Outcomes of Rollator and Powered Wheelchair Interventions - User Satisfaction and Participation

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OUTCOMES OF ROLLATOR AND POWERED WHEELCHAIR INTERVENTIONS

– User Satisfaction and Participation

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Contents

Glossary and abbreviations

Accessibility:	The relationship between capacity and environmental demands (1)
Activity:	Execution of a task or action by an individual (2). Used only in Paper III.
Adaptation:	A process of selecting and organising activities (or occupations) to improve life opportunities and enhance quality of life according to the experience of individuals or groups in an ever-changing environment (3).
Assessment:	The process of determining the meaning of measurement(s) (4).
Assistive device:	Any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customised, that is used to increase or improve the activity and participation of individuals with disabilities (5). The term is used in this thesis, while the term 'assistive technology device' is sometimes used by other authors.
Assistive technology:	Interventions that include a broad range of devices, services, strategies, and practices that are conceived and applied to ameliorate the problems faced by individuals with disabilities (5).
Assistive technology service:	Any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device (5). Is sometimes called 'assistive technology service delivery' (6). The service may encompass various components depending on the selected model. However, most models include: initiative, screening, evaluation, device provision, training, and follow-up (5;7–9).

Capacity: Execution of tasks in a standard environment (2), in this thesis without assistive devices or personal assistance. The immediate potential of the individual to perform tasks which support occupational performance (10).

Determinant: Any factor, whether event, characteristics, or other definable entity, that brings about a change in health condition or other defined characteristic (11), calculated by means of multivariate analyses resulting in adjusted odds ratios. The term *indicator* was used in this thesis when only bivariate analyses were applied, resulting in crude odds ratios.

Disability: An umbrella term for impairments, activity limitations, or participation restrictions (2).

Effectiveness: A measure of the extent to which a specific intervention, procedure, regimen, or service, when employed in the field in routine circumstances, does what it is intended to do for a specific population (11).

Environmental barriers: Environmental factors that have a negative influence on the individual's performance as a member of society (2).

Environmental factors: External features of the physical, social, and attitudinal world, which can have an impact on the individual's performance in a given domain. Environmental factors are a part of the ICF component contextual factors (2), the other part being personal factors.

Equivalence of instruments: Consists of (12):

- *Conceptual equivalence:* The validity of the concept being used when translated from one to another culture, since some expressions have different contents, even if they can be translated directly.
- *Experimental equivalence:* The situations referred to should be relevant in the country and culture where the translated instrument will be used.
- *Idiomatic equivalence:* Idioms and colloquialisms cannot always be translated directly, which means that other words or sentences must be used, which correspond to the meaning of the original expression.
- *Semantic equivalence:* The words used must have the same meanings in the two versions of the instrument; sometimes it is necessary to alter vocabulary and grammar to achieve this.

HAAT model:	Human Activity Assistive Technology model (5).
ICF:	The International Classification of Functioning, Disability and Health: ICF (2).
Measurement:	The quantification of an observation against a standard (4).
Mobility:	The term mobility encompasses a broad range of movements, for example mobility of joints, transfer, walking, swimming, driving, and travel, representing different domains of functioning. In this thesis, however, mobility was delimited to walking or moving about using a mobility device as assistance to or instead of walking (2). Further, the focus was on outdoor mobility, even though aspects of indoor mobility were touched upon.
Mobility device:	Mobility devices are classified in the International Standard for Technical Aids for Persons with Disabilities as 12: Aids for personal mobility. In this thesis mobility devices were limited to 12 06 06: Rollators; 12 21 24: Electric motor-driven wheelchairs with manual steering; 12 21 27: Electric motor-driven wheelchairs with powered steering (13). Usually electric motor-driven wheelchairs are called powered wheelchairs, the term used in this thesis. Furthermore, the manually steered types were called 'scooter type' and the ones with powered steering 'joystick-controlled type'.
Mobility device intervention:	Intervention that includes assistive technology services as well as mobility device(s).
Mobility-related participation:	A construct developed within the framework of the present thesis representing participation aspects which absolutely presuppose mobility.
Occupation:	In this context, a concept primarily used within occupational therapy. Refers to groups of activities and tasks of everyday life, named, organised, and assigned value and meaning by individuals and culture. Occupation is everything people do to occupy themselves, including looking after themselves, enjoying life, and contributing to the social and economic fabric of their communities (14).
Older people:	In this thesis people ≥ 65 years.
Outcome:	The result of an intervention. Examples of outcomes are performance of activities of daily living, consumer satisfaction, and subjective quality of life (15).
Outcome dimension:	Concept operationalised and addressed in the present thesis (16).

Outcomes research:	The study of the results of certain interventions or types of care. Outcomes research seeks to understand the end results of particular health care practices and interventions. End results include outcomes that people experience and care about, such as change in the ability to function. (17).
Participation:	Involvement in life situations (2), corresponding to social participation and social roles (18).
Participation restriction:	Problem an individual may experience in involvement in life situations (2).
PEO model:	Person-environment-occupation model (19).
Performance:	Executing tasks in the current environment. Can be with or without assistive devices or personal assistance (2).
Personal factors:	The particular background of an individual's life and living, composed of features of the individual that are not part of a health condition or health status. These factors may for instance include age, gender, educational background, coping styles, social background, profession, and past and current experience. Personal factors are a part of the ICF component contextual factors, the other part being environmental factors (2).
Powered wheelchair:	See 'Mobility device'.
QUEST:	The Quebec User Evaluation of Satisfaction with assistive Technology (20;21).
Rehabilitation:	The Danish definition is: 'A goal-oriented, co-operative process involving a citizen, his/her relatives, and professionals, over a defined period of time. The aim of this process is to ensure that the citizen, who has significant limitations to his/her physical, mental, and social functioning *or* is at risk of acquiring such limitations, gains independence and a meaningful life. Rehabilitation takes into account the citizen's total life situation and decisions, and it encompasses coordinated, coherent and knowledge-based interventions'. [Translated by Ivor Ambrose] (22).
Rollator:	A frame with two to four wheels. The rollator has handles with brakes, the front wheels are usually castor wheels, and in some cases the rollator has a seat, a basket, or a tray. It is classified as 12 06 06 in The International Standard for Technical Aids for Persons with Disabilities (13).

Transportation of mobility device:	To bring the device when travelling. A QUEST item (21).
User:	An individual who uses assistive technology. Based on different ideologies and/or legislative contexts is sometimes called client, patient, citizen, or consumer.
User satisfaction:	In this thesis the definition used in the QUEST is applied: 'Satisfaction is based on a person's critical evaluation of specific characteristics of the technology. The person's expectations, perceptions, attitudes and personal values affect this assessment' (20).
WHO:	World Health Organization

List of Publications

This thesis is based on the following publications referred to by their roman numerals:[a]

I. Brandt Å. Translation, cross-cultural adaptation, and content validation of the QUEST. Submitted.
II. Brandt Å, Iwarsson S, Ståhl A. User satisfaction with rollators. *Disability and Rehabilitation* 2003; 25 (7): 343–353.
III. Brandt Å, Iwarsson S, Ståhl A. Older people's use of powered wheelchairs for activity and participation. *Journal of Rehabilitation Medicine* 2004; 36 (2): 70–77.
IV. Brandt Å, Iwarsson S, Kreiner S. Are mobility-related participation and user satisfaction separate constructs? Validity in the context of powered wheelchair use. Submitted

[a]Additional results, not previously published, are included in the thesis.
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Outcomes of Rollator and Powered Wheelchair Interventions

– User Satisfaction and Participation

Åse Brandt

Introduction

To be able to move about is a basic human need and important for possibilities to live a rich life in a modern society according to one's own values and wishes. The purpose of mobility may be just to move about, but mobility is also a precondition for participation in societal life such as shopping, visiting friends and family, working, going for a walk, attending cultural events, etc. (23;24). Participation has in turn been found to be vital for health and well-being, and mobility restrictions deriving from limited walking capacity may thus have implications for the individual's everyday life and participation in societal life (25), as well as for society at large, being significant for need of care and for equality policy.

Limited walking capacity warrants rehabilitation interventions in order to prevent subsequent participation restrictions. One essential rehabilitation intervention is the use of assistive technology, which in the practice context is regarded as effective in making mobility and subsequent participation possible in every day life despite disability. In Denmark, where the data for the thesis were collected, and in Sweden, where the scientific processing took place, assistive technology is granted free of charge, financed by duties, VAT, and income taxes, if it is expected to increase the user's degree of activity and participation substantially (26). This is different from most European countries where assistive technology is financed by insurance companies and to a larger extent by the users themselves (27;28).

In Denmark the use of assistive technology is mainly a social policy strategy, based on the fundamental national principle in disability policy of equalisation of opportunities, with the principle of compensation being one of the main pillars, put into practice among other things by granting assistive technology (27;29). In Sweden assistive technology is a

part of the health care system, likewise with the objective of equality, so that people with disability can be fully active members of society (26). In order to know to what extent the intentions of the legislation are fulfilled, knowledge is required about outcomes of rollator and powered wheelchair interventions in terms of participation.

Assistive technology is mainly applied in a community context, often engaging different professions in the implementation of the interventions, although the largest group of professions is occupational therapists (30). The use of assistive technology may be characterised as an environmental modification strategy, which furthermore encompasses modifications to housing and other physical environments. Other occupational therapy interventions aim at restoring or improving the individual's capacities, e.g. training to improve body function and/or to learn new strategies for carrying out tasks (31–34), and assistive technology is often implemented in combination with other rehabilitation interventions. Although assistive technology is employed by a large proportion of occupational therapists, limited occupational therapy research has been directed towards assistive technology, person–environment–activity transactions, and participation (35).

Assistive technology

Assistive technology encompasses the device in question and the related services assisting the individual in the selection, acquisition or use of a device, called assistive technology service. Assistive devices may be products especially designed for people with disability or mainstream products, and they may be used for a wide range of purposes (5;20). In this thesis, however, assistive technology aiming at making participation possible in spite of limited walking capacity was focused upon, i.e. mobility device interventions. The specific devices targeted were rollators and powered wheelchairs, which have been increasingly used for this purpose in the last decade (36).

Rollators and powered wheelchairs

A rollator is basically a frame with two, three, or four rather big wheels, the front wheels usually castor wheels; it has handles with brakes, and in some cases it is equipped with a seat, a basket, or a tray. The history of rollators has to our knowledge not been reported, but rollators have been available for at least 25 years, even though they were only rarely used in the first years of their existence. About 60 more or less different models are now available on the Danish market (www.hmi-basen.dk) and 35 in Sweden (www.hi.se). In Denmark studies of older people's mobility showed that 6.4% of 65–84-year-old age group used a rollator and that a majority were women (37), and in Sweden at least 300,000 use a rollator (38), which is 3–4% of the total population.

Powered wheelchairs are wheelchairs powered by batteries, consisting of two major subgroups. One is the scooter type that has three or four wheels and is steered manually by handlebars, the other is the joystick-controlled type, which has four wheels and is steered electronically, mostly by a joystick. The first report of powered wheelchairs originates from the USA in 1903 (39), but the use of powered wheelchairs was really introduced at the end of World War II, when effective solutions to serious impairments resulting from the war were needed. Now around 80 different models of each type are on the Danish market (www.hmi-basen.dk) and about half as many on the Swedish market (www.hi.se). No statistics concerning powered wheelchair use were available for Denmark. In Sweden 70% of all assistive devices are used by people over 65 years of age (40), but in 2002 only 43% of the Swedish citizens who were granted powered wheelchairs were over 65: 30% were 65–79 years old, and 13% 80 years old

or more. However, in the latter group the proportion had increased by 46% compared to 1997, while the total increase was 35%, indicating that the proportion of older wheelchair users may increase further. In the 18–64 age group, more women than men received a powered wheelchair, whereas the opposite was the case for the 65+ age group, even though more older women than men have limited walking capacity (41). In December 2002 the prevalence of powered wheelchair use in Sweden was 226 per 100,000 inhabitants; in all there were 9,088 powered wheelchair users (36).

Although assistive technology is known to constitute only a little part of societal costs for rehabilitation (42), still many resources are spent, and it is crucial to know whether the users are satisfied with the interventions and whether these are effective in order to be able to decide whether the interventions are justified.

Assistive technology service

Assistive technology service delivery systems differ depending on the country, type of device, kind of problem to be solved, etc. In Denmark and Sweden the municipalities usually are responsible for the provision of rollators and powered wheelchairs. The assistive technology service differs as well, but essentially components concerning initiative, screening, evaluation, device provision, training, and follow-up are included. In most cases the provision of assistive technology is based on the individual situation, even though standard solutions are sometimes applied. It is believed that the different components of the service have great impact on the outcomes of assistive technology, and thus knowledge about this is vital in order to be able to improve the quality or to discontinue ineffective service components.

Assistive technology is sometimes part of a comprehensive rehabilitation process including other coordinated interventions (22), while in other cases it is just a single intervention (5;7–9). In addition, the type and number of professions involved in the process differ, depending on the complexity of the problem to be solved, type of device, traditions, etc. Hence the field of assistive technology services can be characterised as diverse, and when users receive a device, many different kinds of services and professions may have been involved, which often makes it difficult to decide the underlying reasons for positive or negative outcomes of the intervention.

Demographical issues

The risk of limited walking capacity increases with advancing age and is higher for women than for men. A Danish national survey showed that 13.0% of men in the age group 60–66 years, 20.0% of those aged 67–79 and 38.9% of men over 79 could not walk 400 m without difficulty. The corresponding proportions of women with limited walking capacity were 13.2%, 25.3%, and 58.2% (41). In Sweden similar proportions have been reported (40). Consequently, the population mainly focused on in this thesis was the 65+ age group, even though younger age groups were touched upon.

Today most older people in Denmark and Sweden live in their own homes. Compared to earlier times, living an active life has become a positive societal value, and older people are not prepared to accept participation restrictions as much as in the past (43;44). Mainly due to decrease of fertility rates and prolonged life expectancy the proportion of older people will expand in all Europe. In Denmark the proportion of the 65+ population was 14.9% at the start of 2004, while it is expected to increase to 24% in 2030 (45). In Sweden in 2002 the proportion was 17%, expected to expand to 25% in 2030 (46). In particular the number and proportions of very old people will grow (47). This increase in the proportion and number of the older population,

given that the prevalence of limited walking capacity is higher among older people, will probably lead to even more extensive use of mobility devices. At the same time, little is known about the extent to which mobility device interventions make participation possible for older age groups with limited walking capacity, and more knowledge is required in order to select the most suitable and effective interventions to prevent participation restrictions. Since a large part of social and health care is financed by income taxes, further demands for prioritisation and efficient use of public finances may be expected (17).

Outcomes of mobility device interventions

Rehabilitation outcomes are defined by Scherer and Cushman as: 'Outcomes are the result of an intervention. Examples of outcomes are employability, performance of activities of daily living, and consumer satisfaction or subjective quality of life' (15), even though various other definitions prevail (48). Outcomes of assistive technology likewise vary, depending on the perspectives targeted. The perspectives of this thesis were partly those of society at large, requiring knowledge about the effectiveness of mobility device interventions for prioritisation purposes, and partly those of rehabilitation practitioners who also need knowledge about effectiveness of interventions in order to develop the quality of interventions, and furthermore knowledge about user satisfaction is required. Moreover user perspectives were addressed in that the outcomes were based on users' reports and assessments.

User satisfaction

User satisfaction is a crucial outcome dimension representing users' subjective perspectives of assistive technology use (49;50). In the last decade the need for client-centeredness has been widely recognised, requiring knowledge about outcomes from a user perspective (51;52). In relation to assistive technology user perspectives are important, because the interventions aim at improving people's life situation, and if the users are not satisfied, the interventions implemented should be reconsidered (53).

As regards the concept of satisfaction there is no agreement on its definition (50;53–55). The definition selected for the present thesis is that satisfaction in an assistive technology context is the user's critical evaluation of several aspects of the assistive technology, which in turn is influenced by expectations, perceptions, attitudes, and personal values (20). This definition reflects how satisfaction is a result of users' subjective assessment of assistive technology, which is of interest in the present thesis; in addition, the definition underlies a large part of existing outcomes research in the field.

Effectiveness

In the light of society's need for a knowledge base for prioritisation of interventions, outcomes in terms of effectiveness may be considered to be of the utmost importance. Given that effectiveness is understood as 'a measure of the extent to which a specific intervention, procedure, regimen, or service, when employed in the field in routine circumstances, does what it is intended to do for a specific population' (11), participation outcomes can be regarded as a major aspect of the effectiveness of assistive technology, and likewise frequency of use can be regarded as an aspect of effectiveness.

Participation

Participation is defined as 'involvement in a life situation' (2) in the International Classification of Functioning, Disability and Health, ICF, which links to The Standard Rules of Equalisation of Opportunities for Persons with Disabilities (56) and is intended as an instrument for implementation of equalisation policies. The ICF provides a standard lan-

guage and a model for describing functioning consisting of health-related domains that interact dynamically. One component concerns body function and structures and another activity and participation, besides which contextual factors consisting of environmental factors and personal factors are comprised. In the ICF model activity and participation are separated and defined differently, while in an appended list of concrete aspects, activity and participation are integrated, making the relationship between the two constructs unclear (57). Consequently operationalisation for research purposes is difficult (58), and therefore attempts have recently been made to identify aspects characterising each construct, but clarity problems remain (58;59).

During the work with the present thesis the understanding of the concepts used has developed and changed. In Paper III the ICF activity and participation component was used (2), but when it later became clear that the ICF definition delimits activity to execution of tasks in a standard environment, while participation takes place in the current environment, the focus of the current thesis (57;60), we decided not to use the term activity further but rather 'participation', given the focus of this thesis. In addition, the terms 'desired participation' or going to 'desired places' have in some cases been applied to underline the meaningfulness of a participation aspect to the individual. Even so, the term participation is broad, not sufficiently specific for outcomes research concerning mobility device interventions requiring delimitation of the term. Subsequently in the last part of the work (Paper IV) attempts were made to identify participation aspects presupposing mobility.

Frequency of use

Another aspect of effectiveness is frequency of use, since rarely used devices and especially devices not used at all are ineffective for the user and a waste of societal resources. Even though frequency of use seems to be a straightforward outcome dimension, it is comprehended and operationalised differently in studies (61;62). Nevertheless, knowledge about frequency of use is fundamental when assessing the effectiveness of mobility device interventions.

Theories and models

An important basis for measurement of assistive technology outcomes is the theoretical foundation and conceptual models, instrumental in structuring the complex task of measurement, framing research questions and interpreting results (63;64). Only recently has the need for theories and comprehensive conceptual models specifically aimed at the field of assistive technology been recognised, and usually outcomes research in assistive technology is not theoretically based (65;66).

In the ICF assistive technology is called 'products' and is a part of the environmental component, making it clear that assistive technology is not a personal component, which otherwise has sometimes been suggested (67). The ICF is intended for descriptive purposes rather than for explaining mechanisms leading to certain outcomes. Moreover, relationships between products and other environmental factors are not accounted for. Obviously there are shortcomings in the ICF in relation to outcomes research in the field of assistive technology, but since the ICF is widely accepted and important for communication across disciplines and sectors, its terminology was used for the present thesis.

In occupational therapy most conceptual models describe person–environment relationships, based on the belief that physical, social, cultural, economic, and organisational aspects of the environment have decisive influence on occupation[1] (68). One example is the person-environment-occupation model (PEO), illustrating that the better the fit between the person, the environment, and the

[1] For definitions, see glossary.

occupation, the better is the occupational performance. Besides, the model describes how occupational performance is transactional and will change over time whenever any factor within each of the three domains changes (19). However, since no explicit distinction between assistive technology and other environmental factors has been presented, current occupational therapy models omit the possibility of studying relations between assistive technology and other environmental factors. Consequently, present occupational therapy models are insufficient for assistive technology outcomes research.

One conceptual model specifically dealing with assistive technology is Cook & Hussey's Human Activity Assistive Technology (HAAT) model, first presented in 1995 (5). It describes how human performance using assistive devices is influenced by the person, the activity, the assistive technology, and the context in which the activity is performed. The model suggests that each of these domains contains a number of factors that influence human performance, but also that the domains influence each other. This means that performance using assistive technology may change dynamically due to various conditions, implying that these domains need to be addressed in clinical work and research. Even though the model has been available for a long time and seems to contain relevant factors, it has only been used to a limited extent in research (69), and thus it has not been empirically tested. Since the HAAT model nevertheless seemed to be the most appropriate at the time of the studies reported in this thesis, it underlies some of the methodological development accomplished.

Instruments for outcome measurement

In the last ten years a number of instruments for measuring outcomes of assistive technology have been developed, even though only few have been standardised (70). At the prospect of the studies for the present thesis in the late 1990s no instruments aiming at measuring the outcome dimensions chosen, i.e. user satisfaction, participation, and frequency of use, were available in Danish (34).

As regards user satisfaction, the first English version of the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST 1.0) had appeared in 1996 (21). It was intended for measurement of outcomes of assistive technology from a user perspective and developed on the basis of the state of the art in satisfaction assessment (21). Subsequently international psychometric studies followed, and in 2000 the revised version, the QUEST 2.0, based on the results of these studies, was published (20).

When it comes to measurement of participation outcomes of assistive technology, no instruments were available. Some general instruments for measurement of participation outcomes existed, but they were not judged applicable, mostly because they did not take assistive technology into account at all, a situation which has not improved much today (71). Measurement of frequency of use seems to be simple, but no instrument or other standardised way to measure these outcomes were at disposal (61;62).

For this thesis a translation and cross-cultural adaptation process of the QUEST 1.0 was required to make it usable in Denmark. The main objective of such a process is to make sure that the source and the target version of the instrument measure the same phenomenon, ensuring equivalence of the two versions and that the target version is culturally feasible to use (12;72–74). Another quality requirement of measurement instruments is that they should go through psychometric testing (75;76) aiming at making measurements objective in the sense that they should not be dependent on other factors than the phenomenon to be measured (77;78). Since validation is an ongoing process depending on

the purpose of the measurement, it is not possible to make an absolute statement about the validity of an instrument (75;79), and when a measure is reliable it cannot be inferred that it is also valid, even though reliability is a necessary precondition for validity (80).

In the field of assistive technology translation and adaptation processes and psychometric properties of instruments are rarely reported (81;82), implying that it is not possible to assess the trustworthiness of results reported, which in turn makes it difficult to base decisions about prioritisation and quality improvement on them. Consequently research and publication of translation and psychometric testing of assistive technology outcome measurement instruments are called for.

Previous research on mobility device intervention outcomes

Overall, little research on rollator interventions has been carried out, mostly about technical issues and the rollator's impact on body functions. No studies targeting user satisfaction and only few about the effectiveness were identified, showing that rollator interventions were effective (38;83) and cost-effective compared to other rehabilitation interventions (84). A number of studies were about non-use of mobility devices, but since the studies included different kinds of devices the results were difficult to interpret (82).

The body of research concerning adult people's use of powered wheelchairs is slightly larger but still limited, especially regarding user satisfaction and effectiveness outcomes. Most studies concerned assessment of user needs and abilities, how to use a powered wheelchair, accidents, technical features, etc. (85–87). User satisfaction with different characteristics of the powered wheelchair and the services varied. Compared to satisfaction with manual wheelchairs the users' opinions varied as well, even though the overall picture was that users were more satisfied with powered wheelchairs (88–91). As regards effectiveness, most studies targeting participation showed that powered wheelchairs made participation possible (92–95), and that they were used frequently (89;96), while one study revealed that about a fourth of all powered wheelchair users had had their problems solved to a lesser extent than expected (90). Some studies also included other kinds of devices and/or interventions, making it difficult to identify outcomes of powered wheelchair interventions (97–101). Since both user satisfaction and participation outcomes were positive it may be questioned whether the two constructs represent the same or different phenomena. If the constructs are identical, measuring both is redundant and inefficient. Only one study touching upon this issue was identified, revealing that user satisfaction and an aspect of effectiveness defined as 'problem-solving ability' were related but separate constructs (102).

Most of the few outcome studies on mobility device interventions identified were either pilot studies or qualitative studies, and moreover most quantitative studies were rather small (35;92;103;104), making generalisation for prioritisation purposes difficult. In addition, little attention has been paid to reasons and determinants for poor outcomes, necessary as a fundament for developing the quality of interventions.

In conclusion, even though rollator and powered wheelchair interventions are widely used and considered to be of benefit for the users and to fulfil important social and health policies, knowledge about outcomes in terms of user satisfaction and effectiveness, i.e. participation and frequency of use is limited. In addition, underlying reasons for outcomes and the role of assistive technology service are rarely identified. Measurement instruments are scarce and translation and adaptation processes rarely reported, which is also

true regarding psychometric testing. Moreover, the understanding of the constructs underlying the selected outcome dimensions is insufficient, possibly resulting in redundant and inefficient measurements. The need for more knowledge about rollator and powered wheelchair outcomes is essential for prioritisation purposes, especially because the number and proportion of the population with limited walking capacity are expected to continue to increase. Such knowledge is also fundamental for quality development of interventions within rehabilitation, and particularly for occupational therapy as the predominant profession within the assistive technology arena.

Aims

The overarching aim of this thesis was to provide knowledge about outcomes of assistive technology for societal prioritisation purposes and for quality development in community-based occupational therapy practice. The particular focus was on outcomes of rollator and powered wheelchair interventions in terms of user satisfaction and effectiveness.

The specific aims were to investigate

- user satisfaction with rollators one and four months after receipt, and change between the two measurement occasions;
- user satisfaction with powered wheelchairs more than one year after receipt;
- use of powered wheelchairs for participation;
- frequency of use of rollators and powered wheelchairs;
- barriers, indicators and determinants of outcomes of rollator and powered wheelchair interventions

Further specific methodological aims were to:

- translate and adapt the English QUEST 1.0 into Danish language and culture;
- investigate the equivalence and content validity of the Danish QUEST 1.0;
- investigate construct validity and reliability aspects of user satisfaction and participation;
- examine the relationship between user satisfaction and participation

Materials and methods

This thesis comprises four papers, based on three studies; an overview of the studies is given in Table 1.

The translation study consisted of:

1. Translation and cross-cultural adaptation of the English QUEST 1.0 (Paper I).
2. A pre-test and revision of the translated test-version of the instrument based on interviews with rollator users (Paper I).

The rollator study consisted of

1. An empirical follow-up interview study on user satisfaction with and frequency of use of rollators (Paper II)
2. A cross-sectional study of the equivalence and content validity of the Danish QUEST 1.0 (Paper I).

The powered wheelchair study consisted of

1. An empirical cross-sectional interview study on user satisfaction, participation, and frequency of use in relation to powered wheelchair interventions (Paper III).
2. An investigation of validity and reliability aspects of user satisfaction and participation and their relationship based on items and data selected from the empirical part of the powered wheelchair study (Paper IV).

Paper I is thus based on the translation study and the rollator study. *Paper II* on the rollator study, and *Papers III and IV* are based on the powered wheelchair study (Table 1).

The methodological development necessary for the empirical results is presented in the methods section of this thesis.

Study procedures and settings

The leader of all three studies was the author of this thesis, and multidisciplinary committees consisting of experts working in the field of assistive technology were involved in the translation study and the powered wheelchair study. The task of the committees was to advise the study leader during the study phases, including discussion of the results. All three studies were interview studies that took place in Danish municipalities in the users' homes.

The translation study (Paper I)

For this study the approach recommended by Guillemin, Bombardier, and Beaton (12) was applied. The English QUEST 1.0 (21) was translated forwards and backwards, the versions were compared and discussed by the translators and by a multidisciplinary committee. A pre-test took place in a medium-sized Danish municipality of about 43,000 inhabitants. The interviewer was an occupational therapist from the municipality. After each interview the interviewer completed a questionnaire (evaluation questionnaire no.1) consisting of open-ended questions about instrument qualities (Table 1). The results were discussed by the multidisciplinary committee which recommended revisions. Furthermore, one of the authors of the English QUEST 1.0 was consulted. Finally, the instrument was revised, resulting in the Danish QUEST 1.0 (Figure 1).

The rollator study (Papers I and II)

Seven Danish municipalities took part, selected to give maximum variance in terms of size, geographical dispersal, and urban/rural representation. The municipalities provided in all 13 experienced occupational therapists or physiotherapists who carried out interviews. A training seminar was held in order to ensure uniform procedures. The therapists who had granted the rollators asked the users for permission to interview them. In order to avoid bias, the users were interviewed by another therapist from the same municipality (105).

In each municipality first-time rollator users were consecutively enrolled. In some municipalities systematic sampling was applied when all rollator users were not to be included due to resource restrictions, (Paper II). The interviews were carried out about one month after the users had received their rollator (t_1) and again three months after the first interview (t_2). The Danish QUEST 1.0 (Paper I) was used for the interviews (Paper II), and after each interview the interviewer completed an open-ended questionnaire about instrument qualities (evaluation questionnaire no.2) (Paper I) (Table 1) (Figure 1). Finally, QUEST data were made anonymous and sent to the project leader together with the completed evaluation questionnaires.

The powered wheelchair study (Papers III and IV)

The research district consisted of 12 Danish municipalities, selected to be representative of Denmark in terms of size and geographical location. Specific inclusion criteria of the powered wheelchair study were that the users were to be at least 65 years of age and have had a powered wheelchair for at least one year. In small municipalities all users were enrolled, while in larger municipalities users were selected at random from municipality files. Administrative staff from the municipalities contacted the users by letter informing them about the study and asking them to participate. Twelve experienced interviewers from the National Danish Institute of Social Research (SFI) carried out the interviews. After a training session each interviewer contacted the users in order to accomplish the interviews. Subsequently data were made anony-

Table 1. Thesis overview.

Study	Paper	Objectives	Study designs	Samples	Instruments	Data analyses
Translation study	I	Translate and adapt the QUEST 1.0 to Danish language and culture	Not applicable	Not applicable	Not applicable	Not applicable
	I	Pre-test and revise the test version of the Danish QUEST 1.0	Cross-sectional questionnaire study	10 rollator users, mixed age-group	Open-ended study-specific evaluation questionnaire no. 1	Qualitative approach
Rollator study	II	Investigate user satisfaction with rollators, change of satisfaction over time, frequency of use of rollators, and barriers to and indicators of not being satisfied	Follow-up interview study	64 rollator users, mixed age group: 64 at t_1 and at t_2	The Danish QUEST 1.0	Student's t-test; Chi-2 test; Wilcoxon signed rank test; bivariate analyses of ORs[a]; grouping of qualitative responses
	I	Investigate equivalence of the Danish QUEST 1.0 and its content validity	Cross-sectional questionnaire study	132 rollator users, mixed age group: 77 at t_1 + 55 at t_2	Open-ended study-specific evaluation questionnaire no. 2	Grouping of qualitative responses
Powered wheelchair study	III[b]	Investigate user satisfaction with powered wheelchairs, participation using them, frequency of use, and barriers to and determinants for less beneficial outcomes	Cross-sectional interview study	111 powered wheelchair users, age 65+	Structured study-specific 'powered wheelchair questionnaire'	Student's t-test; Chi-2 test; Wilcoxon signed rank test; bivariate analyses of ORs; logistic regression analysis of ORs

Cont.

Table 1. continued.

Study	Paper	Objectives	Study designs	Samples	Instruments	Data analyses
Powered wheelchair study	IV	Investigate aspects of validity and reliability of user satisfaction and participation, and to examine the relationship between them			Study-specific scales: 'user satisfaction' and 'mobility related participation'	Rasch analyses: Conditional maximum likelihood estimates, conditional ratio likelihood tests; Mantel-Haenszel analyses; graphical loglinear Rasch models; methods for conditional inference in Rasch models. Cronbach's alpha; Kendall's tau-b

t_1: at first interview one month after receipt of rollator
t_2: at second interview four months after receipt of the rollator
[a]odds ratios
[b]satisfaction results not presented in papers

mous, entered into a database, and sent to the project leader.

Samples

General inclusion criteria for users were mobility limitations and consequent mobility device use. Besides, they had to be able to answer questions in a structured interview as assessed by the therapists who had been responsible for the mobility device intervention. Since all users were selected from municipality files, an indirect inclusion criterion was that the mobility device had been granted by the municipality for long-term use.

The translation study (Paper I)

The interviewer selected ten rollator users from the files of the municipality on basis of a number of inclusion criteria, defined to represent typical rollator users. They were to have had a rollator for at least six months to make sure they were experienced users, besides which different user categories in terms of gender, cohabitation, and housing were to be represented, and the majority had to be over 70 years of age. Four could not participate, thus four other users were enrolled. The characteristics of the respondents were as follows: The mean age was 76 (range 50–92). Four lived in a private house, three in a flat, two in sheltered housing, and one in a nursing home. It turned out not to be possible to enrol more than one male user.

The rollator study (Papers I and II)

In addition to the general inclusion criteria, the users were to be living in private homes and just have received a rollator for the first time. The first interview was performed in connection with the assistive technology evaluation and implementation process, and all 89 users who were asked to participate in the study agreed to be interviewed, while 64 were interviewed at follow-up (Paper II). The characteristics of the users who were interviewed twice and the users who could not be followed were compared. No differences between the two groups were found, indicating no selection bias due to loss to follow-up.

For Paper I all interviews at t_1 (n=89) and t_2 (n=64) were utilised as the basis for the interviewers' completion of evaluation questionnaire no.2 about qualities of the Danish QUEST 1.0, even though at t_1 only 77 and at t_2 55 evaluation questionnaires were completed. In Paper II only those who were interviewed twice (n=64) were included. The mean age was 76 years (range 41–92 years), about one third were men (n=21) and most lived alone (n=42). The way the sample of rollator users was utilised in Papers I and II is illustrated in Table 1.

The powered wheelchair study (Papers III and IV)

A total of 153 users were asked to participate, but in the end four users were not eligible. Out of the remaining 149 users, 111 (74%) were willing and able to participate. The mean age of the users was 77 years (range 65–92 years), about half were men, and about three fourths lived alone. Approximately three fourths of the users had a scooter-type powered wheelchair, while the remaining had a joystick-controlled type. On average they had used a powered wheelchair for 4.5 years (range 1–22 years) and had had their present powered wheelchair for 3 years (range 1–16). Most were able to transfer to the wheelchair without assistance from others, while 17 were not. In order to investigate whether the study sample was representative of the study population, the study sample and the group of non-respondents were compared. No differences between the two groups were found.

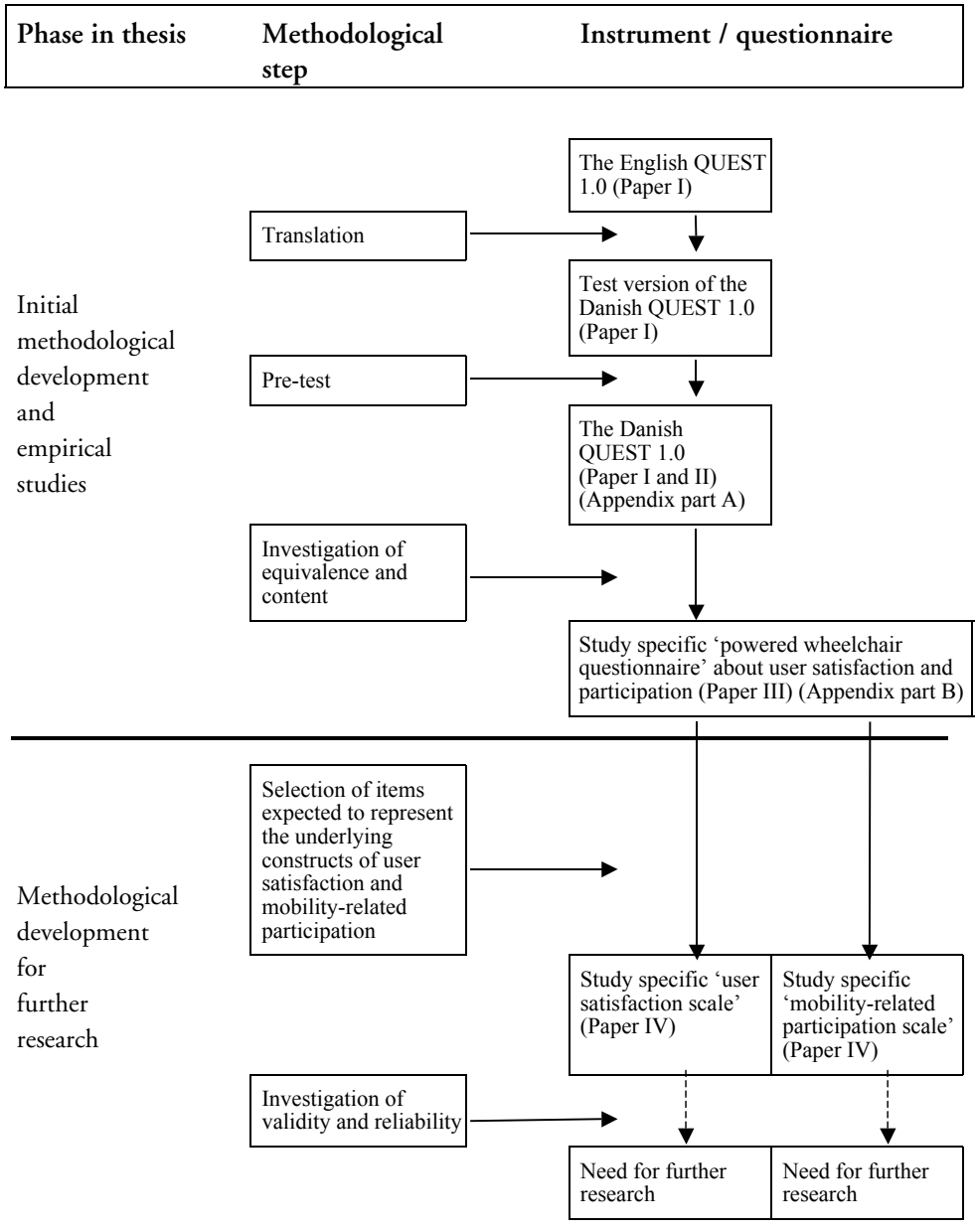

Figure 1. Instrument and questionnaire overview

Instruments and questionnaires

An overview of the different instruments and questionnaires used is given in Figure 1.

The QUEST (Translation and rollator study, Papers I and II)

The English QUEST 1.0

The English QUEST 1.0 (21) was a structured interview questionnaire divided into three parts. Part one consisted of 18 background questions. Part two focused on the user's apprehension of the assistive device and related services in terms of *importance*, including 24 items. Response categories ranged from 1 denoting 'of no importance' to 5 'very important' on an ordinal 5-point scale, and besides, a 'don't know/non-applicable' option was offered. In part three 19 of the 24 items were scored in terms of *satisfaction*, ranging from 1 denoting 'not satisfied at all' to 5 'very satisfied'. Besides, 'don't know/non-applicable' could be selected. If an item was rated 1, 2 or 3 the user was asked to explain the reason for not being fully satisfied.

Preparation of the Danish QUEST 1.0 (Translation study, Paper I)

Since only minor differences between the original version and the back-translated version appeared, only one translation was made, but subsequently the multidisciplinary committee identified needs for cross-cultural adaptation. Besides, some items were not experimentally or idiomatically equivalent. When possible, the wording was adapted. The result of the process was a *test version of the Danish QUEST 1.0*, which was used for the pre-test in Paper I (Figure 1).

In the pre-test some of the rollator users found it difficult to relate to 'importance', and when asked to rate satisfaction some thought they already had answered the question once before. Generally, quite a lot of explanation was needed for the users to understand the questions, and in addition, idiomatic and semantic equivalence problems were identified. Moreover, some content validity problems appeared. No user stated that any items were missing.

In parallel, international validation studies were going on and preliminary results that were published later on were communicated by one of the authors of the English QUEST. More specifically, the rating of importance and a number of items would be deleted from the future version of the instrument because they appeared not to be valid (106;107). Since the users in the pre-test had difficulties relating to importance, this dimension was deleted in the Danish version as well. Four items were deleted for the same reasons.

The result of the translation and adaptation process was the *Danish QUEST 1.0* (108), which is included in the Appendix part A (in English). The modifications made are displayed in Table 2 in Paper I (Figure 1).

Content and equivalence study of the Danish QUEST 1.0 (Rollator study, Paper I)

The Danish QUEST 1.0 (Paper I) was used in the rollator study, in which study equivalence and content validity were also evaluated. In the analysis the responses were regarded as open-ended responses in a quantitative survey and analysed accordingly (109) by grouping and coding the comments. The users understood the wording of the items and the scale, but some had difficulties expressing detailed opinions. The main explanation offered by the interviewers was that the users were satisfied, while a few explained that a rollator is too simple a device to have an opinion about. Some items were not regarded as relevant, either because the users did not have sufficient experience to be able to answer these questions as early as one month after having received their device, or the items were not considered relevant in relation to rollators. Some of the

comments were that numerous items were intertwined, very alike and difficult for the users to separate.

Powered wheelchair questionnaire (Powered wheelchair study, Paper III)

For the powered wheelchair study a study-specific structured questionnaire was constructed, called 'powered wheelchair questionnaire' (Appendix part B). Questions about user satisfaction with powered wheelchairs were composed on basis of the results of the equivalence and content validity study reported in Paper I, even though two items (weight and adjustment) were not included, since they were not considered relevant for powered wheelchair use. The QUEST 1.0 response categories were used.

The rest of the questionnaire was about participation outcomes and background information, constructed on basis of the HAAT model (5), i.e. questions concerning the person, the powered wheelchair and related services, the activity, and the environment. Besides, it was based on literature studies and the practical experiences of the multidisciplinary committee (Paper III). The powered wheelchair questionnaire is included in English in the Appendix part B.

After having constructed the questionnaire, a pilot test was carried out. The test included four male and four female users of powered wheelchairs, ages ranging from 72 to 85 years. After each pilot interview the questionnaire was optimised and the new version used in the following interview. The pilot interviewing was brought to an end when two interviews had not resulted in any need for changes.

'User satisfaction' and 'Mobility-related participation' scales (Powered wheelchair study, Paper IV)

After completion of the empirical study two study-specific additive scales were composed in order to study the constructs 'user satisfaction' and 'mobility related participation'. For construction of the two scales, items from the powered wheelchair questionnaire that were expected to represent the underlying constructs under investigation were selected. Thus the items were used differently from Paper III.

For the user satisfaction scale items with the same contents as the QUEST 2.0 (20) were selected, because the QUEST 2.0 had undergone psychometric testing (102) increasing the probability that the constructed scale would be valid and reliable. Six items concerning the powered wheelchair, called the device subscale, and four about related services, called the service subscale, were selected. However, the device subscale included two items less than the QUEST 2.0 device subscale, because the items in question had not been considered relevant for the powered wheelchair questionnaire. For construction of the mobility-related participation scale, items that presupposed mobility and were judged to represent participation aspects were selected: ten items concerned desired participation aspects and two items were about travelling by bus bringing the powered wheelchair.

Data analyses

Qualitative comments in the rollator study[2]

The qualitative comments about sources of users not being satisfied were regarded as open-ended responses in a quantitative survey and analysed according to that (109). First responses were counted and grouped, then one of the groups was further analysed according to the HAAT model (5).

[2] Paper II presented typical responses which have been further analysed for this presentation.

Quantitative data in the rollator study (Paper II) and the powered wheelchair study (Paper III)

In all analyses the significance level was $p<0.05$ and confidence limits were 95%. Student's t-test was used for continuous parametric data and the Chi-2 test for dichotomised data. Wilcoxon signed rank test was applied in order to examine change between t_1 and t_2 in the rollator study (Paper II) and to analyse difference in frequency of use in the powered wheelchair study (Paper III). The Chi-2 test was used to analyse differences between participation aspects (Paper III) (Table 1).

Indicators of not being satisfied in the rollator study were calculated by bivariate analyses resulting in crude odds ratios (ORs) (Paper II). The term indicator was used when only bivariate analyses had been performed, while 'determinant' was used when multivariate analyses using the logistic regression method had been accomplished as well, resulting in adjusted ORs. In Paper III the logistic regression Backwards LR method was applied, while the Enter method was used for analysis of determinants for user satisfaction with powered wheelchairs, because it had been realised that it is preferable when a specific model is not being analysed (110;111).

'User satisfaction' and 'mobility-related participation' scales (Paper IV)

The construct validity and reliability of the two scales were investigated by examining to what extent they met the requirements of criterion-related construct validity (112) and objectivity (78). For this purpose the fit of item responses to Rasch models was analysed. If item responses fit a Rasch model well, it is evidence of construct validity and unidimensionality (78;112), which means that the scale only measures one underlying construct. In addition, the Rasch model requires measurements to be objective, i.e. that they do not depend in any systematic way on the sample or which items are included in the scale. If measurements are objective it also means that they summarise all available information on the underlying construct from the item responses, called sufficiency (113). If item responses do not fulfil these requirements this may be due to differential items functioning (DIF), meaning that response patterns are not homogeneous across different subgroups of respondents (112).

The response patterns in relation to five subgroups (dichotomised scores, an external criterion, gender, age, and cohabitation) were initially analysed by calculating conditional maximum likelihood estimates of item parameters and performing conditional likelihood ratio tests that compare item parameters in different subpopulations (114;115) (Table 1). Further analyses were accomplished by Mantel-Haenszel procedures and graphical loglinear Rasch models (116;117). For evaluation of the reliability of the two scales we examined to what extent the items were targeted to the study population by using methods for so-called conditional inference in Rasch models (118), Mantel-Haenszel analyses of the relationships between items and person factors (119), and generalisations of Mantel-Haenszel analyses of relations between pairs of items (116;117). In addition, internal consistency was investigated using Cronbach's alpha (75) (Table 1). Finally, the relationships between the user satisfaction and the user participation scales were analysed using Kendall's tau-b (110) (Table 1).

Ethics

All users who participated in the studies gave informed consent and were guaranteed anonymity and confidentiality. Since none of the studies was experimental it was not necessary to have the study formally approved according to Danish ethical rules. In the powered wheel-

chair study, the Danish registration authorities granted the SFI permission for data collection and database construction.

Results

User satisfaction (Paper II)[3]

The users were in general satisfied with their rollators, and the satisfaction increased during the four months of use. However, not all were satisfied with the characteristics of the rollator and the related services. More than 90% were fully satisfied (i.e. satisfied or very satisfied) with the effectiveness and the durability of their device one month after receipt (t_1), while more than 20% were not fully satisfied with the rollator's adjustment, comfort, required effort, transportation of it, and its weight. However, many gave 'non-applicable/don't know' responses to the maintenance, durability, adjustment, and transportation items. Satisfaction with the rollators in terms of comfort, effort, appearance, and safety increased during the three months between the two measurements (Paper II).

As regards related services the rollator users were less satisfied. At t_1 more than 90% were fully satisfied with the service delivery, but more than 20% were not fully satisfied with repairs/servicing, professional service, and follow-up services, even though satisfaction with professional service and follow-up services had improved at the second interview, four months after receipt of the rollator. As to repairs/servicing a large proportion gave non-applicable responses (Paper II).

Concerning satisfaction with psychosocial issues the rollator users were very satisfied, especially in relation to the social circle support, with which 97% were fully satisfied at t_1. Satisfaction with psychosocial factors did not change between the two measurement occasions (Paper II).

Most powered wheelchair users were satisfied, even though some were not totally satisfied. More than 90% of the users were fully satisfied with their powered wheelchair's simplicity of use, appearance, effort required, and need for turning space. Even so, more than 20% were not fully satisfied with transportation of it, its speed, range of operation, power, suspension, and its room for carrying goods. More than half of the users gave 'non-applicable' responses to the item regarding transportation of the powered wheelchair. As to related services fewer were fully satisfied, and more than 20% were not satisfied with follow-up services (Table 2).

Participation (Paper III)

The most frequent participation aspects for which the powered wheelchair was used were going for a ride, shopping, and visiting friends and family. In the summer the powered wheelchair was most frequently used for going for a ride, while in the winter it was for shopping. In the winter the powered wheelchair was used less frequently than in the summer, even though this difference was only statistically significant in relation to going for a ride and moving about in the garden (Paper III).

Most participation aspects were performed by about the same proportion of men and women, but women used their powered wheelchair for more differentiated purposes than men. However, more men than women used the powered wheelchair for going for a ride in the winter. About one third travelled bringing their powered wheelchair, mostly by Special Transport Service provided by the municipality.

Most users found that they could use their powered wheelchair to go to desired places, even though about one fifth could not use it for visiting friends and family.

[3] Results concerning user satisfaction with powered wheelchairs are not included in the papers.

Table 2. User satisfaction with powered wheelchair interventions after at least one year of use[a] (N = 111).

Powered wheelchair characteristics	1: Not satisfied at all *n*	2: Not much satisfied *n*	3: More or less satisfied *n*	4: Quite satisfied *n*	5: Very satisfied *n*
Size	0	4	11	38	58
Safety	3	4	9	44	51
Durability	2	7	9	38	43
Simplicity of use	2	0	7	33	69
Comfort	3	3	12	26	67
Effectiveness	1	4	9	27	69
Appearance	0	2	7	50	52
Transportation	6	7	5	12	17
Effort	2	2	4	36	67
Speed	6	14	22	29	40
Range	3	7	13	29	50
Power	6	9	12	34	43
Space for turning	0	2	7	35	66
Suspension	7	15	21	25	43
Room for carrying goods	11	8	13	28	43
Related services					
Service delivery	3	4	14	22	67
Professional service	5	6	9	35	54
Repair and maintenance	3	5	8	32	42
Follow-up	5	10	15	33	44

[a] not included in papers

[b] missing and not applicable values not included

Frequency of use (Papers II and III)

Overall, the frequency of use was high and there were no 'non-users'. At t_1 in the rollator study nearly two thirds (66%) used their rollator every day, and 3% used it less than once a week, which did not change at t_2 (Paper II). In the summer approximately two thirds of the powered wheelchair users used their device at least once a day and three used it less than once a week. In the winter the powered wheelchair was used less frequently. About one fourth used it at least once a day, and 14 never used it outdoors in the winter (Paper III).

Barriers for beneficial outcomes

Concerning sources of not being satisfied,[4] 214 comments were given, 30 even though the users had rated items '4' or '5' denoting satisfaction. The comments were grouped into: the use of the rollator (*n*=140), services rendered (*n*=49), and adverse physical or psychological effects of using the rollator (*n*=25).

By far the largest number of comments

[4] The results were presented as typical comments in Paper II, while they have been analysed further for this presentation.

Not applicable *n*	Missing data *n*	Not fully satisfied (1-3)[b] *n* (%)	Fully satisfied (4-5)[b] *n* (%)	Median	Inter-quartile range
0	0	15 (14)	96 (86)	5	2–5
0	0	16 (14)	95 (86)	4	1–5
12	0	18 (18)	81 (82)	4	1–5
0	0	9 (8)	102 (92)	5	1–5
0	0	18 (16)	93 (84)	5	1–5
0	1	14 (13)	96 (87)	5	1–5
0	0	9 (8)	102 (92)	4	2–5
62	2	18 (38)	29 (62)	4	1–5
0	0	8 (7)	103 (93)	5	1–5
0	0	42 (38)	69 (62)	4	1–5
9	0	23 (23)	79 (77)	4	1–5
7	0	27 (26)	77 (74)	4	1–5
1	0	9 (8)	101 (92)	5	2–5
0	0	43 (39)	68 (61)	4	1–5
8	0	32 (31)	71 (69)	4	1–5
1	0	21 (19)	89 (81)	5	1–5
2	0	20 (18)	89 (82)	4	1–5
20	1	16 (18)	74 (82)	4	1–5
1	3	30 (28)	77 (72)	4	1–5

concerned the use of the rollator, some of which only had to do with the rollator, not related to the user's capabilities or the environment where it was used. These comments were about malfunctioning brakes (*n*=7) or the rollator being rickety (*n*=3). Other comments were about the interaction between the user and the rollator: difficulties in folding the rollator up (*n*=5) and adjusting it, especially as regards the height of the seat and the handgrips and putting on the basket (*n*=17). The main complaints, however, concerned the interaction between the user, the rollator, and the physical environments. Some comments did not refer to specific environmental characteristics, but were about the rollator being too heavy (*n*=20), large, or unhandy (*n*=19). Concerning specific physical environmental characteristics, some had difficulties using the rollator on uneven or sloping surfaces (*n*=23), others found that it was too heavy to get up stairs or over kerb cuts (*n*=14), into buses or trains (*n*=13) or into the boot of a car (*n*=3). Finally, a few were not satisfied with the design or other characteristics of the rollator (*n*=16).

Some rollator users (*n*=6) were not satisfied with the services received, because they found that the waiting time to get a rollator was too long, but by far the most comments (*n*=20) concerned lack of instruction/training in and information about use and adjustment

of the rollator. Twelve complained about lack of follow-up and eleven did not know whom to address in case of problems with the rollator. A few rollator users (n=10) reported tiredness and pain in hands, arms, and shoulders from using the rollator, while others (n=15) found it difficult to get used to using the rollator, including feeling old, insecure, or embarrassed.

As regards powered wheelchair use, the most frequently reported reasons why the device could not always be used for desired participation were that it could not go far enough or because of stairs, doorsteps, etc. (Paper III). When asked about difficulties[5] with going to places owing to missing or too steep kerb cuts, about half (n=53) answered that it was never or hardly ever a problem, about a fourth (n=29) said that they avoided such places, and about a fourth (n=29) stated that steep or missing kerb cuts were a problem. Concerning difficulties because of stairs about one fifth (n=21) reported that they never or hardly ever encountered this problem, about a third (n=38) answered that they avoided the problem by not going to places with stairs, and about one fifth (n=19) that stairs were a problem. Finally, about a third (n=32) declared that they did not take their wheelchair into shops, and one answer was missing.

Indicators and determinants of less beneficial outcomes (Papers II and III)

The most frequent indicator of not being satisfied with rollators was gender; it was more likely that women would not be satisfied with a number of characteristics of their rollators, e.g. simplicity of use and effort required, and with the professional service. Also the living situation was an indicator of not being satisfied: people who lived alone were more likely not to be satisfied with the effort required to use the rollator, the transportation of it, the professional service, and follow-up services. However, gender and living situation were correlated, indicating confounding. Other indicators were waiting time to get a rollator of more than two weeks and not having other devices (Paper II).

Of the seven investigated potential determinants for users not being satisfied with characteristics of their powered wheelchair and the related services,[6] by far the most frequent determinant was lack of instruction/training in use of the powered wheelchair. If users had not received instruction/training in use of the powered wheelchair, the probability of not being satisfied with the powered wheelchair's safety, effectiveness, motor power, suspense, room for goods, professional service, and follow-up was increased. In addition, the ORs were high, ranging from 3.5–10.4 (Table 3).

Age was a determinant for not being satisfied with the powered wheelchair's appearance, suspense, and service in the sense that it was more likely that users over 76 years of age would be satisfied, while gender was not a determinant. Users having a scooter type wheelchair were more likely to be satisfied with the comfort of the wheelchair and its room for carrying goods (Table 3).

If powered wheelchairs users were over 76 years of age it was more likely that they would not think that the powered wheelchair could be used for going to desired places, and that they would use it less frequently than the younger age group. Likewise it was also more likely that female powered wheelchair users would not think that the powered wheelchair could be used for going to desired places, which was also the case if the users could not transfer to the powered wheelchair without assistance or had visual difficulties. Finally, if the users had a car in the household it was a determinant for less frequent use in the winter.

[5] The results in the rest of this section are not reported in any of the papers.

[6] Not included in papers.

Table 3. Determinants for not being satisfied[a] with powered wheelchairs and related services. Crude odds ratios (ORs)[b] and ORs adjusted by means of logistic regression analysis[c] (N=111).

Factor	Determinant for not being satisfied[a] with	Crude OR	Adjusted OR (95% Cl.)
77–92 years old[d]	Appearance	0.1 p=0.046	0.1 (0.0–0.9) p=0.036
	Suspension	–	0.4 (0.1–0.9) p=0.031
	Service delivery	–	0.3 (0.1–1.0) p=0.050
Female[e]	–	–	–
Lived alone[f]	Comfort	–	6.5 (1.2–35.3) p=0.030
Joystick-controlled model[g]	Comfort	–	6.0 (1.5–23.8) p=0.011
	Room for goods	4.7 p=0.002	3.9 (1.7–11.8) p=0.017
Did not participate in selection of pw[h]	Room for goods	0.4 p=0.031	–
	Follow-up services	0.3 p=0.020	0.2 (0.0–0.6) p=0.009
Did not get any instructions[i]	Safety	4.8 p=0.007	5.4 (1.6–18.5) p=0.007
	Effectiveness	4.7 p=0.012	4.7 (1.3–16.6) p=0.015
	Motor power	–	3.5 (1.0–10.8) p=0.044
	Suspension	6.6 p=0.001	9.1 (2.6–31.6) p=0.000
	Room for goods	2.7 p=0.050	3.8 (1.2–11.9) p=0.023
	Professional service	7.2 p=0.010	10.4 (2.8–38.8) p=0.000
	Follow-up services	3.7 p=0.012	10.4 (2.2–49.1) p=0.003
Did not receive follow-up services[j]	Professional service	–	3.5 (1.0–11.8) p=0.043
	Follow-up services	–	16.4 (3.8–70.4) p=0.000

p.w. powered wheelchair

[a]Not satisfied consists of 'not satisfied at all', 'not much satisfied', and 'more or less satisfied'.

[b]Only results statistically significant at a level of p<0.05 are included

[c]Enter method, not included in papers

Reference groups (OR=1.0): [d]65–76 years old; [e]Male; [f]Lived together/other; [g]Scooter model; [h]Participated in selection of p.w.; [i]Got instruction; [j]Received follow-up services.

User satisfaction and mobility-related participation scales: Validity, reliability, and relationship (Paper IV)

Heterogeneity in relation to gender was disclosed for one item (follow-up services) of the user satisfaction scale, indicating differential items functioning (DIF). However, when the value of women's scores was compared to men's it appeared that no more than half a point on a 40-point scale should be added to make the scores comparable. It was found that the items targeted the population under investigation well, and that the internal consistency was good (Cronbach's alpha = 0.81).

Concerning the mobility-related participation scale no evidence against construct validity and objectivity was identified. However, the items targeted the study population less than optimally since the scale had problems discriminating between persons with a

high degree of mobility-related participation. In addition, the internal consistency was low (Cronbach's alpha = 0.47) and increased after reduction of seven of twelve items (Cronbach's alpha = 0.70).

Both scales fulfilled the requirements of the Rasch model, which is evidence of construct validity. The scales were thus unidimensional and the relationship between them could be investigated, revealing that there was no statistically significant correlation between the two scales (Kendall's tau-b = –.121, p=0.141, two-tailed).

Discussion

In this thesis outcomes of rollator and powered wheelchair interventions in terms of user satisfaction and effectiveness were investigated, mainly among older persons. The rollator users were generally satisfied with their device, and their satisfaction increased over time. Even so they were not fully satisfied; in particular the interaction between the user's physical capacity, the rollator, and the physical environments resulted in user complaints about the rollator being too heavy and unhandy. In addition, the users were not fully satisfied with professional service and follow-up services. Women and persons living alone were more likely not to be satisfied. The powered wheelchair users were satisfied with the received intervention in general, but not all were satisfied with some of the technical characteristics of their device and with follow-up services. If the users had received instruction or training the probability that they would be satisfied was increased. The oldest users were more likely to be satisfied than younger cohorts. The powered wheelchair could be used for desired participation aspects except that some could not visit friends and family, and most did not travel bringing their powered wheelchair. Stairs and kerbs constituted barriers for some, while others circumvented them. It was more likely that the oldest users, women, and users needing assistance for transfer would think that the powered wheelchair could not be used for going to desired places, and that the oldest users would use their device less frequently. Finally, all rollators and powered wheelchairs were used, even though powered wheelchairs were used less frequently in the winter.

In addition, a number of methodological aspects concerning outcomes research were targeted. The QUEST 1.0 (21) was translated and cross-culturally adapted, revealing low efficiency of back-translation and difficulties in obtaining equivalence. The oldest users had difficulties rating their satisfaction, and some questions could not be answered as soon as one month after receipt of the device, and some seemed intertwined. A new construct called mobility-related participation was explored to gain knowledge about participation outcomes to be expected from powered wheelchair interventions. The unidimensionality of the construct was confirmed, but the reliability was low. A user satisfaction scale was likewise tested and evidence of construct validity and reliability was found. Finally, it was revealed that user satisfaction and mobility-related participation were not related constructs.

User satisfaction, participation, and frequency of use

The finding of the high level of user satisfaction raises a number of reflections. It complies with literature (55) which also shows that users may be dissatisfied and still rate their satisfaction as high (50;97). This was found in the rollator study, in which users gave comments indicating dissatisfaction with items they had quantitatively rated high, besides which a huge number of complaints about the rollators emerged. This dualism in assistive device use has been found in other studies (120;121), underscoring the need to keep in

mind that even when assistive devices benefit the user, adverse effects are also to be expected, needing to be prevented as far as possible. The fact that age was a determinant for being satisfied has been found in other studies too, suggesting that older users are not so inclined to be critical as younger age cohorts (50;55). All in all it can be inferred that user satisfaction outcomes should be interpreted with caution. Perhaps high user satisfaction should rather be considered the norm and attention directed towards dissatisfaction, as being the information of interest. That is, dissatisfaction may express really negative experiences, important to take into account for quality development of assistive technology interventions.

There is only little agreement about what satisfaction really represents (54;122). In the present thesis the impact of interventions was focused upon rather than underlying personal factors such as expectations, values, and perceptions as stated in the used definition (20). The analyses of indicators and determinants showed that the actual intervention, e.g. the type of wheelchair, having received instruction/training in use and/or follow-up services, impacted user satisfaction, suggesting that improvement of services can increase user satisfaction. The fact that age was a determinant for user satisfaction with powered wheelchairs probably mirrored values of the age cohort. Gender seemed to play a role for user satisfaction with rollators, but since not being satisfied mainly had to do with physical problems handling the rollator, dissatisfaction was more likely to be caused by women's physical capacity (123) rather than gender preferences. The definition of user satisfaction employed here included expectation, which is often emphasised as a salient factor (48), but the role of expectations may be questioned since some studies have shown that expectations are not always related to satisfaction outcomes (50;55), and it has been demonstrated that older patients' satisfaction was not influenced by their expectations, which to some extent were low or non-existent (122). It might be expected that motivation would play a role for user satisfaction, however, no literature disclosing this has been identified.

Even though effectiveness in terms of participation and frequency of use was high, some users could not use their powered wheelchair for social purposes such as visiting friends and family. This has also been found other studies (124;125) and is of concern, since social relationships are important for quality of life (126). The finding that the oldest age group had a lower degree of participation and frequency of use has also been found in another study (124) and could be interpreted as suggesting that older people benefit less from powered wheelchair interventions. However, these results should rather be ascribed to older people's mobility pattern in general, older people being less active than younger age groups (37), rather than considered specific for older powered wheelchair users. Gender differences also occurred; among other things, women did not think the powered wheelchair could be used for going to desired places. This may be explained by the fact that women's and men's participation aspects in general differ (127;128), and likewise in the powered wheelchair study women used their device for more different participation aspects than men and thus probably experience difficulties more easily. Moreover, men and women relate to technology in different ways, men finding it easier to use high-technology-based devices than women do (129). The proportion of female powered wheelchair users was lower in the study population than in the population of older people in general, while the proportion of women in the rollator study was much the same as in the general older population, suggesting that women may prefer low-tech devices such as rollators to powered wheelchairs.

The fact that all devices were used underscored their effectiveness. In previous studies in general, non-use of assistive devices is much focused upon (130–132) giving rise

to reflection about why all rollators and powered wheelchairs in the present studies were used. No clear-cut answer can be given, but one explanation may be the operationalisation of 'non-use', since non-use in the present thesis was defined as not using the device at all, while other definitions such as 'not full-time use' are applied in other studies (62). Another explanation may be that devices intended for temporary use have been included in other studies resulting in a higher rate of 'non-use' than in the present studies which included only devices for long-term use (133–135). The most probable explanation may, however, be that devices in Scandinavia usually are granted on the basis of trained occupational therapists or physiotherapists' assessments of the user's need for a device, often in the user's home environment. Thus only users who are expected to benefit from using a device get one. Furthermore, studies have shown that the involvement of occupational therapists in the assistive technology provision, preferably by home visits (136), leads to fewer adverse effects, higher frequency of use and more benefits for the users (137;138). Although all devices were used, the users reported difficulties using them, which indicates that the relative advantage must be high (139), since the users had not stopped using their devices in spite of difficulties. Consequently, research concerning rollator and powered wheelchair use should focus on difficulties in use rather than non-use.

Physical environmental barriers in terms of stairs, steep or no kerb cuts, uneven surfaces were identified. Mobility devices follow the users wherever they go, consequently it is the interaction between the device and the physical environment rather than the interaction between the person and the physical environment that influences the outcomes (67;140). Even so the powered wheelchair users did not experience environmental barriers as extensively as expected based on other studies (95;125;141). The reason seemed to be that some users circumvented physical environmental barriers when possible, by e.g. choosing accessible shops. Similar reactions have been found in another study (142) and may be characterised as adaptation, i.e. that the individual organises his/her occupations to improve life opportunities in dynamic environments (3). Although this strategy was profitable for making participation possible in some situations, environmental barriers still resulted in restriction of participation opportunities. Hence reduction of environmental barriers is essential for increasing the effectiveness of powered wheelchair interventions.

Methodological considerations

The insight that the ICF terms activity and participation were not optimal for outcomes research of mobility device interventions resulted in the construction of a scale expected to represent the underlying construct 'mobility-related participation', reflecting expected participation outcomes of mobility device interventions. The existence of one underlying construct was confirmed, and likewise the notion that the construct was a participation dimension was verified by another study in which similar items had been perceived as participation aspects (58). However, the construct was not clear-cut after all, since it appeared that the scale did not discriminate very well between individuals with high degree of mobility-related participation, and besides the internal consistency was low. One issue for reflection is that mobility-related participation mainly takes place in dynamic environments, in which physical environmental demands may differ substantially: the items found to be most difficult involved high physical environmental demands, suggesting that mobility-related participation is mainly determined by the characteristics of the physical environments, i.e. that mobility devices make it possible for users to get about, but that the

physical environment is decisive for mobility-related participation.

Another issue to be reflected upon is that some items were about performance of desired participation aspects, while two concerned travelling, no matter whether it was desired or not. In occupational therapy this differentiation is often emphasised by using the term 'activity' for any activity at all with no preference to the individual, while the term 'occupation' denotes an activity that is purposeful and meaningful to the individual (14;31;143). Consequently differentiation between items presupposing/not presupposing meaningfulness should be studied further. Mobility-related participation can thus be regarded as a promising new concept for future research, which is more specific for mobility device intervention outcomes research than the broad ICF participation concept. However, it remains to be investigated whether the construct is valid for evaluation of mobility devices in general. In spite of the identified limitations of the ICF, it is nevertheless important to direct further efforts towards clarifying and understanding the constructs of the ICF terms, given the pivotal role of the ICF in communication across different disciplines and sectors and in implementation of the UN Standard Rules (2;56;144).

In the thesis it has not been possible to develop a conceptual model for assistive technology outcomes research. Yet attempts have been made to define concepts, which is the first step towards theory development (145). Furthermore, knowledge about factors influencing outcomes was gained illuminating the extent to which the HAAT (5) and the PEO (19) models are applicable. The studies disclosed relationships between the person, the assistive technology, the physical environment, and the participation aspect, thereby confirming the relevance of the domains of the HAAT model and the need to include assistive technology as a separate domain in the PEO model to make it useful for assistive technology research. In addition, the domains were found to be transactional, rather than mere interfaces as described by the HAAT model. To exemplify, the participation aspect 'shopping' using a rollator is influenced by the user's physical capacity to lift the rollator over kerbs on the way to the shop, the user's skills in doing this, the weight of the rollator and goods in the basket, and how accessible kerb cuts and the shop are. All four domains are continuously involved and determine the user's shopping performance, indicating that a conceptual model has to be transactional. Hence, for assistive technology outcomes research a transactional model encompassing four domains based on a combination of the HAAT and the PEO models might be feasible for further development of conceptual models. Additionally, the rollator study showed that outcomes change over time, implying that this aspect should be included in a conceptual model, a feature that both models accommodate.

The translation study showed that only little knowledge about equivalence was gained by back-translating the instrument, in contrast to the multidisciplinary discussions and the empirical studies. Since back-translation is rather resource demanding, the efficiency of the method may be questioned, lending support to those who question its value and relevance (12;73;146). In addition, it has been pointed out that there is no evidence of the effectiveness of back-translations (147). The translation study also revealed that equivalence is difficult to obtain, more so than usually reported (148–150). The reason for the different findings may be that evaluation focusing on equivalence problems is not usually performed. The difficulties in finding equivalent wording further raise the question of how close a cross-culturally adapted instrument must be to the original version in order to claim it to be an identical instrument. During the instrument adaptation process information about non-published results of the international reliability and validity studies were

utilised. It may well be discussed whether this was the right decision, since the adaptations were not based on Danish construct validity and reliability studies. However, it would have been difficult not to use results showing that e.g. the importance scale was not valid. The dilemmas encountered in instrument translation and adaptation illustrate the challenges of the process, but no clear-cut solutions are at hand (151).

Since some of the questions of the QUEST could not be answered shortly after the users had received their device, while the validity of responses about satisfaction with assistive technology service given more than a year after receipt may be questioned, it is difficult to decide at what point of time in the user's 'mobility-device career' a QUEST interview should be accomplished. The fact that the equivalence and content validation studies showed that the oldest users had difficulties scoring their satisfaction casts doubt on whether user satisfaction is a valid measure of the oldest users' perspectives of assistive technology.

Neither the QUEST 1.0 nor the QUEST 2.0 has been psychometrically tested in Denmark. However, the analysis of the user satisfaction scale which is close to the QUEST 2.0 provided evidence of construct validity, confirming international results on the validity of QUEST 2.0 (102;152). In addition, the internal consistency was high even though the instrument consisted of two items less than the QUEST 2.0. This suggests that the QUEST 2.0 probably is reliable, even if responses are not given to all items. However, it is not known to what extent the results are valid in relation to other kinds of assistive technology. The QUEST 2.0 manual (20) recommends summarising data, even though the instrument comprises ordinal data that should not be added. However, if data cannot be summarised it is more difficult to compare outcomes. A method to transform the ordinal scales into interval scales is further application of Rasch analyses, which could be performed along with further psychometric studies, preferably in cooperation with other countries. Thus the studies will be coordinated and sufficiently large sample sizes for Rasch analyses can be obtained (153).

The finding that user satisfaction and mobility-related participation were different constructs indicates that the two outcomes dimensions represent substantially different information. Subsequently measuring one dimension cannot replace measurement of the other.

Indicators and determinants of less beneficial outcomes were identified, expressed by odds ratios (ORs). When interpreting ORs it should be kept in mind that they are ratios, meaning that for instance an OR of 4.00 is more than twice as much as an OR of 2.00. In Paper III the Backward LR method was used, but in the thesis the analysis of ORs for dissatisfaction with powered wheelchairs used the Enter method, because it was realised that this method is preferable when no specific model is being analysed (110;111). The analysis of ORs in Paper III has since been replicated using the Enter method, resulting in reduced ORs but identical trends, and the ORs were still high.

The different study designs and use of instruments may seem complex and difficult to overview. The complexity reflects that the studies have been performed over several years in a dynamic practice-oriented community context establishing the relevance for practice contexts. In the process, each step yielded instruments or insights necessary for accomplishing the next step. An example is the fact that the results of the rollator study indicated that satisfaction outcomes were insufficient for prioritisation purposes, resulting in inclusion of participation outcomes in the powered wheelchair study.

The studies were carried out within a Scandinavian context. The differences from other countries are, among other things, that most assistive technology is provided free of charge,

and usually occupational therapists or physiotherapists are involved in order to secure the quality of the intervention. The results of the present thesis are therefore mainly related to Scandinavia, in contrast to the majority of assistive technology research hitherto. In addition, the research has been carried out within the framework of occupational therapy, but still some of the results may be relevant for other professions in the field of assistive technology.

The study population mainly comprised older people, reflecting that most mobility device users belong to older age groups. Since old age was a determinant for some of the outcomes the results should be applied with caution if used with younger cohorts. In the present thesis rollator and powered wheelchair interventions were specifically investigated and the results can probably not be transferred to other types of devices, since devices have different functionality, yielding different outcomes (83).

The knowledge resulting from the present thesis was intended as basis for societal prioritisation and quality improvement, which should be evidence-based (154). Usually systematic reviews of randomised controlled trials (RCTs) are considered to be the highest level of evidence (154), but in community context the application of RCTs has a number of limitations (155). In occupational therapy random allocation of interventions is mostly impossible since the basic principle of the profession is cooperation with clients based on their preferences (156), besides which it may unethical to withhold interventions which are found to be effective by practical experience (155), and in addition, RCTs tend to leave out personal perspectives (157). These problems apply to assistive technology as well, making the RCT study design impossible to use in most cases. Hence other study designs are required, e.g. follow-up studies that can establish cause-effect relationships, and even cross-sectional studies may be used if there is no doubt about the direction of the cause-effect relationship (158;159). This is true for some of the outcomes in the studies used, which comprised sample sizes of a relatively large size compared to a number of other studies. Even so, it would have been an advantage to have had larger sample sizes for identification of determinants in the rollator study and for the Rasch analyses (153). However, it would have been costly to carry out even larger interview studies, and given the difficulties some of the oldest users had rating their opinions, the validity of a more affordable questionnaire-based survey may be questioned. Nevertheless, in the light of the strong unidirectional outcomes, the results of the present thesis can be considered to be trustworthy and applicable in societal prioritisation and quality development.

Practical implications

In terms of societal prioritisation purposes, it can be concluded overall that rollator and powered wheelchair interventions to a high degree fulfil legislative intentions, and that the level of user satisfaction additionally is high. Moreover, a study has showed that mobility devices are cost-effective compared to other rehabilitation interventions (84). One way to prioritise societal resources is to establish eligibility criteria that should be as valid as possible. The results of this thesis suggest that some eligibility criteria for powered wheelchair grants should be reconsidered:

- In some countries (160) and in Danish municipalities eligibility criteria only encompass applicants who cannot walk at all or transfer to the wheelchair without assistance. However, applicants with some walking capacity should to a higher extent be eligible, since they benefited substantially from using a powered wheelchair.
- Another common eligibility criterion is that the user must be in need of the powered wheelchair for shopping or for going to specific places. Yet the users' needs seem

to be different; the most frequent activity reported was going for a ride, and also visits to friends and family were frequent. The need to go outside to get fresh air and sunlight is a basic health requirement and must be considered as important as more targeted activities (161). Likewise it has been shown that not only physical but also social activities have positive effects on survival rates (162).

- The fact that the proportion of powered wheelchair users is lower among older people, even though the prevalence of limited walking capacity is higher, indicates that old age may be considered a contraindication for granting powered wheelchairs. However, the powered wheelchair study showed that the 65+ age group did benefit from their powered wheelchair and should thus be equally eligible as younger age groups.

Regarding quality development of mobility device interventions, occupational therapy services to be improved were identified:

- In the evaluation phase of the assistive technology service, the user's capacities and the requirements of the environments in which participation is to take place need to be assessed thoroughly in order to define valid requirements for the device model. The problems of lack of match between user, participations aspects, environment, and device have been studied in the US, resulting in a method for systematic matching, the MPT method (163). Application of this or similar systematic methods could probably improve assistive technology outcomes and prevent adverse effects.
- In relation to selection of specific types of powered wheelchairs, the scooter type should be selected if possible, since it was a determinant for satisfaction aspects.
- Instruction or training in the use of the mobility device should always be given, since it impacted user satisfaction substantially. It is important that the users feel comfortable using their device and know how to handle it, as has also been pointed out in other studies (132;134;164).
- Follow-up services should be provided because this was a determinant for user satisfaction with follow-up services.

In addition to mobility device interventions further measures need to be taken to make participation possible for individuals with limited walking capacity:

- Mobility devices cannot be used for long distances, and since only few travelled bringing their mobility device and many were dissatisfied with the transportation of it, better travel opportunities for mobility device users should be provided.
- Some physical environments constituted barriers for participation opportunities and consequently efforts should be made to eliminate them. Modifications of outdoor environments are usually not included in the field of responsibility of occupational therapists, but given that the physical environmental barriers decrease the effectiveness of mobility device interventions, occupational therapists need to widen their field of operation to include institutional environments, i.e. societal institutions and practices and political components (14;165).

Conclusions

The results of the present thesis have yielded knowledge about outcomes of rollator and powered wheelchair interventions as a basis for societal prioritisation of mobility device interventions and for the development of assistive technology services, e.g. in community-based occupational therapy. The main conclusions were the following:

- The rollator and powered wheelchair users were generally satisfied with their device,

and the rollator users' satisfaction increased over time.

- In spite of the high level of satisfaction, some rollator users were dissatisfied with characteristics relating to handling the rollator, while the powered wheelchair users' dissatisfaction mainly concerned technical characteristics of their device. Concerning assistive technology services the users were least satisfied with follow-up services, and some rollator users were not satisfied with professional service either.
- The powered wheelchair could be used for desired participation aspects except that some could not visit friends and family, and most did not travel bringing their powered wheelchair.
- All rollators and powered wheelchairs were used, even though powered wheelchairs were used less frequently in the winter.
- The sources of dissatisfaction with rollators related to the interaction between the user's physical capacity, the rollator, and the physical environments. Some powered wheelchair users reported physical environmental barriers, while others had developed strategies to avoid them, but still environmental barriers prevented users from desired participation aspects.
- Women and users living alone were more likely to be dissatisfied with their rollator, while a determinant for dissatisfaction with powered wheelchairs was not having received instructions for use. Finally, old age was a determinant for being satisfied.
- It was more likely that the oldest users, women, and users needing assistance for transfer would think that the powered wheelchair could not be used for going to desired places, and that the oldest users would use their device less frequently.
- Based on the results, suggestions for eligibility criteria and for development of the quality of mobility device interventions are provided, e.g. that eligibility criteria should include purposes such as just going for a ride and not only more targeted purposes, and that instructions in use and follow-up services should be applied.
- The translation and cross-cultural adaptation of the QUEST 1.0 revealed difficulties in obtaining equivalence and showed that the efficiency of back-translation was low. The oldest users had difficulties rating satisfaction. Some questions could not be answered as early as one month after receipt of the device and some questions seemed intertwined or overlapping.
- The ICF terminology is important but not sufficiently specific for use in assistive technology outcomes research as regards activity and participation.
- A new construct called mobility-related participation was explored to gain knowledge about outcomes especially related to powered wheelchair interventions. The unidimensionality of the construct was confirmed, but the internal consistency was low, indicating that the construct is complex and further research is needed. A user satisfaction scale was likewise tested and evidence of construct validity and reliability was found. Finally, it was revealed that user satisfaction and mobility-related participation were not related constructs. It remains to be investigated whether these constructs are valid for evaluation of mobility device interventions in general.
- Since the theoretical foundation for assistive technology outcomes research is still insufficient, a suggestion for further research is the development and empirical testing of a transactional model encompassing four domains based on the HAAT and the PEO models, including change over time.

Populærvidenskabelig dansk sammenfatning

Nytter rollatorer og elkørestole?

Mennesker med gangbesvær kan opleve manglende muligheder for at udføre aktiviteter, som er forudsætningen for at leve et godt liv og deltage i samfundslivet på lige fod med andre borgere. Desuden vil nedsat mobilitet føre til inaktivitet, der har helbredsmæssige konsekvenser. Derfor sættes der fra samfundets side ind med rehabilitering, blandt andet ergoterapi, hvor hjælpemidler i vid udstrækning anvendes som middel til at gøre aktivitet og deltagelse mulig. For borgere med gangbesvær er det ofte rollatorer og elkørestole, herunder scootertyper, der anvendes.

I Danmark, hvor forskningen, der ligger til grund for afhandlingen, er gennemført, findes der ikke statistikker, der kan give et overblik over forbruget af hjælpemidler. Det gør der derimod i Sverige, hvor den videnskabelige bearbejdning af forskningen har fundet sted. Her er der mindst 300.000 rollatorbrugere svarende til 3–4% af befolkningen og omkring 9.000 elkørestolsbrugere. Antallet af rollator- og elkørestolsbrugere kan imidlertid forventes at stige, idet antallet og andelen af ældre i befolkningen vil øges. På trods af dette er dokumentationen af effekten af mobilitetshjælpemidler sparsom, og desuden er de videnskabelige metoder til effektmåling af hjælpemidler uudviklede.

Formålet med afhandlingen var derfor at undersøge, om rollator- og elkørestolsbrugere var tilfredse med deres hjælpemidler, og i hvor høj grad hjælpemidlerne var effektive, dvs. om de kunne anvendes til deltagelse i hverdagslivet, og hvor ofte de blev brugt. For at kunne gennemføre undersøgelserne skulle QUEST 1.0, et redskab til måling af brugertilfredshed med hjælpemidler, oversættes fra engelsk, pilottestes og tilpasses til danske forhold ifølge en beskrevet metode. Desuden blev begreberne brugertilfredshed og deltagelse undersøgt for at bidrage til den teoretiske viden om effektmåling af mobilitetshjælpemidler.

Oversættelse og tilpasning af QUEST 1.0

Det viste sig, at den del af den anvendte metode, der bestod af tilbageoversættelse af redskabet til engelsk, kun havde begrænset værdi i forhold til at identificere sproglige problemer i det oversatte redskab i modsætning til diskussioner i en tværfaglig gruppe og pilottesten. Dette kan give anledning til at overveje, om tilbageoversættelse, der som regel anbefales, altid skal foretages, især da det er en kostbar procedure. Det var endvidere relativt vanskeligt at finde danske ord, der modsvarede de engelske, ligesom flere af spørgsmålene blev anset for at være irrelevante eller svære at svare på. Disse problemer understreger betydningen af at formidle oversættelsesprocesser, da denne viden giver dem, der skal bruge måleredskaberne til egne undersøgelser, bedre muligheder for at vurdere redskabernes anvendelighed.

Gennemførelse af undersøgelserne

For at undersøge brugertilfredshed med rollatorer og hvor ofte de blev brugt, blev 64 personer i alderen 41–92 år (gennemsnit 76 år), der fik bevilget en rollator for første gang, interviewet en måned efter de havde fået deres rollator og igen tre måneder senere. QUEST 1.0 blev anvendt til interviewene, der blev udført i syv danske kommuner

Undersøgelsen om brugertilfredshed med og brug af elkørestole blev gennemført ved hjælp af en interviewundersøgelse i 12 kommuner blandt 111 elkørestolsbrugere i alderen 65–92 år (gennemsnit 77 år). Brugerne havde haft deres elkørestol i 1–16 år. Der blev an-

vendt et spørgeskema, der var udviklet specielt til undersøgelsen.

Resultater af undersøgelserne

Undersøgelserne viste, at alle rollatorer og elkørestole blev brugt, og at brugertilfredsheden var høj. Brugere af elkørestole kunne anvende deres elkørestol til størstedelen af ønskede aktiviteter og deltagelse – resultater der berettiger den omfattende anvendelse af hjælpemidlerne. Men brugerne var ikke tilfredse i alle tilfælde, og elkørestolene kunne ikke anvendes til alle formål. Nogle elkørestolsbrugere var desuden utilfredse med kørestolens tekniske kvaliteter, fx affjedring og hastighed. Rollatorbrugerne beskrev årsagerne til deres utilfredshed med deres hjælpemiddel som en kombination af manglende kræfter, en tung og uhåndterlig rollator, de ikke havde lært at køre, og miljømæssige barrierer såsom ujævne fortove og kantsten. Det var især ældre kvinder og aleneboende, der var utilfredse med deres rollatorer.

Hvad angår serviceydelser var brugerne af begge typer hjælpemidler mindst tilfredse med opfølgning, og desuden var en del rollatorbrugere ikke tilfredse med den faglige indsats. Rollatorbrugerne fortalte bl.a., at de ikke havde fået instruktion i rollatorens helt basale funktioner som fx sammenklapning af den, og hvordan man kommer over en kantsten med den.

En analyse af faktorer, der havde betydning for brugernes tilfredshed med elkørestole, viste, at instruktion i brug af elkørestolen havde betydning for brugernes tilfredshed med den faglige indsats og med opfølgningen, og at tilfredsheden med opfølgningen blev øget, hvis der rent faktisk havde været foretaget opfølgning. Disse resultater viser således, at den ergoterapeutfaglige indsats kan forbedres, så flere brugere bliver tilfredse, samt hvordan. Valg af hjælpemiddelmodel bør i højere grad baseres på en analyse af brugerens fysiske kapacitet og af det miljø, hvori hjælpemidlet skal anvendes. Desuden bør der gives instruktion i brug af hjælpemidlet, ligesom der bør foretages opfølgning. Det viste sig desuden, at jo ældre brugerne var, desto højere var deres tilfredshed. Dette kan tyde på, at ældre er mindre kritiske end yngre, hvorfor man skal være varsom med en alt for optimistisk tolkning af data om ældres tilfredshed med hjælpemidler.

Undersøgelsen viste, at der var flest, der brugte elkørestolen til at køre en tur om sommeren, mens elkørestolen om vinteren fortrinsvis blev brugt til indkøb. Elkørestolen kunne i mindre grad anvendes til at komme til fjernereliggende steder og til besøg hos venner og familie. Årsagen var først og fremmest miljøbarrierer i form af trin og trapper. Da brugerne blev direkte adspurgt om disse problemer, var der omkring en fjerdedel, der anså trin, trapper og fortovskanter for at være et problem. Det er færre, end hvad man kunne forvente, men kan formentligt forklares ved, at lige så mange angav, at de tilpassede deres aktiviteter ved kun at færdes på steder uden disse barrierer. Undersøgelsen viste også, at personer, der kunne komme over i kørestolen uden hjælp, havde størst nytte af den, formentlig fordi de kunne gå ind i bygninger med trapper. For at såvel rollatorbrugere som elkørestolsbrugere kan få fuld nytte af deres hjælpemidler, bør man derfor fra samfundsmæssig side prioritere at fjerne miljøbarrierer.

Kun en tredjedel af elkørestolsbrugerne medbragte deres elkørestol i bil og bus. Da mobilitetshjælpemidler ikke kan anvendes til at færdes over lange afstande, er det vigtigt, at samfundet stiller transportmuligheder med adgang for brugere af mobilitetshjælpemidler til rådighed.

Begreberne brugertilfredshed og deltagelse

For at få mere viden om målemetodik blev begreberne brugertilfredshed og deltagelse nærmere undersøgt. Det viste sig, at bruger-

tilfredshed var et både troværdigt og pålideligt begreb, hvilket bekræftede udenlandske resultater. Begrebet deltagelse er bredt, og der blev derfor udviklet et nyt begreb, mobilitetsrelateret deltagelse, der mere præcist afspejler deltagelsesaspekter, der forudsætter mobilitet. Analyserne viste, at der var tale om et sammenhængende begreb, dvs. at det bestod af en enkelt dimension, men analyserne viste også, at de emner (items), der indgik, ikke var optimale. Begrebet ser lovende ud i forhold til effektmåling af mobilitetshjælpemidler, men der kræves mere forskning, før det kan anvendes i praksis.

Idet niveauet af både brugertilfredshed og deltagelse var højt, kunne der måske være tale om det samme fænomen, hvorved det kun ville være nødvendigt at måle ét af dem. De to begreber viste sig imidlertid at være helt forskellige, så det ene kan ikke erstatte det andet. Da både brugertilfredshed og deltagelse er vigtige effektmål, må begge måles i forbindelse med evaluering af hjælpemidlers effekt: Et hjælpemiddel, der virker godt, men som brugeren ikke er tilfreds med, er en dårlig løsning, ligesom et hjælpemiddel, brugeren er tilfreds med, men som ikke virker tilstrækkeligt godt, også er det.

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Paper I

Translation, Cross-cultural Adaptation, and Content Validation of the QUEST

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Abstract

Outcome evaluation is important, but only few assessment instruments are available in the field of assistive technology. It was decided to translate and adapt the QUEST 1.0 (the Quebec User Evaluation of Satisfaction with assistive Technology 1.0) into Danish language and culture instead of constructing a new instrument. A number of methods were applied including forward- and backward translation, multidisciplinary discussions, pre-testing and a larger test focusing on cross-cultural equivalence and content validity. The study showed that a systematic and comprehensive translation and cross-cultural adaptation process is necessary and valuable, and that the methods used were useful for revealing equivalence and validity problems, even though backward translation turned out to be less efficient. Besides, the substantial need for adaptation attracted attention to the question of how close a translated version should be to the original version. The study uncovered more equivalence problems than reported in similar studies, probably due to the target group of this study being mainly older people requiring rather colloquial language. In the study the instrument was adapted, aspects of content validity of the Danish QUEST 1.0 were investigated, and further studies were suggested.

Key words: Outcome assessment; questionnaires; evaluation; equivalence; content validity; satisfaction; assistive technology; rehabilitation

Introduction

Outcome assessment is vital as basis for improvement of the quality of interventions or to document effectiveness or efficiency (1), and the value of subjective assessments has increasingly been recognised along with the growing awareness of client-centred interventions (2). In spite of that only few outcome measurement instruments suitable for use within the area of assistive technology are available, and in the late ninety nineties in Denmark there were not any (3;4). In such situations there are basically two ways to go. One is to develop a new instrument, and another is to translate and adapt an instrument developed in another country (5). In any case the instrument in question needs to go through psychometric testing (6). Development of a new instrument takes a long time and demands considerable resources, but may be necessary if no suitable foreign instrument can be identified. Translation and adaptation of an instrument is usually less demanding and besides, the instrument may be used for comparison of results between countries (7;8). A few years back the Quebec User Evaluation of Satisfaction with assistive Technology 1.0 (QUEST 1.0) was the only available instrument for measuring outcomes of assistive technology based on users' subjective assessments (9), and it seemed to be a relevant and useful instrument for use in Denmark instead of developing a new instrument. The QUEST 1.0 was developed in English and French by Canadian occupational therapists, and could not be used directly in Danish language and culture. A translation and adaptation process was therefore called for, making the instrument feasible for use in Denmark and ensuring that the Danish version measured the same phenomenon as the original version, which is especially challenging in relation to measurement of attitudes and opinions (6;10).

Various approaches may be applied for translation and cross-cultural adaptation of instruments (6;8;11). One approach is the one recommended by Guillemin, Bombardier and Beaton who carried out a literature review of methods for translation and cross-cultural adaptation of instruments and developed guidelines for cross-cultural adaptation (11). They stress that the adaptation must ensure that the translation is fully comprehensible and that there is cross-cultural equivalence of source and final version, which includes semantic, idiomatic, experimental, and conceptual equivalence. Other authors define these concepts in slightly different ways, but basically similar challenges are addressed (6–8).

A significant feature of an instrument is its validity, i.e. whether it actually measures what it is intended to measure, which is a substantial part of ensuring that an instrument developed in one culture is valid in another (12;13). Hence translation and cross-cultural adaptation should be followed by assessment of validity. It is not possible to make an absolute statement about the validity of an instrument, since validation is an ongoing process and depends on the purpose of the measurement, but as a rule the first step in a validation process is to examine content validity in order to determine whether the content of the instrument is relevant to the concept being measured and whether the instrument covers all relevant aspects (12;13). Content validation is usually investigated by asking experts or representatives of the target group about the relevance of the content in a structured way. Subsequently more formal statistical methods are used to assess other kinds of validity of the measurement (13;14).

In spite of the importance of structured and thorough translations and cross-cultural adaptations of assessment instruments, translation and adaptation processes are rarely reported in scientific articles in the field of rehabilitation. The reason may be that the work has not been carried out or that it just has not been published, because the translation and

adaptation were not the aim of the project, but rather the means to obtain results. In any case it is important that such processes are reported so that practitioners and researchers can assess the trustworthiness of instruments and in order to report experiences to guide others in similar situations.

Aim

The objectives of this study were to translate and adapt the Quebec User Evaluation of Satisfaction with assistive Technology 1.0 (QUEST 1.0) from English into Danish language and culture, and to investigate aspects of content validity.

Study approach

For the present study the approach recommended by Guillemin, Bombardier and Beaton was applied (5). In order to strengthen the study further, aspects of content validation were included. In short, Guillemin *et al*. recommend several translations of the instrument to be prepared followed by back-translations. A multidisciplinary committee should compare the various translations and back-translations in a structured way and use these versions for adaptation of the instrument, preferably in cooperation with the author of the instrument. The translated instrument should then be pre-tested by a sample of the target population in order to check for errors and to establish face validity in terms of acceptance of the questions.

In the present study a multidisciplinary committee was established. It consisted of seven experts working in the field of assistive technology: occupational therapists and vendors of rollators. Their main tasks were to advise the project leader (author) about the accomplishment of the project and to review and discuss the translation of the QUEST 1.0, the results of the pre-test, and the subsequent adaptations. The committee took part in the first two steps of the study. The study consisted of three steps:

- Step one: Translation of the original English QUEST 1.0 into Danish
- Step two: Pre-test of the Danish QUEST 1.0 test version
- Step three: Investigation of content and equivalence of the Danish QUEST 1.0.

The two first steps resulted in revised versions of the QUEST, which were used in the following steps of the study. The process of the current study and the naming of the different versions of the instrument are displayed in Figure 1.

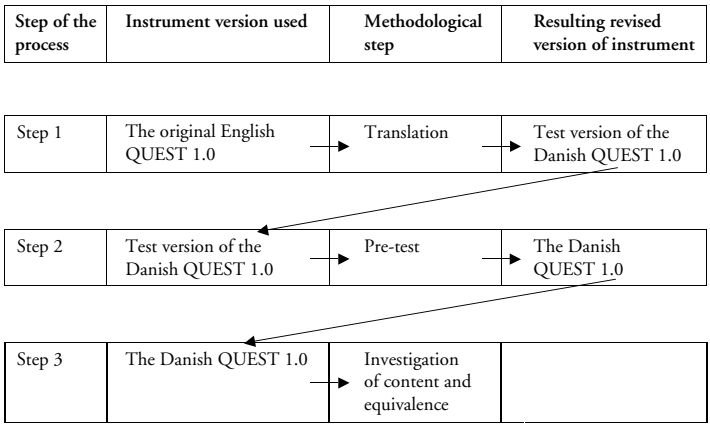

***Figure 1**. The process of the translation, cross-cultural adaptation and content validation of the QUEST.*

Material

Step one: Translation of the original English QUEST 1.0

The original English QUEST 1.0 consists of the instrument and an instructional manual (15). The instrument is divided into three parts. Part 1 contains 18 structured questions on general information concerning the user, the device, and the environment in which the user's opinions have developed. Part 2 and Part 3 focus on the user's apprehension of the assistive device and related services in terms of importance (Part 2) and satisfaction (Part 3). For administration of Part 2, 24 items printed on cards in a playing card format are presented one at a time to the user while the interviewer formulates the actual question. If the item e.g. is 'Weight', the interviewer may formulate the question as 'How important do you think the weight of your rollator is?' If the user does not understand the meaning of any item, the interviewer should elaborate on the basis of definitions presented in the form used for entering answers. The user is asked to rate the importance of each item in relation to the device in question on a 5-point ordinal scale. Score 1 denotes 'of no importance' and 5 'very important'. Furthermore, there is a possibility to score an item as 6, denoting 'user does not know' or 'non-applicable'. As to the physical format the scale is presented on 'an interactive assessment box' (a flat box containing the materials; the scale is represented on one of the sides of the box) placed in front of the user, and the user is to answer each question by pointing at the score that characterises his or her opinion. When the 24 questions have been answered the user is invited to add any other item that might be of importance.

Part 3 is administered in a similar way, and 19 of the 24 items are again scored by the user, but this time the user rates his or her satisfaction with each item. The scale is presented on the other side of the assessment box, and it is also an ordinal 5-point scale. In this scale 1 denotes 'not satisfied at all', 5 'very satisfied', and 6 that 'user does not know' or 'non-applicable'. If the user rates an item 1, 2 or 3 he or she is asked to explain the reason for not being fully satisfied. Finally, the user is asked to rate his or her global satisfaction with the assistive technology, i.e. the device and related services.

The instructional manual consists of an introduction, theoretical background, a description of the instrument, and guidelines for administration. In addition, suggestions for data analyses are given. Examples of items and response categories are exhibited in Table 1.

Step two: Pre-test of the Danish QUEST 1.0 test version

The result of the translation and adaptation process in step one of the study was a test version of the Danish QUEST 1.0, which was the material used in step two of the present study (Figure 1).

Step three: Investigation of content and equivalence of the Danish QUEST 1.0.

The pre-test in step two of the study resulted in the Danish QUEST 1.0 (16), which was the material used in step three of the present study (Figure 1).

Methods

Step one: Translation

A native Danish-speaking occupational therapist, reading and understanding English well, and working in the field of assistive technology (author) translated the English QUEST 1.0 including the instructional manual into Danish. After that the translation was trans-

Table 1. Examples of items and response categories of the original the Quebec User Evaluation of Satisfaction with assistive Technology 1.0 (QUEST 1.0)[a]

Item no.	Item	Response categories
QUEST Part 1: General information (items 1–18)		
1	Date of birth	Year/month/day
7	Frequency of use	Always / frequently (every day) / sometimes (1xmonth <> 1x/week) / rarely (<1xmonth) / never
14	Home-based services	None / public services / private services / voluntary agencies and support services / non-applicable
QUEST Part 2: Importance ascribed to satisfaction variables (items 1–24)		
1	Simplicity of use (Ease in using the ATD[b])	1 = of no importance
7	Professional service (Quality of information on ATD provided, accessibility and competence of professionals)	2 = of little importance 3 = more or less important 4 = quite important
14	Appearance (Design, form, color and acceptability of ATD)	5 = very important 6 = does not know/non-applicable
21	Training (Learning how to use ATD)	
QUEST Part 3: Rating of satisfaction variables (1–19)		
	Same satisfaction items as part 2 except that only 19 items are included.	1 = not satisfied at all 2 = not much satisfied 3 = more or less satisfied 4 = quite satisfied
	If the user answers 1–3 he/she is asked to explain the sources of dissatisfaction.	5 = very satisfied 6 = does not know/non-applicable

[a]Demers L, Weiss-Lambrou R, Ska B. The Quebec user Evaluation of Satisfaction with assistive Technology (QUEST). Montreal, Canada: Louise Demers, Université de Montréal and Centre de recherche de l'Institut universitaire de gériatrie de Montréal, 1997

[b]Assistive Technology Device

lated back into English by a native American English-speaking U.S. occupational therapist living in Denmark. The two versions and the original English version were compared and discussed by the two translators and by the multidisciplinary committee, focusing on equivalence aspects. When difficulties in translation and adaptation occurred one of the authors of the original English QUEST 1.0 (Weiss-Lambrou) was consulted. Since only few discrepancies between the two versions were found, the instrument was only translated forward and back once and not several times as recommended.

Step 2: Pre-test

Since the Danish QUEST 1.0 was going to be used for a research project about user satisfaction with rollators, the users in the pre-test were all rollator users. Inclusion criteria were that the users should have had their rollator for at least six months and besides, that different user categories in terms of gender, cohabitation, and housing should be represented. Because 60–70% of all users of assistive technology are older people (17), the majority of the users were to be more than 70 years of age. On basis of these criteria ten users were selected from the files of a Danish municipality. An introductory letter explaining the purpose of the pre-test and guaranteeing confidentiality and anonymity was sent to the selected users to ask them to participate in the test. Four could not participate because of tiredness or they felt insecure, and therefore four other users were enrolled. The median age of the ten users was 71 years and the mean age was 76 years (range 50–92). Four lived in a private house, three in a flat, two in sheltered living, and one in a nursing home. It was not possible to enrol more than one male user.

The pre-test was carried out by an experienced occupational therapist from a Danish municipality, who was also a member of the multidisciplinary committee. The interviews lasted 1–2.5 hours and were carried out in the users' homes. First the users were interviewed by means of the test version of the instrument, which included a question about missing items, and then they were asked whether they considered any of the asked questions not relevant. Immediately after each interview the interviewer answered a number of questions formulated by the multidisciplinary committee concerning the interviewer's perception of whether the users had understood the questions and the rating scales, how the format worked, and whether there were other problems using the test version or understanding the manual.

When all interviews had been carried out the interviewer's responses were compiled and discussed by the multidisciplinary committee, which used them for further adaptation of the instrument. In accordance with Guillemin *et al.* (11), there was close personal contact with the Canadian authors, and preliminary results from an international reliability and validity study of the original English QUEST 1.0, which were later published in scientific journals, underfed the Danish validation process (18–20).

Step three: Investigation of content and equivalence

In connection with a study on user satisfaction with rollators (21), a content and equivalence study of the Danish QUEST 1.0 (16) was performed. It was carried out in six Danish municipalities that enrolled and interviewed rollator users. Each municipality was to provide two interviewers who had to attend a training session about study procedures and administration of the instrument. In the end, one of the municipalities only provided one interviewer, so in all there were 11. All interviewers were occupational therapists or physiotherapists with at least two years of practical experience.

First-time rollator users were consecutively enrolled in the study as part of the service

delivery process. In big municipalities users were selected at random and in the small municipalities all users were enrolled. They were interviewed twice by means of the Danish QUEST 1.0 (16): one month after they had got their device and the second time three months after the first interview. After each interview the interviewer was asked to evaluate the QUEST by completing a questionnaire based on the questions in the pre-test containing five open-ended questions concerning: Missing or poorly phrased items; Items irrelevant in general or in relation to rollators; Difficulties understanding items; Problems concerning the format of the instrument; Other comments.

The number of interviews/evaluations that each interviewer carried out differed according to the number of new rollator users in the municipality, how much time each municipality had decided it could spend in the project, and the number of users lost to follow-up (21). In all 134 evaluations were carried out; 77 at the first interview and 55 at the second. The median number of evaluations per interviewer was 10 (range 7–28). Since each evaluation was composed by five questions, there were 670 responses.

Data analysis

The responses were regarded as open-ended responses in a quantitative survey and analysed accordingly (22). First the number of comments, 'no comments' and missing responses were recorded. Then the comments were coded by developing a coding frame, i.e. all the comments were grouped by themes, and from this grouping a coding scheme was developed (17). The author then coded all the responses, and in order to ensure reliability another experienced occupational therapist independently recoded the responses. The two codings were compared, discrepancies were identified and discussed, and a common coding was agreed upon.

Ethics

The users who participated in the study gave informed consent and they were guaranteed anonymity. The Danish registration authorities granted permission for data collection and database construction. Since the study was not experimental, according to Danish ethical rules, it was not necessary to have it formally approved.

Results

Step one: Translation

Only few and minor differences between the original version and the back-translated version were identified and will not be commented upon further. In spite of that, the multidisciplinary committee identified several words and expressions that needed adaptation. Some of the corrections concerned precision of language, but most related to cross-cultural equivalence. Some of the items in Part 1 (general information) were not experimentally equivalent: home-based services, service delivery system of assistive technology and funding of assistive technology. The items were changed so that they ended up relevant for Denmark.

The scaling of importance and satisfaction in Part 2 and Part 3 was challenging in terms of semantic equivalence, and discussions in the multidisciplinary committee resulted in some changes of wording. As to the items, in some cases it was difficult to find idiomatically equivalent Danish words[1] (Table 2).

Finally, the multidisciplinary committee changed some of the text in the manual to

[1] For Scandinavian readers: For instance 'social circle support' was changed from 'Social støtte' to 'Støtte fra socialt netværk'. Another example is 'Global satisfaction', which was changed from 'Tilfredshed alt i alt' to 'Tilfredshed med hjælpemidlet som helhed'.

Table 2. Problems and subsequent adaptations at different steps of the cross-cultural adaptation of the English Quebec User Evaluation of Satisfaction with assistive Technology version 1 (QUEST 1.0)[1] into Danish language and culture

	Problems and subsequent adaptations at different steps in the study		
Original English wording	Step 1: Translation	Step 2: Pre-test	Step 3: Investigation of content and equivalence[2]
Rating scales			
Of no importance	CE:[3] Reformulated	SE[4]/CE/CPS:[5] Deleted	
Of little importance	CE: Reformulated	SE/CE/CPS: Deleted	
More or less important	CE: Reformulated	SE/CE/CPS: Deleted	
Quite important		SE/CE/CPS: Deleted	
Very important		SE/CE/CPS: Deleted	
Does not know / non-applicable		SE/CE/CPS: Deleted	
Not satisfied at all			
Not much satisfied	SE: Reformulated		
More or less satisfied	SE: Reformulated		
Quite satisfied	SE: Reformulated		
Very satisfied			
Does not know / non-applicable			

Cont.

suit Danish practice context. For practical and economic reasons the multidisciplinary committee changed the physical format from an assessment box to sheets of laminated paper displaying the two scales. The format of cards displaying each item was maintained. The result of the process was the Danish QUEST 1.0 test version.

Step two: Pre-test

The rollator users did not have any problems understanding the questions in Part 1 of the instrument. Concerning the rating scales, some of the users found it difficult to relate to 'importance'. After all, most did not have any problems using the rating scales as such, even though the interviewer observed that three users did not distinguish between '4' and '5'.

Generally, the rollator users needed quite a lot of explanation in order to understand the questions in Parts 2 and 3. Moreover, some users found it difficult to understand the meaning of specific words, suggesting idiomatic equivalence problems (Table 2). Some thought that the interview was too long-winded, became tired, and had difficulties concentrating at the end of the interview, in particular the oldest rollator users (four users >80 years of age). Concerning content validity all users stated that 'installation' and 'device compatibility' were not relevant, five found that

Table 2 continued

Original English wording	Problems and subsequent adaptations at different steps in the study		
	Step 1: Translation	Step 2: Pre-test	Step 3: Investigation of content and equivalence[2]
Items[6]			
1. Simplicity of use			SE
2. Repairs/servicing			
3. Maintenance	SE: Reformulated		
4. Installation	IE:[7]Reformulated	CV[8]/CPS: Deleted	
5. Effectiveness	IE: Reformulated	IE: Reformulated	SE
6. Cost		CPS: Deleted	
7. Professional service	IE: Reformulated	IE: No corrections made	SE
8. Durability			SE
9. Multi-purposefulness	IE: No corrections made	CV/CPS	
10. Adjustments		CV/CPS	
11. Comfort	IE: No corrections made		SE
12. Service delivery	IE: No corrections made	IE: Reformulated	SE
13. Follow-up services		SE: Reformulated	SE
14. Appearance			
15. Transportation			SE
16. Device compatibility	IE: Reformulated	CV/CPS: Deleted	
17. Weight			
18. Safety			SE
19. Dimensions			
20. Motivation		SE: Reformulated	SE/CPS
21. Training		CPS: Deleted	
22. Social circle support	IE: Reformulated	IE: Reformulated	SE/CPS
23. Reactions of others			SE/CPS
24. Effort			
Global satisfaction	SE: Reformulated		

[1] Only rating scales and items from Part 2 and 3 are presented in the table
[2] No subsequent adaptations were made
[3] CE: Conceptual equivalence
[4] SE: Semantic equivalence
[5] CPS: In accordance with Canadian Psychometric Studies
[6] All items have an explanatory text, which in some cases was changed; text not displayed.
[7] IE: Idiomatic equivalence
[8] CV: Content validity

'adjustments' and three that 'transportation' were not relevant. Only one or two considered any other items to be irrelevant. None suggested more items.

The instrument format worked well except from the fact that the surface of the laminated sheets displaying the scales seemed to be too slippery. The manual also worked well apart from a few expressions: 'evaluate', 'sort', and 'variable'.

Adaptation of the instrument

The results of the pre-test resulted in deletion and change of wording and procedures. The wording of five items was changed to make them easier to understand (Table 2), e.g. the wording of 'Effectiveness' and 'Follow-up'[2]. Attempts were made to change two items, 'professional service' and 'multi-purposefulness', but it turned out not to be possible.

Preliminary results of the international validation studies going on in parallel and that were later published showed that the rating of importance was not valid (19). The Canadian authors of the QUEST informed us that it would be deleted from the future version of the instrument (19;20), and it was decided to do so in the Danish version as well. Besides, the deletion of the rating of importance would shorten the interview considerably. In addition, the items 'installation', 'device compatibility', 'cost', and 'training' would be deleted in the future version of the English QUEST (18;20), and therefore it was decided to do the same in the Danish version, even though the pre-test did not reveal any problems with the two last mentioned items (Table 2).

The format was changed so that there only was one sheet of non-laminated paper displaying the satisfaction scale, but the playing card format with one item on each card was maintained. In the manual the words 'evaluate', 'sort', and 'variable' were changed by paraphrasing the text.

The result of the translation and adaptation process was the final version of The Danish QUEST 1.0 consisting of Part 1 about general information; Part 2 about the user's satisfaction with the assistive technology; manual; kit consisting of an assessment form for entering data, a paper sheet displaying the satisfaction scale, and 20 cards representing the satisfaction variables.

Step three: Investigation of content and equivalence

Less than a fourth (n=137) of the 670 responses consisted of comments, most responses (n=394) consisted of the answer 'no comments', and the remaining responses (n=139) were missing, i.e. nothing was written in the questionnaire. From the analysis of the 137 comments three main issues emerged: users' difficulties in understanding and answering the questions, contents, and assessment kit. In addition, there were a number of minor issues. Some of the comments concerned more than one issue, why the total number of comments was over 137.

Users' difficulties in understanding and answering the questions

A little more than a fourth (n=40) of the comments concerned users' difficulties in understanding and answering the questions. Of these 12 comments were about the difficulty

[2] For Scandinavian readers: The Danish wording of 'Effectiveness. Goal achievement with the assistive technology device' was changed from 'Effektivitet. I hvor høj grad hjælpemidlet lever op til sit formål' to 'Virkning'. Hvor godt hjælpemidler virker efter hensigten'. Another example was 'Follow-up services. Ongoing support services for assistive technology device', which was changed from 'Opfølgning. Hvor meget der blev fulgt op på, om hjælpemidlet fungerer praktisk og teknisk efter det er blevet leveret' to 'Opfølgning. Om nogen har kontaktet brugeren for at høre, om det går godt med hjælpemidlet. Om der er nogen, brugeren kan kontakte'.

of keeping the user's attention, but only four expressed that the users had difficulty understanding the wording of the items. Some comments concerned some users' difficulties expressing detailed opinions (*n*=24). In some cases the interviewers offered explanations for this, one of the most common (*n*=12) was that the users were satisfied and therefore had difficulties expressing detailed opinions. Another reason was that a rollator is a too simple device to have an opinion about (*n*=4). Four comments were about users' difficulty rating their satisfaction, especially in terms of scoring, and that these users preferred to describe their satisfaction in their own words. There were no comments on the wording of the scale. One comment was that a user did not like to express dissatisfaction because it could hurt the service provider's feelings and another was that the interviewer found it difficult to formulate the questions. In two comments it was suggested that the questionnaire should be changed so that the questions were formulated beforehand.

Contents

Many of the comments concerned the item relevance: 26 comments were about irrelevant and 14 about redundant items. The reasons why items were considered irrelevant mainly had to do with the timing of the interview and the type of device investigated. In relation to some of the items ('repairs/servicing', 'maintenance', and 'durability') the users did not have sufficient experience to be able to answer these questions one month after having received their device. In relation to one item ('service delivery') in three comments it was expressed that it was not necessary to ask the question at the second interview, since the user already had answered it at the first interview. The items 'multi-purposefulness' and 'adjustment' were not considered to be relevant in relation to rollators (*n*=3 and *n*=2), mainly because a rollator does not need to be adjusted by the user. The item 'funding source' (in Part 1) was regarded as irrelevant by some (*n*=4), because the municipalities funded all devices. Some of the comments (*n*=14) were that numerous items were intertwined and much alike, in particular 'professional service' / 'service delivery'; 'durability' / 'safety'; and 'motivation' / 'social circle support' / 'reaction of others'.

Assessment kit

About one fifth (*n*=31) of the comments had to do with the use of the cards displaying the items and the sheet showing the rating scale. Some found it distracting to have to use the sheet and the cards and that the users forgot to use them or they were not necessary (*n*=21). Four comments were that users with visual impairment could not use them. Five interviewers reported that it was easier to use the cards and the rating sheet at the second interview, and another that the format had a positive influence on user concentration during the interview.

Other issues

Some (*n*=3) comments were that the second interview did not yield much new information and that it was tedious to go through all the questions again the second time. One interviewer thought that the questionnaire ought to be shorter and the interview possible to carry out by telephone, while two found that the second interview was easier to perform. In three comments it was reported that a consequence of the first interview was change of device or residence. Finally, in two cases the users' difficulty in answering the questions raised suspicion that they might be suffering from dementia.

Discussion

The study showed that cross-cultural translation and validation are challenging and call for thorough and systematic procedures in order to establish the validity and equivalence of an instrument. Besides, experiences with different methods were collected, content validity aspects were highlighted, and suggestions for improvements of the QUEST and for further studies were identified.

In the study a number of different methods including forward and backward translation, multidisciplinary committee discussions, pretesting, and further content and equivalence studies were applied, most of them useful and resulting in profound knowledge about equivalence and content problems. However, one of the methods applied, backward translation, did not seem to be as efficient as the other methods, since only few equivalence problems were revealed in this step in contrast to the subsequent steps. In the literature there is no agreement about the value and relevance of backward translation of instruments, which is included in some recommendations, while argued against in others (5;7;8). In one article it was explicitly pointed out that there is no evidence of the effectiveness of backward translations (23). Since the backward translation in this study did not yield much information about equivalence problems and it was rather resource-demanding, the results can support the opinion that backward translation may not always be necessary.

Some of the problems encountered during the process were general, while others were specifically related to the investigated device, the rollator. The general problems mostly had to do with idiomatic or semantic equivalence. Even though major attempts had been made to find equivalent wording, problems occurred in subsequent steps of the process, and in some cases the wording did not end up satisfactory. The reason for this was mainly that the English language contains substantially more words, and besides, many words (e.g. effectiveness and professional service) are in Danish loanwords that people in common do not always understand. The other Scandinavian languages are much similar, hence the challenge of finding understandable and equivalent wording can probably be generalised to Scandinavia. One solution may be to elaborate the wording quite a lot, but this raises the question of how close a cross-culturally adapted instrument must be to the original version in order to claim it to be an identical instrument. There is no clear-cut answer to this question (24), but if the present study had been part of the international reliability and validity studies of the QUEST 1.0, the results might have had an impact on further development of the instrument. This indicates that the ideal – but usually not possible – situation may be to develop instruments simultaneously in the countries where they are to be used.

The users' difficulties understanding the wording and the interviewers' difficulties explaining the meaning of the questions, not being quite sure they understood them themselves were closely related to the equivalence problems. Some of these problems may be solved by wording whole questions instead of just single-word-items and by working out explanations of the items, even though this solution must to be tested in order to examine whether it actually is effective. Furthermore, the problems may not be significant after all, because if they were, inter-rater reliability deficits could be expected, but such deficits have not emerged in international reliability tests (18;19). Even so, the international results may not apply to Denmark, and national reliability tests need to be carried out (6).

Conceptual equivalence problems only occurred in relation to the rating scales. In particular, it was difficult to find correct wording for the importance rating scale to make sure that the same phenomenon and the distance between each point were equivalent between

instrument versions. Still, this may not be that important after all, since the use of two very different translations of one of the rating scales in the SF-36 rendered the same result (23). The authors suggest that the reason could be that the rank of the response may be as important as the description.

Compared to a number of other studies, the present study revealed rather many equivalence problems. Quality of Life instruments, which may be considered to be as complex to translate and adapt as an satisfaction assessment instrument, have for example been adapted for use in Denmark, and only few problems have been encountered (25;26). In a Dutch translation and adaptation process of the QUEST 1.0 only minor adaptations were made (27). The reason for the different findings may be that no evaluation focusing on equivalence problems was performed in the mentioned studies. Another explanation may be that the target group of the current study was mostly older people, and for instance very old users (>80 years old) had difficulties relating to the rating scales. Since older people often have a short educational background they may require high clarity and colloquialism of the language used. This indicates that psychometric tests should include older people if they are included in the target group.

Only few content validity problems were identified, some of which may be connected with the timing of the interviews. At the first interview when users had just got their devices, they may not e.g. have had any need for repair and maintenance, and could therefore not express their satisfaction with these issues. On the other hand, if an interview is performed too long after the users have got their device, there is a risk of information bias (28), because the users may not be able to remember issues like professional service and service delivery. This indicates that some of the questions in the QUEST should be asked straight after the users have got their devices and that some should be asked much later. Thus the validity of the instrument may be challenged, and more studies are needed to explore this.

Most content validity problems seemed to be related to the device used in the tests, the rollator: 'installation' and 'device compatibility' were found to be irrelevant in the pre-test. However, identical results were found in international psychometric studies that included a wide range of devices, thereby validating the results of the present study (18;19). Because our results were supported by these studies it was decided to delete these items, even though quantitative testing usually has to be performed before deletion of items. Further two items (cost and training) were deleted in The Danish QUEST 1.0, but only on basis of the international studies, which may be regarded as unfortunate, especially because there is a need to gain knowledge about user satisfaction with training (29;30). Finally, the interviewers suggested that an explanation why some users had difficulties answering some of the questions might be that a rollator is too simple a device. Since the QUEST is also intended for even simpler devices, e.g. walking-sticks, it may be questioned whether it is applicable for evaluation of all devices as stated in the manual (31), which needs to be studied further.

The fact that no missing items were identified might suggest that the QUEST 1.0 actually is comprehensive, at least in relation to evaluation of rollators, but in practical use it has now appeared that especially items about the service delivery process actually are missing (32), e.g. user involvement in selection of the device, training, and goal-setting (33;34). This type of missing items might have been identified if a literature review as recommended by McDowell had been performed (13).

A limitation of this study is that it only included rollator users and not users of other devices, and other content and equivalence problems may have occurred in relation to other devices, and thus some of the results of this study may only apply to evaluation of rol-

lators, which should be kept in mind when applying the Danish QUEST 1.0 to other sorts of assistive technology. Most of the equivalence problems, however, may be considered to be general, and the content validity problems were validated by the international studies, indicating that the results to some extent are valid in relation to evaluation of user satisfaction with other sorts of devices.

After the present study had been carried out, the QUEST 2.0 in English (31) was published and consequently translated into Danish (35) based on the knowledge gained from the present studies, even though not all results from the current study could be applied without changing the QUEST 2.0 substantially, which once again calls attention to the problem of how close original and target versions need to be in order to claim to be identical instruments.

Conclusions

In conclusion, the present study highlighted the need for and value of systematic translation, cross-cultural adaptation, and content validation of instruments developed in another country. The study showed that multidisciplinary discussions and pre-testing focusing on cross-cultural equivalence and content validity were useful methods for revealing equivalence and validity problems, but that they are not sufficient and there is a need for larger studies as well. Furthermore, backward translation did not seem to be efficient, lending support to recommendations not stressing backward translations as important. The study revealed more equivalence problems than reported in similar studies, probably due to the fact that the target group of this study was mainly older people. The study also identified a number of content validity problems, some of which may be considered as general while others probably were related to evaluation of rollators. Suggestions for solutions of encountered equivalence and content validity problems were offered after having validated results by international psychometric studies, and needs for further validity studies and for reliability studies were identified. Furthermore, the question of how close a translated version of an instrument needs to be to the original instrument in order to claim that it is identical was high-lighted.

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Paper II

Satisfaction With Rollators Among Community-living Users: A Follow-up Study

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Abstract

Purpose: Rollators are used in order to make mobility possible for people with restricted walking ability. The use of rollators is increasing, but only little is known about outcomes. The aim of this study was to investigate users' satisfaction with rollators.
Method: A follow-up study was carried out in seven Danish municipalities. One month after they had got their device, 89 users of rollators were interviewed by means of the QUEST 1.0. Three months after the first interview a second interview took place and data from the 64 users possible to follow were analysed.
Results: The users were satisfied with their rollators, and the frequency of use was high. However, many of the users were frail, and some of them were not fully satisfied in all respects. Especially women, users living alone and first time users were likely to be dissatisfied. The main problem identified was handling the rollator, and for several users the physical environment caused accessibility problems.
Conclusions: Rollators are valuable for the users and a relevant societal intervention. However, a better match between person and technology, enhanced user training and follow-up can improve the outcome of the intervention. Furthermore, better rollator design is called for, and buses and the outdoor environment need to be made more accessible.
Keywords: accessibility, assistive technology, disability, functional limitations, mobility, QUEST

Introduction

In order to participate in societal life it is crucial to be able to get about. In 1994, 33% of the Danish population 60 years or older could not walk 400 meters without resting and 30% could not walk up and down a staircase without resting (1). In most European countries the number of older people is going to increase (2,3) and even though the health of the older population is improving, it can be expected that the number of older people with mobility restriction will grow.

Another trend is that older people want to be active and participate in societal life to a higher degree than before. Since one way to make this possible is to use assistive technology and because it now is less stigmatising to use it, the demand for assistive technology is growing. In the Nordic counties and some other European countries people who have a need for assistive technology have the device granted for free, and as a result public expenses are growing (4).

One of the assistive devices often used to reduce mobility restrictions is the rollator. In most European countries the word 'rollator' is used, which is in accordance with the ISO 9999 Classification of Technical aids for people with disabilities (5). In some cases another terminology is used such as 'wheeled walker', 'rolling walker', or 'four-wheeled walker' (6–8), which makes it difficult to identify what sort of device a paper refers to. A rollator is basically a frame with three or four rather big wheels, the front wheels are usually castor wheels, the rollator has handles with brakes, and in some cases it has a seat, a basket or a tray (figure 1). However, it is of outmost importance to know whether the investigated device actually is a rollator or for instance a walking frame with small front wheels, because the outcome of a study may be completely different depending on type of device. The design and usability of rollators have been improved in recent years, and they have become very popular among people with mobility restrictions. A rollator is used to make activity and participation possible in terms of getting about in the home, going shopping, calling on friends, etc. In Sweden at least 250,000 persons use a rollator (9) which is about 4% of the total population, and in Denmark a study on older people's mobility showed that 6.4% of 56–84 year old people used a rollator and that a majority were women (10). In the Nordic countries 80–100 different rollator models are available, and the cost varies (www.hi.se; www.hmi.dk). Most rollators cost €150–250 and even though a rollator is not an expensive device the total societal cost may add up. For example, in Sweden the estimated public cost per year is about €15,000,000 (9).

Figure 1. A typical rollator with four wheels, handles with brakes, a seat, and a basket.

Given the growing proportion of elderly people it is of utmost importance to optimise the utilisation of societal resources for interventions aiming at reducing disability in this population segment. However, even though rollators are so popular and a substantial amount of societal costs are spent, only little is known about the use and outcome of

rollators. The main part of the sparse research about rollators is about how body functions are affected by rollator use in laboratory environments. Published studies report evidence of rollators being superior to walking frames in terms of e.g. heart rate, oxygen saturation, stride length, walking distance, and gait performance (11–13).

When it comes to use of rollators in everyday life and user satisfaction even less is known, and the literature search performed for this study resulted in only few studies. A report on a Swedish study on older women's use of rollators showed that the women interviewed said that the use of a rollator was a prerequisite for living an independent life (9), and that 95% actually used their rollator. Another Swedish study showed that 34% of mobility devices were not used (14), while still another reported that 16% never were used (15). In a US study 36% of the respondents did not use their mobility device, because they did not need it anymore (16). Given the previously mentioned definitions differences, in many studies different types of devices such as walking sticks, walking frames, rollators and wheelchairs were put together as one group, viz. 'mobility devices', for which reason it may be difficult to interpret the results. Another reason why it may be difficult to compare different studies is that in some cases the devices are intended for short-term use and in some cases for long-term use (17).

In a recent Dutch study complaints about rollators were collected. The study showed that the users were overall satisfied with their rollator, but still they had a number of complaints, e.g. about brakes, wheels, and tyres. The users thought they had had too little influence on selection of model and that they did not get sufficient information about the use of their rollator (18).

This leaves a number of questions about to which extent rollators are actually used and about how users experience using a rollator in terms of satisfaction. Knowledge about this may be used to reform some aspects of the quality of the service rendered to users, thereby improving the users' everyday life. In turn, such knowledge will enhance societal resources being spent in the best possible way. Therefore, the objectives of this study were to:

- investigate users' satisfaction with their rollators,
- investigate to what extent rollators actually were used,
- investigate whether users' satisfaction and frequency of use changed over time,
- explore indicators for users' dissatisfaction with rollators.

Materials and methods

Research district

Seven Danish municipalities took part in the study: three small municipalities (< 20,000 inhabitants) and four medium sized municipalities (20,000–50,000 inhabitants). The services rendered and the selection of rollators vary between municipalities, and in order to obtain external validity the participating municipalities were selected on the basis of maximum variance in terms of size and geographical dispersal, and furthermore urban as well as rural municipalities were represented.

Sample

In order to include users representing the most common group actively using rollators indoors as well as outdoors, the participants were persons with mobility restrictions living in private homes who were granted a rollator for long-term use. In all the municipalities included decisions on granting rollators were made by occupational therapists or physiotherapists based on their acquired experience. Only first time users were included in the study.

Beforehand, the municipalities had stated

how many interviews they were able to carry out given the resources available for data collection. From the small municipalities all new users during the inclusion period participated. In the medium-sized municipalities, standard procedures to select users at random were employed. Exclusion criterion was cognitive disability based on previous knowledge about the users.

Design

The study was a follow-up study. A first interview took place one month after the users had got their rollators (t_1). A second interview was carried out after four months (t_2), because from practical experience it is known that most users of assistive technology should have got used to their device at this point of time.

Interview instrument

The Danish version of the Quebec User Evaluation of Satisfaction with assistive Technology version 1 (QUEST 1.0) was used (19). At the time for this study the QUEST 1.0 was the only scientifically tested instrument measuring user satisfaction in relation to assistive technology available. It is theory-based and standardised, and a number of studies have been carried out establishing acceptable reliability and validity (20,21).

The QUEST 1.0 consists of two parts:

1. Eighteen structured questions aimed at describing the context in which the device was used, including a number of user characteristics such as age, gender, functional limitations, living situation and receipt of services. All information recorded was based on the user's subjective description. Furthermore, one of the questions concerned the frequency of use with the following response alternatives: 'always', 'at least once a day', 'at least once a week', and 'less'.
2. Twenty-three questions about user satisfaction in relation to certain characteristics of the assistive device and the service delivery process, and furthermore one question about global user satisfaction with the device. Only 21 questions were used, because three of the questions were not regarded as relevant in relation to rollators. The users rated their satisfaction on a scale from 1–5 (1=not satisfied at all, 2=not much satisfied, 3=more or less satisfied, 4=quite satisfied, 5=very satisfied), and whenever a question was considered non-applicable it was rated '*6*'.

Procedure

The first author served as project leader and was in charge of the design of the project, training of the interviewers, and performed the data analysis. None of the authors had any contact with the respondents. The interviews were carried out by two occupational therapists or physiotherapists from each of the participating municipalities, with the restriction that they could not interview their own clients. In order to reassure basic reliability and validity prerequisites, definitions and instructions for the interviewers were worked out, and prior to the data collection a training seminar was held in order to instruct the interviewers and to make sure the procedures were the same in all seven municipalities. The interviews were carried out in accordance with the instructions of the QUEST (19), but in case the interviewer already had the information for part one of the QUEST, this was filled out beforehand; otherwise the interviewer asked the user during the interview. The questions in part two were stated as issues, e.g. 'multipurposefulness', and the interviewer had to change each issue into a question: 'how satisfied are you with the multipurposefulness of your rollator?' In case the user did not understand the question the interviewer should elaborate on the question in order to make

sure the user fully understood the question. If the user scored less than '4' the interviewer was to ask the user to explain the reason for not being satisfied. The interviewer recorded the ratings and the explanations in the QUEST form.

During a six months spring and summer period the interviewers contacted the users who were guaranteed anonymity and the users who gave informed consent were enrolled. The interviewer then visited the user in his or her home and carried out the interviews. Three months after the first interview the interviewer contacted the user again, and the second interview was carried out in the user's home as well in case the user was willing to participate.

Data analysis

In case the group of users not possible to follow was significantly different from the group of users followed, it may indicate that the participants of the study were not representative for the study population. Thus the study sample and the users not possible to follow were compared as regards age, gender, living situation, housing and whether they had other assistive devices. The Students t-test was used for testing continuous parametric data and the Chi-2 test for dichotomised data.

Change of frequency of use and satisfaction between the first and the second interview was calculated using Wilcoxon signed rank test, and odds ratios (OR) were calculated in order to identify indicators for dissatisfaction at the first and at the second interview. The independent variables were selected from the first part of the QUEST 1.0 consisting of questions about age, gender, living situation, housing, waiting time to get the rollator, whether the user had got instructions, frequency of use, former experience from using a rollator and whether the user had other devices. Dichotomization of the independent variables can be seen in table 4, which displays the results of the analysis. The dependent variables representing the outcome dimension 'dissatisfaction' originated from the second part of the QUEST 1.0. In the QUEST 1.0 only few instructions on statistical analysis including dichotomization are given. However, more instructions are given in the most recent version, QUEST 2.0 (22), and even though this version was not translated into Danish at the time for the study, the instructions were still feasible. In the QUEST 2.0 it is recommended to group scorings 1–3 as 'not fully satisfied' and scorings 4–5 as 'satisfied' when data are dichotomised, and this principle was applied. The concept investigated was satisfaction, but in order to focus on risks of users not being satisfied, for this part of the analysis 'not fully satisfied' was called 'dissatisfied'. ORs were calculated with 95% confidence intervals, and as to the interpretation of ORs two principles were applied: only statistically significant ORs ($p<0.05$) or ORs ≥3.0 were reported.

Furthermore, the Chi-2 test was used to determine correlations between background variables. In case of statistically significant correlations and ORs, confounder control was carried out. In all calculations the significance level was $p<0.05$.

The qualitative comments that users gave when they were not satisfied were reviewed, and typical comments were extracted for illustration.

Respondents

All 89 users who were asked to participate agreed to be interviewed at the first occasion (t_1) and 64 users participated in the second interview (t_2). In 10 out of the 25 cases not possible to follow, the reason was that the person had died or fallen seriously ill. Other reasons were that three persons did not want to participate and in six cases it was not possible to carry out the interviews because of lack of resources, and finally no reason was given in six cases.

Table 1. Characteristics of sample of rollator users (N=89).

	Total sample N=89	Follow-up sample *n*=64	Respondents not possible to follow *n*=25	Difference between follow-up sample and sample not possible to follow *p*-value
Mean age in years (SD)	76.3 (10.4)	76.0 (10.7)	77.3 (9.7)	n.s.
Age in years: range	41 – 93	41 – 92	59 – 93	n.s.
Female *n* (%)	59 (66.2)	43 (67.2)	16 (64.0)	n.s.
Lived alone *n* (%)	61 (68.5)	42 (65.6)	19 (76.0)	n.s.
Housing *n* (%)				
House	47 (52.8)	36 (56.3)	11 (44.0)	n.s.
Flat	32 (36.0)	20 (31.3)	12 (48.0)	n.s.
Other	10 (11.2)	8 (12.5)	2 (8.0)	n.s.
Had other assistive devices *n* (%)	56 (63.0)	39 (60.9)	17 (68.0)	n.s.
Service *n* (%)				
Meals on wheels	12 (13.5)	4 (6.3)	8 (32.0)	<0.001
Home care	49 (55.0)	35 (54.7)	14 (56.0)	n.s.
Nursing care	9 (10.1)	5 (7.8)	4 (16.0)	n.s.
Private domestic help	12 (13.5)	8 (12.5)	4 (16.0)	n.s.

n.s.: non significant

The characteristics of the users who were interviewed twice and the users who could not be followed were compared. There were no statistically significant differences between the two groups except from the percentage of users getting meals on wheels. Therefore only the sample interviewed twice (N=64) was used in the result analysis (table 1).

At t_1 the mean age of the users was 76, range 41 to 92 years. Nearly all users (98%) reported motor impairments. More than two thirds (67%) were women and approximately two thirds lived alone (67%). Just above half of the rollator users lived in a private house (56%) and another third lived in a flat (31%). Nearly two thirds reported having other assistive devices as well (62%), and more than half of the sample answered that they got domestic help provided by the municipality (55%). Fewer reported that they got other services such as meals on wheels (6%), nursing care (8%), or domestic help paid by themselves (13%) (table 1).

Results

Sixty-four rollator users answered a number of questions about their rollator and the service rendered one month and four months after they had got their rollator.

All the rollators had four wheels, but at least 17 different rollator models were represented, supplied by various companies. However, one company was dominant, since it supplied 26% of the rollators used. The waiting time to get a rollator was 1.9 weeks (SD 1.5) ranging from zero to six weeks. Seventeen percent of the sample answered that they had participated in the selection of rollator model

Table 2. Frequency of use of rollator one month and four months after the users had got their rollator (N = 64).

Frequency of use	Interview at t_1 *n* (%)	Interview at t_2 *n* (%)
Always	14 (21.9)	18 (30.0)
At least once a day	28 (43.7)	28 (46.7)
At least once a week	20 (31.3)	12 (20.0)
Less	2 (3.1)	2 (3.3)
Missing data	0	4
Total	64 (100)	64 (100)

No statistically significant changes of frequency of use were found.
t_1: one month after the users had got their rollator
t_2: four months after the users had got their rollator

and most users (81%) stated that they had got training or instructions in using it.

Frequency of use

The results showed that the frequency of use of rollators was high. At t_1 nearly two thirds (66%) used their rollator every day and at t_2 more (77%) used it every day. However, this change was not statistically significant. At both interviews 3% used it less than once a week (table 2).

Satisfaction

At t_1 the users' global satisfaction with their rollator was high; 92% were fully satisfied. However, a more multi-faceted picture emerged concerning satisfaction with specific characteristics of the rollator and about certain aspects of the service rendered when the users got their rollators. See table 3.

As to the characteristics of the rollator the users were especially satisfied with the effectiveness (94%) of their rollator. Nevertheless, not all were fully satisfied with some of the characteristics of the rollator: weight (30%); the effort required using the rollator (28%); and the comfort using it (23%). Furthermore, a considerable percentage was not fully satisfied with transportation of the rollator (24%) and the adjustment of it (21%), but many users answered 'non applicable' to the questions about these issues.

In terms of service the users were satisfied with the service delivery (94%). However, about one fourth was not fully satisfied with the professional service, and 22% were not fully satisfied with follow-up services. Nearly one third was not satisfied with repairs and services, but only few users had rated their satisfaction on this issue and most users (80%) answered 'non-applicable' to this item. As to the questions about psychosocial issues the users were more satisfied, especially in relation to the social environment, as 97% were satisfied with the social circle support and 95% with other people's reactions.

In order to clarify the reasons why the users were not fully satisfied with certain characteristics of their rollator, some of the typical comments are presented below:

Weight: Most comments were that the rollator was too heavy, but other comments expressed problems in handling and using the rollator. *'It is too heavy to get over kerbs and steps'; I cannot lift it into the trunk of my car / up the stairs'.*

Transportation: The comments were mostly about getting the rollator into a bus or a car, but some of them concerned foldability. *'Difficult to get into the bus because of steps'; 'Takes up too much room in a car'; 'Hard to fold together and open it again'.*

Effort: There were rather a lot of comments about the problems related to the effort required. Some of the comments had to do with the user getting tired and experiencing pain in the arms, while other were about the rollator and the environment such as difficulties

Table 3. User satisfaction with rollators one month and four months after the users had got their rollator. The instrument used was the Danish version of QUEST 1.0 (N = 64).

	After one month (t_1)					
	Fully satisfied[a]	Not fully satisfied[b]	Non applicable	Missing data	Median[c]	Inter -quartile range[c]
	n (%)[d]	*n* (%)[d]	*n*	*n*		
Simplicity of use	53 (85)	9 (15)	2	0	5	4–5
Maintenance	27 (82)	6 (18)	31	0	5	4–5
Effectiveness	60 (94)	4 (6)	0	0	5	4–5
Durability	30 (91)	3 (9)	30	1	5	4–5
Multi-purpose-fulness	44 (86)	7 (14)	13	0	5	4–5
Adjustments	30 (79)	8 (21)	24	2	4.5	4–5
Comfort	49 (77)	15 (23)	0	0	5	4–5
Effort	46 (72)	18 (28)	0	0	4	3–5
Appearance	52 (84)	10 (16)	2	0	5	4–5
Transportation	19 (76)	6 (24)	39	0	4	3.5–5
Weight	40 (70)	17 (30)	7	0	4	3–5
Safety	54 (86)	9 (14)	1	0	5	4–5
Dimensions	55 (86)	9 (14)	0	0	5	4–5
Repairs /servicing	9 (69)	4 (31)	51	0	5	2–5
Professional service	41 (76)	13 (24)	10	0	5	3.8–5
Service delivery	59 (94)	4 (6)	1	0	5	4–5
Follow-up services	40 (78)	11 (22)	12	1	5	4–5
Motivation	56 (89)	7 (11)	0	1	5	4–5
Social circle support	60 (97)	2 (3)	2	0	5	4–5
Reaction of others	53 (95)	3 (5)	6	2	5	4–5
Global satisfaction	46 (92)	4 (8)	0	14	5	4–5

[a] 'Fully satisfied' includes 'very satisfied' and 'quite satisfied' (22).
[b] 'Not fully satisfied' includes 'not satisfied at all', 'not much satisfied', and 'more or less satisfied' (22).
[c] 1–5 scored scale, with 1=not satisfied at all and 5=very satisfied (19)
[d] On each question this percentage was calculated on the number of respondents answering the specific question on the 1-5 scored scale

After four months (t_2)						Change between t_1 and t_2
Fully satisfied[a]	Not fully satisfied[b]	Non applicable	Missing data	Median[c]	Inter -quartile range[c]	
n (%)[d]	*n* (%)[d]	*n*	*n*			*p*-value
55 (86)	9 (14)	0	0	5	4–5	0.383
44 (94)	3 (6)	17	0	5	4–5	0.108
59 (92)	5 (8)	0	0	5	4–5	0.703
56 (97)	2 (3)	6	0	5	4–5	0.164
45 (88)	6 (12)	13	0	5	4–5	0.084
29 (91)	3 (9)	32	0	5	4–5	0.111
58 (91)	6 (9)	0	0	5	4–5	0.006
54 (87)	8 (13)	1	1	5	4–5	0.008
60 (94)	4 (6)	0	0	5	4–5	0.009
22 (67)	11 (33)	30	1	5	3–5	0.233
46 (79)	12 (21)	6	0	4	4–5	0.378
60 (94)	4 (6)	0	0	5	4–5	0.043
58 (91)	6 (9)	0	0	5	4–5	0.519
19 (86)	3 (14)	42	0	5	4–5	0.276
46 (85)	8 (15)	10	0	5	4–5	0.041
44 (90)	5 (10)	14	1	5	4–5	0.669
40 (89)	5 (11)	16	3	5	4–5	0.025
57 (93)	4 (7)	3	0	5	4–5	0.434
58 (98)	1 (2)	5	0	5	4–5	0.617
54 (95)	3 (5)	6	1	5	4–5	0.338
48 (94)	3 (6)	0	13	5	4–5	0.803

with sloping pavements and uneven surfaces. *'My arms hurt when I have groceries in the shopping basket'; 'My arms become tired'; 'It pulls down the pavement and I have to use much strength to keep it on the pavement'; 'Hard to use on uneven ground'; 'Difficult to manoeuvre because of too small wheels'.*

Comfort: When the users were not fully satisfied with physical comfort, the reasons given were mostly the same as the ones concerning effort. Comments about psychological comfort mainly had to do with getting used to using a rollator, feelings of embarrassment and that the rollator made the user feel old. *'It is not so much the device, but getting used to using it'; 'I do not want to use it outdoors'; 'I felt old'.*

Adjustment: There were not so many comments, and most of them were about adjustment of the height of the handles, but some of them were also about fitting on the shopping basket. *'I cannot change the height (of the handles), because the screws are too tight'; 'The shopping basket is difficult to fit on'.*

Professional service: There were quite a lot of comments on this issue. Most of them were about lack of information, since a number of users did not know whom to contact if they got problems with the rollator, and many had not got sufficient training using it or directions for use. *'I did not know where to phone to have it repaired'; 'I only got instructions about the brakes'; 'The first model was too high and the man who delivered the rollator did not react'; 'They ought to deliver illustrated instructions for use'.*

Follow-up services: Most of the comments just stated that there had not been any sort of follow-up, but a few also specified why they were dissatisfied with no follow-up. *'I had to enquire to have the rollator replaced'; 'The rollator needs to be adjusted'; 'Follow-up would have been helpful, because I got no instructions in the use of the rollator'.*

At t_2, i. e. when the users had had their rollator for four months, they were generally more satisfied than at t_1. An exception was transportation of the rollator where the users' satisfaction decreased, but the change of satisfaction was only statistically significant in the feeling of comfort and of safety; the effort required to use the rollator; and the appearance of the device. As to the services rendered the users were statistically significantly more satisfied with the professional service and with follow-up services at t_2.

Indicators for being dissatisfied with rollators

Indicators for dissatisfaction were investigated at t_1 and t_2. Some indicators only emerged at one of the times of measurement, e.g. dissatisfaction with the multi-purposefulness and weight of the rollator, with maintenance and other people's reactions. Generally, more indicators of dissatisfaction emerged at t_2 than at t_1, but fewer were statistically significant at t_2 (table 4).

Some indicators of dissatisfaction were present at t_1 as well as at t_2, the trend being that the strength of the indicators got weaker over time. In one case the indicators changed to the opposite: the probability that cohabiting users would be more dissatisfied with follow-up services than users living alone was four times as high at t_1, but the opposite was the case at t_2.

The most frequent indicator for dissatisfaction was gender. It was more likely that women would be dissatisfied with simplicity of use and multi-purposefulness of the rollator; effort required using it; transportation of it; and the professional service. Also the living situation of the users indicated dissatisfaction, with people living alone being more likely to be dissatisfied with the effort required to use the rollator, the transportation of it, and the professional service. However, there was a significant correlation between gender and living situation ($p = 0.004$), which indicates that gender may be a confounding factor. Therefore confounder control was carried out, and

after that the odds ratio that users living alone would be dissatisfied with transportation at t_1 was 2.1 ((0.9–3.2), p=0.07) as opposed to 8.2 ((1.1–61.3), p=0.05) before adjustment. If the users had waited for more than two weeks to get their rollator the probability that they would be dissatisfied with a number of factors was increased, especially in terms of the service rendered. Furthermore, if the users did not have other devices, i.e. were first time users, they were likely to be more dissatisfied with transportation of the rollator; the weight and safety of it; and with the service delivery. Finally, frequency of use seemed to play a role, since users who did not always use their rollator were more likely to be dissatisfied with their device in terms of simplicity of use, comfort and weight of the rollator.

Discussion

The study revealed that users are overall satisfied with their rollators, that there is a high frequency of use and compliance, and that the users are satisfied with the effectiveness of their rollator. Thus the rollator proves to be a useful device for people with restricted walking ability suggesting that this societal intervention is worthwhile. Furthermore, assistive technology is not costly compared to other rehabilitation interventions (23) indicating that rollators probably are cost-effective. Nearly all users were satisfied with other people's reactions and support, mirroring the fact that rollators have become 'normalised' and that it is not so stigmatising to use one anymore. This development has been going on for a while and a US study on mobility devices from 1995 showed a similar result (24).

However, the users were not completely satisfied with some of the characteristics of the rollator and the service, and even though the users had got their mobility problem solved, some experienced new problems caused by using the device. The emergence of adverse effects has also been revealed in a number of other studies (6,25,26), and it is important to minimise such effects as much as possible, in order to improve the users' outcome of assistive technology and to make the societal intervention more effective.

The users' main problems were related to handling the rollator. These problems may originate from the user's restricted physical capability or from the device, which may have been a heavy and unhandy model. This study does not reveal which is the case, but a better match between person and technology could probably avoid the occurrence of a number of problems for the users. In order to optimise the match between person and technology, the user's physical and cognitive ability and the environment where the rollator is to be used should be assessed, resulting in valid identification of requirements to the rollator model. The problems of lack of match between person and technology have been studied in the US resulting in a method for systematic matching, the MPT method (24, 27,28). This or similar methods are rarely used in the Nordic countries, and often the user just gets the rollator model that the municipality in question keeps in stock.

Most users had got training in using the rollator, but in spite of this quite a large proportion of them were not satisfied with the professional services including training. Besides, some of the users reported that they did not know how to handle some of the basic functions of the rollator. This suggests that the training ought to be improved so that the user would feel comfortable using the new device, and furthermore improved training may reduce some of the users' problems handling the rollator. The importance of training has been established in a number of other studies (24, 29–31). Equally, a number of users were not satisfied with follow-up services, even though the satisfaction increased over time, suggesting that follow-up visits improve the users' satisfaction. This result is in line with a

Table 4. Indicators for users' dissatisfaction with rollators presented as crude odds ratios (N=64)[a].

	Age, years		Gender		Living situation		Type of housing	
	≤70	>70	Male	Female	Together	Alone	Flat	Private house
Simplicity of use								
t_1								
t_2			1	4.6			1	3.9
Multi-purposefulness								
t_1								
t_2			1	3.0				
Adjustment								
t_1			4.0	1				
t_2								
Comfort								
t_1								
t_2								
Effort								
t_1			1	3.0	1	3.5		
t_2			1	3.8	1	3.9		
Transportation								
t_1			1	3.0	1	8.2*		
t_2			1	3.1	1	3.0		
Weight								
t_1								
t_2	1	3.2						
Safety								
t_1							3.0	1
t_2								
Maintenance								
t_1								
t_2			3.9	1				
Professional service								
t_1					1	4.2		
t_2			1	4.1	1	3.5	1	3.0
Service delivery								
t_1								
t_2								
Follow-up services								
t_1					4.1	1		
t_2					1	4.4		
Motivation								
t_1								
t_2								
Reaction of others								
t_1								
t_2							4.9	1

[a] all data originate from QUEST 1.0 interviews (19) t_1: one month after the users had got their rollato
*p<0.05, **p<0.01. ***p<0.001

Waiting time		Instruction		Frequency of use		Experience		Other devices	
≤2 weeks	>2 weeks	Yes	No	Always	Not always	Yes	No	Yes	No
				1	3.6				
3.0	1								
				1	6.3***				
								3.4	1
1	4.0								
								1	4.4
				1	3.1			1	3.3*
								1	3.3
								1	5.4
1	4.3								
1	5.6					7.5*	1	1	14.7**
1	4.5					5.8	1	1	6.1
1	5.4	1	4.2						
1	3.3								
								1	3.3

t_2: four months after the users had got their rollator Note: only odds ratios ≥3.0 are presented.

Dutch study where the QUEST 1.0 was tested. One of the consequences of the study was that regular follow-up procedures using the QUEST were implemented after the test period, because the follow-up visit solved a number of the users' problems improving the effectiveness of the device (32,33). The need for follow-up has also been documented in other studies (34,35).

Generally, the users' satisfaction with their rollator improved after they had had it for some months. One of the reasons is probably that the second interview served as a follow-up-visit, where the users could ask the interviewing therapist questions and have problems with their rollator, if any, solved. Another reason may be that the users most likely needed time to get used to their device. This is supported by an interview study of device users, which showed that the negative image of a mobility device was limited to the user's first product and passed over (12).

A number of factors indicating probabilities of users' dissatisfaction were identified. Even though most of these indicators were not statistically significant, still some of them were rather strong suggesting that certain user-groups were more likely to be dissatisfied than others. These groups were women; users living alone; first time device users; and users who did not always use their device. This means that it is especially important that the professional intervention is carried out carefully in relation to these user-groups in terms of matching person and technology, training in using the rollator, and follow-up.

The most frequently reported problems occurred in relation to outdoor mobility, directing attention to the interaction between the user, the rollator, and the physical environment. On the one hand there is a need to improve the design of the rollators so that they easier can force obstacles in an outdoor environment, and on the other hand there is a need for improved outdoor environment design. The requirements of people with functional limitations to the environment are in many cases not created by the users' functional limitations, but by the design of the devices they use. For instance, the requirements of a stick in relation to the outdoor environment and the means of public transportation are completely different from those of a rollator (36). In order to improve accessibility to the outdoor environment for rollator users and other users of assistive technology, it is necessary that designers and planners take the requirements of different devices into account.

In this study compliance as well as frequency of use were high, exceeding rates presented in most other studies (14,15,27). There may be several explanations of the diverse results, one being that our study only included rollators and not other mobility devices such as sticks and walking frames. Another explanation may be that devices intended for temporary use have been included in other studies (17,37) resulting in a higher abandonment rate compared to our study where the rollators were intended for long-term use. Compared to a Dutch study on users' satisfaction with rollators, the results of the present study are somewhat different (18). The main complaints in the Dutch study concerned the brakes, including brake cables, wheels, and tyres. The most obvious explanation for the difference is the short time of follow-up in our study. In the Dutch study there was no restriction on the length of time of use, so some of the rollators may have been rather old. The fact that the time of measurement has an impact of outcomes is also illuminated in our study, where satisfaction and indicators of dissatisfaction changed over time. Consequently, it is imperative that studies clearly specify exactly which device is investigated and that the user-group and time of measurement are defined, otherwise it is not possible to compare study outcomes.

The results of this study may have been more statistically significant if it had been possible to include more users, and the results

must be interpreted with the limited sample size in mind. Other limitations are that the number of potential subjects was not recorded and that only one instrument measuring subjective outcome was used, and besides it would have been interesting to evaluate objective outcomes as well. Furthermore, it is a limitation that the QUEST 1.0 has not been validated in Denmark. There might be cultural differences, since according to their comments some users seemed to have problems distinguishing between the questions. Another study limitation is the fact that only limited reliability and validity precautions were taken. For further investigation of user satisfaction in relation to assistive technology, there is a need for methodological development.

Finally, there was a substantial number of non-applicable answers to some of the questions, especially the ones about maintenance, durability, adjustments, transportation and repairs /servicing. One reason is probably that the users had had the device for a short time only, so that the problems in question had not yet occurred. This suggests that this type of questions should only be asked when users have had their device for a longer period of time. In relation to adjustment and transportation of the rollator, the reason for the non-applicable answers may have been that the users did not need to adjust or transport their rollator. Presumably the non-applicable answers hampered the validity of some of the results, e.g. the change in indicators for satisfaction with follow-up services does not seem to be a real change, but caused by many 'non-applicable' answers. However, the possibility to answer 'non-applicable' is important; otherwise users might be forced to give an answer they do not have sufficient experience to answer, which may bring about bias. Another option is that they might just omit answering the question, which contains less information than a 'non-applicable' answer, because the reason for a missing answer is unknown.

Our study indicates a need for improvement of professional services, the devices, and the physical environment, but it is of course not possible to know whether these suggestions actually will improve users' outcomes of using rollators. In order to investigate the effectiveness of such interventions controlled experimental studies traditionally are used, but they are difficult to carry out, because it is hard to control all relevant factors in a community trial (38).

This study demonstrated that the users are satisfied with their rollator, that the frequency of use and compliance are high, and that the they get used to their devices over time. Nevertheless, many users are frail, and some of them are not fully satisfied in all respects. Especially women, users living alone and first time users are likely to be dissatisfied. The main problem is that they have problems handling the rollator. There is a need for a better match between person and technology, for improved user training and for follow-up. Furthermore, improved rollator design is called for, and accessibility to buses and to the outdoor environment must be improved. Besides, studies on interventions for improving outdoor mobility for users of rollators are needed. Finally, the importance of precise definitions of time, person and device in research on assistive technology is emphasised.

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Paper III

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OLDER PEOPLE'S USE OF POWERED WHEELCHAIRS FOR ACTIVITY AND PARTICIPATION

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***Objective*: The aims of this study were to investigate outcomes of older people's use of powered wheelchairs and risk factors for negative outcomes.**

***Design*: The study was a cross-sectional interview-study including 111 powered wheelchair users over 65 years of age.**

***Results*: All participants used their powered wheelchair in the summer; nearly all users regarded it as important and found that it gave them independence. The wheelchair made activity and participation possible for the users. The most frequent activity in the summer was going for a ride, and in the winter it was shopping. However, some could not use the wheelchair for visits, and supplementary travel modes are called for. Users who could not walk at all or who could not transfer without assistance were more likely not to be able to carry out prioritized activities. Furthermore, other risk factors for negative outcomes and need for further research were identified.**

***Conclusion*: The use of powered wheelchairs is a relevant societal intervention in relation to older people with limited walking ability in order to make activity and participation possible. It is likely that a larger proportion of older people could benefit from this intervention, in particular if current practices are improved taking activity and participation outcomes into consideration.**

Key words: self-help devices, assistive technology, treatment outcomes, rehabilitation, occupational therapy, mobility, eligibility determination.

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INTRODUCTION

For most of us, mobility is a prerequisite to be able to carry out important activities and to participate in societal life, e.g. going for walks, shopping and visits (1–3). Impaired body functions, such as limited walking ability, may lead to restricted activity and participation (4). In order to improve this, rehabilitation measures are usually taken, e.g. physical training. Even so it is not always possible to restore body functions totally, and adaptive strategies such as the use of assistive technology may then be employed (5, 6).

People with very limited walking ability often use manual wheelchairs to improve their mobility. However, using a manual wheelchair requires considerable stamina and upper extremity strength and mobility, especially outdoors. If the person does not possess these abilities or loses them, e.g. due to progressive illness, a powered wheelchair may be used instead (7) to enhance activity and participation (8).

In some countries, e.g. the Nordic countries, assistive technology is granted free of charge provided it is considered a relevant rehabilitation strategy, but in some other countries the provision of assistive technology depends on insurance conditions. Furthermore, regulations and assistive technology service systems differ between countries (9). In Denmark there are no national formalized eligibility criteria, but the device must represent a substantial improvement in the person's possibilities to carry out activities and/or to participate in societal life, and in some cases eligibility criteria have been formulated locally (9).

In this study the term "powered wheelchair" is used, denoting a wheelchair powered by batteries. Powered wheelchairs are divided into two major subgroups, and both are included in this study. One is the scooter type that has 3 or 4 wheels and is steered manually by handlebars, the other is the joystick-controlled type, which has 4 wheels and is steered electronically by a joystick.

Theories and models in relation to assistive technology

As regards theoretical frameworks reflected in research into assistive technology, to our knowledge no specific studies have been published. The *International Classification of Functioning* (ICF) provides a structure describing environmental facilitators and barriers influencing activity and participation, but it does not aim at describing relationships (4). A number of other theories and models describe activity performance as a person-environment-activity transaction, (e.g. 10, 11), but no explicit distinctions between assistive technology and other environmental factors have been presented, omitting the possibility of studying relations between the use of assistive technology and other environmental factors. Even so, one model, "The human activity assistive technology (HAAT) model" (12), developed by Cook & Hussey, describes how human performance is influenced by factors concerning the person, the activity, the assistive technology and the context in which the activity is performed,

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when an assistive device is used. The model suggests that each of these domains contains a number of factors that influence activity performance, but also that these factors influence each other. This means that performance using assistive technology may change due to various conditions, e.g. different environments, characteristics of the device, the user and the activity, implying that these factors need to be addressed in clinical work and research.

Outcomes of using a powered wheelchair

Most literature on powered wheelchairs concerns the assessment of user needs and abilities, how to use a powered wheelchair, technical features, etc. (e.g. 13), while research on activities and participation and other outcomes of using powered wheelchairs is scarce. Moreover, the studies are mainly qualitative or pilot studies (7, 14) and the majority of the body of research has methodological limitations (15).

The few studies found mainly identified positive outcomes in terms of opportunities to carry out activities and participate in societal life, and that the users' self-esteem was enhanced (7, 8, 16). In contrast, a larger Dutch study on the effectiveness of powered wheelchairs showed that nearly a quarter of the users found that their powered wheelchair solved their mobility problems to a lesser extent than expected (17). The study did not examine the causes underlying this kind of result, but a number of studies have found that one essential factor might be physical environmental barriers (16, 18).

One often-used outcome measure in relation to assistive technology is frequency of use, since it may indicate aspects of how effective and useful the device is (19). This applies especially to non-use, since non-used devices are ineffective for the user and a waste of societal resources. In a Danish study it was found that 11% never or hardly ever used their powered wheelchair, while a Swedish study showed that all powered wheelchair users of a 70–76-year-old population used them (20).

Need for knowledge about outcomes of using powered wheelchairs

Walking ability decreases with age, for example, it is estimated that 20% of Danish men aged 67–79 years and 39% of those over 79 years of age are not able to walk 400 metres without difficulty. Women's walking ability is even more affected, as 25% of women aged 67–79 years and 58% of women over 79 years of age cannot walk 400 metres without difficulty. These figures are similar in other western countries. Thus a large number of older people have mobility problems and the use of powered wheelchairs could be expected to be frequent among older people. However, this is not the case. Only 1.0–1.6% of older people use powered wheelchairs (3, 20). Currently, Danish municipalities report an increasing number of applications for powered wheelchairs from older people, and some of the municipalities are concerned about the expense. In order to determine whether this expense is justified, information about the outcomes of powered wheelchairs is crucial. It is important to determine whether people who have a powered wheelchair can actually use it to carry out prioritized activities, and if they cannot, to determine the reasons for this.

It is complex to measure outcomes of assistive technology and identify factors resulting in positive or negative outcomes (6, 12). However, if factors predicting outcomes of using a powered wheelchair can be identified, this will be important background knowledge for planning intervention programmes and for the assessment of older applicants' expected benefit of a powered wheelchair.

The aim of this study was to examine outcomes of older people's use of powered wheelchairs. The first objective was to describe frequency of use, the users' perception of the wheelchairs' importance, and the users' feeling of independence while using it. The second objective was to investigate activities carried out using the powered wheelchair, accomplishment of prioritized activities, and barriers to this. The third objective was to identify risks of negative outcomes.

MATERIALS AND METHODS

Project organization

A project leader (first author) managed the project, constructed the project questionnaire and analysed the data. A project steering group was set up, comprising 7 persons representing different expertise: users, vendors, occupational therapists, physiotherapists and researchers within the field of rehabilitation. The tasks of the project steering group were to advise the project leader about the contents of the questionnaire and to discuss the results of interviews. Persons employed by the National Danish Institute of Social Research (SFI) carried out the interviews.

The study was part of a larger project, which also included issues on, for example, satisfaction with the powered wheelchair and related services. A Danish report has been published and further results will be presented elsewhere.

Design

The study had a cross-sectional interview design. Interviews were carried out by means of a structured interview questionnaire constructed for the study. All results are based on the powered wheelchair users' subjective statements.

Research district

Procedures and local regulations for granting powered wheelchairs to older people differ between Danish municipalities, especially in relation to the sizes and geographical locations of municipalities. In order to obtain national representation the sampling was carried out on the basis of municipality size and random location; all Danish municipalities were divided into 3 groups consisting of small (<10,000 inhabitants), medium-sized (10,000–100,000 inhabitants) and large municipalities (>100,000 inhabitants). An equal number of users was included from each group. The municipalities were selected at random from each group; 2 large, 4 medium-sized, and 6 small municipalities were selected. Of the 12 municipalities selected originally, 1 large municipality did not want to participate and 3 small municipalities did not have enough older users of powered wheelchairs. Consequently, another large and 3 small municipalities were included, resulting in 12 municipalities in all.

Sample of users

There is no national register of assistive device users in Denmark, but each municipality keeps records. On the basis of earlier studies (3, 21) it was calculated that in order to obtain a sufficiently large sample to be able to carry out the analyses, approximately 110 users were needed. Given an expected response rate of 70%, 160 users had to be asked to participate. From the selected municipalities persons aged over 65 who had had a powered wheelchair for at least 1 year were selected. In the 4

small municipalities all users were enrolled, while in the large and medium-sized municipalities users were selected at random by computer.

A total of 153 users were asked to participate. Three users were found to be under 65 years of age and another user did not have a powered wheelchair but a three-wheeled moped, and therefore these 4 users were excluded. Of the remaining 149 users, 117 were willing to participate. However, 6 could not be interviewed, because they were not able to participate at the time of the interview, either because they were ill or because they were on holiday. Thus there were 38 non-respondents and 111 users were interviewed (74%).

The mean age of the users was 77 years (median 76, range 65–92 years) and approximately half were men ($n = 56$). Nearly one-third of users ($n = 32$) were not able to walk at all, but a larger proportion could only move round in a wheelchair ($n = 53$). Of the remaining 58 users, 1 could only walk short distances with personal assistance, more than half ($n = 38$) could do this using an assistive device, and about one-third ($n = 16$) could walk shorter distances without any assistance. Some ($n = 17$) could not transfer to the wheelchair without help from others. About three-quarters ($n = 84$) of the users had a scooter-type powered wheelchair, and the remaining ($n = 27$) had a joystick-controlled type. On average, the users had used a wheelchair for 4.5 years (range 1–22 years). Some ($n = 18$) had impaired visual function and could not read a normal newspaper at all or only with great difficulty. Finally, only few ($n = 15$) could drive a car, but more than half ($n = 62$) had driven a car previously, and about one-fifth ($n = 24$) had a car in the household. Most of the users lived alone ($n = 77$). About half lived in a private house ($n = 55$), while some ($n = 14$) lived in a flat, slightly more than one-third lived in sheltered housing ($n = 37$) and 2 lived in a nursing home.

In order to investigate whether the study sample was representative of the study population, the study sample and the group of non-respondents were compared as regards all data available for the latter: age, gender, and size of municipality. The Student t-test was used for continuous parametric data and the χ^2 test for dichotomized data. No statistically significant differences at the level of $p < 0.05$ were found between the 2 groups.

Procedure

Administrative staff from the municipalities contacted the selected users by letter, informing them about the study and asking them to participate. If the users did not reply they were contacted by phone and asked whether they were willing to participate. Names and addresses of the users willing to participate were sent to the SFI, and anonymous data concerning age, gender and municipality of residence of those not willing to participate were reported to the project leader.

Twelve experienced interviewers carried out the interviews in spring and summer months. In order to obtain reliability the interviewers went through a training session prior to the interviews. Each interviewer contacted the users in order to arrange the interviews and after they had carried out the interviews on home visits. Data were made anonymous and entered into a database. If a user could not participate, age, gender and municipality of residence were recorded. All data were finally sent to the project leader.

Interview instrument

The study-specific questionnaire used in the interviews was a structured questionnaire constructed on basis of the aims of the study, practical experiences of the project steering group, literature studies and the human activity assistive technology (HAAT) model (12). It was constructed in close co-operation between the project steering group and the project leader. The SFI was also consulted. After the questionnaire had been constructed a pilot test was carried out. The test included 4 male and 4 female users of powered wheelchairs, ages ranging from 72 to 85 years, from a municipality not selected for the study. After each pilot interview the questionnaire was optimized and the new version used in the following interview. The pilot interviewing stopped when 2 interviews had not resulted in any changes.

The interview questions were structured and close-ended with the exception that in some questions the response category "other" was included, giving the opportunity for comments. The interview questions concerned the following issues:

Person. Six questions about background factors (age, gender, cohabitation, car in household, housing, how long the user had had the powered wheelchair) and 4 about aspects of body functions (walking ability (based upon questions in the Functional Limitations Profile (22)), ability to transfer to wheelchair, visual function (whether the person had difficulty reading a normal newspaper), ability to drive a car).

Assistive technology. One question about the type of powered wheelchair.

Activity. Seven questions: 1 about indoor/outdoor use of wheelchair, 2 about activities carried out using the wheelchair outdoors in the summer and in the winter (11 response categories based on results from a study on older people's outdoor mobility (3), the categories are shown in Table I), 2 about travelling by bus and train using the powered wheelchair and about bringing it in a car, 1 about which prioritized places the powered wheelchair could not be used to go to (same response categories as the question about outdoor activities), and 1 about how the users in that case reached these places [response categories: go with others, by taxi, by special transportation supplied by the municipality, by private car, does not go, other].

Environmental barriers for carrying out prioritized activities. One question about the reasons why the powered wheelchair could not be used to go to prioritized places (response categories: distance barriers, weather conditions, physical ability to sit long enough, and physical environmental barriers).

Outcome dimensions. Five questions: 1 about agreement with the statement that the powered wheelchair could be used to go to prioritized places (response categories: total agreement, partial agreement, partial disagreement, total disagreement, and does not know), 1 question concerning how important the wheelchair was for the user (response categories: the same as the ones used for going to prioritized places), 1 concerning whether it made the user feel more independent (response categories: total agreement, partial agreement, partial disagreement, and does not know), and 2 about frequency of use in the summer and in the winter (response categories: at least once a day, once per week, once per month every summer/winter, does not use it).

Data analysis

The first part of the study was merely descriptive. In the second part differences between male and female activities and differences between activities carried out in the summer and winter were tested using the χ^2 test. Wilcoxon's signed rank test was used to analyse differences between frequency of use in the summer and winter.

In the third part odds ratios (OR) for the investigated negative outcomes (dependent variables) for individuals who had certain characteristics (independent variables) were computed. ORs provide information about probability, and ORs higher than 1.0 indicate a greater probability of the investigated outcome, whereas ORs less than 1.0 indicate a lesser probability. If 1.0 is included in the confidence limits the probability is neither greater nor lesser (23). The independent variables included in this analysis were age, gender, walking ability, ability to transfer, visual function, car in household, ability to drive a car and cohabitation. The dependent variables (negative outcomes) were the following 4 outcome dimensions: the user did not agree that the wheelchair could be used for going to prioritized places, the user did not feel independent using the powered wheelchair, and low frequency of use in the summer/in the winter. The outcome dimension "importance" could not be analysed because of lack of variance of the data.

In order to carry out the analysis data was dichotomized. The general principle applied was maximum contrast. For instance, walking capacity was divided into "could walk a little" and "could not walk at all". As regards continuous data (age), the median was used for dichotomization. Data about agreement with statements were dichotomized so that agreement and partial agreement were categorized as "yes", partial disagreement and disagreement as "no" (corresponding to the dependent variables: "the user did not agree that the wheelchair could be used for going to prioritized places" and "the user did not feel independent using the powered wheelchair"), and if the user did not know, the answer was not included in the analysis. Frequency of use was dichotomized in different ways concerning summer and winter, because it cannot be expected that the powered wheelchair is used as often in the winter as in the summer. If the wheelchair had been used at least once a day in the summer it was categorized as "frequent use", and if it was used less it was "low frequency of use". In the winter, if the wheelchair had been

Older people's use of powered wheelchairs

Table I. *Older men's and women's activities using powered wheelchair in summer and winter (n = 111)*

Activities	In the summer			In the winter		
	Men ($n = 56$) *n* (%)	Women ($n = 54$) *n* (%)	All ($n = 111$[a]) *n* (%)	Men ($n = 56$) *n* (%)	Women ($n = 54$) *n* (%)	All ($n = 111$[a]) *n* (%)
Go for a ride	49 (88)	43 (80)	92 (83)****	34 (61)***	20 (37)	54 (49)
Shopping	41 (73)*	45 (83)	87 (78)	32 (57)***	40 (74)	73 (66)
Visit friends and family	33 (59)	30 (56)	63 (57)	22 (39)	20 (37)	42 (38)
Go to church, churchyard	14 (25)*	20 (37)	35 (32)	7 (13)**	10 (19)	18 (16)
Go to daycentre, club, etc.	17 (30)	12 (22)	30 (27)	13 (23)	11 (20)	24 (22)
Moving around in the garden	9 (16)	13 (24)	22 (20)*****	2 (4)	1 (2)	3 (3)
Moving around indoors in own or other's home	8 (14)	11 (20)	19 (17)	5 (9)	7 (13)	12 (11)
Go to café, restaurant, etc.	8 (14)	10 (19)	18 (16)	6 (11)	5 (9)	11 (10)
Go to cinema, library, theatre, etc.	4 (7)**	12 (22)	16 (14)	2 (4)**	10 (19)	12 (11)
Other activities	10 (18)	9 (17)	19 (17)	8 (14)	7 (13)	15 (14)

[a] The sample consisted of 56 men and 54 women and 1 with unidentified gender.
* $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$ compared with women. **** $p < 0.05$ and ***** $p < 0.01$ for the whole group compared with

used at least once a week it was categorized as "frequent use", and if it was used less it was "low frequency of use".

The ORs were computed in 2 steps. First, bivariate analyses were carried out using the χ^2 test, and crude ORs were computed, then multivariate analyses were performed. All independent variables were included in the multivariate analysis of each outcome dimension in order to exclude the confounding effect of these variables. The crude ORs identify groups of users that may be at risk of negative outcomes, while the multivariate analysis reveals the influence of each independent variable, that is, when the impact of other confounding variables is excluded. For the multivariate analysis the logistic regression method (backward: LR) was used excluding variables stepwise one at a time, the exclusion criterion being the highest statistically significant value. The confidence limits were 95%. In all analyses the significance level was $p < 0.05$.

Ethics

The users who participated in the study gave informed consent and they were guaranteed anonymity. The Danish registration authorities granted the SFI permission for data collection and database construction. Since it was not an experimental study it was not necessary to have the study formally approved according to Danish ethical rules.

RESULTS

Importance, independence and frequency of use

Of the 111 users nearly all regarded their powered wheelchair as very important ($n = 102$) or somewhat important ($n = 6$), 2 users did not think that it was important, and 1 answer was missing. A large proportion of the users also agreed that the powered wheelchair gave them freedom to get about independently ($n = 99$), some partly agreed ($n = 6$) and only few disagreed ($n = 6$).

All used their powered wheelchair outdoors. About four-fifths ($n = 88$) used it entirely outdoors, some ($n = 14$) also used it indoors all the time, and the remaining ($n = 9$) also used it indoors now and then. In the summer the major part of the users ($n = 71$) used their powered wheelchair outdoors at least once a day, one-third ($n = 36$) used it at least once a week, 3 used it less, and 1 answer was missing. In the winter they used their powered wheelchair less frequently outdoors ($p < 0.001$); about a quarter ($n = 26$) used it at least once a day, less than half ($n = 46$) used it at least once a week, about a fifth ($n = 25$) used it less, and some ($n = 14$) never used it outdoors in the winter.

Activities carried out using the powered wheelchair

The most frequent activities the powered wheelchair was used for were going for a ride, shopping, and visiting friends and family. In the summer the most frequent activity was going for a ride ($n = 92$), while fewer used it for that in the winter. The most frequent activity carried out in the winter was shopping ($n = 54$). In the winter the activities investigated were carried out less frequently than in the summer, even though this difference was statistically significant only in relation to going for a ride ($p < 0.05$) and moving around in the garden ($p < 0.01$) (Table I).

Most activities were carried out by about the same proportion of men and women, but more women than men used the wheelchair for shopping, for going to church and cemetery, and for going to the cinema, library, theatre, etc. This was the case in the summer as well as in the winter. However, more men than women used the powered wheelchair for going for a ride in the winter (Table I).

About one-third ($n = 39$) of the users used their powered wheelchair when they travelled longer distances, while the rest did not. Only a few ($n = 10$) then transported their powered wheelchair in their private car. Even fewer ($n = 6$) went by bus or train sitting in their wheelchair, while a larger proportion ($n = 27$) used special transportation, i.e. travelling in a specially equipped bus supplied by the municipality.

Use of the powered wheelchair to accomplish prioritized activities

By far most users agreed totally that they could use their powered wheelchair to carry out prioritized activities ($n = 84$), 10 agreed partly, 8 disagreed partly, 7 disagreed totally and 2 did not know. As to specific activities nearly a third ($n = 40$) had problems using the wheelchair to carry out one or more activities. In particular, visits to friends and family caused problems since about a fifth ($n = 23$) stated that they would like

Table II. *Number of users who could not use their powered wheelchair to carry out prioritized activities and reasons for this (n = 40[a])*

	Number of users	Reasons: The wheelchair cannot go far enough	It is too cold	Cannot sit for sufficiently long time	Too many stairs, doorsteps, etc.	Other reasons	Missing reason
Going for a ride	4	4	0	0	0	0	0
Shopping	6	1	1	0	1	2	1
Visit friends and family	23	10	1	0	7	3	2
Go to church and churchyard	7	2	1	1	2	1	0
Go to daycentre, club, etc.	2	0	0	0	1	0	1
Moving around the garden	1	0	0	0	0	1	0
Moving around indoors at home or in other people's homes	2	0	0	0	1	1	0
Go to café, restaurant, etc.	5	1	0	0	3	1	0
Go to cinema, library, etc.	4	1	0	0	3	0	0
Other purposes	10	0	0	0	0	1	9
Number of times a reason was mentioned		19	3	1	18	10	13

[a] Some users could not carry out several activities, and therefore the number of activities that could not be carried out is higher than the number of users having problems.

to use their powered wheelchair for this activity, but that it was not possible (Table II).

Experience of barriers to carrying out prioritized activities. The most frequent reasons why the powered wheelchair could not always be used to carry out prioritized activities were that it could not go far enough or that there were too many stairs, doorsteps, etc. along the way or at the destination. Cold weather and problems with sitting in the wheelchair for a sufficiently long time were only rarely reported as barriers (Table II).

When the users could not use the powered wheelchair to move around outdoors, some just did not go ($n = 17$), others ($n = 16$) went by car driven by friends or family, and only few ($n = 8$) went by taxi or special transportation supplied by the municipality.

Risks of negative outcomes

When users of powered wheelchairs were over 76 years of age it was more likely that they did not think that the powered wheelchair could be used for prioritized activities (OR = 3.0). After adjustment for confounding factors this risk was even higher (OR = 6.3). Age was also a risk factor in terms of frequency of use, both in the summer and the winter, since the probability that the age category 77–92 years would use their powered wheelchair frequently was 3–4 times less than the younger age category. It was also much more likely that women did not think that they could use their powered wheelchair to carry out prioritized activities compared with men. When the crude odds ratio was calculated it was not statistically significant, but after adjustment the odds ratio became statistically significant and much higher (OR = 9.5), especially having a car in the household seemed to be a confounding factor. Gender had no impact on any of the other outcomes investigated (Table III).

The users' physical abilities had some impact: when the users were not able to transfer without assistance or to walk at all, the risk that they would not think that they could use the wheelchair for prioritized activities was much increased. After adjustment of the data walking ability was not a risk factor anymore, mainly because the ability to transfer seems to have been a confounding factor. This is underlined by the fact that the risk that users who were not able to transfer without assistance would think that they could not use the powered wheelchair for prioritized activities was very high (OR = 25.3) after adjustment. When the users could not walk or transfer without assistance the risk that they would not feel independent using their powered wheelchair was also increased. After adjustment of the data, however, only ability to walk turned out to be statistically significant, being a confounding factor in relation to ability to transfer.

Visual function also played a role, since it was more likely that users with visual difficulties could not carry out prioritized activities (OR = 3.1), and the risk increased after the data had been adjusted (OR = 8.5). The change of OR after adjustment was mainly caused by the variable "having a car in the household", which in other words was a confounding factor in relation to visual function.

Table III. *Characteristics of older users in risk of negative outcomes using powered wheelchair in terms of goal attainment, feeling of independence, frequency of use in the summer and winter. Crude odds ratios (OR) and ORs[a] adjusted by means of logistic regression analysis* (n = 111)

Determinant	Did not agree that the powered wheelchair could be used to carry out prioritized activities		Did not agree that the powered wheelchair gave independence		Low frequency of use in the summer: < every day		Low frequency of use in the winter: < every week	
	Crude OR	Adjusted OR (CI)	Crude OR	Adjusted OR (CI)	Crude OR	Adjusted OR (CI)	Crude OR	Adjusted OR (CI)
77–92 years old[b]	3.0*	6.3* (1.4–28.4)	1.1		3.4**	3.3** (1.5–7.5)	2.7*	3.7** (1.5–9.2)
Female[c]	2.9	9.5** (1.8–50.1)	2.2		0.7		1.2	
Could not walk at all[d]	5.0**		15.2**	15.0* (1.7–134.5)	1.0		1.8	
Need of assistance to transfer to p.w.[e]	8.4**	25.3*** (4.4–145.5)	6.5*		0.7		2.4	
Some visual difficulties[f]	3.1*	8.5* (1.6–43.7)	1.1		2.0		1.0	
Car in household[g]	2.5		2.0		1.1		2.0	3.2* (1.1–8.9)
Could not drive a car[h]	1.2		n.p.		0.8		1.1	
Lived alone[i]	1.7		2.4		1.2		2.1	

[a] 95% CI and only ORs statistically significant at a level of $p < 0.05$ are included.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
p.w. = powered wheelchair.
Reference groups (OR = 1.0): [b] 65–76 years old; [c] Male; [d] Could walk a little; [e] Not need of assistance to transfer to p.w.; [f] No visual difficulties; [g] No car in household; [h] Could drive a car; [i] Lived together/other.
n.p. = not possible to carry out analysis.

It had no impact on any of the outcome variables whether the user was able to drive a car or not. However, when there was a car in the household the probability that the user would not use the powered wheelchair in the winter was increased.

DISCUSSION

The findings in this study demonstrate that older people with limited walking ability benefit from using a powered wheelchair. Almost all users regarded their powered wheelchair as important and found that it gave independence. They also thought that the wheelchair in most cases could be used for activity and participation, and all used their powered wheelchair. Thus this societal intervention can be considered to be relevant. But the study also identified barriers for effective use of the powered wheelchair, and results of the analysis of risk factors for negative outcomes provided us with new knowledge indicating the need for development of improved intervention strategies.

The activities that older people carried out using their powered wheelchairs were similar to the activities that older people without limited walking abilities carry out walking or cycling (3) thereby enhancing activity and participation, even though some users could not carry out all prioritized activities using the powered wheelchair. These results are in line with the results of other studies (7, 8, 17, 20).

The main activity that some users could not always carry out using the powered wheelchair was visiting friends and family, which is of concern because social relationships are important for participation in societal life (2). The barriers reported in the current study concerned the characteristics of the powered wheelchair, and the physical environmental context. As to the characteristics of the powered wheelchair, the problem was that it could not go far enough, probably because some family members live so far away that it would not be realistic to go in a powered wheelchair, even if it could go farther. The physical environmental barrier preventing the users from visiting friends and family concerned stairs, doorsteps, etc., while this type of barrier did not prevent the users from shopping. On the basis of former studies it was expected that physical environmental barriers would prevent the powered wheelchair users from carrying out more activities (14, 18), so it was surprising that the physical barriers did not play a more pronounced role. The explanation may be that the users had adapted their behaviour (5, 24) by going routes without physical barriers or by going to accessible places rather than to places they really want to go to (25). The explanation given is supported by the fact that especially physical barriers played a role in relation to visiting friends and family, and in contrast to public facilities such as, for example, shops, the specific homes of friends and family cannot just be substituted with another.

Users over 76 years of age were more likely not to think that the powered wheelchair could be used to carry out prioritized activities. This finding is supported by a study about older people's activity performance, which revealed that older people show age-related decline (26). However, other studies have

shown that age does not seem to be a factor in its own right, but due to other factors such as impaired body function, bad health or environmental barriers (3, 27). One of the reasons for these different results is probably the methodological approach of the studies, indicating that more research is needed about age as a factor for outcomes of assistive technology. Knowledge about the age factor is especially important because the prevalence of assistive device use increases in older age (28).

The gender distribution of the study sample differed from the gender distribution of the general population of people over 65 years of age. Given the sampling strategy applied, it is likely that the sample is representative for the Danish population of older powered wheelchair users, implying that a greater proportion of older men than of older women use powered wheelchairs. Another gender difference was that it was much more likely that men could use their powered wheelchair to carry out prioritized activities. On the other hand women used the powered wheelchair for more differentiated activities than men did. One explanation for these gender differences may be that men's and women's activities generally differ (3, 29–30) and another that men and women relate to technology in different ways, men finding it easier to use high technology based devices than women do (e.g. 31). Still, the issue of gender and use of assistive devices is largely unexplored, and in order to obtain reliable knowledge about this phenomenon other studies are needed.

Methodological considerations

The HAAT model (12) was used in this study, and it seems to be useful. The investigated factors have proved to play a role for the outcome dimensions investigated; some personal factors influenced the possibility to carry out prioritized activities, the range of the powered wheelchair and stairs and doorsteps may be barriers, and the sort of activity carried out also played a role. The study does shed some light upon how these factors influence a number of outcome dimensions, but still only little is known about the interrelationships between the 4 domains, how they influence various outcome dimensions, and underlying mechanisms. An example is physical barriers and why in some situations they constitute major problems and in other situations minor problems for users of powered wheelchairs.

The current study was a cross-sectional study. A drawback of this design is that it is difficult to establish the direction between cause and outcome, and in order to obtain this, longitudinal analytic studies should be carried out (32). Such studies and qualitative studies can give us further knowledge about some of the issues raised in this study, for example, concerning the significance of age, gender and physical environmental barriers.

The study was performed in Denmark, and the results can be considered as representative of this country. Some of the results may apply to other countries, but not all due to different geographical conditions or assistive technology service systems.

Practical implications

The study shows that users with some walking ability and/or ability to transfer to the wheelchair without assistance benefited substantially from using a powered wheelchair. However, in some countries (33) and some Danish municipalities the eligibility criteria for granting a powered wheelchair are that only applicants who cannot walk at all and/or are not able to transfer to the wheelchair without assistance are entitled to get one. Another common criterion is that the user must be in need of the powered wheelchair for shopping or for going specific places. Yet the users' needs seem to be different; the most frequent activity reported in the current study was going for a ride, and also visits to friends and family were frequent. The need to go outside to get fresh air and sunlight is a basic health requirement and must be considered as important as more targeted activities (e.g. 34). Likewise, it has been shown that not only physical, but also social activities have positive effects on survival rates (35). Thus, early intervention before the user may lose all walking ability would enable the user to stay active and prevent participation restrictions. The results of the present study do not support the mentioned criteria for granting powered wheelchairs, and since eligibility criteria should be as valid as possible a revision of existing criteria should be considered.

The powered wheelchair cannot be used in all situations to carry out prioritized activities, especially in case of long distances and environmental barriers. In order to make participation in societal life possible there is a need to supplement powered wheelchairs with other transport possibilities.

In conclusion, the vast majority of older powered wheelchair users consider their device to be important and that it gives them independence, and all of them use it. The powered wheelchair makes it possible for them to carry out most prioritized activities and to participate in societal life. This means that provision of powered wheelchairs can be regarded as worthwhile. However, in some cases, especially for visits, the powered wheelchair cannot be used and other means of transportation must be supplied in order to make participation possible. The results of this study indicate that the use of powered wheelchairs should be extended to older people with less impairment than is common today preventing activity limitations, even though exact criteria cannot be stated on the basis of this study. A number of risk factors in relation to various outcome dimensions have been identified, which is useful for planning measures to improve older people's outcomes of using a powered wheelchair. Finally, a number of issues that need further investigation have been identified, especially the significance of age, gender and physical environmental barriers in relation to the use of powered wheelchairs to enable activity and participation.

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Paper IV

Are Mobility-Related Participation and User Satisfaction Separate Constructs?

Validity in the Context of Powered Wheelchair Use

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Abstract

Objective: To investigate validity and reliability aspects of mobility-related participation and user satisfaction in the context of powered wheelchair use.
Design: Interview survey
Setting: General community
Participants: 111 of 149 eligible persons (74%) having used a powered wheelchair for at least one year, mean age 77 years (range 65–92).
Interventions: Not applicable
Main outcome measures: The objective was not to investigate outcomes as such, but rather constructs of outcome dimensions.
Results: The mobility-related participation and user satisfaction scales used were valid. Thus unidimensionality and the expected underlying constructs were confirmed. The reliability of the user satisfaction scale was good, while the mobility-related participation scale was not optimal. In the latter, Cronbach's alpha was low, and Rasch analysis revealed that the scale had problems discriminating between persons with a high degree of mobility-related participation. Finally, it was shown that the two constructs were not related, but separate constructs.
Conclusion: In spite of a relatively small sample, validity and the unidimensionality of the two scales were confirmed. It was revealed that the two constructs are separate, indicating the two measurements cannot replace each other. Reliability problems of the mobility-related participation scale indicated that the concept was complex, requiring further studies.
Keywords: psychometrics, self-help devices, rehabilitation, old age

Introduction

In rehabilitation a wide range of instruments are used to measure outcomes of interventions, and often several instruments are applied to cover different outcome dimensions. An important shortcoming is, however, that psychometric qualities such as the validity and reliability of the instruments used often are not known sufficiently well (1). Research on assistive technology outcome measurement is still in its infancy, but like other social and health care interventions assistive technology interventions need to be based on outcome research, requiring valid and reliable measurements (2).

Outcome research is crucial in order to be able to select rehabilitation interventions that are effective and to improve the quality of the interventions. A wide range of outcome dimensions may apply, such as satisfaction, feeling of safety, frequency of use, improved body functions, activities of daily living (ADL), and participation in societal life. Traditionally, outcomes concerning improvement of body functions and ADL capacity have been focused upon, but lately and especially after the launch of the International Classification of Functioning, Disability and Health (ICF) (3), the need for outcomes concerning involvement in real life situations, i.e. participation, has been recognised as crucial (4). In the Scandinavian countries assistive technology is granted free of charge if the user's level of participation is expected to improve substantially. Hence participation may be regarded as effectiveness of the intervention, given that effectiveness is defined as 'a measure of the extent to which a specific intervention, procedure, regimen, or service, when employed in the field in routine circumstances, does what it is intended to do for a specific population' (5).

In the field of assistive technology, provision of mobility devices aimed at increasing possibilities for citizens with limited walking capacity to participate in societal life is among the most common interventions, and among older people with considerably limited walking capacity the use of powered wheelchairs is rapidly increasing. For example in Sweden, the provision of powered wheelchairs for citizens aged 80+ increased by 46% from 1997–2002, while the increase was 35% for younger age groups (6). Given the fact that powered wheelchairs mostly are used to make participation possible (7), the aim of powered wheelchair interventions may be expressed in terms of increasing *"mobility-related participation"*. The term delimits participation aspects, which absolutely presuppose mobility in contrast to some other participation aspects, such as telecommunication and reading. Representing effectiveness of the intervention, we consider mobility-related participation as one essential outcome dimension for research in this field. Another important outcome measure is *"user satisfaction"*, expressing subjective perspectives of the assistive technology intervention (8). Seen in the light of the increasing awareness about the necessity of client-centred rehabilitation practices (9), user satisfaction is vital.

In practice contexts in general, powered wheelchairs are considered as an effective intervention, while only limited research targeting mobility-related participation and/or user satisfaction is available. Nevertheless, most of the few studies identified concluded that powered wheelchairs were effective in terms of enhanced participation (7;10–12), and that users in general were rather satisfied; a little more with the device itself than with service provision (13–15). Since the results of studies about participation as well as user satisfaction outcomes indicated positive outcomes of the powered wheelchair intervention, it may, however, be questioned whether participation and user satisfaction represent the same phenomenon or whether they represent different constructs. Only one study touching upon this issue was found, revealing that user satisfaction and an aspect of effectiveness defined

as "problem-solving ability" were related but separate constructs (16).

When it comes to instruments for measuring mobility device outcomes, few are available, and thus most studies have used study-specific instruments or questionnaires. Even so, instruments need to be valid and reliable in order to ensure trustworthy data, and the psychometric testing should be performed in the culture where they are to be used (17) and in relation to the target group (18). Validity refers to the degree to which an instrument measures what it is intended to measure, covering several validity aspects. Validity cannot be proved as such, but several studies and tests have to be performed to display evidence of different aspects of validity. One validity aspect is criterion validity, which is demonstrated by comparing the results with those deriving from another assessment measuring a similar phenomenon, which may also be called an external criterion (18;19). Construct validity aims at demonstrating to what extent an instrument measures the underlying construct it is expected to measure (18;19). Only one underlying construct should be present for a scale to be summarised, and in addition the summarised score should be sufficient, meaning that all information from the measurement should be expressed by the summarised score (20). Reliability concerns the variability of measurements; one aspect is internal consistency, though regarded by some authors as related to validity (19;21), and another reliability aspect involves the degree to which the items of an instrument target a population (18;22). When a measure is reliable it cannot be inferred that it is also valid, even though reliability is fundamental for validity (21).

While methodologies used in assistive technology outcomes research still mostly are based on scarce scientific evidence, considerable resources are currently being spent on attempts to measure outcomes of assistive technology. Little is known about e.g. overlaps between different instrument used, and likewise little is known about the validity and reliability of the instruments used (1). Hence studies investigating the construct validity of e.g. mobility-related participation and user satisfaction certainly are called for.

In the context of research on outcomes of powered wheelchair use among older people, the objective of the present study was to investigate the construct validity of mobility-related participation and user satisfaction, and to examine the relationships between them. In addition, aspects of reliability were examined.

Materials and methods

The present study was a part of a larger cross-sectional interview study on older people's use of powered wheelchairs (7). Project organisation, study design, research district, sample of users and procedures have been reported in detail elsewhere (7) and are thus only briefly introduced here. A project leader (first author) managed the project and constructed the instrumentation in co-operation with a steering group representing different expertise within the field of assistive technology.

The research district consisted of 12 Danish municipalities, selected to be representative of Denmark. Persons aged 65+ who had had a powered wheelchair for at least one year were included. In some smaller municipalities all users were enrolled, while in larger municipalities users were selected at random in order to make the distribution of users from small and larger municipalities representative of Denmark. In all 149 persons were selected, of whom 117 were willing to participate. In the end, six could not be interviewed and thus 111 out of 149 eligible users were interviewed (74%). Their mean age was 77 years (range 65–92), 56 were men and 54 women (one unknown gender), and 34 lived together with somebody else, while 77 lived alone.

Administrative municipality staff con-

tacted the users by information letters, asking them to participate. Twelve experienced interviewers from the National Danish Institute of Social Research (SFI) carried out the interviews. After a training session each interviewer contacted the users in order to make appointments for interviews at home visits.

Instruments

When it comes to operationalisation of the constructs under investigation, at the time of this study instruments for measurement of outcomes of assistive technology in terms of participation and user satisfaction hardly existed. Therefore, it was considered necessary to develop study-specific instruments. The instruments used for this study were part of a larger study-specific questionnaire (7).

Mobility-related participation instrument

From the larger questionnaire (7) 12 items intended to represent the construct of mobility-related participation were selected, constituting the mobility-related participation instrument (Table 1). Ten items were about desired participation aspects, offering two response categories: 'Can/cannot use the powered wheelchair for desired participation', and two items were about travel by bus offering four response categories: Never; rarely; sometimes; often.

User satisfaction instrument

At the time when the data for this study were collected, the only instrument targeting user satisfaction in relation to assistive technology

Table 1. Items of the two instruments used and distribution of responses (N=111).

	Mobility-related participation	Response alternative	
Item no.	Instrument and item	Cannot use powered wheelchair *n* (%)	Other response alternatives *n* (%)
P1	Shopping	6 (5)	105 (95)
P2	Go to daycentre, clubs, etc.	2 (2)	109 (98)
P3	Visit friends and family	23 (21)	88 (79)
P4	Go to café, restaurant, etc.	5 (5)	106 (95)
P5	Go to cinema, library, etc.	4 (4)	107 (96)
P6	Go for a ride	4 (4)	107 (96)
P7	Go to church and churchyard	7 (6)	104 (94)
P8	Get about in own and others' homes	2 (2)	109 (98)
P9	Get about in the garden	1 (1)	110 (99)
P10	Other participation aspects	10 (9)	101 (91)
P11	Go by accessible bus	77 (69)	34 (31)
P12	Go by bus, train, etc.	98 (88)	13 (12)

Cont.

was the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST) (23). Later on, the QUEST has been used in several studies, and besides, English, French, and Dutch versions have undergone psychometric testing (24;25), resulting in the QUEST 2.0 (26). In Denmark aspects of equivalence and content validity of the Danish QUEST 1.0 have been examined, suggesting improvements of items. In addition, content and equivalence problems were identified, most of which, however, related to items that were deleted in the QUEST 2.0 (unpublished observation). Based on these findings and the

Table 1 continued.

User Satisfaction	Response alternative						
	Not satisfied at all *n* (%)*	Not much satisfied *n* (%)*	More or less satisfied *n* (%)*	Quite satisfied *n* (%)*	Very satisfied *n* (%)*	Non applicable *n*	Missing *n*
Device subscale							
S1 Dimensions	0 (0)	4 (4)	11 (10)	38 (34)	58 (52)	0	0
S2 Safety	3 (3)	4 (4)	9 (8)	44 (39)	51 (46)	0	0
S3 Durability	2 (2)	7 (7)	9 (9)	38 (38)	43 (44)	12	0
S4 Simplicity of use	2 (2)	7 (6)	0	33 (30)	69 (62)	0	0
S5 Comfort	3 (3)	3 (3)	12 (11)	26 (23)	67 (60)	0	0
S6 Effectiveness	1 (1)	4 (4)	9 (8)	27 (24)	69 (63)	0	1
Service subscale							
S7 Repairs / servicing	3 (3)	5 (5)	8 (9)	32 (36)	42 (47)	20	1
S8 Service delivery	3 (3)	4 (3)	14 (13)	22 (20)	67 (61)	0	1
S9 Professional service	5 (5)	6 (5)	9 (8)	35 (32)	54 (50)	2	0
S10 Follow-up services	5 (5)	10 (9)	15 (14)	33 (31)	44 (41)	1	3

Criterion variable	Response alternative				
The wheelchair can be used for going to desired places	Totally agree *n* (%)	Partly agree *n* (%)	Partly disagree *n* (%)	Totally disagree *n* (%)	Missing *n*
	84 (77)	10 (9)	8 (7)	7 (7)	2

Exogenous variable	*n* (%)	Missing *n*
Gender: Male / female	56 (51) / 54 (49)	1
Age: 65-76 / 77-92	57 (51) / 54 (49)	0
Cohabitation: Alone / other	34 (31) / 77 (69)	0

*Missing values are not included

QUEST 2.0, a study-specific instrument was constructed to represent the underlying construct of user satisfaction. Items equivalent to QUEST 2.0 items were included except from two, not considered to be relevant in relation to powered wheelchairs (satisfaction with weight and adjustment). The study-specific user satisfaction instrument thus consisted of six items concerning the powered wheelchair, called the device subscale, and four concerning related services, called the service subscale. Five response categories and a 'non-applicable' option were offered (Table 1). To sum up, the differences between the study-specific instrument and the QUEST 2.0 were item formulation, fewer items were included, and a non-applicable response category was offered.

The mobility-related participation instrument and the user satisfaction instrument were both intuitively expected to be uni-dimensional index-scales, meaning that they were each assumed to measure one single construct and that they were additive (27;28). However, none of the instruments had undergone any psychometric testing.

Data analysis

In order to examine the validity of the two instruments it was investigated to what degree they met the requirements of criterion-related construct validity (28) and objectivity (29) by analysing the fit of item responses to Rasch models. If item responses fit a Rasch model well, it is evidence of construct validity (28;29). For item responses to fit a Rasch model, a number of requirements must be fulfilled. One requirement is unidimensionality of the scale, meaning that it only measures one single underlying construct, called 'the latent trait', because it is a phenomenon that cannot be measured directly, but has to be measured by more tangible events, such as behaviours, opinions, etc. In the present study 'mobility-related participation' and 'user satisfaction' were expected to be the latent traits of the two used instruments. One specific requirement met by Rasch models is that measurements are objective in the sense that they do not depend in any systematic way on how persons are sampled or on what items are included in the scale (29). Andersen (30) also showed that the Rasch model is characterised by a statistically sufficient total score summarising all available information on the latent trait from the item responses, called sufficiency. The requirements of objectivity and sufficiency may therefore be seen as two equivalent requirements. In addition, the sufficiency of the total score ensures that the score provides the most reliable measure of the latent trait for the given set of items (20).

A specific requirement of construct-valid measurements (28) and therefore also of the Rasch model is that response patterns are homogeneous across items and individuals, i.e. that the probability of a response to an item does not depend on other factors than the contents of the item and the latent trait being measured. Another way to express this is to say that no differential item functioning (DIF) should be present in the sense that item responses and person factors are conditionally independent given the latent trait.

In order to examine the degree to which items are targeted to the population, the distribution of the values of the latent trait in the population must be compared to item thresholds. A threshold is the level at which the likelihood of endorsing a given response category turns to the likelihood of failing to do so and vice versa (22). It is usually claimed that optimal reliability for a specific population requires that items are centred around the midpoint of the distribution of the latent trait. Low reliability can subsequently only be improved by replacement of the current set of items with either a larger set of items or with a set of items that are better targeted to the population being examined.

In this study, first the two items of the

mobility-related participation scale about travelling by bus (P11 and P12) were dichotomised to align the response categories with the other items in the instrument into 'never'/'other'. Then the score groups of both investigated scales were computed. The score groups of the mobility-related participation scale consisted of the number of desired participation aspects the powered wheelchair could not be used for, ranging from 0 to 12. The user satisfaction scale was an ordinal scale encompassing five response categories, and scores were then computed by counting the thresholds between each step for each item. That is, five satisfaction categories produce four item thresholds and since there were ten items, the score groups ranged from 0 to 40. Subsequently the distribution of percentages of persons for each score group was computed.

Prior to examination of both scales in terms of fit of item responses to Rasch models, five subgroups of persons were defined and dichotomised. One subgroup was defined by the scores of each scale in order to investigate the performance of the scale in relation to low and high scoring. No difference between the score groups in relation to the latent trait should occur. The scores were dichotomised by dividing the number of persons into two groups of about equal size. A second subgroup was a criterion variable that was expected to be positively related to the latent traits of the two scales. In the present study the criterion variable was defined by an item about users' agreement to whether they could use the powered wheelchair for going to desired places with response categories 'agree'/'partly agree'/'partly disagree'/'disagree', dichotomised into 'agree'/'disagree'. The other three subgroups were defined by the exogenous variables gender, age, and cohabitation, across which the scale might not be homogeneous. Age was dichotomised by the median. No difference between each exogenous variable in relation to the latent trait should occur.

The analytical strategy used was to run initial multiple tests of the fit of item responses to Rasch models and in case of lack of fit, further analyses were performed. The first step then was to test the homogeneity of item responses across the five different subgroups of persons defined above, by calculating conditional maximum likelihood estimates of item parameters and performing conditional likelihood ratio (CLR) tests that compare item para-meters in different subpopulations as suggested by Andersen (31;32). Evidence of heterogeneity (lack of homogeneity) may surface due to both differential item functioning (DIF) and local dependence (LD), defined to be present if $p<0.05$. Local dependence occurs if the response to an item depends on the success or failure on one or more other items. The Rasch model requires items to be locally independent. In order to identify the specific sources of DIF or LD whenever initial analyses rejected the Rasch model, Mantel-Haenszel procedures and analyses by graphical loglinear Rasch models (33;34) were used.

To examine the degree to which the items targeted the specific population of the study, the distribution of the values of the latent trait in the population, expressed as intervals defined by person thresholds, were compared to item thresholds. For this, methods for so-called conditional inference in Rasch models were used (35), which avoid specific assumptions concerning the distribution of the latent traits in the population. In addition, Mantel-Haenszel analyses of the relationships between items and person factors (36) and generalisations of Mantel-Haenszel analyses of relations between pairs of items were applied (33;34), resulting in intervals defined by person thresholds. The intervals contain the values of the latent trait, in which a specific score has the largest probability of appearing. A set of items is well targeted for a specific population if the thresholds of the items are distributed around the centre of the distribution of the person thresholds.

After performing the various Rasch analy-

ses, reliability in terms of internal consistency was evaluated by means of Cronbach's alpha, applying stepwise item deletion (18). Finally, in order to investigate the relationship between the latent traits of the two scales, correlation was analysed using Kendall's tau-b (37).

The analyses were carried out using the Digram software for examination of validity and objectivity (38), while the SPSS 12.0 was used for the remaining analyses (39).

Ethics

The users who participated in the study gave informed consent and were guaranteed confidentiality and anonymity. The Danish registration authorities granted the SFI permission for data collection and database construction. According to Danish ethical rules, formal approval was not applicable.

Results

Validity and objectivity

Mobility-related participation instrument

The results of the comparison of estimates of item parameters across different score groups, groups defined by the criterion variable, and by gender, age, and cohabitation are displayed in Table 2. The comparison across the two score groups resulted in p=0.044, which however was not considered to be convincing evidence of heterogeneity, since multiple testing was performed. Thus evidence of DIF appeared only in relation to the criterion variable (p=0.009). Further analysis suggested that this problem only had to do with one item, P4 (go to cafés and restaurants), and that the item bias appeared to be uniform, i.e. the magnitude of association between the criterion variable and item P4 was the same for all levels of the latent trait. As demonstrated by the results of the conditional likelihood tests of homogeneity of item responses when the uniform DIF had been taken into account, no additional evidence against the model was revealed (Table 3).

As regards the degree to which the items target the specific population under consideration, the comparison of the distribution of the values of the latent trait in the population and the thresholds of the items is displayed in Table 4. For example, it can be seen that a total score equal to 4 had the largest probability of appearing if the value of the latent trait was smaller than –0.40 and larger than –1.00. Since the majority of persons were situated between –1.00 and –4.93, while nine out of twelve item thresholds were over –1.00, the results indicated that the items were less than optimally targeted for the sample investi-

Table 2. Conditional likelihood ratio (CLR) test of homogeneity of item responses across different subgroups for the mobility-related participation

Group defined by	Group	CLR	df	p
The score	0–9, 10–12	20.1	11	0.044
The criterion variable	Agree, disagree	25.1	11	0.009
Gender	Male, female	12.9	11	0.300
Age	65–76, 77–92	9.5	11	0.572
Cohabitation	Not alone, alone	11.2	11	0.427

Table 3. Conditional likelihood ratio (CLR) test of homogeneity of item responses across different subgroups for the mobility-related participation instrument.*

Group defined by	Group	CLR	df	*p*
The score	0–9, 10–12	22.2	12	0.035
The criterion variable	Agree, disagree	17.4	12	0.137
Gender	Male, female	15.0	12	0.242
Age	65–76, 77–92	9.8	12	0.633
Cohabitation	Not alone, alone	11.1	12	0.521

* Item P4 is assumed to be uniformly biased relative to the criterion variable

Table 4. Distribution of persons and items in the mobility-related participation instrument.

Score group*	Percentage of persons for each score group	Estimated value of the latent trait for each score group	Interval defined by person thresholds†	Estimated value of the latent trait for each item
12		+ infinity	+inf–3.48	
11		3.29	3.48–2.58	
10		2.40	2.58–1.97	P 9 (2.52)
9		1.78	1.97–1.46	P 2 (1.79)
				P 8 (1.79)
8		1.27	1.46–1.01	P 5 (1.03)
				P 6 (1.03)
7		0.78	1.01–0.56	P 4 (0.77)
6	2.7	0.31	0.56–0.11	P 1 (0.55)
				P 7 (0.37)
5	2.7	–0.20	0.11– –0.40	P10 (–0.09)
4	1.8	–0.79	–0.40– –1.00	
3	14.5	–1.53	–1.00– –1.81	P 3 (–1.27)
2	41.8	–2.54	–1.81– –3.03	
1	32.7	–4.08	–3.03– –4.93	P11 (–3.49)
0	3.6	– infinity	–4.93– –inf	P12 (–4.99)

*Consists of the number of participation aspects the users could not accomplish using the powered wheelchair.

†Intervals of the estimated values of the latent trait, in which a score group had the largest probability of appearing. For instance a score of 4 had the largest probability of appearing between the thresholds of –0.40 and –1.00 of the estimated value of the latent trait.

gated. That is, the scale had problems discriminating between persons with a high degree of mobility-related participation (i.e. ceiling effect), and less than optimal reliability for twelve dichotomous items. When it comes to internal consistency, Cronbach's alpha was 0.47, but after stepwise reduction to five items (P1, P2, P6, P8, P9), alpha increased to 0.70.

User satisfaction instrument

Significant evidence against homogeneity was disclosed by comparison of score groups and comparison of men and women, while comparison across groups defined by the criterion variable, by age, and by cohabitation suggested homogeneity (Table 5).

Based on the initial multiple testing, evidence of DIF related to only one item, S10 (follow-up services). Further analyses which included uniform DIF in the model resulted in test results with no evidence of DIF at all, but with significant evidence against homogeneity, which, however, can be explained as a result of multiple testing (Table 6). Apart from the problem of DIF for one item the items measuring satisfaction appeared to be construct valid and objective.

When evaluating the effect of the DIF of item S10 by comparing the item thresholds for men and women (Table 7), no clear trend was

Table 5. Conditional likelihood ratio (CLR) test of homogeneity of item responses across different subgroups for the user satisfaction instrument

Group defined by	Group	CLR	df	*p*
The score	0–33, 34–40	55.6	37	0.044
The criterion variable	Agree, disagree	48.6	37	0.140
Gender	Male, female	57.4	37	0.017
Age	65–76, 77–92	39.8	37	0.345
Cohabitation	Not alone, alone	46.3	37	0.427

Table 6. Conditional likelihood ratio (CLR) test of homogeneity of item responses across different subgroups for the user satisfaction instrument.*

Group defined by	Group	CLR	df	*p*
The score	0–33, 34–40	60.5	41	0.025
The criterion variable	Agree, disagree	51.1	41	0.135
Gender	Male, female	47.0	41	0.126
Age	65–76, 77–92	42.2	41	0.420
Cohabitation	Not alone, alone	452.1	41	0.114

* uniform DIF of item S10 relative to gender is assumed

Table 7. Estimated thresholds* of the latent trait for the different items of the user satisfaction instrument.

Item	Score threshold			
	1	2	3	4
	Estimated value of the latent trait thresholds			
S1	–inf	–0.03 >	–0.55	0.98
S2	–0.28 >	–0.71 >	–0.80	1.57
S3	–0.67	0.43 >	–0.65	1.62
S4	– inf.	–inf.	0.49	0.64
S5	1.50 >	–1.56	–0.10	0.40
S6	–0.30 >	–0.75	–0.39	0.56
S7	–0.09	0.23 >	–0.51	1.25
S8	0.39 >	–1.70	0.05	0.27
S9	–0.28	–0.01 >	–0.55	1.15
S10				
Male	–1.21	1.48 >	–1.30	1.46
Female	0.92 >	–0.71	1.04	1.26

*The scale consists of five response categories divided by four thresholds

apparent. In other words, as shown in Table 7 there was no consistent direction of difference among the item thresholds between men and women. Another way to evaluate the effect of DIF is to attempt to equate scores for women with scores for men, taking the confounding effect of the DIF into account, by first estimating the value of the latent trait for women followed by calculation of the expected score if the responding persons had been men. These calculations indicated that basically half a point should be added to a woman's score to make it comparable to a man's. The range of observed scores was 17–40 with associated score thresholds from –0.392 to 3.399.

Concerning internal consistency, Cronbach's alpha was 0.81 for the whole satisfaction scale, 0.79 for the device subscale and 0.64 for the service subscale.

Correlation of mobility-related participation and user satisfaction

There was no statistically significant correlation between mobility-related participation and user satisfaction (Kendall's tau-b = –.121, p = 0.141, two-tailed). When the user satisfaction subscales were correlated separately with mobility-related participation, a statistically significant but weak negative correlation with the device subscale appeared (Kendall's tau-b = –.190, p=0.020, two-tailed), but there was no statistically significant correlation between mobility-related participation and satisfaction with related services (Kendall's tau-b = –.077, p = 0.326, two-tailed).

Discussion

The results of this study shed light on the validity of two constructs important for outcome research in the field of assistive technology, namely user satisfaction and mobility-related participation. Since hardly any communality between the two constructs was found, the results indicate that user satisfaction and mobility-related participation represent quite different phenomena. The results deliver a better understanding of these two outcome dimensions and underline the need to measure both in research on assistive technology. Further, the two scales investigated are sufficiently valid. However, the reliability of the mobility-related participation scale needs to be improved.

The absence of relationships between mobility-related participation and user satisfaction indicates that the two constructs yield separate information about outcomes of assistive technology. This result is somewhat different from a Dutch study, which correlated user satisfaction with the assistive technology and its effectiveness in terms of its problem-solving ability, resulting in statistically significant correlations ($r = 0.38$ for the device, $r = 0.23$ for service) (16). Even though these correlations were rather weak, they exceeded our results, and the difference may derive from a number of sources, e.g. the use of different instruments, samples, and types of devices studied (40); for instance our sample consisted of older people, while the Dutch sample included substantially younger users (aged 18+, mean age 58 years) (16). The fact that the correlations reported in the Dutch study were significant while the correlations we reported were not, is most likely a result of sample size differences.

Since a latent trait (underlying construct) is not tangible, researchers have to define what it represents; in the present study one latent trait was 'mobility-related participation'. In a study on the activity and participation component of the ICF, Jette, Haley and Kooyoomijan (41) found three dimensions: mobility activities, daily activities, and social participation. The latter dimension included e.g. 'go out to public places', 'visit friends and family', take care of local errands', and take part in social activities'. Since these items are similar to those of the mobility-related participation scale of the present study, the comparison with Jette *et al.*'s study confirms that our scale targets participation.

Applying Rasch analysis, in the mobility-related participation scale evidence of DIF was found, which usually counts against the validity of a summed scale (28). In the present case this conclusion is, however, not clear-cut. If we assume that the response to the criterion variable depends on the latent trait, i.e. the construct mobility-related participation, the interpretation of DIF becomes a question of whether it is the criterion variable that affects item P4 (go to cafés and restaurants) or whether it is the other way round. Relying on the first interpretation alternative, we might solve the DIF problem by removing item P4 from the scale. Given the second interpretation we should do nothing but take into account the confounding of the relationship between the latent trait and the criterion variable during the analysis of criterion validity. We regard the second interpretation as the most plausible, i.e. that the response to item P4 has its own impact on the criterion variable. Based on this, the analysis disclosed no evidence against the construct validity and objectivity of the scale.

When it comes to reliability, the mobility-related participation scale did not perform optimally. There were problems discriminating between persons with higher degrees of mobility-related participation as shown by the Rasch analysis, revealing a ceiling effect. Besides, some of the items had the same or very close estimated values (P2/P8, P5/P6, P1/P7), while the intervals between other items (P3/

P11/P12) were too wide for precise measurement. Internal consistency demonstrated by using the classical Cronbach's alpha was low. There is not total agreement in the literature about the interpretation of alpha levels, but most authors consider that levels of at least .70 indicate acceptable or good reliability (18;19;21). It should be kept in mind that a high number of items in a scale may increase alpha, while if the alpha level is low the reason may be that the scale is short and/or one or more of the items do not have much in common. If exclusion of an item results in a higher alpha value, it indicates that the item may not fit into the scale (18;21). The latter may be the case of the mobility-related participation scale, because after exclusion of seven of the twelve items alpha increased. The items suggested to be deleted by the Cronbach alpha analysis were not identical to those identified as redundant by means of the Rasch analysis, making it difficult to decide which items to delete in case of further development of the scale. One reason not to delete items following a Cronbach alpha analysis is that it reveals the property of the scale in relation to the particular population and not a property of the scale as such (42). Nunnally directly warns against automatic deletion of items as a consequence of stepwise deletion, claiming that items may be discarded spuriously because low correlations may reflect statistical differences in relation to other items, rather than differences in terms of contents (21). Such problems are avoided when using Rasch analysis, which implies the requirement of objectivity, i.e. that measurements do not depend systematically on how persons are sampled or which items are included in the scale (29).

In order to be able to recommend the mobility-related participation scale for further studies, allowing for analysis based on sum scores, additional studies confirming these first results on reliability are needed. One aspect worth looking into is the contents of the items. One issue is that the first ten questions focus on carrying out desired participation aspects, while the last two concern participation no matter whether it was desired or not, rendering considerably higher frequencies of the response option 'does not carry out the activity'. In occupational therapy, the differentiation into activity/participation of no specific meaning and preference versus activity/participation perceived as meaningful by the individual is crucial (43;44). In the light of this differentiation, a hypothesis for further studies on the construct validity of mobility-related participation is that as it stands, the scale might include two different aspects of participation. Another possible explanation for the fact that the 12-item mobility-related participation scale did not demonstrate optimal reliability is that items P11 and P12 involve entering a vehicle, which specifically increases physical environmental demands (45).

The user satisfaction scale proved to be valid and reliable, thus performing better than the mobility-related participation scale. This is hardly surprising, since the QUEST has undergone a number of tests and adaptations (24;25). Still, there was a minor DIF problem in the user satisfaction scale concerning gender, highlighting an aspect not hitherto reported in previous studies involving the QUEST, but given the range of the satisfaction score from 0 to 40, we did not consider the effect of differential item functioning to be a serious problem.

The internal consistency of the total user satisfaction scale was good, indicating high reliability. However, when it comes to the two subscales, only the device subscale demonstrated high internal consistency while the corresponding alpha value of the service subscale was not quite as good. The reason may be that the service subscale is shorter, or that one or more items do not have much in common (18;21). In contrast to the results of the present study, a Dutch study investigating a

QUEST version with the same service subscale (16) showed higher internal consistency. Even though further investigation is necessary, reasons such as different instrument formats, samples, and types of devices included (42) are rather obvious.

A drawback of the present study, necessary to keep in mind while interpreting the results, is the limited sample size. When using Rasch analysis, a larger sample is preferred (46). If present, despite the limited sample size, serious problems with the scales investigated would nevertheless have appeared. Another aspect related to sampling is the fact that only older powered wheelchair users were included, and thus it may be questioned to what extent the results are valid for other populations. Even so, the present study is a contribution to current knowledge on the constructs mobility-related participation and user satisfaction, showing that these are separate and valid. It remains to be investigated whether the two constructs are valid for research involving other types of assistive technology.

Conclusion

The study showed that the constructs of mobility-related participation and user satisfaction both are valid and thus uni-dimensional. Even so, the internal consistency of the mobility-related participation scale was less than optimal, indicating need for optimisation and further testing. The study revealed that the constructs of mobility-related participation and user satisfaction are separate and not related, indicating that the two measurements cannot replace each other. A limitation of the study was the small sample of older persons. Still, the study contributes to the knowledge base of outcome research within the field of assistive technology. In particular, the results concerning participation outcomes are of interest, since this outcome dimension is attracting increasing attention and in the context of use of assistive technology it may be regarded as an aspect of effectiveness. In addition, the study has provided knowledge about practical evaluation of assistive technology.

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Appendix

A. Instrument used in the rollator study:

The Danish Quebec User Evaluation of Satisfaction with assistive Technology 1.0 (Danish QUEST 1.0)[1,2]

QUEST Part 1: General information

User

1. *Date of birth:* (day/month/year)
2. *Age:* (years)
3. *Gender:*
   Male/female
4. *Disabilities:*
   Motor / sensory and perception / cognition / language / behaviour / others:
5. *Participation in selection of assistive technology device (ATD):*
   Yes / no / not applicable
6. *Functional problem areas:*
   Meal preparation / eating / hygiene / dressing / communication / housework / mobility / transportation / others:

Assistive technology device

7. *Frequency of use:*
   Always / frequently (every day) / sometimes (not every day, but more than once a week) / now and then (less than once a week, but more than once a month) / rarely (less than once a month) / never
8. *Previous experience with other ATD of the same kind:*
   Yes, specify / no
9. *Primary reasons for using ATD:*
   Meal preparation / eating / hygiene / dressing / communication / housework / mobility / transportation / others:
10. *Length of time since ATD was obtained:*
    (Months)
11. *Other ATDs being used presently:*
    Specify

Environment

12. *Housing:*
    Detached house / terrace house / flat / sheltered housing / institution (nursing home or similar) / other:
13. *Living situation:*
    Alone / with spouse or partner / other family member(s) / other:
14. *Home-based services:*
    None / meals on wheels / home care / nursing care / private domestic help / do not know or not applicable
15. *Provider of ATD delivery services:*
    Therapist from municipality / nurse from municipality / therapist from county ATD centre / others:

16. *Instruction / training in use of ATD:* Describe
17. *Waiting period for ATD delivery (from time of application to receipt of ATD):* (Weeks and months)
18. *Funding source:* Municipality / institution (e.g. nursing home) / hospital / self / family or friends / others:

QUEST Part 2: Rating of satisfaction variables

Scale:

Not satisfied at all (1) / not much satisfied (2) / more or less satisfied (3) / quite satisfied (4) / very satisfied (5) / does not know or not applicable (6).

If the user answers 1, 2, or 3 he/she is asked to explain the source of dissatisfaction.

Questions:

The interviewer is to formulate a sentence based on each item, e.g. 'Simplicity of use' concerning the user's rollator will be formulated as 'How satisfied are you with the simplicity of use of your rollator?' If the user does not understand the question, the interviewer can use the text supplied below each item for elaboration of the question.

1. *Simplicity of use*
   Ease in using ATD
2. *Repairs / servicing*
   Ease in having the ATD repaired and serviced
3. *Maintenance*
   Simplicity of upkeep and care of the ATD by oneself
4. *Effectiveness*
   Goal achievement with the ATD
5. *Professional service*
   Quality on information on ATD provided, accessibility and competence of professionals
6. *Durability*
   Robustness and sturdiness of the ATD
7. *Multi-purposefulness*
   Possibility to adapt and use the ATD for multiple activities/purposes
8. *Adjustments*
   Simplicity in setting/fixing the components of ATD
9. *Comfort*
   Physical and psychological well-being associated with the use of ATD
10. *Service delivery*
    Ease in acquiring the ATD including length of time
11. *Follow-up services*
    Ongoing support services for ATD
12. *Appearance*
    Design, form, colour and acceptability of the ATD
13. *Transportation*
    Convenience of transporting the ATD via the desired means of transportation
14. *Weight*
    Ease in lifting and/or moving
15. *Safety*
    Degree to which the ATD is safe, secure and harmless
16. *Dimensions*
    Convenience of the device's size (height, width, length)
17. *Motivation*
    Incentive to use the ATD at home and in public
18. *Social circle support*
    Support from family, peers & employer in using the ATD, whether physical or psychological
19. *Reaction of others*
    Positive and encouraging attitude of others
20. *Effort*
    Little physical or psychological exertion required in using the ATD.

21–23. *Other:*

24. *Global satisfaction*

B: Questionnaire used in the powered wheelchair study

Study-specific 'powered wheelchair questionnaire'[3]

- *How long have you had your present powered wheelchair?*
- *How do you control your powered wheelchair?*
  With one hand (joystick) / with two hands (handlebars)
- *Are you able to transfer to your wheelchair independently?*
  Yes, without difficulty / Yes, but with difficulty / No, only with assistance, possibly using a lift
- *Now you will be asked a number of questions concerning your satisfaction with your powered wheelchair. How satisfied are you with*

a. the dimensions of the powered wheelchair (height, length, width)?
b. the safety of the wheelchair?
c. the durability of the powered wheelchair (whether it breaks easily)?
d. how easy it is to use the powered wheelchair?
e. the comfort of your powered wheelchair?
f. the effectiveness of your powered wheelchair?
g. the appearance of your powered wheelchair?
h. how easy it is to bring the powered wheelchair when travelling by private car, taxi, or bus?
i. the effort required to use the powered wheelchair?
j. the speed of the powered wheelchair?
k. how far the powered wheelchair can go?
l. the power of your powered wheelchair in order to be able to negotiate hills, thresholds, etc.?
m. the room needed to turn the powered wheelchair?
n. the suspension of the powered wheelchair?
o. room for transportation of goods when using the powered wheelchair?
p. repair and maintenance of your powered wheelchair?

Not satisfied at all [1] / not much satisfied [2] / more or less satisfied [3] / quite satisfied [4] / very satisfied [5]

- *When you got your powered wheelchair, how satisfied were you with the service delivery, for instance how easy it was, how long it took, how it was selected?*
  Same response categories as former question about satisfaction.

- *How satisfied were you with the information and support professionals gave you in order to be able to use the powered wheelchair effectively?*
  Same response categories as former question about satisfaction.
- *(In the former question the user was asked whether anyone from the municipality had contacted the user to ask about problems using the powered wheelchair). How satisfied are you with this?*
  Same response categories as former question about satisfaction.
- *In the summer, how often do you usually use your powered wheelchair outdoors?*
  At least once a day / at least once a week / at least once a month / at least once every summer / I do not use my powered wheelchair in the summer.
- *In the summer, what do you use your powered wheelchair for (more responses possible)?*
  Shopping / daycentre, club, etc. / visit friends and family / café, restaurant, etc. / cinema, theatre, library, etc. / go for a ride / church, churchyard / indoors in own or other's home / in the garden / cannot remember / other activities.
- *In the winter, how often do you usually use your powered wheelchair outdoors?*
  At least once a day / at least once a week / at least once a month / at least once every winter / I do not use my powered wheelchair in the winter.
- *In the winter, what do you use your powered wheelchair for? (More responses possible)*
  Same response categories as summer question.
- *Do you have problems using the powered wheelchair to go to the places you wish to go to (all year)?*

a. *Because kerb cuts are missing or they are too steep?*
   No, never / no, hardly ever / no, I adapt by avoiding missing or poor kerb cuts / yes, it happens / yes, usually

b. *Because there are steps into shops?*
   No, never / no, hardly ever / no, I adapt by avoiding places with steps / yes, it happens / yes, usually / I do not bring the powered wheelchair into shops.

- *Do you travel by accessible bus bringing your powered wheelchairs?*
  Yes, often / yes, now and then / hardly ever / no, never
- *Do you travel by bus or train bringing your powered wheelchairs?*
  Same response categories as former question.
- *Are there any of the following activities for which you would like to use your powered wheelchair but cannot? (More responses possible)*
  Same response categories as questions about activities in the summer and winter, except that 'cannot remember' was not a possible response.
- *Why do you not use your powered wheelchair for that activity / those activities?*
  For each activity the following response categories were offered: Distance barriers / weather conditions / physical ability to sit long enough / too many steps, thresholds, etc.
- *To what extent do you agree with the following statements?*

a. *The powered wheelchair gives me freedom to get about without having to ask anybody else for assistance.*
   Totally agree / partly agree / partly disagree / totally disagree / do not know

b. *I can use the powered wheelchair to go to prioritised places.*
   Same response categories as for a.

- *How important is the powered wheelchair for you?*
  Very important / quite important / of little importance / not important at all / do not know
- *In what year were you born?*
- *Do you live alone or together with someone?*
  Alone / together with spouse or cohabitor / together with others / other.

- *Is there a private car in the household?*
  Yes / no
  If yes, can you bring your powered wheelchair when travelling in the car?
  Yes / yes, but on a trailer / no
- *Does the following statement fit your situation? I do not walk at all.*
  Right / wrong
- *Do you have any difficulties reading a normal newspaper text (with glasses if you usually wear them)?*
  No difficulties / yes, a little difficulty / yes, much difficulty / yes, I cannot at all
- *Respondent's gender (entered by interviewer)*
  Man / woman
- *Housing (entered by interviewer)*
  Private house / sheltered housing / flat / farm house / other

[1] The wording from the original English QUEST 1.0 is used when applicable; in the study, Danish wording was used.

[2] Only questions and answer categories are shown, not the original QUEST form.

[3] The instrument is translated into English for the purpose of this thesis, but was used in Danish in the study.

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Outcomes of Rollator and Powered Wheelchair Interventions

User Satisfaction and Participation

Åse Brandt

Rollator and powered wheelchair interventions are often applied to make participation possible for citizens with limited walking capacity. However, the research-based knowledge about outcomes is insufficient for societal prioritisation purposes and for quality development of assistive technology within occupational therapy contexts. In this thesis outcomes in terms of user satisfaction, participation, and frequency of use were investigated based on users' subjective assessments, collected by cross-sectional and follow-up interview studies in Danish municipalities, mainly among older persons. The levels of user satisfaction and participation were high, all devices were used, and user satisfaction increased over time, indicating that the interventions benefit the users and are worth while from a societal perspective. Even so, some rollator users had difficulties handling their rollator, the powered wheelchairs could not be used for all participation purposes, and some users were not satisfied in all respects, especially regarding assistive technology service. Physical environmental barriers and determinants for less beneficial outcomes were identified. Based on the study results suggestions for eligibility criteria and for quality development of e.g. occupational therapy services were provided. As regards methodological aspects of outcomes research, instrument translation and adaptation difficulties were identified. User satisfaction and a new promising construct, mobility-related participation, specifically targeting participation outcomes of mobility device interventions, were explored, requiring further research. Finally, further development of conceptual models for use in assistive technology outcomes research was suggested.

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