KNEE MUSCLE STRENGTH, GAIT PERFORMANCE AND PERCEIVED PARTICIPATION AFTER STROKE

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ABSTRACT

Objective: To assess the relationships between knee muscle strength, gait performance and perceived participation in subjects with chronic mild to moderate post-stroke hemiparesis.

Design: Descriptive analysis of convenience sample.

Setting: University Hospital.

Participants: Fifty men and women (mean age 58 ±6.4 years) 6 to 46 months post-stroke.

Interventions: Not applicable.

Main Outcome Measures: Isokinetic concentric knee extension and flexion strength was measured at 60º/s. Gait performance was assessed by Timed "Up & Go", Comfortable and Fast Gait Speed, Stair Climbing ascend and descend and 6-Minute Walk. Perceived participation was assessed with the Stroke Impact Scale.

Results: There was a significant correlation ($p<.01$) between knee muscle strength and gait performance for the paretic but not for the non-paretic lower limb. Strength for the paretic limb explained 34% to 50% of the variance in gait performance; the addition of strength for the non-paretic limb explained at most a further 11% of the variance in gait performance. There was a significant correlation ($p<.01$) between gait performance and perceived participation; gait performance explained 28% to 40% of the variance in perceived participation.

Conclusion: Knee muscle strength is a moderate to strong predictor of walking ability in individuals with chronic mild to moderate post-stroke hemiparesis. Walking ability influences perceived participation, but the strengths of the relationships indicate that other factors are also important.

Key words: Cerebrovascular Accident; Muscle, skeletal; Gait; Rehabilitation;

Stroke is one of the most common neurological disorders and impacts on all domains in the International Classification of Functioning, Disability and Health, ICF.[1] One of the main impairments after stroke is reduced muscle strength.[2] This post-stroke muscle weakness is a major contributor to activity limitations related to mobility. Several studies have shown that muscle weakness after stroke is significantly correlated with measures of gait performance.[3] The reduction in gait performance, in turn, may prevent the resumption of activities of daily living.[4] which can have an adverse effect on perceived participation, i.e. the involvement in a life situation.[1, 5-7]

Walking is one of the most important domains of the Activities and Participation components in ICF Core Set for Stroke.[8] A major aim of stroke rehabilitation is therefore to optimise the recovery of muscle function in order to regain walking ability[9] and thereby support patients' attempts to participate in everyday activities.[5] One component of stroke rehabilitation that has gained increased interest in recent years is progressive resistance training, using free weights or specific strength training equipments with loads of 80% or more of one repetition maximum (1RM).[3, 10] Different muscles in the lower limb can be trained, but the knee extensors and flexors have most often been included in the protocols. Although several questions about progressive resistance training remain to be answered, it is clearly an efficient way to improve muscle strength in subjects with chronic stroke[2, 3, 10] as well as in healthy older individuals.[11, 12] To be clinically important, this training regimen should improve not only knee muscle function but also walking ability and perceived participation after stroke. Currently, we have very limited data demonstrating that strength gains influence walking ability and participation in a meaningful way.[3, 10] It follows that we need a thorough understanding of the relationships between knee muscle function, walking ability and participation after stroke.

The relationship between knee muscle function and walking ability has been investigated in several studies.[13-21] There is generally a moderate to strong relationship between the knee extensor and flexor strength in the paretic limb and gait performance.[13-16, 18, 20, 21] Muscle strength in the non-paretic lower limb can also be affected after stroke,[19, 22] but it is less clear to what extent it contributes to reduced walking ability after stroke.[13, 15, 18-20]

As participation has recently replaced the term handicap in the ICF,[1] there is very limited knowledge of the relationship between participation and other components in the ICF. One study[6] has addressed the relationship between gait performance and satisfaction with participation in community and family activities post-stroke, using the Re-integration to Normal Living (RNL).[23] Approximately 1 year post-stroke, endurance (assessed by the 6-minute walk test) was the only significant determinant of integration into the community.[6] Thus, further studies are needed to address how participation is related to gait performance after stroke.

The aim of this study was to determine the relationships between knee extension and flexion strength, gait performance and perceived participation in subjects with chronic mild to moderate post-stroke hemiparesis.

SUBJECTS AND METHODS

Subjects

A total of 50 community-dwelling subjects were recruited to the study. All subjects had been treated in the Comprehensive Integrated Rehab Unit at the Department of Rehabilitation, Lund University Hospital over the period 2000-2002. The inclusion criteria were: i) a minimum of 6 months and a maximum of 48 months post-stroke (only cortical/subcortical); ii) residual hemiparesis at discharge from interdisciplinary rehabilitation services; iii) at the time of the study no medication, cognitive dysfunction, neglect, visual deficit, depression, or other physical or mental diseases that could impact upon knee muscle strength, gait performance or perceived participation; iv) able to understand both verbal and written information; and v) able to walk without supervision at least 300 m with or without a unilateral assistive device. The Ethics Research Committee of Lund University, Lund, Sweden approved the study.

Prior to testing, all subjects were medically checked by the responsible physician (JL) and completed a questionnaire, which provided demographic and medical information. To characterize the group, each subject was interviewed and scored with the Functional Independence Measure motor domain (FIM; Swedish version of FIM[SM])[24] prior to the first test session. A majority (94%) of the subjects were rated independent or modified independent, with a median for the FIM motor domain score of 87 (74 to 91). The occurrence of increased muscle tone in the paretic lower limb was assessed with the Modified Ashworth scale (MAS) prior to each of the two test sessions.[25] The tested muscle groups were: hip adductors, hip extensors and flexors, knee extensors and flexors and ankle dorsi flexors and plantarflexors. Most subjects had low or no increased muscle tone (median value of 1). At each test session 19 to 23 subjects were scored 0, and 7 subjects had a score higher than 3 (maximum total score for the paretic lower limb was 35). There were small differences between the test-sessions; the mean MAS for the different test sessions varied from 1.48 to 1.64 (range 0-8). This is consistent with recent findings that spasticity is present in a minority of hemiparetic stroke patients and rare in those with mild to moderate disability.[26]

Knee muscle strength

Isokinetic concentric knee muscle strength measurements were obtained using a Biodex® Multi-Joint System II isokinetic dynamometer[a] with the Biodex advantage software version 4.0. The standard Biodex knee unit attachment was used. Each subject was seated in the adjustable chair of the dynamometer, sitting with back support and hip flexion 85º. The dynamometer was positioned so that the lateral knee joint line was aligned with the movement axis of the dynamometer. The subject was firmly stabilised with straps across the shoulders, waist and thigh. The ankle cuff of the lever arm was strapped 3 cm proximal to the malleoli of the tested leg. The subjects sat with folded arms throughout the test. Before each measurement the full range of motion (ROM) was set. All individuals had full passive range of motion in both knee joints. To account for the influence of the gravity effect torque on the data, each subject's lower limb was weighed and the Biodex software corrected the data.

It has been reported that stroke patients cannot perform at higher angular velocities due to spastic antagonist restraints.[27] Studies of concentric knee muscle strength measurements in chronic stroke patients have therefore used low angular velocities (30-90º/s).[28-30] All subjects in the present study had a fairly good motor recovery and could perform the concentric contractions at the low velocity (60º/s). Thus, all subjects exhibited isolated movements without clinically evident synergies. This is consistent with recent findings that hemiplegic limb synergies are very rare in hemiparetic stroke patients.[31] Concentric knee muscle strength measurements at 60º/s in chronic stroke patients has also been found to be highly reliable (intraclass correlation coefficient, $ICC_{2,1}$, .89 to .94; the standard error of measurement, SEM%, 7% to 12%; the smallest real difference, SRD%, 26% to 48%).[32]

After a structured warm up the subject performed, in succession, three maximal concentric knee extension and flexion contractions of the non-paretic lower limb at 60º/s. After a 5-minutes rest the same procedure was performed with the paretic lower limb. Throughout the tests, subjects were asked to push and pull as hard and fast as possible. The maximal peak torque (in Newton meter; Nm) from each mode, for the paretic and the non-paretic lower limb, was recorded.

Gait performance

Gait performance was assessed by six tests: Timed “Up & Go” (TUG), Comfortable and Fast Gait Speed (CGS and FGS), Stair Climbing ascend and descend (SCas and SCde) and 6-Minute Walk (6MW). These six gait performance tests have been found to be highly reliable in men and women with mild to moderate post-stroke hemiparesis ($ICC_{2,1}$ .94 to .99; SEM% <9%; SRD% 13% to 23%).[33]

For TUG[34] each subject sat in a chair (seat height 44 cm, depth 45 cm, width 49 cm, armrest height 64 cm) placed at the end of a marked 3-m walkway. Subjects were instructed to sit with their back against the chair and on the word “go”, stand up, walk at a comfortable speed (‘like fetching something in your kitchen’) past the 3-m mark, turn around, walk back and sit down in the chair. The times were measured in seconds.

For CGS and FGS subjects were timed in a corridor. The total distance was 14 m and the subjects were timed over the middle 10 m. Subjects were informed that they would be timed for part of the 14 m walkway. For CGS, the subjects were told to walk at a self-selected comfortable pace (‘like walking in the park’). For FGS, the subjects were told to walk as fast and safely as possible without running (‘like hurrying to reach the bus’). The times in seconds for CGS and FGS were used to calculate the two velocities (m/s).

For SCas and SCde, subjects were tested on a flight of stairs with 12 steps and rails on both sides. Each step was 135 cm wide, 15 cm high and 30 cm deep with a black rubber strip around the edge. Subjects were instructed to walk as fast and safe as possible, and preferably in a step-through pattern; four subjects walked in a step-through pattern in SCde and two of them also used a step-through pattern in SCas. Before starting, each subject decided whether or not to use the handrail: thirty-six subjects used the handrail during SCas and 39 subjects during SCde. The time (in seconds) from when the first foot left the ground until the second foot touched the ground on the last step was measured for SCas and SCde separately.

For 6MW, subjects were instructed to walk 30 m between two marks in a 2.2 m wide corridor. After passing either mark, they were told to turn and walk back. Subjects were also instructed to cover as much ground as possible (‘to walk as far as possible during six minutes’). They were allowed to rest and then to continue walking; only one subject had to rest. Subjects were informed when three minutes of the test remained. The distance covered was measured to the nearest meter.

No verbal encouragement was given during the gait performance tests. All subjects were independent walkers but were allowed to use, if needed, their ankle-foot orthosis and their assistive device. A digital stopwatch with an accuracy of one decimal figure in units of 1 sec was used to measure time

Perceived participation

Perceived participation was assessed by Stroke Impact Scale 3.0 (SIS; Swedish version).[35] SIS is a self-report questionnaire that assesses eight aspects of the impact of a stroke on an individual’s self-perceived health: strength; hand function; activities of daily living; mobility; communication; emotion; memory and thinking; and participation. SIS is administered by a medical professional in an interview of about 15 minutes duration. All items in the eight domains are scored on a 5-grade scale from 5 (limited none of the time) to 1 (limited all of the time). The mean for each domain is calculated and can be analysed separately. SIS has been shown to be both valid and reliable.[36-38]

The first author scored each subject. As the relationship between gait performance and perceived participation was of specific interest, only the data from the SIS Participation domain were used in the analyses. SIS Participation addresses the impact of stroke on: work;

social activities; quite recreations; active recreations; role as a family member; religious activities; life control; and ability to help others. For each subject, the mean score of these eight items was calculated as a composite score and converted into a percentage value using the following expression defined by Duncan [35]:

100 x (the mean value of the eight items -1)/(5-1)

which yields a value lying in the range 0 to 100. High values represent no or low restriction in participation whereas low values indicate more restricted participation.

Procedure

Knee muscle strength was measured and gait performance was assessed at two different test sessions one week apart. This allowed us to demonstrate that the isokinetic knee extension and flexion strength measurements and the gait performance tests used in the present study were highly reliable (see above).[32, 33] As the subjects generally performed slightly better during the second test sessions (implying a small learning effect), the results from the second test sessions for both isokinetic strength and gait performance were used in this study. Perceived participation was only assessed once, as the SIS has been shown to be both valid and highly reliable.[36-38]

Statistical analyses

Knee muscle strength and gait performance provided 10 quantitative variables for the analyses: 2 strength measurements for the paretic lower limb, 2 strength measurements for the non-paretic lower limb and 6 gait performance assessments. Perceived participation provided 1 quantitative variable: the percentage value of SIS Participation. There were no missing values so the statistical analyses included all variables for all the 50 subjects.

The differences in the mean between the men and the women for knee muscle strength, gait performance and perceived participation were determined using the t-test. The relationships between knee muscle strength and gait performance and between gait performance and SIS Participation were tested with the Pearson's correlation coefficients (r). Statistical significance levels were based on the hypothesis that the values of these coefficients are zero.

In this study, we were specifically interested in the relationship between knee muscle strength and gait performance and between gait performance and perceived participation. To determine these relationships and the possible influence of other factors, stepwise multiple regression analyses were performed. In the first set of analyses, the various assessments of gait performance were the dependent variables; the independent variables were the paretic and non-paretic strength measurements. As the knee extension and flexion strength measurements were significantly ($p<.01$) correlated for both the paretic ($r=.78$) and the non-paretic lower limb ($r= .85$), they were used separately in the multiple regression analyses. We then added other independent variables (not related to knee muscle strength) that could influence the relationship: sex, age, time since stroke onset, type of stroke and side of weakness. In the second set of analyses, the dependent variable was perceived participation; the independent variables were firstly the six gait performance assessments separately and then each gait performance assessment in combination with sex, age, time since stroke onset, type of stroke and side of weakness.

The R^2 value represents the proportionate contribution of the independent variables to the variance of the dependent variable. The suitability of this approach – the aptness of the linear model and the normality of the residuals – was addressed in scatter-plots of the residuals and predicted values, in normal probability plots, in Q-Q plots and One-Sample Kolmogorov-Smirnov tests.

All calculations were performed using the SPSS 11.0 Software for Windows.[b] Significance levels smaller than .05 represented statistical significance, whereas values greater than .05 were considered not significant (ns).

RESULTS

A total of 38 men and 12 women were included in the study. The sex ratio reflects the number of men and women admitted the Comprehensive Integrated Rehab Unit at the Department of Rehabilitation, Lund University Hospital over the period 2000-2002 (122 men and 48 women). The ages for the men were [mean, ±SD (range)] 59 ±7 years (46-72), and for the women 58 ±5 years (50-66). The time from stroke onset was 17 ±9 months (6-46). Thirty-seven subjects had an ischemic stroke and 13 a hemorrhagic stroke. Twenty subjects had weakness in the right side and 30 in the left side.

The summary statistics of knee muscle strength are presented in Table 1. The knee extension and flexion strength in the non-paretic limb was significantly lower for the women ($p<.001$). In the paretic limb, knee extension strength was also significantly lower for the women ($p<.05$), whereas knee flexion strength was not significantly different between the men and the women.

Insert Table 1 about here

The summary statistics for gait performance and SIS Participation are presented in Table 2. As there were no significant differences between the men and the women for gait performance or for SIS participation, the data from the men and the women were analysed together. There was a ceiling effect in SIS Participation, illustrated by four subjects (8%)

attaining the maximal value of 100%. The smallest percentage attained by any subject was 34%. The median value for SIS Participation was 81%.

Insert Table 2 about her

Knee muscle strength and gait performance

The correlation coefficients (r) between knee muscle strength and gait performance, their significance levels and a summary of the results of the multiple regression analyses (R^2) are presented in Table 3. All correlation coefficients for knee muscle strength in the paretic limb and gait performance were significant (p<.01), whereas none of the correlation coefficients for the non-paretic limb were significant. Knee muscle strength in the paretic limb explained 34% to 50% of the variance in gait performance. The R^2 values for knee extension and knee flexion strength in the paretic limb were very similar and explained more of the variance for 6MW and less for SCas and SCde. When knee muscle strength in the paretic and non-paretic lower limbs was combined, strength in the non-paretic limb contributed up to 11% for eight of the twelve analyses, but together they explained at most 51% of variance in gait performance. When the other independent variables (sex, age, time since stroke onset, type of stroke and side of weakness) were added in the multiple regression analyses, age or right side weakness contributed each 6% to the variance of TUG (Table 3).

Insert Table 3 about here

Gait performance and perceived participation

For the second set of analyses the data are presented graphically in Figure 1, together with the Pearson correlation coefficients (r) and the R^2 values. All relationships were significant ($p<.01$). The gradients of the regression lines indicated that for each gait performance test, a better performance corresponded to a higher SIS Participation value. Gait performance explained 28% to 40% of the variance in perceived participation. When the independent variables (sex, age, time since stroke onset, type of stroke and side of weakness) were added into the multiple regression analyses, age in combination with TUG or 6MW contributed an additional 7% to the variance in SIS Participation. The combination of a better performance in TUG and 6MW and higher age corresponded to a higher SIS Participation value.

Insert Figure 1 about here

DISCUSSION

The aim of this study was to assess the relationships between knee extension and flexion strength, gait performance and perceived participation. The main findings were that knee muscle strength and gait performance as well as gait performance and perceived participation were significantly related. Gait performance could explain between 28 and 40% of the variance in perceived participation, whereas knee muscle strength in the paretic lower limb could explain up to 50% of the variance in gait performance. Knee muscle strength in the non-paretic lower limb was of some importance but together the strength in the two lower limbs did not explain more than 51% of the variance in gait performance. Increasing age contributed, although to a small degree, to the explanation of both gait performance and SIS Participation.

Relationship between knee muscle strength and gait performance

Our results confirm the general contention that knee muscle strength is positively related to walking ability after stroke.[3, 9] The relationships between knee extension strength in the paretic lower limb and gait performance were very similar to those in other studies.[13-16, 18, 20, 21] Two studies have, however, not detected a significant relationship.[17, 19] One study, with a sample of only 12 stroke patients, showed a non-significant trend[17] and the other study, based on 20 stroke patients and average muscle torque, detected no significant correlations.[19] The relationship between knee flexion strength and gait performance in this study is similar to that of knee extension strength and gait performance. Three studies that addressed the relationship between knee flexion strength and gait performance reported similar results.[16, 19, 20]

A variety of equipment, modes (isometric and isokinetic) and angular velocities (12º/s to 180º/s) have been used in these previous studies. In addition, the age-range, time since stroke and degree of recovery of the subjects varied considerably, which most likely explain the differences in the results. Two other factors that can influence the results are the reliability of the measurements and the sample size. The measurements of knee muscle strength and the assessments of gait performance used in this study were highly reliable and the sample size was, in our opinion, large enough for the conclusions drawn.

The lack of relationship between knee muscle strength in the non-paretic lower limb and gait performance indicates that strength in the non-affected lower limb post-stroke is much less important for the walking ability than strength of the affected lower limb. The relationship between strength in the non-paretic lower limb and gait performance has attracted much less attention and the results are conflicting. Two studies reported no significant relationships between knee extension or flexion strength in the non-paretic lower limb and gait performance,[13, 15] whereas three studies found a significant relationship.[18-20] The differences in the results might again be explained by differences in study design: in particular, the age-range of the subjects and the degree of post-stroke disability. As an example, one study assessed very old subjects that were severely affected by stroke. Gait performance was assessed by TUG and the mean value in seconds for TUG was 42 s for the stroke subjects and 12 s for the controls,[20] compared with 13.7 s in this study.

When we combined the values for the paretic and non-paretic lower limbs in the multivariate regression analyses, strength in the paretic lower limb was the strongest predictor of gait performance but the effect of the strength in the non-paretic lower limb was not negligible. Furthermore, strength influenced the various assessments of gait performance differently. For example, both knee extension and flexion strength in the paretic lower limb was the strongest predictor of endurance, assessed by 6MW, whereas strength in the non-paretic lower limb had no affect on endurance. If muscle strength in the paretic limb is reduced, muscle fatigue increases, which impacts on overall endurance. On the other hand, knee extension and flexion strength in both the paretic and non-paretic lower limbs contributed to stair climbing, assessed by SCas and SCde (cf. Table 3). Stair climbing is dependent on strength in both lower limbs, which could explain the results from the multivariate regression analyses. Very few studies have assessed the contribution of strength in both lower limbs to gait performance. One study used a stepwise regression model, including both paretic and non-paretic knee extension muscle strength, and found that strength in the paretic lower limb alone explained 54% of the variance in fast gait speed, five months post-stroke.[18]

The only other variables that influenced the predictions in this study were age that contributed to the relationship between TUG and knee extension strength, and right sided weakness that contributed to the relationship between TUG and knee flexion strength. The contribution of age can be interpreted, as increasing age leads to muscle weakness and TUG is dependent on strength in both lower limbs. The importance of the side of weakness is explained less easily but may have occurred by chance.

Relationship between gait performance and perceived participation

Participation, as defined in the ICF classification, is a major goal of rehabilitation. Even if there is some agreement about the meaning of the term participation, the problem remains that of quantifying participation and relating the measures to other aspects of ICF. In a recent review, the psychometric and administrative properties of outcome measures assigned to the ICF Participation category and commonly used in stroke rehabilitation research were presented and discussed.[39] The authors found no consensus about the most important indicators of successful involvement in life. We used SIS as a measure of perceived participation as it has good internal consistency and validity.[36-38] It was easy to administer and covered several important aspects of social functioning. Only four subjects obtained the maximum score of 100 and no subject the minimum score of 0, indicating a low floor and ceiling effect for this group of stroke patients.

Gait performance and perceived participation post-stroke was found in this study to be significantly related; gait performance explained up to 40% of the variance in perceived participation. Not surprisingly, there were only small differences between the results for the different gait performance tests (cf Figure 1). Even though they measure different aspects of walking ability the six gait performance tests are strongly related.[33] One study has investigated the relationship between gait performance and handicap after stroke using the former ICIDH terminology.[6] One year post-stroke, endurance (assessed by 6MW) was significantly associated with the Re-Integration into Normal Living (RNL Index),[23] indicating a positive relationship between endurance and community integration. However, no significant relationship was found between RNL Index and other measures of gait performance, such as TUG and CGS.[6] Although there are similarities between the RNL Index and SIS Participation, data from the two studies are not fully comparable, as a low degree of community mobility does not directly imply a low level of perceived participation.

An interesting finding in this study was that age contributed to the variance in SIS Participation in combination with TUG or 6MW. This suggests that the ability to rise from a chair and to walk longer distances were more important for perceived participation in the older stroke subjects. As few subjects in our study were older than 70 years, studies with a greater age span are needed to fully understand the implications for stroke rehabilitation.

Limitations

A limitation of this study was that we only measured knee muscle strength. Weakness in hip and ankle muscles, as well as other physical impairments, such as postural control, coordination, balance, evolving synergy patterns, sensorimotor function, muscle tone, can also influence gait performance after stroke.[19-21, 40] However, in order to assess the relative contribution of factors determining gait performance after stroke, a study with many more subjects have to be designed. As participation is a complex interaction between body structures and functions, activities, and external factors in the environment,[7, 41] other factors, such as mood, coping ability, social support, vocational situation and previous leisure activities may influence perceived participation. None of these factors were studied here because the main aim was to assess specifically the relationship between gait performance and perceived participation. As participation is a fairly new term and there are very few outcome measurements based on this definition, this area of stroke rehabilitation holds potential for future research. As studies of one post-stroke sample cannot be generalised to the entire population of stroke patients, the results and conclusions in this study are germane for independent individuals with mild to moderate post-stroke hemiparesis.

CONCLUSION

The results show that knee muscle strength is a moderate to strong predictor of walking ability, and that walking ability, in turn, impacts on perceived participation. The strength of the relationships, however, indicates that other factors are important for both gait performance and perceived participation. The results imply that improvements in knee muscle strength following an intervention, such as progressive resistance training, may partly affect gait performance but that gait performance, in turn, may influence perceived participation to a smaller degree. Further research is needed to understand the relationship between muscle strength, gait performance, and the engagement in a life situation for post-stroke subjects.

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Suppliers

a. Biodex Medical Systems, Inc., 20 Ramsay Road, Shirley, New York, 11967-0702

b. SPSS Inc, 233 S Wacker Dr, 11th Fl, Chicago, IL 60606

LEGENDS

Figure 1 The relationship between SIS Participation and gait performance. High SIS values represent no or low restriction in participation whereas low values indicate more restricted participation. For each of the six gait performance tests, a better performance corresponded to a significantly ($p<.01$) higher SIS Participation value.

Table 1: Summary of the Isokinetic Knee Muscle Strength Measurements

	Men			Women		
Test	Mean	± SD	Range	Mean	± SD	Range
Extension 60º/s (Nm)						
Nonparetic	146.6	±43.1	74–268	101.3	±25.7	70–148
Paretic	99.7	±41.5	13–191	67.5	±26.7	22–115
Flexion 60º/s (Nm)						
Nonparetic	81.5	±28.1	16–149	52.1	±13.5	33–82
Paretic	47.2	±28.7	9–119	32.4	±15.7	7–63

Table 2: Summary of the 6 Gait Performance Tests and the SIS Participation

Test	Mean	± SD	Range
TUG (s)	13.7	±5.3	7.0–27.7
Gait speed (m/s)			
Comfortable	.94	±.28	.36–1.53
Fast	1.35	±.44	.49–2.12
Stair climbing (s)			
Ascend	10.3	±4.7	5.5–25.6
Descend	10.9	±5.8	4.4–27.5
6MWT (m)	398	±136	122–648
SIS participation (%)	76.2	18.4	34–100

Table 3: Correlation Between the Gait Performance Tests and the Isokinetic Knee Muscle Strength Measurements (*r*), and the Results of the Stepwise Multiple Linear Regression Analyses (R^2)

Measurements	TUG	CGS	FGS	SCA	SCD	6MWT
Extension 60º/s						
Paretic (*r*)	–.65*	.61*	.67*	–.58*	–.61*	.70*
Nonparetic (*r*)	–.14†	.12†	.19†	–.07†	–.13†	.26†
Paretic (R^2)	.42	.37	.44	.34	.38	.49
Paretic and nonparetic (R^2)	.51	.46	.50	.45	.46	.49‡
Paretic, nonparetic and increasing age (R^2)	.57	.46‡	.50‡	.45‡	.46‡	.49‡
Flexion 60º/s						
Paretic (*r*)	–.64*	.61*	.65*	–.61*	–.61*	.71*
Nonparetic (*r*)	–.15†	.09†	.15†	–.06†	–.10†	.25†
Paretic (R^2)	.41	.37	.42	.37	.37	.50
Paretic and nonparetic (R^2)	.41‡	.42	.42‡	.44	.42	.50‡
Paretic, nonparetic and right side weakness (R^2)	.47	.42‡	.42‡	.44‡	.42‡	.50‡

Abbreviations: CGS, comfortable gait speed; FGS, fast gait speed; SCA, stair climbing ascend; SCD, stair climbing descend.
**P*<.01, †not significant, ‡ the added independent variable did not contribute to the variance of the dependent variable.

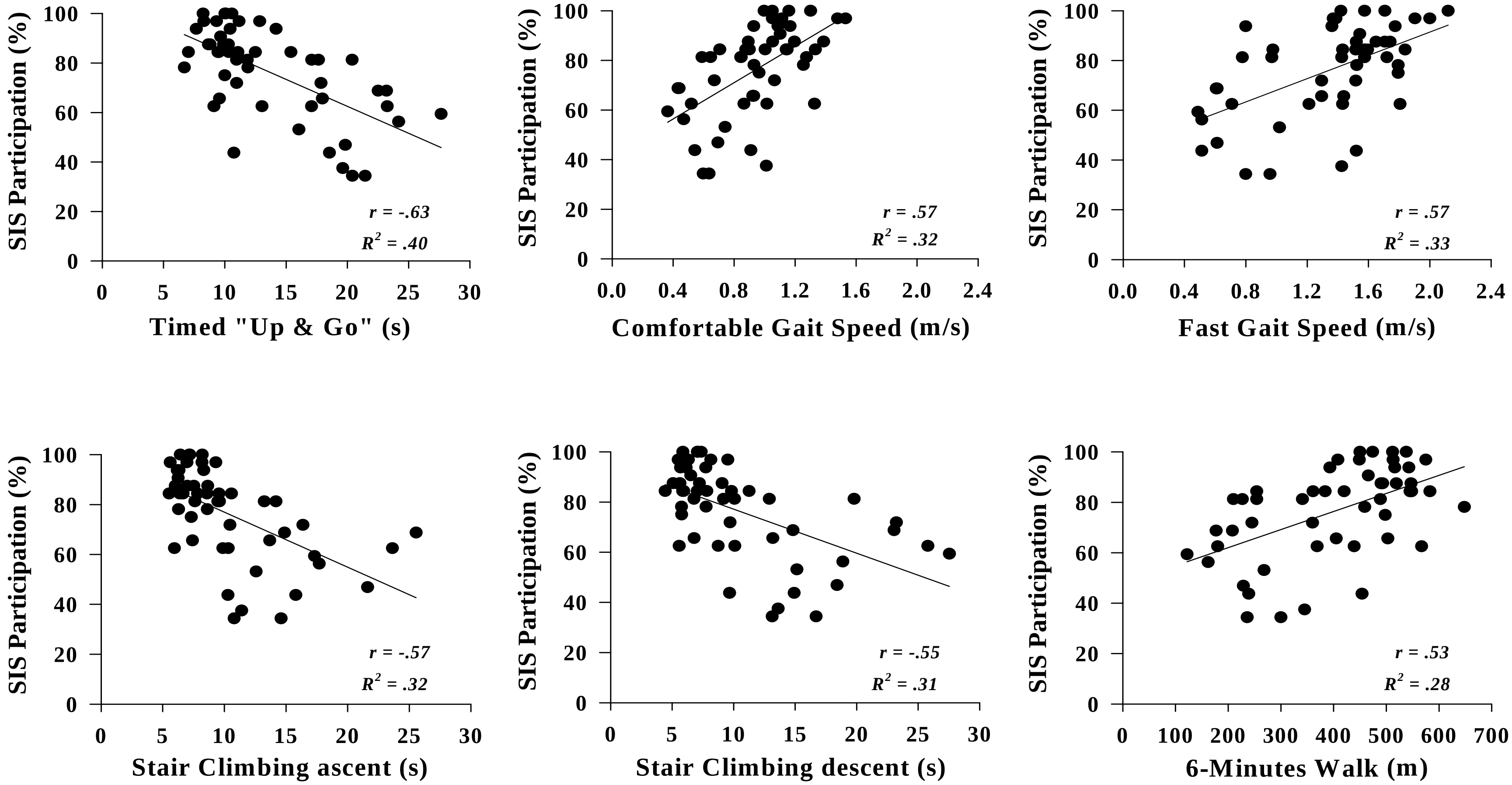
SIS Participation (%)
Timed "Up & Go" (s)
r = -.63
R² = .40
Comfortable Gait Speed (m/s)
r = .57
R² = .32
Fast Gait Speed (m/s)
r = .57
R² = .33
Stair Climbing ascent (s)
r = -.57
R² = .32
Stair Climbing descent (s)
r = -.55
R² = .31
6-Minutes Walk (m)
r = .53
R² = .28

Figure 1