to be more pronounced at continuous condition. The changes in stroke technique can be dissociated from the changes in blood lactate concentrations using intermittent swimming. REFERENCES: 1. Dekerle J, Nesi X, Lefevre T, Depretz S, Sidney M, Marchand H, Pelayo P. Stroking parameters in front crawl swimming and maximal lactate steady state speed. Int J Sports Med 2005; 26: 53-58

P-085

The Relationship of Arm-Stroke Index to some Physical Characteristics and Performance in Swimming

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INTRODUCTION: The aim of this study was to examine the relationship of the arm-stroke index (ASI) to some physical characteristics and performance in swimming. METHODS: The study was conducted on 36 (17 male age of; 14.6±2.1, height(cm); 167.7±11.4, weight(kg); 59.2±10.5 and 19 female age of; 14.8±1.9 height(cm); 159±7.5, weight(kg); 52.2±7.4) competitive swimmers. The subjects swam four different styles (Freestyle [FR], backstroke [BA], butterfly [FY], breaststroke [BR]) for 100 meters at their best speeds, with 15 minutes in between. for each style, the ASI was calculated by dividing the number of arm strokes by the swimming velocity in m/s. The relationship between the variables was studied through correlation analyses (Spearman). The Mann- Whitney U test was used to compare male and female swimmers. The Friedman test was used for differences between different swimming styles and Wilcoxon was used for the post-hoc evaluation. RESULTS: The hand length (cm), arm length (cm) and the hand grip (kg/f) values of male and female swimmers were found 18.6±1.3 and 18.2±1, 66.6±4.9 and 64.9±3.6, 32.8±10.2 and 24.8±5.6 respectively. Important significant correlations of varying degrees between ASI and the physical characteristics of height (in males; r(FR)= -0.83, r(BA)= -0.84, r(BR)= -0.89; [p<0.001]), weight (in males; r(FR)= -0.96, r(FY)= -0.84, r(BR)= -0.84, in females; r(FY)= -0.78; [p<0.001]), the lengths of the arm (in males; r(BA)= -0.81, r(BR)= -0.83; [p<0.001]), hand grip (in males; r(BR)= -0.80, in females; r(BA)= -0.79; [p<0.001]). A significant decrease in ASI with age in both sexes was observed (p<0.01). Similar relationship was observed between ASI and swiming velocity (in males; r(BA)= -0.88, r(FY)= -0.86, in females; r(FR)= -0.82, r(FY)= -0.87, r(BR)= -0.86; [p<0.001]). DISCUSSION: This study shows that certain physical characteristics effect ASI, and that development of ASI is reflected in swimming velocity. It is important to note here that the mechanical effect of leg kicking must not be overlooked. Attention paid to these points in designing the training programs of competitive swimmers will play a positive role and help increase their performance levels.

P-086

Effects of Aerobic and Anaerobic Training on Blood Nitric Oxide Levels and the Role of Gender

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The positive effects of aerobic exercise on the nitric oxide is known, but the effects of nitric oxide on anaerobic training and on the role of gender is not clear. Therefore, in this study, aerobic (swimming group) and anaerobic (volleyball group) training effects on blood nitric oxide levels and the role of gender in this effect were investigated. In this study; participants between the ages of 20-25 and have similar physical characteristics, from swimming as a aerobic group; 8 female and 11 male athlete, from volleyball as a anaerobic group; 8 female and 11 male athlete and as a control group that does not do regular exercise have 8 female and 11 male were included to the study. Wingate test and the lactate minimum speed (LMS) test was applied the volunteers. For the nitric oxide analysis from venous blood, cadmium is used as the reductor to 'Griess method' has been identified with. Lactic acid analysis was determined by electro-enzymatic method for lactate minimum speed. Data were analyzed using the SPSS 11.0 statistical program, significance as p value <0.05 were used. Basal serum nitric oxide levels in male aerobic group was higher from control group (p <0.05) and anaerobic group (%11.4). Basal serum nitric oxide levels for females; no significant differences were found between the aerobic, anaerobic and control group (p> 0.05). But aerobic group's basal serum nitric oxide level was bigger from the other two groups. There were no significant differences found between male and female groups at basal serum nitric oxide levels and there were no significant relationship between basal serum nitric oxide levels and lactate minimum speed in all group. In male and female's; aerobic group lactate minimum speed were higher than control group (p<0.05), peak power and mean power of anaerobic group were higher than aerobic group (p<0.05). As a result; positive effect has been found on the blood serum nitric oxide levels with regular aerobic exercise training at significant level in males, these effect not the same for females. There were no significant effects of anaerobic training on blood nitric oxide levels.

P-087

Analysis of the Shots According to Set Playing (6-6) Position in Waterpolo at European B Waterpolo Championships in Lugano 2009

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INTRODUCTION: The aim of the present study was to analysis the shoots according to set playing (6-6) position in waterpolo matches at 2009 European Waterpolo B Championships in Lugano. METHODS: Therefore totaly 14 waterpolo matches including 10 teams shoots analyzed with Waterpolo Match Analysis Program (WP_Pro_Analiz, Izmir-Turkiye, 2009), PC using statistic software program SPSS for Win, release 11.0.0 – Standart Version (Copyright© SPSS Inc., 1989-2001) and excel program. The following parameters analyzed for the shoots; the ending point of the shoots in the goal, fake number of achieved shoots, preliminary position of the shoots and the shoots distance achieved from the goal. RESULTS: From the important findings of the analysis, the % 34.1 (157 shoot) of the total 460 shoot ending at the left down side in the goal, the % 30.4 (140 shoot) of the total 460 shoot achieved from the position 3 (P3) but only % 19.3 (27 shoot) scored of the total 140 shoot from this position (P3), the % 41.5 (191 shoot) and % 33.9 (156 shoot) of the total 460 shoot achieved with no fake and one fake respectively, the % 50.7 (233 shoot) and % 21.5 (99 shoot) of the total 460 shoot achieved from set (6-6) position shoot

and fast break shoot respectively, the % 10 (46 shoot) of the total 460 shoot achieved from the center position, the % 9.6 (44 shoot) and % 8.3 (38 shoot) of the total 460 shoot achieved with cross-pass shoot and faul shoot respectively and the last important finding the % 59.1 (271 shoot) of the total 460 shoot achieved from 5-7m away from the goal. DISCUSSION: The present study provided effective information on the achieved shoots in the waterpolo games and also the findings is usefull to the coaches for different game strategies, usefull for the goalie and the field players for whom specialization for the shoot.

P-088

Identification of a Bias in the Natural Progression of Swim Performance

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The longitudinal progression of athletic records has been described by best fit curves which can be used to extrapolate future athletic performances. Any subsequent signifi-cant deviations from these curves would suggest compelling evidence of cataclysmic changes introduced into the sport. We evaluated recent elite swim performances to de-termine if bias can be identified within competitive swimming. Predictions of the 2008 Olympic swimming competition were calculated for each event and compared to actual performances. Results indicate a bias existed during the 2008 Olympic Games (and not in earlier games) such that performances were faster than predicted. Speculation of the causes of this observation include but are not limited to new swim suits, ergogenic aids, better training, and improved technique.

P-089

Swimming Performances of Japanese Masters Swimmers

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INTRODUCTION: Today, a wide variety of people participate in Masters swimming. In some studies, age- and gender-related differences in the performance of Masters swimmers had been discussed. However, the relationship between the swimming performance and the swimmer's training status is not clear. The purpose of this study is to clarify the swimming performances of Masters swimmers in relation to age, gender, training status and swimming career. METHODS: Subjects were 187 male (40.5 ± 9.6 yr) and 163 female (43.0 ± 10.0 yr) Japanese Masters swimmers, who participated in Swimming Science Clinic held in Tokyo Tatsumi International Swimming Pool. The swimming performance was determined by 10-min swimming test (T-10). During T-10, the stroke count for each 50 m was measured. The subject's daily training duration and mileage, weekly training frequency, and swimming career were surveyed by questionnaire. All the data were compared between gender, and between each 5-yr age group. The T-10 result was subjected to regression analysis with age, weekly training mileage, swimming career and average stroke count. RESULTS: The results of T-10 and the answers from the questionnaire showed few significant differences between gender and between each 5-yr age group. The mean results for men and women were, respectively, as follows: T-10, 522.2 ± 91.8 and 490.9 ± 73.3 m; daily training duration, 1.2 ± 0.4 and 1.2 ± 0.4 hr; daily training mileage, 1722 ± 767 and 1659 ± 665 m; weekly training frequency, 2.6 ± 1.3 and 3.3 ± 1.3 per week; swimming career, 10.7 ± 10.3 and 9.7 ± 9.1 yr. From the regression analysis, the results of T-10 was found to have correlations with weekly training mileage and stroke count (r = 0.45 and -0.63 in men, r = 0.45 and -0.49 in women), and relatively weak correlations with age and swimming career (r = -0.20 and 0.22 in men, r = -0.25 and 0.28 in women). DISCUSSION: The results of this study suggested that the swimming performance declines as aging advances. However, the swimmer's training status seems to make more positive effects on the performance than that decline. Also, the swimming career could have some effect on swimming performance. The negative correlation between the results of T-10 and average stroke count suggested that an efficient stroke technique is important to improve swimming performance. ACKNOWLEDGMENTS: We thank Mitsumasa Miyashita, the former chairman of the Medical and Scientific committee of Japan Swimming Federation.

P-090

Tendencies in Natural Selection of Qualified Young Swimmers

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INTRODUCTION: High level results in modern sport require the great physical and psychical efforts from young athletes. Some specialists offer to conduct the early orientation for children with usual abilities and gifted young ones. This problem has difficulties not only in search of such criteria but also in some social and moral aspects. Aim of this study was to find out facts of change in young swimming leaders, and to discover the reasons of this replacement. METHODS: We compared the data of two investigated young swimmers contingents, which optimal age for the best achievements came on the 1990s and on the first decade of 2000s. In total 210 girls and 216 boys aged 12-19 years were surveyed. We investigated testing data: 1) anthropometry and definition of biological age; 2) bio-energetic parameters and functional abilities of swimmers in swimming flume. Biological age (BA) defined by a method of the author (T.S.Timakova, 1986, 2006). Differs between chronologic age (CA) and BA distributed all swimmers over five groups: (R1, R2, N, À1; À2). The investigative data were processed by means of standard statistic methods. The classification and factor-typological description of objects were used as well. RESULTS: Comparison of 1990s swimmers contingent by the types of biological development showed the definite tendencies of age allocation. But only some athletes of younger ages moved forwards in the following years. Particularly it relates to the contingent of girls. At the 2000s swimming generation the shift towards increase of candidates age for national team selection was shown. The most of 15-16 years swimmers differed by signs of their age norm development. But at the next ages the number of retarded swimmers was increased in both sexes. In order to determine the reasons of young leaders change with the years we used 14-aged athletes classification in all volume of testing data. The different states of swimmers singled out classis were obtained. Two main reasons explain the character of leading swimmers change at different age groups. One cause is in short-term advantage in ontogenesis for a part of swimmers. The other reason pertains to using of premature intensive training program for swimmers with more complicated variants of age development. CONCLUSION: The need of studying characters of age development in young swimmers was revealed. It allows to find the peculiarities in training process and to define the optimum age of the best achievements demonstration.

P-091

Tethered Swimming as an Evaluation Tool for Arm Strength Imbalance

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INTRODUCTION: Tethered swimming force is related to performance1 and can be measured with high reliability[2]. The feasibil-

ity to measure force variations during single arm strokes and identify any imbalances during swimming was examined by the present study. METHODS: Eight swimmers (age:14.7±1.4 yrs) performed a series of tethered swimming tests: 15 s using full stroke (SW), 15 s using arms only (ARM), five strokes using the right and five using the left arm only (1ARM-R, 1ARM-L). The force for each arm stroke was measured for 10 cycles during the SW and ARM and during five strokes of the 1ARM-R and 1ARM-L tests, applied at maximum intensity. The tethered force was recorded by a piezoelectric force transducer connected to an A/D converter system (MuscleLab, Ergotest). A trigger was used to manually insert a signal synchronised with force recordings into the system, and separated the arm-strokes. The hand-grip strength was also evaluated with the right (ISO-R) and the left arm (ISO-L). RESULTS: The test-retest reliability of force per arm-stroke measurement and the validity of arm-stroke separation was verified (ICCreliability=0.98, ICCvalidity=0.94, $p<0.05$). Mean force of 10 strokes with the right (R) and left (L) arm during the SW was higher compared to ARM test (SW, R: 95.1±18.3, L: 97.0±20.3 N, ARM, R: 69.4±9.9, L: 71.3±12.9 N, $p<0.05$). Mean force of five strokes during 1ARM-R and 1ARM-L was similar to ARM (1ARM-R: 69.4±9.5, 1ARM-L: 66.2±10.3 N, $p>0.05$) Right and left arm tethered forces were no different within each test and were highly correlated between tests ($r=0.80$ to $r=0.92$, $p<0.05$; exception of ISO-R with ARM-R, $r=0.64$, $p>0.05$). ISO-R was higher compared to ISO-L (34.4±7.9 vs. 31.8±5.8 kg, $p<0.05$) and both correlated with 1ARM-R and 1ARM-L respectively ($r=0.80$ and $r=0.91$, $p<0.05$). DISCUSSION: Tethered force measurement in separate single arm strokes during swimming may be a valid, easy and useful procedure to identify imbalances between arms. These imbalances may not be similar to those observed after on land force evaluation. REFERENCES: 1. Kjendlie, P.-L. and Thorsvald, K. (2006). A tethered swimming power test is highly reliable. Portuguese Journal of Sport Sciences, 6(S2): 231-233 2. Taylor S, MacLaren D, Stratton G, Lees A. (2003). The effects of age maturation and growth on tethered swimming performance. In J.C. Chatard (ed), Biomechanics and Medicine in Swimming IX. Saint-Etienne, France, Publications de l' Universite de Saint-Etienne, pp. 185-190.

P-092

Blood Lactate Responses During Interval Training Corresponding to Critical Velocity in Different Age-group Female Swimmers

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INTRODUCTION: During interval swimming at intensity corresponding to critical velocity (CV) the blood lactate concentration increases progressively in adult and young but not in children male swimmers.1,2 There are no reports for lactate responses in female swimmers. The purpose of the study was to examine the lactate responses of female swimmers when swimming at CV. METHODS: Three groups of female swimmers, 8 children (C), 11 young (Y) and 7 adults (A), (age, C: 10.4±0.6 yrs, Y: 13.1±0.4 yrs, A: 19.9±4.4 yrs) were timed in distances of 50, 100, 200, 400 m. The slope of the time vs. distance relationship was calculated to express CV. In a following day swimmers of Y and A groups performed a 5x400 m, and swimmers of the C group performed a 5x300 m training set aiming to maintain CV. Blood lactate, RPE and RPE to La ratio were determined after each repetition. RESULTS: Critical velocity of Y and A was higher compared to C group (C: 0.962±0.05, Y: 1.168±0.09, A: 1.217±0.05 m/s, $p<0.05$) but was no different between Y and A groups ($p>0.05$). The average velocity (AV) during the training set corresponded to 101±2, 98±3 and 98±3% of CV and was similar with the CV (AV, C: 0.967±0.05, Y: 1.147±0.08, A: 1.189±0.06 m/s). Blood lactate concentration during the training set was not changed after each 400 m repetition in all groups and was not different between groups (range of blood lactate, C: 4.1±1.1 to 4.9±1.2 mmol/l; Y: 4.4±1.3 to 5.1±1.6 mmol/l; A: 3.5±1.2 to 4.1±1.6 mmol/l; $p>0.05$). RPE and RPE to La ratio were not different between groups and were increased after the second and third 400-m compared to the first repetition respectively ($p<0.05$). DISCUSSION: Female swimmers within the age range of 10 to 19 years old, maintain CV in a long duration interval training set with steady-state lactate concentration and within a range lower than that reported for male swimmers.1,2 The longer duration of the standard distances (50, 100, 200, 400 m) used for CV calculation or inherent differences between genders may account for the differences. REFERENCES: 1. Fillipatou E, Toubekis A, Douda H, Pilianidis T, Tokmakidis SP. (2006). Lactate and heart rate responses during swimming at 95% and 100% of the critical velocity in children and young swimmers. Port J Sp Sci, 6(S2):132-134. 2. Ribeiro LF, Lima MC, Gobatto CA. (2008). Changes in physiological and stroking parameters during interval swims at the slope of the d-t relationship. J Sci Med Sport, doi:10.1016/j.jsams.2008.10.001.

P-093

Predicting Performance Using Critical Swimming Speed in Young Swimmers

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INTRODUCTION: Predicting performance by a two-parameter model has been applied to marathon runners, rowers and cyclists, but there is still a gap on research in swimming. Therefore, the aim of the present study was to compare the actual performances in 200 m, 400 m, 800 m and 1500 m with the performance predicted by critical swimming speed (CSS) of a two-parameter mathematical model with different distances combinations in young swimmers. METHODS: Eleven young swimmers (Age: 14.3 ± 0.5 years) of national competitive level have joined the study. Maximal free-style swimming trials were conducted for the distances of 200, 400, 800 and 1500 meters (randomized order). Each distance was predicted by all the possible combinations of two distances to compose the linear regression equation between distance and time values. The level of agreement between the actual performance and the predicted performance obtained by three possible combinations for each distance was identified using Bland and Altman analysis. RESULTS: Predict performance in young swimmers through CSS by a two-parameter model in training condition lead to inaccurate values despite the good level of agreement of some combinations of distance, since any difference in the performance value may represent a victory or a defeat in swimming events. (best level of agreement for 200m = bias 9.9s, limits -10.4 to 30.3s (400-1500m); 400m = bias 7.1s; limits -22 to 7.8s 200-800m); 800m = bias 1.9s, limits -27 to 30.9s (400-1500m); 1500m bias 7.5s; limits -64.6 to 79.7s (200-800m)). DISCUSSION: Interesting results were obtained with adults engaged in competition situation. However, predicting performance by CSS in training situation does not seem to be accurate for young swimmers, probably because it is not possible to provide motivation similar to the competition situation. Competitive experience may also have influenced this result. Despite the limitations related to predict the CSS from the mathematical model of two parameters, as used in the present study, we can observed that this is still the easiest way to predict the CSS. REFERENCES: 01. Dekerle, J, Brickley, G, Sidney, M and Pelayo, P. (2006) Application of the critical power concept in swimming? Portuguese Journal of Sport Sciences. Biomechanics and Medicine in Swimming X., 6 (2): 121-124.

P-094

Competition Specific Diagnostics and Results for Elite Water Polo Players

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INTRODUCTION: In elite water polo there are certain special abilities, which are very important to achieve success during a match. Increasing importance is given to some game-related parameters such as the maximal throwing velocity, the maximal vertical jump height and the cyclical and noncyclical movements of the legs. For screening these abilities a water polo specific test battery was carried out with German elite and junior national squad members. METHODS: 15 male water polo players of the German elite and junior national squad (MW: 16.4 ± 3.0 yrs; 184.5 ± 9.2 cm; 84.0 ± 12.5 kg) participated in the study. The athletes performed four water polo specific test procedures. For measuring the cyclical movements of the legs (CM) the athletes had to carry 1/8 of their body weight above the water surface as long as possible, performing only the "Eggbeater Kick". For testing the noncyclical movements of the legs (nCM) two balls were installed in the upper two corners of a water polo goal and the athletes had to touch both balls alternately as often as possible within 60 seconds (s). Maximal throwing velocity (TV) was measured during a power shot with 5m distance to the goal with a sports radar gun. For determining the maximal vertical jump (J) ability a modified jump-and-reach test was conducted. The athletes started in a horizontal position on the water surface and tried to reach the highest possible point on a scale. RESULTS: The results of the testing procedures were: CM 23.80 ± 7.13 s; nCM 75.87 ± 11.26 jumps/60 s; TV 68.53 ± 4.82 km/h; J 155.87 ± 8.61 cm. Positive correlations between the results of the tests were only found between the jump height and the cyclical and the noncyclical movements of the legs (J:CM r = 0.65, p < 0.01; J:nCM r = 0.86, p < 0.01). DISCUSSION: It could be shown that there exists no correlation between maximal throwing velocity and maximal jump height. Our results are in accordance with the literature (Feltner 1994) indicating that a high ball velocity not only depends on a high vertical reach. The throwing velocity during a water polo match is affected by many more factors. However, the individual results are compared to the collected mean values and specific training recommendations are given to the coaches too increase these abilities to achieve greater success. REFERENCES: Feltner, M.E. (1994). 3D Kinematics of the throwing arm segments during a penalty throw in water polo. ASB Proceedings, 1994.

P-095

Developing Competence and Swimming Technique Through Teaching from an Aesthetic Learning Perspective

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INTRODUCTION: This is a qualitative pilot study of teaching and aesthetic learning processes in water sports with physical education students at Department of Exercise and Sport Sciences. The study presents an outline of a phenomenological, didactical theory that through an aesthetic learning approach with particular emphasis on body awareness, play, narratives and the use of metaphors suggests a practice that not only develops technical swimming competence but a much broader range of competencies: personal, social, practical wisdom/phronesis (1). METHODS: Video recordings and observations of Physical Education students during the teaching and learning process lead to first-person narratives (2)(3) and auto-ethnographic tales (4) from the students as well as the teachers perspective. The students keep a logbook which they update, not as a training journal but as phenomenological, experiential descriptions, after each lesson. Qualitative in depth interviews related to selected passages of video recordings and the students log books are performed. RESULTS: The embodied teaching and learning approach (5)(6) performed in this study points out alternative ways of teaching aquatics and reveals some learning opportunities that have not yet been described in an aquatic context. As a result of this approach the students develop a more noticeable body competence: an increased body awareness and consciousness of the relationship between bodily experience and the water. Moreover they also gain greater confidence while being in the water under different circumstances, submerged and at the surface, immobile and in movement. On another level, as future PE teachers and swim teachers, they initiate a professional development of phronesis, which goes hand in hand with a growing consciousness of the importance of that same concept. REFERENCES: 1. Aristoteles (1976): The Ethics of Aristotle, The Nicomachean Ethics, Penguin, Hammondsworth. 2. Polkinghorne D. E. (1988) Narrative Knowing and the Human Sciences, State University of New York Press. 3. Ricoeur, P. (1984) Time and Narrative (vol. 1). The University of Chicago Press. 4. Sparkes, A. C. (2002) Telling tales in sport and physical activity: A qualitative journey. Champaign, IL: Human Kinetics. 5. Bresler, L. (ed.) (2004) Knowing Bodies, Moving Minds: Towards Embodied Teaching and Learning. London: Kluwer Academic Publishers. 6. Schilhab, Juelskjær & Moser (eds.)(2008) Learning Bodies, Danish School of Education Press.

P-096

The Swimming Ability Of Primary School Children: Achievement Of Desired Competence Goals

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INTRODUCTION: The teaching of swimming is compulsory in Norwegian primary schools. The national primary school curriculum does not specify either the number of hours or the distribution of content, thus a wide variety of teaching solutions are chosen. The national curriculum does however, site the competency goal of swimming 200m as the desired outcome by the end of grade 4 (10 yrs of age). The aims of this study are; a) to determine the achievement rate for this competency goal, b) to compare two sub-groups whose instruction is distributed differently while receiving the same volume of instruction, and c) to compare these groups to a group who receive supplementary training units, i.e. who have a greater volume of instruction. METHODS: Children (7 to 13 yrs of age, n=219) from a local school district were tested using the criterion model of 200m (roll out, 100m on front, rest 3min, 100m on back). However, as many as 93% of all children tested did not reach this goal. Thus, an easier goal was introduced: 12,5m, rest, 12,5m. The results in this study are largely based on this latter test. RESULTS: None achieved the easy goal after grade 2. Only 65% achieved it after grade 3, 67% after grade 5, 75% after grade 7 and 81% after grade 8. The children who started swimming instruction in grade 2 had a slightly better outcome after grade 7 than those who started in grade 3, however it was not statistically significant. Children receiving supplementary instruction had a significantly ($p<0.05$) better performance after grade 7. CONCLUSIONS Most children do not achieve the desired goal by the desired school age. Explanations can be: A) The number of hours of instruction is not enough, B) The program should be started earlier, C) The quality of instruction is not good enough. Children who started

earlier seemed to have an advantage over those who had a postponed start. However, the difference was not significant and thus this study should be followed up. Lastly, observation of instruction and interviews with the teachers involved would suggest that much can be achieved by raising the level of quality of instruction. REFERENCES: Swimming and lifesaving education (2008), The Directory of Education, Norway.

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The Swimming Ability of Primary School Children: The Influence of Volume and Distribution of Instruction

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INTRODUCTION: The teaching of swimming is compulsory in Norwegian primary schools. The school curriculum does not spesify the number of hours or the distribution. The curriculum does however, site the competency goal of 200m as the desired outcome by the end of grade 4. The aims of this study were, a) to determine how many children achieve the described goal, b) to compare two sub-groups whose instruction is distributed differently while receiving the same number of hours of instruction, and c) to compare the above named sub-groups to a group who received a supplimentary unit along the way, i.e. who have a greater volume of instruction. METHODS: When children from a local school district were tested using the criterion model of 200m (roll out, 100m on front, rest 3min, 100m on back), very few succeeded. A simpler test was introduced following the same pattern but with reduced distance and time of rest. Children from 7 to 13 yrs of age were tested. Children who start instruction in grade 2 were compared to children who start only in grade 3, using the t test for group differences. These children were also compared to a group who benefitted from a supplimentary unit of instruction, also using the t test for group differences. RESULTS: Fewer than 50% of the children achieve the desired goal. Even on the simpler test, none achieved the goal after grade 2. Only 60% achieved it after grade 3, 65% after grade 5 and 83% after grade 7. The children who started in grade 2 had a slightly better outcome after grade 7 than those who started in grade 3. The children who had the supplimentary unit of instruction had a significantly better performance after grade 7. DISCUSSION: In this sample, most children do not achieve the desired goal. The explanation may be a) the number of hours of instruction is not enough, b) the program should be started earlier, c) the quality of instruction is not good enough. Observation of instruction and interviews with the teachers involved would suggest that much can be achieved by raising the level of quality of instruction. CONCLUSIONS The children who started earlier seemed to have an advantage over those who had a postponed start. The group receiving more instruction, as expected, performed better than the others. REFERENCES: 1.Madsen Ø., Irgens P. (2008). Slik lære du å svømme. The Norwegian Swimming Federation. Bodoni Press, Bergen 2.Directory of Education, Ministry of Education (2008). Teaching swimming and life saving in pri

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Analyses of Instruction for Breath Control While Swimming the Breaststroke

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INTRUDUCTION: One of the difficulties for developing good swimming technique is how to control breathing. Breath control is important for acquiring other swimming skills though it is not clear what the trigger for inhalation is while swimming. It is the purpose of this research to make clearer what the important factors are to prevent unwilled-drinking while swimming. METHODS: We explained the purpose and methods of this study to the seven subjects voluntary participated, who were healthy university students, and informed consent was obtained from all of them. We conducted the experiment in a swimming pool. One pressure sensor was placed inside the nasal passage and another was placed in the mouth. Intranasal and oral cavity pressures were measured at the same time. The data were analyzed to detect the pressure changes while three kinds of face positions,Case1: Nose placed above the water surface but a mouse was in the water, Case2: Nose and a mouse were both immersed into water, Case3: Face was rising up and immersing down into water simulated swimming the breaststroke. RESULTS: We verified that trained swimmers vary the amount of air blown out of the airways, nose and mouth, independently, by using pressure sensors attached in the nose and mouth simultaneously. In Case1 and Case2, the nasal and oral pressure curves showed peaks at same time in untrained subjects, but in trained, peaks appeared severally on nasal and oral pressure curves. Especially in Case3, the end of oral positive pressure was delayed 0.38sec (Average) from the end of nasal positive pressure in trained subjects, and in untrained subjects, the delayed time was 0.11sec (Ave.). These intervals between exhaling from the nose to exhaling from the mouth and this occurred while swimmers were facing up to the surface of the water. DISCUSSION: Trained swimmers breathe out from the nose while their faces are in water. In case of instruction for beginners, in order to prevent unwilled-drinking it is effective if the instructor has the learner pronounce "Mnn" with the nose, then once that is completed, pronounce "Pha" or "Pa" from the mouth to blow out. REFERENCES: 1. Wheatly, JR., Amis TC., Engel LA.(1991) Relationship between alae nasi activation and breathing route during exercise in humans. J. Appl. Physiol., 71(1): 118-124 2. Hideki Hara, et al. (2006)The function of nasal pressure for breathing in the breaststroke.Biomechanics and Medicine in Swimming, No.X, 137-139

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Evaluation of the Kinaesthetic Differentiation Abilities in Male and Female Swimmers

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INTRODUCTION: Events longer than 50 meters also require a good distribution of the effort during the swim. The control of the swim pace largely depends on the coordinative and sensory-perceptive abilities; kinaesthetic differentiation skills are required. The repeatability of two procedures aimed to measure the kinaesthetic differentiation abilities and the corre-lations between the differentiate performances and the best performances with respect to gender and to the amount of speed changes have been studied. METHODS: 8 male swimmers (15.38±1.84 years, 168.9±11.7 cm, weight 57.6±13.3 kg) and 10 fe-male swimmers (15.75±1.39 years, 167.8±6.0 cm, 57.9±8.8 kg) participated in this study. The kinaesthetic differentiation's abilities were evaluated by eight 25m front crawl swims at different paces (50% and 80% of the maximum) according to two pro-cedures: 8/1 and 8/4, performed in a single day and during four days running, respec-tively. The performance on the 25m was analysed. RESULTS: 8/1 and 8/4 procedures are reliable (ICC=0.77). Males showed little differences between the two procedures in the 25m (R=0.84 and 0.75 in the 50%max and 80%max of the 8/1, respectively; R=0.72 and 0.73 in the 50%max and 80%max of the 8/4, respectively, $p<0.05$). The females showed significant correlations only in the 8/4 (R=0.77 at 80%max, $p<0.05$). DISCUSSION: Both collecting the data in a single day and during four days running are reliable and re-peatable methods to measure the performances connected to the kinaesthetic differentia-tion abilities. Generally, at 50%max where due

to the high speed reduction it should be more difficult to regulate the pace, males achieve the best significant correlation. At 80%max, where the speed is close to the maximum, both males and females showed good significant correlations. This is in accordance with the literature that shows a lower degree of the differentiation abilities in females than males. REFERENCES: 1. Hirtz P (1988). Koordinative Fähigkeiten im Schulsport, Berlin: Volkseigener Verlag. 2. Invernizzi PL, Scurati R, Roione GC, Michielon G (2005). Analysis of kinaesthetic differentiation abilities in master swimmers during aquatic and terrestrial activities AIESEP 2005 Congress "Lifestyles: the impact of education and sport", Lisbon, 141.

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Swimming in Eyesight Deprivation: Relationships With Sensory-Perception, Coordination and Laterality

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INTRODUCTION: Keeping the control of the direction during the displacement is important in swimming, particularly for backstroke and open water events. Sensory-perception, coordination and laterality can have relationships to the ability in swimming straight. The aim of this study was to analyse the relationships among sensory-perception abilities, eyesight, coordination and laterality in preserving a straight swim during the front crawl (FC), the backstroke (BA) and the breaststroke (BR). METHODS: 28 young swimmers participated in this study (10.8±1.3 years, 146.2±11.3 cm, 37.7±8.8 kg, arms span 148.7±13.5 cm). The trajectory of the swim without the sup-port of visual feedback was evaluated in 25m FC, BA and BR (three trials per stoke). The swimmers' coordination and the leg dominance were evaluated through the a Sta-rosta's Coordination test. Hildreth's index showed the arm laterality and gliding tests were used to evaluate the swimmers' sensory-perceptive skills. RESULTS: No relationships between strokes were found in blind swimming. No relationships were found between the coordination and the deviations in blind swimming. Gliding and Dive-gliding tests are strictly related to the blind swimming (R=-044, p<0.01, both). The 96.4% of the subjects was right hand dominant (RH) and 66.6% of them was left leg dominant (RH-LL). In the blind BR, RH-LL compared to the right leg dominant (RH-RL) showed a significant better score (7.88±2.49 vs 9.88±1.90 points, p<0.05). No differences were found in blind FC and BA. DISCUSSION: In absence of eyesight information, swimmers mainly deviate to the right in FC and BR, to the left in BA, probably depending on the swimming technique and to the hand dominance. Starosta's test seems not to be useful alone to represent swimming coordi-nation, but shows the RH-LL dominance in about 70% of subjects. Gliding tests sup-port the relationship between sensory-perception and swimming management. RH-LL better manage the direction of swimming than RH-RL, supporting higher level of RH-LL performance than subjects with other kind of laterality. BR could be advisable to practice the balance during propulsive actions, better dealing with the control of the di-rection of swim displacements. REFERENCES: 1. Novàk J (1982). Swimming direction and visual control. In: Biomechanics and medicine in swimming. Champaign, IL: Human Kinetics, 345-347. 2. Oberbeck H (1989). Seitigkeitsphanomene und Setigkeitstypologie im Sport. Schorndorf: Hofmann Verlag, 173.

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Progression in Teaching Beginning Swimming: Rank Order by Degree of Difficulty

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"Teach first things first"! But what comes first? Where do we start? Also, children are different and no progression will suit all. However, it should be possible to a) agree on content and b) find a progression that suits a majority. Children 5-6 yrs of age (N=146) received 18 hrs of instruction, in small groups. A theoretical progression of 19 skills was created from the international literature, examining course content of leading educational organizations. A single head instructor coordinated all teaching. Evaluation of progress and recording of criterion success on the 19 skills was overseen by the same head instructor. The number of children succeeding on each skill was deemed a reflection of the degree of difficulty. The actual rank order of skills derived from these learners was correlated to the theoretical rank order using Spearman's rank order correlation. Rho proved to be 0.97. Among other results, all (paired) skills on the front proved easier than the corresponding skill on the back. Arguements are presented to defend retaining the theoretical rank order as well as arguements for adjusting the rank order. However, when individualising teaching, there seems to be an optimal progression for each child, albeit slightly different from one child to another. It was surmised that degree of difficulty may not be the only criterion to be used when creating a progression.

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The Validity of a Traditional 25m Test of Swimming Competence

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A universal definition of the ability to swim has yet to be agreed upon. There is however, growing agreement on the need to relate the content of swimming instruction to the causes of drowning. Yet some retain the notion that "how far" one swims is the most important criterion. Discussions rage about the number of meters, when in fact, this is not really the point. In a certain local setting (as elsewhere) a traditional definition of 25m as the sole definition of "can swim" with no additional criteria, has survived. A conceptual model (reported elsewhere) emphasizes broader competence. The operationalization of this conceptual model culminated in a combined test which included other elements but retained the same distance. This combined test was used as the criterion to test the validity of the traditional test. When these two tests were compared to one another, they were found to be dramatically different, thus measuring different qualities. Among children already declared able to swim by the traditional test, only 5.7% satisfied the conditions of the conceptual test. It was concluded that the traditional test was not a valid measure of the ability to swim.

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School Swimming - a Team Effort: An Intervention Study

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INTRODUCTION: A variety of factors affect learning. The importance of the total environment is typically under estimated. Parents and teachers often "send" or "take" children to lessons and then ignore both process and progress. The aim of this study was to create an intervention involving parents, teachers and school and to test it's effectiveness. METHODS: The intervention consisted of parent and teacher meetings with the Coordinator of Swimming for Lillehammer School District. Topics discussed were a) using tub, sink, shower, etc, at home i.e. 'homework' b) introducing swimming as a conversational topic at home and in the classroom, and c) how to assist children with goal setting. These activities was carried out by parents and teachers for a full school year. One year later, children exposed to the intervention were

colmpared to children not exposed. The data were tabulated using SPSS (16). The differences were quantified by use of the Mann - Whitney U test. RESULTS: A simple test instrument focused on confidence skills (breath holding on land, face under water, breath holding with head submerged, open eyes, retrieve an object from the bottom in chest deep water, float 6-8 sec.) showed that children who had been exposed to the intervention in Grade 2, not only possessed greater readiness at the onset of Grade 4 but achieved more during their 4th year. DISCUSSION: The effort involved in creating a team approach to school swimming, raising awareness and involving parents and teachers, was well worth the effort. By the end of Grade 4 children were very comfortable in the water and rapid progress demonstrated that a careful and exacting, sometimes slower early approach pays off later. The most fundamental skills are the most important and haste in acquiring stroking movements is counter productive. CONCLUSIONS Children exposed to the intervention performed significantly better than those not exposed, not only during the period of the intervention (one year) but for the entire following year. REFERENCES: 1.Langendorfer S.J., Bruya, L.D.(1995). Aquatic Readiness. Champaign, IL. Human Kinetics 2.Stallman R.K., Junge M., Blixt T.(2008). The teaching of swimming based on a model derived from the causes of drowning. Int J of Aquatic Research and Educ., 2(4), 372-382 3.Brenner R.A., Moran K., Stallman R.K., Gilchrist J., McVan J.T. (2005). Swimming ability, water safety education and drowning prevention. In: Bierens J.(ed), Handbook of drowning. Heidelberg: Springer, 112-116.

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Observation Skills in Learning processes – A didactic Challenge

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Students of exercise and sport and outdoors instructors need to be qualified in order to develop and lead activities in and on the water with different target groups .This makes it necessary to achieve observable "concrete competences" in the water, including the attainment of knowledge about one self and others while being active in water under different circumstances. Experiences with special focus on skills to observe and communicate when developing quality in the Learning Process of Swimming and Lifesaving Competences. Relations between the "non swimmer " , "water activities" and " child development aspects" are in focus . This is explored by asking questions such as : WHO – is the non-swimmer? WHAT – does the non-swimmer's behavior in water look like WHY – do you think this appears so? The project looks at observations skills integrated in the learning process FROM different perspectives, SUCH AS: look at two non-swimmers compare and describe – When they looks feeling safe,- How they are motivated for challenges,- Ways they react in positive communication,- if they show use full cooperation between the mass of water , body balance and movements . The main focus is intensive use of IT-and video to support communication and motivate reflection on praxis behavior. Some simple methods to analyze video with producing still pictures, reflection and feedback training and exchange of good advices among students in the learning process are presented. Hopefully this project will develop useful practical tools to help future swimming teachers in achieving relevant competences and motivate them to be curious about the experiences of the individual non-swimmer. The project offers answers to the question of how a study process can be organized to achieve this necessary PRACTICAL knowledge (the desired and necessary competences). The project is connected to TIES- Technology and Innovation of Educating swimmers. Leonardo da Vinci – Life Long Learning program. The poster will present brief examples from specific parts of the students course work processes with well known problematic challenges regarding basic competences in the water. The poster will present additional interactive examples where the visitor can try some observation skills in pairs.

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Infant Behavior During Aquatic Activities

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INTRODUCTION: Although the increasing interest, the research about infant swimming is quite rare. The interest around infants' behaviors during a swimming session allows characterizing or estimating physical demand and its responses to basic aquatic motor skills (Richards and Gibson, 2006). The aim of this study was to assess infants' behaviors during aquatic sessions. METHODS: The sample included 14 infants with 13.7±7.5 months-old and 7.71±7.54 months of background in infant swim programs. Sessions were conducted in an indoor swimming pool with 16 m length and 1 m depth. All had 30 min duration and were conducted by a specialized instructor. Parents accompanied the infant and helped the instructor on the proposed skills. All sessions were recorded with a video camera, placed away from the swimming pool to avoid significant changes in infant's natural behavior. The observation was made by three experts and corroborated by the Kappa index test. The registered dimensions were decomposed into several categories. "Motor behavior" and "affective-emotional" were the two main dimensions, along with a parents' behavior characterization. "Motor behavior" decomposed in "infant interactions", "displacements", "submersion" and "jumps". "Affective-emotions" dimension was decomposed in "infants' look direction" and "infants' facial expression". Data were analyzed according to the percentage of occurrence frequencies in each dimension and categories. RESULTS: The motor dimension, "displacements" (61%), "interaction with other infants" (42.8 %) and "interaction with objects" (37.6%), were the most frequently observed behaviors. On the other side, other specific tasks as "submersion" or "jumps" only represented 4.6%. Regarding "affective-emotional dimension", the "infant look mainly directed to the objects" (28.8%), followed by the "look to their parents" (14.7%) were the main categories. "Indifference and passiveness" (10.5%) and "laughter" (14.7%) were also observed. DISCUSSION: One can speculate that the infants' behavior is often influenced by parents' experience in water activities. In the aquatic environment the infants' emotions are more camouflaged and hidden away from a "naked eye" because of the overwhelming atmosphere they are exposed to, while considering water a new and discoverable fountainhead. REFERENCES: 1.Richards JE, Gibson T. Extended visual fixation in young infants: look distributions, heart rate changes and attention. Child Development 2006; 68: 1041-1056.

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Imagery Training in Young Swimmers: Effects on the Flow State and on the Performance

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INTRODUCTION: Imagery training is the ability to develop mental images increasing human performances. Flow is one of the peak moments corresponding to a state of optimal experience that can be

measured through the Flow State Scale (FSS) questionnaire related to 9 fundamentals or dimensions (D1 to D9) in which Flow can be subdivided. This study aimed to observe the effects of a specific Imagery training on the Flow and on the swimming performance. METHODS: Sixteen young swimmers volunteered for the study: i. Experimental (13.0±0.53 years, 52.5±6.5 kg, 161±7 cm); ii. Control (13.25±1.04 years, 55.38±7.95 kg, 165±8 cm). Supplementing the swimming training during three weeks, Experimental subjects accomplished a specific mental training on the Imagery based on visualizing three images representing important phases of the front crawl. The FSS questionnaire was filled out by subjects before and after training as well as the performance on 100m front crawl stroke was surveyed. RESULTS: FSS was not repeatable for the D5 and D8 dimensions. In the other dimensions no differences were found in the Control, whereas a significant difference ($p<0.05$) was noticed in some answers of the Experimental subjects referring to the D3, D6, D7 and D9 dimensions. In the 100m front crawl stroke no differences ($p>0.05$) were found between Experimental and Control as well as between the pre and post training in the intra-group comparisons. DISCUSSION: The lack of the repeatability in D5 (concentration on the task avoiding distractions) is probably related to the young age of swimmers that could induce difficulties in the concentration. Flow state tends anyway to vary after the Imagery training, in D3 (clarity of targets) and in D6 (sense of control) in particular. Imagery training aided athletes in identifying a specific target in order to increase the motivation in reaching it. The negative trend in D7 (lack of the oneself awareness) and in D9 (the autotelic experience) probably depends on forcing a voluntary execution of the technical movement instead of automatic movements the Imagery training would have induced. An extended training for a longer period and with swimmers of different age is advisable in order to study effects on the swimming performance. REFERENCES: Csikszentmihalyi M (1990). Flow. The Psychology of Optimal Experience. New York: Harper and Row. Jackson SA, Marsh H (1996). Development and Validation of a Scale to Measure Optimal Experience: the Flow State Scale. JSEP, 18: 17-35.

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Shallow or Deep Water for Settling in? A Study in children Aged 3 to 6 Years

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INTRODUCTION: Several studies and theories about swimming teaching methods refer to the best age for starting swimming learning the influence of aids on water first experiences. In a learn-to-swim program the question of what is the best environment condition in aquatic set-tling in arises. The choice could depend on the depth of the swimming pool of the sport facilities or on the teaching methodology. This study aimed to compare the out-comes of a settling in carried out in deep or shallow water in 3 to 6 years children. METHODS: Twenty-two children were selected according to age, anthropometric characteristics and swimming skills (no experience) then assigned to a learn-to-swim program aimed to a first experience and settling in practiced on shallow or deep water condition: SW, shallow water (4.8±0.7 years, 16.8±1.6 kg, 108±7 cm); DW, deep water (age 5.3±1.4 years, 17.2±3.4 kg, 110±11 cm). Sixteen classes 60-minutes long were attended by children practicing an open multi-lateral approach to maintain a high attention and mo-tivation and to achieve the maximum educational effect. The SW group moved into the deep water during the two last classes before the final evaluation of acquired abilities that was performed into the deep water. RESULTS: Children practicing the learning program in the deep water obtained a higher mean score, but not significantly different than the children having a shallow water settling in program ($p=0.20$). DISCUSSION: Contrasting guidelines come from the literature: according to DW advocates children have not to switch from a simplified situation (shallow water) to a more difficult one, starting again the way to settle in, whereas according to SW advocates children can practice in a simplified condition, with more stable supports and then with more dy-namic exercises. The little difference found between SW and DW could actually be due to the fact that SW have to better get acquainted to the new environment (as they experience deep water only twice) whereas DW children performed the test in the same situation they managed since the first class. However guided experiences both in shallow and deep water lead to similar results in approaching swimming baselines with no differences in the quickness or quality of learning. REFERENCES: 1. Langendorfer SJ, Bruya LD (1995). Aquatic readiness. Developing water compe-tence in young children. Champaign, IL: Human Kinetics. 2. Schmitt P (1992). Nager de la Découverte à la Performance. Paris: Vigot.

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The Role of Verbal Information about Sensory Experience from Movement Apparatus in the Process of Swimming Economization

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INTRODUCTION: In physical education, the way the information is transferred and received in the process of learning motor swimming activities determines the direct effectiveness of the process. METHODS: The assumption behind the experimental research was to assess the impact of verbal information transmitted by the researcher on the economization of effort. To do this three groups were created: (1) control; (2) experimental I; (3) experimental II. The first group performed movement tasks on the swim ergometer without verbal information, which could have prepared them to perceive sensory experience from the movement apparatus. In the experimental group I, while performing tasks on the ergometer, a verbal message was prepared, transferred and verified, so that the tested individuals could consciously prepare themselves for the information they were getting from the movement apparatus. The experimental group II, while performing identical tasks on the ergometer, received verbal information previously prepared and tested within the experimental group I. The measure of the economization was determined from the aggregate of heart rate frequency and rest time. RESULTS: Calculation of correlation coefficients proves the significance of the relationship between verbal information and effort economization. In the measurements we tested relevance on the confidence level, $p<0,05$. statistically relevant differences demonstrated effectiveness of effort after restitution (scientifically better in the experimental group; -4,10). DISCUSSION: Self control, which is a conscious act of positioning limbs in relation to one another, to the body, head, and hence the structure of muscle tension and their sequence, may directly affect the decrease of the physiological impact of the work. REFERENCES: 1. Arnold PJ (1988) Kinesthetic perception and sports skills: Ross S., Charett L. (ed.) Persons Minds and Bodies. University Press of Canada, North York, Ontario, 51-59. 2. Costill DL (1966) Use of a swimming ergometer in physiological research. Research Qartarly, 37: 564-565. 3. Strath JS, Swarz AM, Dawid R, Basset JR (2000) Evaluation of heart rate as a method for assessing moderate intensity physical activity. Medicine and Science in Sports and Exercise, International Life Sciences Institute, 465-469.

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The Informativeness of Field Tests and Laboratory Assessments in Forecasting the Actual Performance of Swimmers

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INTRODUCTION: Various methods can be applied in assessing the level of fitness and functional condition of athletes, as well as in forecasting their performance. Still the specific nature of the kind of sports is a significant factor in selecting tests and control exercises. Therefore the adapted tests, i.e. the tests when the load of movements corresponds to the specific character of the sports movements performed or the testing is carried out just by assessing competitive physical loads, are more suitable for assessing special fitness of athletes in all sports. The aim of the study was to compare the informativeness of field tests (research done in the swimming-pool) and laboratory assessments in forecasting the possible performance of athletes in the 50 m distance. METHODS: The sample was comprised of 12 swimmers (age – 18.63 ± 0.6 years, body mass – 72.6 ± 2.57 kg). First, each participant performed the tests in the water. The special field tests were meant to establish the indices of muscle power and anaerobic capacity, and the subjects performed a control 50 m freestyle swim the best they could. After two days the indices of relative muscle power (W/kg), anaerobic power, anaerobic capacity, anaerobic performance and functional indices of cardiovascular system were taken. RESULTS: The obtained results showed that well-trained swimmers, in comparison with the poor ones, had the highest values in muscle power, anaerobic power, anaerobic capacity and some cardiovascular indices, such as PWC170, more optimal values or relative indices such as velocity of adaptation to loads, ratio JT/RR of ECG. The results in vertical high jump test and relative muscle power showed weak correlation with the 50 m time swim. Relatively small values of correlation were found in the anaerobic power, and higher values – in the anaerobic capacity indices obtained during the laboratory tests. The highest values in correlation between the results in control swim and the assessed indices were obtained during the testing in field conditions. DISCUSSION: These indices are significant and should be used in doing laboratory research in the functional condition and level of fitness among swimmers. The sum total of indices registered with the help of the computerized ECG analysis program enables us to single out the elements restricting the working capacity of athletes as well as to provide individual recommendations about monitoring the training process.

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Evolution in Swimming Science Research: Content analysis of the "Biomechanics and Medicine in Swimming" Proceedings Books from 1971 to 2006

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INTRODUCTION: The aim of this study was to analyze the evolution of the swimming science research based on the content analysis of the "Biomechanics and Medicine in Swimming" Proceeding books from 1971 to 2006. METHODS: It was evaluated the content of all the 622 papers published in the Proceedings books of the Symposiums of Biomechanics and Medicine in Swimming. It was defined two main categories: (i) The "Aquatic activity" studied in each paper analyzed and; (ii) The main "scientific area" applied for the assessment. The main category "Aquatic activity" (including Competitive swimming; Water Polo; Synchronized Swimming; Diving; Hydrotherapy; Infant Swim; Head-out Aquatic Exercises; Fin Swimming; others). The main category "Scientific area" adapted from Clarys, (1996) (including Biomechanics; Psychology; Sociology; Pedagogy/Teaching; Biochemistry; Physiology; Thermoregulation; Hydrodynamics; Electromyography; Anthropometry; Equipments/Methodologies; Clinical Medicine/Traumatology; Interdisciplinary assessment). RESULTS: There was an increasing number of papers published within the period of time analyzed (ranging from 23 papers in 1971 to 145 manuscripts in 2006). The "Aquatic activity" sub-categories with more research done was the "competitive swimming" (ranging from 78.8% in 1971 to 100% in 1996). In the last decade there is a slight but increasing interest in "head-out aquatic exercises" (e.g., 6.9% in 2006; the second most studied aquatic activity). "Biomechanics" was the area of assessment most often (ranging from 27.3% in 1988 to 60% in 1979), followed by the "Physiology". Since 2003 it is verified an increasing number of "interdisciplinary assessment" manuscripts (e.g., 9.7% in 2003 and 21.4% in 2006, shifting from the third to second area of interest). DISCUSSION: In the 1971-2006 time frame there was an increasing interest in swimming science research. "Competitive swimming is the main "Aquatic activity, but there is an increasing interest in "Head-out aquatic exercises". "Historically, main interests are about "Biomechanics" and "Physiology" issues, but nowadays there is a trend for "interdisciplinary assessments". REFERENCES: 1. Clarys JP (1996). The historical perspective of swimming science. Foreword to the Biomechanics and Medicine in Swimming VII. In: Troup JP, Hollander AP, Strasse D, Trappe SW, Cappaert JM, Trappe TA (eds). Biomechanics and Medicine in Swimming VII, pp. xi-xxxiv. E & FN Spon, London.

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A Model for Raising Water Safety Awareness in a Developing Country: A Case Study from Tanzania

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INTRODUCTION: While it is known that a vast majority of drowning deaths occur in developing countries, accurate surveillance is difficult. The scope is poorly documented and thus underestimated, especially compared to malaria, HIV, etc. Given the underestimation of the problem, interventions are not common. The aim of this project is to suggest a model which might be applied similarly in other developing countries, to raise awareness and initiate interventions. METHOD: A survey identified the most well developed youth organization. The Scouts have been in Tanzania since 1913, with a nation wide infrastructure and local groups over the entire country. They are highly visible in most local communities. Discussions between the Tanzanian Scout Assoc., the Tanzanian Life Saving Society (TALISS), and the Norwegian Life Saving Association, led to a cooperative project and a curriculum was created for youth leaders. RESULTS: In June, 2009, seventeen Scout leaders participated in the first 3 day camp. The camp was staffed by both Scout and TALISS personnel. Basic swimming skills, CPR, non-swimming rescues and how to approach youth with relevant safety messages were covered. Three other efforts have since succeeded and interest is growing. The latest was a one day Water Safety Workshop held at the International School Moshi, Jan. 9, 2010. DISCUSSION: Other organizations now wish to cooperate in further activities. The 4th of the above mentioned courses also included the Tanzanian Swimming Association. The curriculum is being refined and plans are underway for applications for funding to train Head Instructors who would carry out the course at targeted at risk sites around the country. CONCLUSIONS: Close investigation of existing organizations and the use of personal contacts is the key ingredient to a net-working which can make such efforts possible. Use of local media is vital in raising

public awareness. In Moshi, Jan. 2010, it was also clearly demonstrated that local sponsors can be found to make such initiatives cost effective and affordable. Similar surveys might reveal other organizations with strong infrastructure and networking possibilities, in other countries or different local settings. REFERENCES: 1. Vervaecke H.,(ed) (2002). ILS World Drowning Report. The International Life Saving Federation. ILS HQ, Leuven, Belgium 2. Bierens J. (ed).(2005). Handbook of Drowning. Heidelberg: Springer

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Cognitive Profiles and Neuro-Motor Properties of Physically Active Masters Swimmers

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INTRODUCTION: Typical aging is associated with declines in executive cognitive processes; decision making, storing and retrieving information. Recent research shows that with very modest physical activity interventions, cognitive function is enhanced in previously sedentary individuals. However, no studies have examined the relationship between long term, high levels of physical activity and executive cognitive function in aging adults. METHODS: Subjects were 106 masters swimmers, MS, (45 men, 69 women) between 30-83 yrs of age grouped in line with normative data. All subjects were highly active (min. exercise 450 min/wk), and were administered the following tests: Letter Number Sequencing (LNS) assessing working memory capacity, Trails-B test assessing cognitive efficiency, Simple Reaction Time (SRT) and Choice Reaction time (CRT) for information processing speed, and Nerve Conduction velocity (NCV). Analyses included t-tests to compare performance between MS with general population (GP) norms (when available for the specific test), and bivariate inter-correlations between measures. RESULTS: Cumulative activity levels of the swimmers averaged 1236.2 ± 914 min/wk. Compared with the GP, MS had superior performance on the LNS measure of working memory capacity (LNS) for all age groups beginning with those older than 35 yrs. MS also had faster NCV compared with the GP in the 50-59 yr olds (MS = 59.5 ± 8.3 m/s; GP = 54.2 ± 13.0 m/s) and in the 60-69 yr olds (MS = 60.5 ± 7.8 m/s; GP = 51.7 ± 11.5 m/s). MS had similar NCVs in those older than 70 yrs and younger than 50 yrs. MS did not differ from population norms on the Trails-B, except the 65-69 age group (MS = 97.6 ± 30.3 s; GP = 67.1 ± 9.3 s) who were significantly slower than the GP. Population norms were not available for the specific reaction time test used in this study. Bivariate correlations indicated that LNS was significantly associated with SRT(r = -0.33), CRT (r = -0.32), age (r = -0.31), and Trails-B (r = -0.4). Trails-B was significantly associated with SRT (r = 0.32), CRT (r = 0.39), and LNS (r = -0.4). DISCUSSION: These results indicate that working memory, as measured by LNS, is superior in MS compared to the GP. Additionally, neuro-motor properties (NCV) which typically decline with aging are preserved in this group. These data indicate declines in cognitive ability, specifically working memory, may be attenuated by high levels of physical activity.

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Water Safety and the Environment: A Model for Developing Countries - A Case Study from Tanzania

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INTRODUCTION: The TALISS Swimming Club in Dar es Salaam, Tanzania, a member club of the Tanzanian Life Saving Society, practices drowning prevention by offering swimming and water safety lessons. They are keenly aware of the high drowning rate of developing countries including Tanzania, the risk of living along the coast, the lack of safe swimming facilities and the plight of their beaches, both public and private. The aim of this project was thus, to create a model which might be used in other developing countries, and other parts of Tanzania, to a) combine environmental and water safety concerns, b) to address the issue of access to safe swimming areas, c) to address the issue that while many learn to swim in pools, people drown in open water. It was hypothesised that voluntary cleaning of a local public beach could influence public behaviour. METHODS: Given the risk of living close to the sea, the policy decision has been made to teach swimming in the sea whenever possible. Courses offered in the pool rutinely end with several sessions in the sea. Coco Public Beach has long been popular but unsafe because of indescriminate throwing of trash. TALISS combines these circumstances in the "Clean Up Coco Beach" project. Children from the club and their leaders, wearing their club T-shirts, now routinely clean the beach. The conditions were so difficult at the start that the members were forced to wear gloves and shoes. RESULTS: The club has succeeded in creating it's own safe swimming area. Sustainability remains difficult however, trashing public facilities is endemic. The club routinely cleans first and swims after. While necessarily cleaning each time, the effort required has been noticably reduced. Beach users report that their behavior has changed. DISCUSSION: Watching children clean the beach has appeared to raise awareness. Adults have been observed to slowly change their habits. Some approach the children asking who they are and why they clean. A growing number have pledged support to the club and youth sometimes ask to join in the cleaning and even to join the club. CONCLUSIONS: The TALISS club members in their club T-shirts are highly visible and have clearly influenced public behavior. This kind of collective, voluntary action can change behavior. REFERENCES: 1. The International Life Saving Federation (2002). The ILS World Drowning Report. ILS HQ, Leuven, Belgium, Dr. H. Vervaecke, (ed). 2. TALISS Swimming and Life Saving Club, Minutes of meeting, Jan, 2009

P-115

A Social-Cognitive Investigation of the Coach-Created Motivational Climate and Coaching Behavior in Norwegian Youth Swimming

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INTRODUCTION: The ways in which coaches relate to their athletes, and the achievement standards they emphasize, have an impact on athletes' well-being. Thus, grounded in achievement goal theory (Nicholls, 1989), the purpose of this investigation was to examine how Norwegian swimmers perceived their coaches' behavior and the corresponding motivational climate, and how these influenced a range of well-being parameters (e.g., burnout, vitality, and positive/negative affect). METHODS: A total of 202 male and female Norwegian swimmers (ages 14-24) completed a battery of questionnaires (e.g., Motivational Climate Scale for Youth Sports, CBAS-PBS, Athlete Burnout Questionnaire, Subjective Vitality Scale, and the PANAS). RESULTS: We conducted a canonical correlation analysis to determine the multivariate association between the two sets of variables. The perceived motivational climate was the predictor variable. Athletes' perceptions of coaching behavior and a range of well-being parameters (e.g., burnout, vitality, and positive and negative affect) were the criterion variables. The multivariate relationship was significant, Wilk's $\lambda = .43$ $F(40, 360) = 4.7$ $p < .001$. The canonical function emerged with a canonical correlation, rci, of .70 (49 % overlapping variance) and a redundancy index of 30. DISCUSSION:

Consistent with earlier findings, athletes who perceived coaching behaviors that emphasized positive reinforcement, mistake-contingent encouragement, corrective instruction given in a positive and encouraging fashion, and proper technical instruction perceived a mastery climate. In contrast, coaching behaviors that emphasized punitive technical instruction were positively correlated with an ego climate. However, perception of a mastery climate was also positively correlated with coaching behaviors that emphasized non-reinforcement, punishment, and ignoring mistakes. Further, our findings indicated that there was a positive relationship between an ego climate and the three dimensions of burnout. We also found a positive relationship between a mastery climate, vitality, and positive affect. All coaches should, therefore, strive to create a mastery climate in youth sports that promotes athletes' well-being and optimizes their achievement motivation. REFERENCE Nicholls, J.G. (1989). The Competitive Ethos and Democratic Education. Harvard University Press.

P-116

Framework for Drowning Prevention based on the Haddon Matrix

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INTRODUCTION: Drowning is a leading cause of death worldwide. Injury prevention models and theories aim-ing to educate people might play a role in drowning reduction. Aim: To suggest a framework for drowning prevention interventions based on the Haddon Matrix (Haddon, 1980). METHODS: Three studies were under-taken; (1) a major literature review of quantitative research was obtained to identify potential risk factors of drowning, (2) qualitative content analysis was used to analyze publicly available drowning incident videos (n = 41), and (3) semi-structured interviews of individuals involved in drowning incidents (n = 34). Finally, the variables that were present in all three specific sets of data were synthesized to formulate a suggested prevention framework that might occur prior, during and after a drowning episode. RESULTS: Table 1 depicts the Haddon Matrix framework for developing drowning prevention interventions. DISCUSSION-CONCLUSIONS: Given that the role of a lifeguard is mainly preventive and that successful prevention would reduce the need for rescue and treatment, the proposed framework could play a vital role in accident prevention and safety promotion (pre-event). Water safety educators can emphasise the in-event issues to prepare aquatic profes-sionals and the general public to handle an emergency situation. Finally, post-event issues can help to gen-erate feedback in all variables that are involved in a drowning episode. REFERENCES: Haddon, W. (1980) Advances in the epidemiology of injuries as a basis for public policy. Public Health Reports, 95(5), pp. 411-421.

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Head Depth and Velocity during Swim Starts in Competition in 1.22 m Depth Pool

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INTRODUCTION: The majority of the competitive swim start literature emphasizes the biomechanical analysis of the start as a means to improve performance. While there have been studies that examine the racing start depths and velocities achieved when performing swim starts, these studies took place in controlled settings. Currently, we are unaware of any studies that have analyzed underwater depths and velocities during competitions in 'calibrated' space from the perspective of start safety. METHODS: USA Swimming registered swimmers competing in an age group and open invitational swim meet were filmed. The starting depth was 1.22 m and the starts (n = 471) from a 0.76 m block were stratified according to age group (8&U, 9-10, 11-12, 13-14, and 15&O) and stroke performed during the first lap (Freestyle, Breaststroke, and Butterfly). Dependent measures included the maximum head depth (MHD) and head velocity at MHD (VEL). RESULTS: For MHD, there was a significant main effect for Age Group ($F(4, 456) = 12.53$, $p < .001$) and Stroke ($F(2, 456) = 16.91$, $p < .001$) with the shallowest in the 8&U (0.45 ± .15 m) and the deepest in the 13-14 and 15&O (0.63 ± .14 and 0.62 ± .10 m, resp.). MHD differed between the three strokes with the shallowest for Freestyle (0.51 ± .14 m) and the deepest for Breaststroke (0.63 ± .17 m). For VEL, there was a significant main effect for Age Group ($F(4, 456) = 27.46$, $p < .001$) and Stroke ($F(2, 456) = 8.45$, $p < .001$). VEL increased with age with the slowest in the 8&U (1.88 ± .55 ms-1) and the fastest in the 15&O (2.76 ± .50 ms-1). Swimmers attained greater VEL in Freestyle and Butterfly (2.44 ± .68 and 2.37 ± .53 ms-1, resp.) than Breaststroke (2.15 ± .55 ms-1). DISCUSSION: MHD for all starts averaged 0.57 m below the surface, or 0.65 m from the pool bottom. Adjusting for the distance from the center to the top of the head (0.15 m), the average distance from the pool bottom becomes 0.50 m. If the variance is used to compute the 'noise' within the measurement, 95% of MHD values fall within the range of 0.18 to 0.82 m. This fact coupled with the observation that mean VEL for all starts exceed minimum threshold estimates consistent with catastrophic injuries, suggests that the margin of error for starts in 1.22 m water depth is small. The older swimmers performed starts that were deeper and faster than the younger swimmers and as a result, the older swimmers seem to be at a greater risk for injury when performing starts in this pool depth.

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Athletic Rehabilitation of a Platform Diver after Shoulder Dislocation for Return to Competitions

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INTRODUCTION: A high school diving swimmer injured the left supraspinatus tendon because of shoulder dislocation during the water entry stage of 10m dive. He started athletic rehabilitation (rehab) on 5th day after injury, and he returned to the competition of National Sports Festival in Japan, and won the second prize of 10m platform dive on 26th day after injury. The objective of this case study is to retrospectively analyze the rehab program and to suggest effective physical therapy procedures in the biomechanical aspect. METHODS: The medical record including magnetic resonance imaging (MRI) was confirmed, and the physical therapy records of hospital and pool side rehab were retrospectively analyzed in biomechanical, anatomical and kinesiologic aspects. This study program was approved by the Saitama Prefectural University Ethical Committee. RESULTS: The dislocated shoulder was spontaneously reduced, when a coach raised him from lying to sitting position to apply a sling at the pool side. Then, he took emergency care at a hospital because of joint swelling and severe pain. Diagnosis was supraspinatus tendinitis, and MRI indicated swelling of the supuraspinatus tendon and glenohumeral hydrarthrosis. Anti-inflammatory medication and immobilization were prescribed. Then, general conditioning exercises were applied during immobilization period. Stabilizing exercise and scapula abduction-adduction exercises were applied after immobilization period. As pool side rehab programs, following therapies were applied: joint mobilization, mobilization with movements (MWMS, Mulligan, 2004), stretching, taping, education of scapula and humeral head positioning, proprioceptive neuromuscular facilitation (PNF), and soft tissue massage. DISCUSSION: Principle of rehab was immobilization during acute phase (2 weeks), then started stability exercises of glenohumeral joint and scapula, and moved on finally functional approach. He was subacute stage at the first day of the pool side

rehab; because, he had positive sign of painful arc. Maneuvers of MWMS applied posterioinferior force on the humeral head and mechanically avoided impingement of supraspinus tendon under the coracoacrominal arch. MWMS with light weight and PNF facilitated proprioception to gain good motor control of arm movements. REFERENCES: 1. Mulligan BR. (2004). Manual Therapy, NAGS, SNAGS, MWMS etc. Plane View Services, Wellington, New Zealand.

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Comparisons of Water- and Land- based Physical Activity Interventions in Japanese Subjects with Metabolic Syndrome

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INTRODUCTION: We previously reported that group-based physical activity (PA) intervention had beneficial effects on weight loss and metabolic syndrome (MS) risk factors in Japanese subjects with MS1). Although, water- and land-based PA interventions were often conducted, it is unknown which PA interventions were more effective. The aim of this study was to compare the efficacy of these two interventions in Japanese subjects with MS or several MS risk factors. METHODS: Eight subjects with MS or several MS risk factors were selected either water-based PA intervention (WPI, n=4) or land-based PA intervention (LPI, n=4). The main outcome measures were body weight, body mass index (BMI), %Fat and Lean body mass (LBM), Vo2max and daily physical activity (DPA) level (walking steps per day). Both interventions had 10 week duration. RESULTS: After 10-weeks, participants in both groups lost their weight (WPI group: from 67.3±2.6 to 64.4±2.0 kg, LPI group: from 61.5±2.7 to 59.4±3.5 kg, $p<0.05$), BMI (WPI group: from 26.3±2.0 to 25.1±2.1 kg/m2, LPI group: from 25.7±1.6 to 24.6±1.8 kg/m2, $p<0.01$), %Fat significantly (WPI group: from 34.3±10.3 to 31.1±10.6 %, LPI group: from (36.9±2.5 to 34.7±2.5 %, $p<0.01$). DPA levels were maintained pre- to post-intervention at WPI group (from 13,145±3,178 to 13,163±1,593 steps/day), and significantly increased at LPI group (from 9,752±3,858 to 13,610±2,148 steps/day, $p<0.05$). The results showed statistically no significant differences in body weight loss and decrement of %Fat between the WPI and LPI groups. DISCUSSION: From the results, it was suggested that the effects of losing body weight and %Fat were similar regardless of the selection of PA interventions in short term. However, there is a possibility that the efficacy will differ with the long term PA intervention, and further examination might be necessary to investigate the difference of efficacy at water-based and land-based PA interventions. REFERENCES: 1) Yamatsu K, Hanai A: Comparison of Groups- and Home-based physical activity intervention in Japanese subjects with metabolic syndrome. XXX FIMS world congress of sports medicine, Barcelona, Spain, 6: 542, 2008. ACKNOWLEDGMENTS This study was partly supported by the Grant-in-Aid Northern Regions Lifelong Sports Research center (SPOR).

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The Influence of Ai Chi on balance and Fear of Falling in Older Adults: a Randomized Clinical Trial

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INTRODUCTION: Balance and fear of falling (FOF) are major problems in older adults. In water viscosity provides postural support, reducing these hindrances. Ai Chi, a variant of Tai Chi, performed in water, includes slow exercises of the arms, legs and torso, with gradual narrowing of the base of support and may have a positive effect on coordination and balance in older adults (Sova & Konno, 2003). Only one study however with chronic stroke patients was found (Noh et al., 2008). Our study examined the effect of Ai Chi on balance and fear of falling in older adults. METHODS: Thirty older adults were randomly allocated to an experimental or control group. Inclusion criteria were aged 77-88 yrs with either high or medium risk of falling (POMA score from 0 to 24). Minimal adherence was 75%. Balance was assessed with the Performance-Oriented Mobility Assessment (POMA) and FOF with Falls Efficacy Scale (FES). The experimental group received 16 Ai Chi sessions over 6 weeks at a community aquatic centre. The control group received no instruction and was encouraged not to change their ADLs. Prior to intervention, 2 familiarization sessions were held. Many participants had never experienced aquatic therapy and/or had a significant fear of falling. RESULTS AND DISCUSSION: Following intervention the experimental group improved balance (Wilcoxon Z, $p=0.001$) but not fear of falling ($p=0.306$), whereas no change was seen in the controls ($p=0.254$). The control group regressed in FOF ($p=0.011$). Clinically significant effects sizes (ES) to the advantage of the experimental group were found of 1.3pts for the tPOMA (balance), with 1.1pts and 1.4pts for bPOMA and gPOMA respectively. A clinically significant ES for the FES was also reached (1.5pts), but was more a result of the increase in FOF in the controls. Findings suggest that an Ai Chi program leads to a clinical relevant increase of both static and dynamic balance in older persons. There is a tendency to decrease FOF, although statistical significance has not been reached. Nevertheless as FOF increased in the control group, a clinical relevant difference between groups at the end of study was found. REFERENCES: Noh D-K, Lim J-Y, Shin H-I, Paik N-J. The effect of aquatic therapy on postural balance and muscle strength in stroke survivors – a randomized controlled pilot trial. Clin Rehabil 2008; 22: 966-76. Sova R, Konno J. Ai Chi Balance, Harmony & Healing. 2nd ed. Washington (EUA): DSL Ltd.; 2003.

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Predictors of Performance in Pre-Pubertal and Pubertal Male and Female Swimmers

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INTRODUCTION: Swimmers should be in a good body shape and need muscular force in order to achieve a successful performance. For example, arm-span appear to be important determinant of front-crawl swimming performance in young swimmers1 and swimming force is related to sprint swimming velocity2. The purpose of this study was to identify the anthropometric characteristics, body composition and strength as predictors of performance of the 50 m front-crawl swimming in pre-pubertal and pubertal male and female swimmers. METHODS: Seventy-two swimmers (n=72), were divided into two groups, pre-pubertal (n=30) aged 10.5±0.5yrs and pubertal (n=42) aged 13.7±1.5yrs. They underwent a battery of anthropometric, body composition and muscle strength measurements. The Principal Components Analysis (PCA) extracted three components, Component-1: Anthropometric-Tethered Swimming Force (TSF), Component-2: Body Composition and Component-3: Body Dimension. These components were then used in a simultaneous multiple regression procedure to determine which components best explain the variance in swimming performance. RESULTS: Based on the PCA, the Component-1 explained 65.1% of the total variance, Component-2 the 14.6% and Component-3 the 8.2% respectively. In total sample, the anthropometric and TSF were significantly correlated with performance ($r=-0.71$, $p<0.001$). When the multiple regression models were applied to the pre-pubertal swimmers (y=27.242-0.420*TSF+1.01*c-arm), 90.9% of the variation was explained by the average TSF (83.7%) and arm circumference (7.2%) while in pubertal swimmers (y=-38.661-0.111*TSF), the 70.4% of the

variation was explained only by the average TSF. CONCLUSION: Selected anthropometric characteristics and strength are important determinants of successful performance. Although morphological characteristics composed one dimension of successful performance, muscle strength may be useful in explaining differences in swimming score. These findings may have practical implication for both training and talent identification in swimming. REFERENCES: 1. Jürimäe J, Haljaste K, Cicchella A, Lätt E, Purge P, Leppik A, Jürimäe T. (2007). Analysis of swimming performance from physical, physiological, and biomechanical parameters in young swimmers. Pediatr Exerc Sci, 19(1):70-81. 2. Yeater R, Martin B, White M, Gilson K. (1981). Tethered swimming forces in the crawl, breast and back strokes and their relationship to competitive performance. J of Biomechanics, 14(8): 527-537.

P-122

Competitive Systematization in Age-Group Swimming: an Evaluation of Performances, Maturational Considerations, and International Paradigms

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INTRODUCTION: The most appropriate method for grouping youth swimmers to assure fair competition has been debated for decades with little progress being made. The goals of this study were to evaluate the appropriateness of the age-groups at the 2nd FINA World Youth Swimming Championships and to discuss age-grouping systems used by swimming federations in the world as a means of gaining a better insight into the most appropriate age-group stratification paradigm. METHODS: All data were acquired from the official website of FINA (http://www.fina.org). The single age-grouping for each sex was composed of four CAs (ages 14-17 years for girls and ages 15-18 for boys). A relative frequency distribution of all competitors and the top 8 finishers in all 17 individual events as well as that of the relay finalists were examined for each of the four CAs. Chi-square tests, one-way ANOVA with Tukeyâ€™s post-hoc test, and Pearson product moment correlation coefficients were performed to test the research hypothesis that older swimmers within the multi-age-groups represent a greater proportion of participants and finalists. RESULTS: In girls, there were 66, 148, 218, and 322 swims by 14, 15, 16, and 17 year olds, respectively. In boys, there were 46, 152, 259, and 486 swims by 15, 16, 17, and 18 year olds, respectively. A significant difference was found between the observed and expected values in both sexes ($p < 0.01$). The mean relative frequencies (%) of the top 8 swimmers over 17 events were also significantly different among CAs in both sexes. The oldest CA in both sexes (age 17 for girls and age 18 for boys) had a significantly greater proportion compared with all other age categories ($p < 0.05$). The age-related differences were more evident in boys. DISCUSSION: Age classification systems clearly influence participation and competition outcomes in competitive youth swimming. The number of swimmers qualifying for competitive events and qualifying for finals at the Youth Championships is significantly greater for swimmers who are the oldest in their age-groups. Grouping swimmers by the use of broad CAs is not the optimal way to encourage younger competitors.

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The Effect of an Intervention Program of Swim Learning on the Development of Fundamental Motor Skills of Boys and Girls

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INTRODUCTION: Fundamental motor skills (FMS) assist children to attain control of their bodies, form complex skills and movement patterns through their involvement in sports and other recreational activities. FMS do not simply develop as a result of age; they must be instructed and practiced (Haywood & Getchell, 2002). The main purpose of the present study was to examine the effect of a swimming intervention program on the development of fundamental motor skills. METHODS: The sample was consisted from 90 early elementary school students, aging 5 to 7 years old. The Bruininks Oseretsky Test of Motor Proficiency Short Form (Bruininks, 1978) was used to assess the motor proficiency for our sample. The two groups had no previous experience from participation in organized physical activities. The experimental group-EG (n = 44) followed the 20-week systematic intervention program of learning swimming, while the control group-CG (n = 46) did not. RESULTS: The EG and CG were assessed at baseline (1st assessment), after the end of the intervention program (2nd assessment), and 2 years after the second assessment (follow up-3rd assessment). A significant multivariate interaction was found between group (CG and EG) and time (1st, 2nd & 3rd), with respect to the total BOTMP-SF score (Ë = .394, F = 31.528, p = .000, ç2 = .606). Significant post hoc univariate interactions, with Bonferroni adjustment, were evident for running speed and agility (F = 22.722, p = .000, ç2 = .526), static balance (F = 6.499, p = .004, ç2 = .241), reaction speed (F = 5.170, p = .010, ç2 = .201) and standing broad jump (F =22.310, p = .000, ç2 = .521), with the experimental group scoring higher than the control group in the second and third assessments. DISCUSSION: The present study provides evidence that swimming instruction increases the fundamental motor skill development of children. The differences between the EG and CG were evident, two years after termination of the swimming intervention program. Overall, swimming intervention programs support the development of FMS in early elementary school children. REFERENCES: 1.Barton, G. V., Fordyce, K., & Kirby, K. (1999). Theimportance of development of motor skills to children. Teaching Elementary Physical Education, 10(4), 9-11. Beyer, E. (1987). Dictionary of sport science. Ed:Schorndorf. 2.Goodway, D. J., Heather, C., & Phillip, W., (2003). Effects of motor skill instruction on fundamental motor skill development. Adapted Physical Quarterly,20, 298-31

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Wireless Activity Monitoring System for Water Walking

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The purpose of our study was to develop an activity monitor system for the energy expenditure in water walking. In order to establish the innovative algorithm and the estimation equation of the energy expenditure during the water walking, the authors conducted a fundamental physiological experiment for adult subjects, males (n=29, age 27 to 73) and females (n=21, age 33 to 70). In each trial session, the pacemaker navigated the subject walkers and they kept steady speed (25m/min, 30m/min, 35m/min and 40m/min) at least five minutes. Last two round trips, the authors acquired their expired gas by the Douglas bag method. Simultaneously, the tri-axial acceleration of the walker head and his traveling velocity were measured by the accelerometer and the stopwatch. The authors proposed a multiple regression equations, which has three terms and constant for the energy expenditure on both the males and females. The authors hypothesized that the oxygen consumption during the water walking consists three parts, such as the basal metabolic energy, the joint consumption energy and the propelling energy. Each term has those three parts energy distribution. The individual physical body parameters (sex, age, height and weight) and his kinematical data, such as walking velocity, body acceleration were adopted for the variables for the estimation equation. Adjusted coefficients of determination of the estimation equations on both the male and the female were r^2 =

0.735 (p=1.34×10^-27), r^2 = 0.730 (p=3.37×10^-17) respectively. Based on our developed estimation equations, the authors prototyped a wearable activity monitor with 2.4GHz wireless function for the walkers. This wearable activity monitor designed to be attached on the occipital head of the walker and measured both the acceleration and the position. Measured data were sent to the database server and calculated the energy expenditure in real time. Then, total walking distance, expenditure energy were transmitted and delivered to the walker by the bone conductive speaker.

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The Effects of Rubber Swimsuits on Swimmers Measured by a Lactic Acid Curve Test

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INTRODUCTION: The rubber swimsuit was one of the causes of the record rush in 2009. Similar to wetsuit, the rubber swimsuit was made from Neoprene rubber. The effects of wearing a wetsuit on swimmers were widely reported. Tomikawa et al. suggested that the benefits of wearing a wet suit were not only the improvement in swimming propulsion efficiency, but the reduction in energy consumption. This study verified the influence of wearing the rubber swimsuit on the swimmer's exercise load by using a lactic acid curve test. METHODS: Eight female university swimmers participated in this study. They performed the lactic acid curve tests with four different suits. They wore three types of rubber swimsuits and a cloth swim suit with water-repellent. All swimsuits were full-length type covering from shoulder to ankle. The lactic acid curve test consisted of 4 times 200m swimming. The speed of four stages in the test was set from the best record of each 200m freestyle race (80%V200, 85% V200, 90% V200, 95% V200). The speed was controlled by pace maker. Blood from the fingertip was taken 0 min and 3 min (5min) after each trial and the blood lactate was determined. RESULTS: The blood lactate concentration after 90% V200 and 95% V200 trials with rubber swimsuits tended to be lower than those with a cloth swimsuit (90% V200; rubber swimsuits 3.01±1.42 mmol/L, cloth swimsuit 3.89±1.37 mmol/L, 95% V200; rubber swimsuits 8.73±2.57 mmol/L, cloth swimsuit 10.46±2.57 mmol/L), but not significant. An examination of the trials revealed that the number of arm strokes decreased due to the use of the rubber swimsuits. DISCUSSION: It is suggested that the rubber swim suits improved propulsion efficiency and decreased swimmer exercise load same as wearing wetsuit, indicating that the rubber swimsuit may improve the race performance of swimmers. REFERENCES: 1. Tomikawa et al.; Factors related to the advantageous effects of wearing a wetsuit during swimming at different submaximal velocity in triathlete. Journal of Science & Medicine in Sport,, 11(4), 417-423, 2008.

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Comparison of the Development of Underwater Exercise Between China and Japan

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INTRODUCTION: In China, the effect of the underwater exercise as prescription or physical therapy has not been recognized enough by people. According to the investigation in 2004 (Ying Wang), only six places of 96 swimming pools in Beijing, China have served exercise programs in the water. 94 % of participants were women from 18 to 40 years old. The aims of the participants doing underwater exercise program were diet (96%) and beauty (48%). In this study, we clarified the problems of promotion of the underwater exercise in China, and we examined the promotion plan for this plan in China. METHODS: A questionnaire about the promotion of underwater exercise was used for the investigation in Beijing, China. We performed questioner surveys in 103 swimming pools in Beijing City in July in 2008 The questions were about swimming pools facilities, exercise classes and future expectations. We also collected a precedent study about the underwater exercise in Japan, a history document and arranged factor: how to work to affect the spread of the present conditions of the underwater exercise. RESULTS: Significant differences were observed in the depth of swimming pool, the water temperature, and the room temperature between China and Japan(p<.0001). Swimming pools in Beijing showed that the depth of swimming pool was deeper (199.4±43.9cm), the water and room temperatures were lower (27.6±1.0˚, 27.9±0.8˚, respectively). Swimming pools in Japan showed that the depth was shallower (123.3±61.1cm) and the water and room temperatures were warmer (30.3±0.9˚, 31.3±1.7˚, respectively). DISCUSSION: For promoting the underwater exercise in Beijing, the condition of the pool facility is one of the most important keys. Swimming pools should be shallower (100~120cm) and the water and room temperatures should be warmer (30˚~35˚). Shallower and warmer pool facilities will help the promotion of the underwater exercise. The setting of the policy to make awareness of peoples¡¯ health through underwater exercise would be profitable for many people. In the underwater exercise program, depending on Chinese present conditions, to improve the underwater exercise program, like many people aim, may contribute the nation's health promotion. The management philosophy is to make wide publicity of the underwater exercise to make many people aware of it. Not only to pursuit profit, but also to contribute to nation's health.

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Preliminary Results of a "Multi-2D" Kinematic Analysis of "Straight- vs. Bent-arm" Freestyle Swimming, Using High-Speed Videography

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Synchronized, high-speed digital cameras were used for underwater videotaping of swimmers, each of whom were required to perform a series of trials with both bent-arm and straight-arm pull patterns. The resulting video footage was digitized and processed using "Multi 2-D" motion capture software. Results demonstrated (1.) The advantages of using high-speed videography for quantifying swimming stroke mechanics. (2) The resulting data provided insight into the relationship between the varying degrees of elbow-bend during the pull cycle, and fluctuations in linear hip and wrist velocities.

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Electromyography in Water Cycling at Different Cadences

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INTRODUCTION: Equipment that is used to improve physical fitness on land are being adapted for water, such as the bicycle. The effects of cadence and load on lower limb muscles activities using elec-

tromyography (EMG) are well documented in cycling literature[1,2] . The purpose of this study was to compare the EMG activity of Rectus Femoris (RF) Biceps Femoris (long head), Gastrocnemius medialis (GAS) in watercycling at different intensities, performed during cycling in an aquatic-specific bike. METHODS: Eight male subjects, between ages of 19 and 30.Each subject completed in a randomized order a 30 seconds of exercise in a water cycling (HidroRaider, Italy) bout at the cadence of 60, 80, 100 bpm, with an interval of 3 minutes. Using a wireless signal acquisition system (bioPLUX research, Portugal) and EMG sensors (emgPLUX, Portugal), muscle activity of Rectus Femoris (RF) Biceps Femoris (long head), gastrocnemius medialis (GAS) of the right leg was recorded throughout the test and was synchronized with the video images. The raw EMG was processed offline using Python data analysis software (version 2.4). The signals were subsampled to a frequence of 200Hz, then low-pass filtered with a smoothing window of 10 samples and full-wave rectified. In order to analyse only the most significant swim cycles, we selected the [middle-100; middle+ 300] samples of the raw signal on all identical pathways. For each subject, muscle and test condition, the mean, standard deviation, maximum and minimum values of EMG were determined. RESULTS: The results demonstrated that the mean EMG signal value of the muscles increased with the different cadences (60,80, 100 bpm). The values were higher in GAS and BF than in the RF. The exercise realized in the cadence 100bpm showed a relevant difference from the exercise realized in the 60 bpm in the EMG signal for the three muscles. DISCUSSION: The increase of the EMG activity with change cadence in water influences the lower extremity muscular activity during cycling. This shows that speed of the movement could be an important variable to take in account in cycling training in aquatic environments.REFERENCES: 1. Baum BS, Li L. (2003) *Lower extremity muscle activities during cycling are influenced by load and frequency*. Journal of Electromyography and Kinesiology, 13(2), 181-190. 2. Sarre, G.; Lepers, R.; Maffiuletti, N. & Millet, G.(2003). *Influence of cycling cadence on neuromuscular activity of the knee extensors in humans*. Eur J Appl Physiol, 88: 476–479.

WS-001

Invited Workshop in CFD Methodology: its Usefulness and Basic Steps

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Computational methods for swimming and aquatic research has a relatively recent history. One of the first important papers were published in 1996 and modeled drag on a circular disc the size of a hand by computational fluid dynamics (Bixler & Schloder 1996). From this point in time, numerous studies has already been published, and CFD is believed to be an important research tool for future studies in swimming and aquatics. The aim of this 30 min workshop is to discuss these questions: What is CFD methodology? Which problems can CFD solve? What are the basic steps for doing a CFD analysis? CFD applied to swimming research: past, present and future directions. The workshop aims at reaching an audience of young researchers and novices to CFD. Referece: Bixler, B. & Schloder, M. (1996). Computational fluid dynamics: an analytical tool for the 21st century swimming scientist. Journal of Swimming Research, 11, 4-22.

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