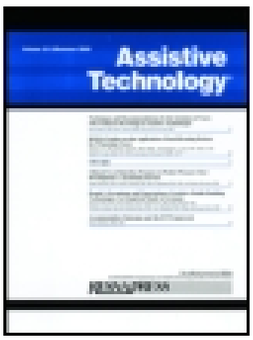

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Environmental barriers to participation and facilitators for use of three types of assistive technology devices

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ABSTRACT

The aim was to compare the presence of environmental barriers to participation and facilitators for assistive technology (AT) use and study the relation between barriers and AT use in three different AT devices. A cross-sectional survey was conducted. Inclusion criteria were ≥one year of experience as a user of myoelectric prosthesis (MEP), powered mobility device (PMD), or assistive technology for cognition (ATC) and age 20-90 years. Overall, 156 participants answered the Swedish version of the Craig Hospital Inventory of Environmental Factors and a study-specific questionnaire on facilitating factors. Non-parametric tests were used for comparisons. Barriers to participation were lowest in MEP users (md=0.12; p>0.001), and highest in ATC users (md=1.56; p>0.001) with the least support for AT use (p>0.001 - p=0.048). A positive correlation between fewer barriers and higher use of MEP was seen (r=0.30, p=0.038). The greatest barriers to participation were Natural environment, Surroundings and Information, and the most support came from relatives and professionals. Support, training and education are vital in the use of AT. These factors may lead to a more sustained and prolonged use of AT and may enable increased participation. Future research should focus on interventions that meet the needs of people with cognitive disabilities.

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KEYWORDS
Electronic aids to daily living; information technology and telecommunications; prosthetics; service delivery; wheelchair transportation; wheeled mobility aids

Background

Assistive technology (AT) devices are expected to be used to a high degree, but research shows that they are used in varying degrees, and some are not used at all (Wessels, Dijcks, Soede, Gelderblom, & De Witte, 2003). This is an unfortunate fact for individuals and for society, because a large part of health care resources finance these ATs. In rehabilitation, ATs can be prescribed to improve the activity performance of individuals with disabilities, enhance independence, and improve participation in daily life. Being able to participate in everyday activities is defined as a human right (United Nations, 2008). Additionally, participation is an important outcome of rehabilitation interventions (Kielhofner, 2007), and it may be restricted by lack of accessibility. Accessibility can be improved by the use of ATs, but the access to ATs varies between countries. In Sweden, for example, the service delivery process of ATs is governed by laws, ordinances, and regulations that, among other things, regulate who is eligible for AT. Additionally, most ATs are financed by the government, which means that many people in Sweden have access to ATs (Dahlberg, Blomquist, Richter, & Lampel, 2014). Therefore, Sweden is a good place to study the participation in and use of AT.

AT is defined as "any product, instrument, equipment, or technology adapted or specially, whether acquired commercially, modified or customized, that is used to maintain, increase, or improve the functional capabilities of individuals with disabilities" (International Standards Organization [ISO], 2011). For many people with disabilities, participation in daily activities—both at home and in society—depends on well-functioning ATs (Auger et al., 2008; Gramstad, Storli, & Hamran, 2013; Hemmingsson, Lidström, & Nygard, 2009; Lenker, Harris, Taugher, & Smith, 2013; Lidström & Hemmingsson, 2014). Hence, there seems to be a causal relationship among participation in daily activities, AT prescription, and AT use.

Several factors influence the extent of AT use, including environmental factors related to the device, intervention related factors, factors related to the surroundings, and personal factors (Wessels et al., 2003; Widehammar, Pettersson, Janeslätt, & Hermansson, 2017). The concept environment is complex and includes not only the physical and structural environment, but also the social and psychological environment and the attitudinal environment (World Health Organization, 2001). The experiences of environmental factors is subjective and can thus be regarded differently between individuals, either as barriers or facilitators, both by their presence and absence (Pless & Granlund, 2011). When environmental barriers are reduced, people with disabilities are better able to participate in the social, educational, and vocational aspects of life (World Health Organization, 2001). Similarly, a person's participation in society can be improved by added facilitators, such as support or training in AT use (World Health Organization,

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2001). However, it is not known whether there is a relation between the extent of AT use and environmental barriers to participation.

Different types of ATs are used to various extents, and there is a knowledge gap concerning the relationship between the environmental impact on AT use and the users' participation in everyday life because most studies only explore one type of AT device or a single type of patient group (Lenker & Paquet, 2003; Lenker et al., 2013). The results of these studies are diverse. In one study, 50% of patients with cognitive impairments chose not to use their prescribed AT (De Joode, Van Heugten, Verhey, & Van Boxtel, 2010). In another study examining myoelectric arm prosthesis (MEP), the non-use varied from 12% to 75% (E. A. Biddiss & T. T. Chau, 2007). The influence of the environment on AT use seems to be dependent on the type of AT and on the user's ability, age, and context (Wessels et al., 2003). To broaden the perspective, this study considers AT users who have different types of ATs and are at different ages, different stages in life and, thus, in varying contexts. These AT users use MEP, powered mobility devices (PMD), or assistive technologies for cognition (ATC). These ATs were chosen because they are all rather expensive electronic technical devices that require education and training for optimal use (Lenker & Paquet, 2003). The aim of this study was to describe and compare the presence of environmental barriers to participation and environmental facilitators for AT use and to examine the relation among barriers to participation, facilitators for AT use, and the frequency of AT use as experienced by users of these three different types of devices.

Methods

The design of the study was a descriptive and comparative cross-sectional survey. The Regional Ethics Committee in Uppsala approved the study (2012/275).

Sample and recruitment

The inclusion criteria were as follows: individuals who had at least 1 year of experience as users of MEP, PMD, or ATC; aged 20 to 90 years; and mental and cognitive ability to understand and fill in the questionnaires. The intention was to recruit 50 participants in each of the three groups based on an earlier study of environmental barriers and participation (Larsson Lund & Lexell, 2009). Since we expected a response rate between 40% to 50%, more than 150 people were asked to participate. Participants were enrolled in the study in two different ways. Individuals with MEP were recruited from a department of prosthetics and orthotics in a clinic with national uptake, and individuals with PMD or ATC were recruited from centers for service and delivery of AT in three different counties in central Sweden. For the ATC group, the prescribers of the ATC devices were contacted first to ensure that the intended person was able to understand the questionnaires; if not, the person was not asked to participate. To ensure representation from people of different ages, each sample group was stratified according to age (i.e., younger = 20–41 years; middle-aged = 42–64 years; and older = 65 and above). Depending on the stratum size, every second, third, or fourth person was selected, resulting in an equal number of people from each stratum. The selected individuals received written information via regular mail and gave their informed consent to participate in the study. One reminder was sent to all non-respondents. In total, 156 (61%) persons agreed to participate (Table 1).

Participants

In each AT group, the participants used varying types of AT: In MEP, there were users of trans-radial prosthesis (n = 44) or trans-humeral prosthesis (n = 7); in PMD, there were users of scooters (n = 31) or four-wheeled chairs with joystick steering

Table 1. Demographic data for 156 participants who use MEP, PMD, or ATC.

	Total n = 156 (%)	MEP n = 51 (33)	PMD n = 58 (37)	ATC n = 47 (30)
Sex, female/male (%)	56/44	37/63	60/40	72/28
Age mean ± *SD* (years)	46.0 ± 16.8	41.1 ± 17.4	54.1 ± 15.5	41.8 ± 14.2
Diagnosis ICD-10, *n* (%)	14¤		6¤	8¤
V. Mental & behavior disorders#	31 (22)			31 (79)
VI. Diseases of nervous system	47 (33)		39 (75)	8 (21)
XIII. Diseases of musculoskeletal system	10 (7)		10 (19)	
XVII. Congenital malformations	31 (22)	31 (61)		
XIX. Injury, acquired amputation	23 (16)	20 (39)	3 (6)	
Living status, *n* (%)	2¤		1¤	1¤
Single	67 (43)	19 (37)	24 (42)	24 (52)
Cohabitating	73 (47)	29 (57)	28 (49)	16 (35)
Single together with parents	14 (9)	3 (6)	5 (9)	6 (13)
Vocational status, *n* (%)	2¤		1¤	1¤
Working full or part time	60 (38)	37 (72)	12 (21)	11 (24)
Student	14 (9)	4 (8)	3 (5)	7 (15)
Retired	24 (15)	7 (14)	14 (25)	3 (7)
Disability pension*	56 (36)	3 (6)	28 (49)	25 (54)
Frequency of AT use, *n* (%)				
Daily use	119 (76)	41 (80)	37 (64)	41 (87)
Weekly use	17 (11)	3 (6)	12 (21)	2 (4)
Monthly use	7 (4.5)	0 (0)	6 (10)	1 (2)
Less than monthly use	7 (4.5)	4 (8)	3 (5)	0 (0)
Never use	6 (4)	3 (6)	0 (0)	3 (6)
Experience of AT use	15¤	2¤	7¤	6¤
Mean ± *SD* (years)	11.6 ± 11.1	22.9 ± 10.9	7.1 ± 5.2	3.7 ± 2.7

Notes. SD = standard deviation. *Disability pension temporary or permanent; ¤missing; #Neuro psychiatric disorder (n = 26) and mild intellectual disability (n = 5).

(n = 19); and in ATC, there were time management devices (n = 8) or specialized designed cellphones (n = 36). The amount of experience with AT use varied from 1 to 30 years (Table 1). In total, the participants were frequent users of the prescribed AT. Additional demographic data from the participants are presented in Table 1.

Questionnaires

The Craig Hospital Inventory of Environmental Factors (CHIEF) is a valid and reliable instrument that investigates the relationship between participation and the environment of people with disabilities (Whiteneck et al., 2004). The CHIEF instrument can differentiate between people with and without disabilities and between people in different disability groups (Whiteneck et al., 2004). In this study, the Swedish version, CHIEF-S (Larsson Lund & Lexell, 2009), was used. The CHIEF items each represent a barrier, operationalized as, for example, "In the past 12 months, how often has the natural environment —temperature, terrain, climate—made it difficult to do what you want or need to do?" The focus of the CHIEF is on quantification of the barriers experienced, which also represent separate

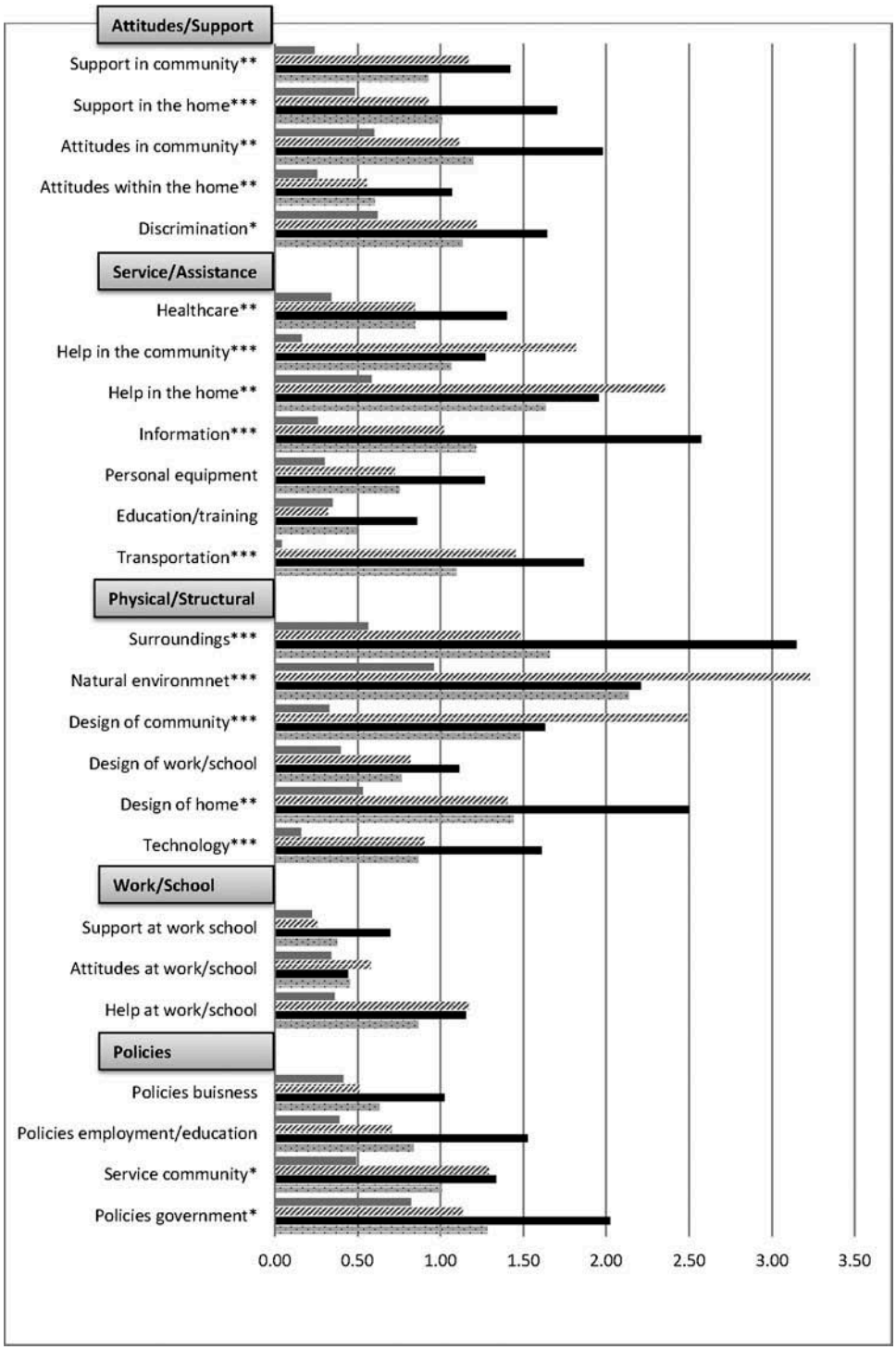

Figure 1. CHIEF-S item product scores in users of myoelectric prostheses, powered mobility devices, and assistive technology for cognition.

subscales in the instrument, within five domains of the environment: *attitudes/support; services/assistance; physical/structural; work/school;* and *policies*. Respondents rate the frequency of the occurrence of the 25 barriers (see Figure 1) using the following scale: 0 = never; 1 = less frequently than once per month; 2 = monthly; 3 = weekly; and 4 = daily. If the respondent states that a barrier exists, the magnitude of the barrier is rated using the following scale: 1 = small problem, and 2 = large problem. The total CHIEF-S score is calculated based on the mean product of the magnitude and the frequency of all non-missing questions. A total score of 8 indicates the greatest possible experience of environmental barriers, and 0 indicates no barriers. When items related to school and work are irrelevant, participants may answer not applicable, which will generate the same result as the answer "no barriers."

Because the CHIEF-S only examines barriers, an additional study-specific questionnaire was used that focuses on environmental facilitators (Janeslätt, Lindstedt, & Adolfsson, 2015). The seven questions asked about different environmental factors that facilitated the use of the AT. The questions were based on environmental factors from chapters e1 to e5 in the International Classification of Functioning (ICF; Janeslätt et al., 2015), and were answered using the following scale: 1 = not at all; 2 = little; 3 = moderate; 4 = much; and 5 = very much. The study-specific questionnaire also included demographic questions about living conditions, vocational status, diagnosis, experience, and frequency of AT use. The ATC group was offered assistance with completing the forms.

Statistical analysis

Descriptive statistics were used to illustrate the demographic data of the participants and to assess the data distribution. CHIEF-S scores were calculated according to the manual (Whiteneck et al., 2004). Given the highly skewed nature of the CHIEF-S scores, non-parametric statistics were used to analyze both the CHIEF-S scores and the environmental facilitators score. The barriers and facilitators were analyzed both for differences within (sex, age) and between the three AT groups. A Kruskal Wallis test and a 2-tailed Mann-Whitney *U* test were used to test for significance. Spearman's rank order correlation test was used both for correlation between barriers to participation and frequency of AT use and between facilitators for AT use and frequency of AT use. The level of statistical significance was set at $p < 0.05$. Statistical analyses were carried out using the IBM software SPSS statistics version 22.

Results

Environmental barriers to participation

Barriers to participation in the physical/structural domain were the most problematic, followed by barriers in services/assistance, and attitudes/support (Table 2).

A comparison between the three groups was made and the differences were significant ($p = < 0.001$) for the total CHIEF-S score and for all domains except work/school. The post hoc analysis revealed that participants who use ATC differed

Table 2. Environmental barriers to participation reported in CHIEF-S scores as median (range) grouped in type of AT.

Environmental domains CHIEF-S sub scores and total score	Total *n* = 15 Median (Range)	MEP *n* = 51 Median (Range)	PMD *n* = 57 Median (Range)	ATC *n* = 47 Median (Range)	*p*-Value*	Between groups *p*-value #MEP–PMD	Between groups *p*-value #MEP –ATC	Between groups *p*-value #PMD–ATC
Attitudes/support (*n* = 154)	0.20 (0–7.60)	0.00 (0–7.60)	0.20 (0–7.20)	0.80 (0–6.00)	**<0.001**	**0.024**	**<0.001**	**0.015**
Services/assistance (*n* = 154)	0.37 (0–8.00)	0.00 (0–4.00)	0.62 (0–8.00)	1.17 (0–5.00)	**<0.001**	**<0.001**	**<0.001**	NS
Physical/structural (*n* = 153)	0.67 (0–6.40)	0.00 (0–4.33)	1.33 (0–6.40)	2.00 (0–6.25)	**<0.001**	**<0.001**	**<0.001**	NS
Work/school (*n* = 146)	0.00 (0–8.00)	0.00 (0–6.00)	0.00 (0–6.67)	0.00 (0–8.00)	NS	NS	NS	NS
Policies (*n* = 150)	0.00 (0–8.00)	0.00 (0–7.50)	0.13 (0–8.00)	0.75 (0–8.00)	**<0.001**	**0.030**	**<0.001**	NS
CHIEF-S total score (*n* = 155)	0.52 (0–6.42)	0.12 (0–5.28)	0.62 (0–6.42)	1.56 (0–6.07)	**<0.001**	**<0.001**	**<0.001**	**0.050**

Notes. Higher median scores indicate more barriers. NS = No significance. Significant at $p < 0.05$; significant differences in bold. *Kruskal Wallis test; #Mann-Whitney *U* test.

significantly from the two other groups in the domain attitudes/support, and differed from the MEP users in the other domains with significantly higher scores regarding barriers. In contrast, the MEP users reported significantly less environmental barriers in all domains, except work/school, compared to the other groups, thus indicating a low degree of barriers to participation (Table 2).

The mean product scores of each of the 25 CHIEF-S items (Figure 1) show the influence of barriers in each domain in more detail. As shown in Figure 1, the greatest barriers to participation in each distinct AT group were the items: *natural environment* and *policies government* (MEP); *natural environment* and *design of community* (PMD); and *surroundings* and *information* (ATC).

In the ATC users, there were differences in barriers to participation based on age. The middle-aged (age 42–64) group reported significantly ($p < 0.001$ – $p = 0.017$) more barriers in all domains, except work/school, and in the total CHIEF-S score compared to the younger ATC users (age 20–41), and the middle-aged group reported more barriers in the attitude/support ($p = 0.012$) and policies ($p = 0.024$) domains, and in the total CHIEF-S score ($p = 0.011$) compared to the older group (age >65). For the MEP users, there was only one difference based on age, with the younger (age 20–41) and middle-aged (age 42–64) MEP users experiencing significantly ($p = 0.023$ and $p = 0.022$) more barriers in the domain attitudes/support than the older MEP users (age >65). Within the group of PMD users, there were no statistically significant differences based on age.

Relation between barriers to participation and frequency of AT use

The degree of barriers to participation was unevenly distributed based on the different types of AT devices and the frequency of AT use (Figure 2). Those who reported fewer barriers seemed to use their AT more frequently, except for the ATC users, where daily users reported the most barriers. The correlation analyses between barriers and frequency of use showed that there was a significant positive correlation for the MEP users ($r = 0.30$, $p < 0.038$), with fewer barriers related to higher use.

Facilitators for AT use

There were variations in how much support the participants received. Participants reported receiving much support from relatives and professionals highly, whereas support from *rules and regulations* and *authorities and organizations* were rated low. When comparing the groups, there were significant differences in four of the seven categories of facilitating factors. Post hoc analyses showed that the users of ATC reported receiving the least support. The results also showed that the users of PMD and ATC differed most, with significant differences in four of the seven items (Table 3).

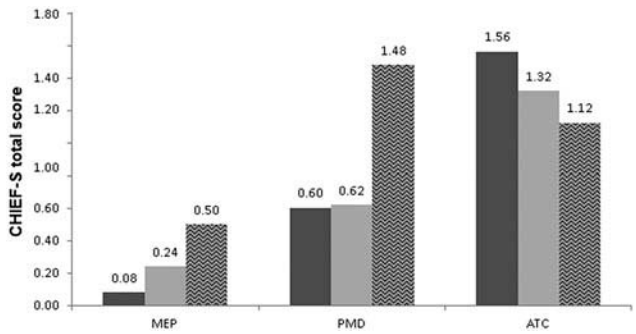

Figure 2. CHIEF-S total product score distributed based on the frequency of use in users of myoelectric prostheses, powered mobility devices, and assistive technology for cognition.

Relation between facilitating factors for AT use and frequency of AT use

Analyses of the relation between facilitating factors for AT use and the reported frequency of AT use showed a significant negative correlation between support received from rules and regulations and frequency of ATC use. The daily users reported no support, whereas participants who used their ATC less frequently reported more support from rules and regulations ($r = 0.29$, $p = 0.050$).

Discussion

To our knowledge, this is the first study to show and compare the influence from environmental barriers to participation and facilitators for AT use in three different types of AT devices. The main finding from this study is that there are significant differences in AT use depending on the type of assistive device. Two groups stand out in the comparisons: ATC users and MEP users. Based on the results, it appears that ATC users lack support, and thus do not use their devices to the fullest, leading to barriers related to their participation in society. MEP users report very few barriers to participation, and the users of PMD stand out for getting more support than the other users.

In all domains, except work/school, users of ATC reported a higher degree of barriers to participation compared to users of the other AT devices, and the daily users reported more barriers to participation compared to the less frequent users. These findings are quite unexpected since previous research shows that frequent use provides experiences and skills—factors that are expected to reduce barriers to participation (De Jonge & Rodger, 2006). Less frequent ATC users may have a higher degree of cognitive ability and may thus face fewer barriers, or, barriers are not recognized until ATC devices are used more frequently. Participants with less cognitive ability need more help to structure their daily life, but they appear to lack the support related to AT use that is needed to achieve this structure. Furthermore, the user's learning ability affects the support and training of AT use (Batavia & Hammer, 1990). Another factor affecting AT use is the product design and functionality of ATC, which is often designed for commercial production (Lidstrom, Lindskog-Wallander, & Arnemo, 2015). The paradox seems to be that the user's cognitive difficulties affect their learning ability in regard to use of the ATC (Judge, Robertson, Hawley, & Enderby, 2009). In addition, persons related to the user may also have difficulty in understanding the functionality of the ATC and may not be able to provide the support that is needed. Our findings showed that ATC users report that the most support is given by professionals and not by relatives.

Table 3. Environmental facilitators for AT use reported as medians grouped by type of AT.

Facilitator for AT use	Total n = 156 Median (Range)	MEP n = 51 Median (Range)	PMD n = 58 Median (Range)	ATC n = 47 Median (Range)	p-Value*	Between groups p-value #MEP–PMD	Between groups p-value #MEP–ATC	Between groups p-value #PMD–ATC
Relatives supports	**4** (1–5)	**4** (1–5)	**4** (1–5)	**2.5** (1–5)	**<0.001**	NS	**<0.001**	**<0.001**
Professionals supports	4 (1–5)	4 (1–5)	4 (1–5)	3 (1–5)	NS	NS	NS	NS
Relatives encourages	**4** (1–5)	**4** (1–5)	**4** (1–5)	**3** (1–5)	**<0.001**	**0.048**	**0.014**	**<0.001**
Professionals encourages	3 (1–5)	3 (1–5)	3 (1–5)	4 (1–5)	NS	NS	NS	NS
Social support and services supports	**3** (1–5)	**3** (1–5)	**3** (1–5)	**2** (1–5)	**0.048**	**0.040**	NS	**0.035**
Authorities and organizations supports	2 (1–5)	2.5 (1–5)	2 (1–5)	1 (1–5)	NS	NS	NS	NS
Rules and regulations supports	**2** (1–5)	**2** (1–5)	**3** (1–5)	**1** (1–5)	**0.045**	NS	NS	**0.024**

Notes. 1 = no support, 2 = little support, 3 = moderate support, 4 = much support, 5 = very much support. NS = No significance. Significant at $p < 0.05$; significant differences in bold. *Kruskal Wallis Test; #2-tailed Mann-Whitney *U* test.

Therefore, it is important to provide information to relatives about the device's functions to achieve the sustained use of ATC over time (Borgestig, Sandqvist, Ahlsten, Falkmer, & Hemmingsson, 2016).

In contrast to the ATC users, users of MEP reported the fewest barriers in all domains, except work/school, thus suggesting a high degree of participation. As we expected, the natural environment was the greatest barrier for MEP users. This item contains climate, terrain, and temperature; hot and cold weather are both well-known problems for prosthesis users in terms of socket comfort and motor control (E. Biddiss & T. Chau, 2007). Further, the degree of barriers seems to be directly related to the amount of time the users wear the MEP; more barriers indicate less use. This finding is in line with the results from a qualitative study in which daily MEP users experienced few barriers to participation (Widehammar et al., 2017). The results from the present study also confirm the findings from the qualitative study in regard to facilitators. In the present study, participants with MEP reported receiving much support from relatives and professionals, similar to the way in which prosthesis users earlier described how support from family and health professionals had a positive impact on prosthesis use (Widehammar et al., 2017). The relationship between use, skill in prostheses use, and performance of daily activities has been shown previously (H. Lindner, Hiyoshi, & Hermansson, 2017; H. Y. Lindner, Eliasson, & Hermansson, 2013). Prosthesis skill may have an impact on performance and, thus, participation. This emphasizes the significance of the health professionals' role in training, supporting, and educating MEP users.

Another result in line with previous research (Arthanat, Nochajski, Lenker, Bauer, & Wu, 2009) is that most barriers for PMD users are seen in the physical/structural domain and more specifically, in the items natural environment and design of community. However, based on our results, it seems as if the PMD users received much support from all aspects of the environment, which may explain the high use of the PMD; all PMD users reported using their PMD to some extent. The physical/structural domain on the CHIEF questionnaire is also the most common barrier in other studies of environmental barriers to participation (Cao, Walker, & Krause, 2015; Fleming, Nalder, Alves-Stein, & Cornwell, 2014; Liao, Lau, & Pang, 2012; Lien, Guo, Chang, Lin, & Kuan, 2014; Zhang, Yan, You, & Li, 2015). These studies include persons with traumatic brain injuries and stroke survivors, who have reduced mobility and/or cognitive impairments, and therefore comparable with the PMD and ATC groups in this study.

All participants in the present study reported receiving the least support from authorities and organizations. This may indicate that laws and policies do not constitute any support to people who need AT. Furthermore, the physical/structural domain was the greatest barrier to participation for the entire group. It appears to be society has not succeeded in terms of providing accessibility for everyone. Sweden has laws both for accessibility and against discrimination (Sveriges Riksdag, 2016), but the laws may not be followed. Based on these results, the attitude toward accessibility among people in general needs to change to improve equality in society.

The participants' reports on support and encouragement differed most between users of PMD and ATC, with

significant differences in four of the seven items. An explanation of these differences may be the service delivery of the ATs. In Sweden (and many European countries), education and training on how to use the PMD in different contexts is mandatory to gain access to the device (Steel & De Witte, 2011). The wheelchair user obtains a "driver's license" for the PMD after completing the training course. In the service delivery for the MEP users who participated in this study, the Sörbye-concept (Sörbye, 1980) was used. This concept includes structured training (Hermansson, 1991), with an assessment of the capacity for controlling the MEP and practicing MEP use during the performance of daily activities. Regular follow-up with support for both the user and the family is included in this service delivery concept. This may explain why the MEP users in the present study reported daily use to a higher extent than users from other countries (E. A. Biddiss & T. T. Chau, 2007). There is no similar structure for prescription of devices for ATC in Sweden. The prescription, support, and training are different based on the nature of the device and the individuals' need. The users may need support both to learn how to manage and use the device, and support to adjust the device and adapt it to changes in everyday life. Users of ATC may thus benefit from a service delivery system similar to that of the PMD or MEP, but designed specifically to the needs of these users to ensure the proper use of ATC in different contexts and to reduce the dissatisfaction and abandonment of the devices. In a review of ATC in traumatic brain injury (Brunner, Hemsley, Togher, & Palmer, 2017), the authors concluded that research is necessary to investigate the training interventions that address factors fundamental for success. Further research and development of procedures for support and training for users of ATC is thus needed(Wang, Ding, Teodorski, Mahajan, & Cooper, 2016).

Recommendations

Based on the findings from this study, we conclude that training and support are vital for the future use of complex AT devices. We therefore recommend that prescription and training of these devices should be made according to a strict program. First, identification and removal of barriers to AT use (Widehammar et al., 2017), followed by education and structured training (Hermansson, 1991) on how to use the AT device in different contexts (Powell et al., 2015; Radomski, Anheluk, Bartzen, & Zola, 2016; Steel & De Witte, 2011). The assessment of the capacity for controlling the AT device and practicing AT use during the performance of daily activities is also an important part of the prescription (Lindner et al., 2017), as well as regular follow-up with support for both the user and the family(Widehammar et al., 2017). Our suggestions are that the training should be structured, and follow a protocol similar to a protocol for drivers' license. A checklist with content similar to the users training protocol could be used to give information and assistance to the relatives. The protocol and the training sessions need to be individually adapted depending on the individuals' characteristics and the design and functionality of the device. We recommend, also, that future research should be made in an attempt to further develop and evaluate specific training programs for users of ATC.

Strengths and limitations

A potential limitation of this study is the use of a non-validated questionnaire for studying facilitators for AT use. There are instruments available for examining environmental facilitators (e.g., the Facilitators and Barriers Survey; Gray, Hollingsworth, Stark, & Morgan, 2008; or the Measure of the Quality of the Environment; Boschen, Noreau, & Fougeyrollas, 1997). These questionnaires examine both barriers and facilitators, but they are more extensive, are not available for Swedish conditions, and do not evaluate facilitators for AT use. Therefore, we decided to use the current questionnaire despite its limitations; the questionnaire has also been used before and worked out well in a Swedish context (Janeslätt et al., 2015).

Because CHIEF-S is not designed for people with cognitive impairments, the questionnaire could be conducted through a structured interview if the prescriber deemed it necessary. This helps strengthen the study by providing a higher response rate than expected for this category of people (70% response rate), but it also introduces a potential threat to the study's internal validity because support in completing a survey can have both positive and negative effects. In addition, critiques in the CHIEF (Ephraim, MacKenzie, Wegener, Dillingham, & Pezzin, 2006) indicate a weakness in allowing participants to answer "not applicable" on questions concerning work and school. This answer generates the same score as the answer "no barriers," and makes it impossible to distinguish whether a person is unable to work due to barriers at work or if the person simply prefers not to work or is retired. In the present study, the "not applicable" alternative resulted in very few valid answers, and thus represented a non-significant portion of the data in the subscale work/school. A strength of the study is the varied sample, which includes participants of different ages and from different contexts. However, not all of the underlying functional limitations of the participants are known. This is a factor that may potentially influence the reported barriers and facilitators. Future research should refine the response options and validate the CHIEF-S for AT use.

A comparison between three different types of AT devices with a focus on environmental factors influence on use of the devices, as in this study, has to our knowledge never been done before. We chose to study expensive AT devices because the prescription of these has a large impact on the providers' economy. This limits the generalizability of our findings but, since the number in each group was large enough to make comparisons, the results may be useful to understand the difference in environmental impact on the use of these devices. Further studies on the impact of environment on use of simple and cheap AT devices are needed to learn about the impact of cost on the use.

Conclusion

In conclusion, this study supports the well-known fact that users of ATC could benefit from a more structured service delivery process with training and regular follow-ups, similar to what many users of MEP or PMD receive. Support and

training in AT use are vital for the use of MEP, PMD, and ATC. Clinicians should recognize the importance of educating relatives so they can support the users on the daily use of the device. This support may increase the chances of achieving a more sustained and prolonged use of most AT devices, particularly ATC, and could thus reduce the barriers to participation. Future research should focus on the interventions needed to meet the needs of people with cognitive disabilities.

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References

Arthanat, S., Nochajski, S. M., Lenker, J. A., Bauer, S. M., & Wu, Y. W. (2009). Measuring usability of assistive technology from a multicontextual perspective: The case of power wheelchairs. *American Journal of Occupational Therapy*, *63*(6), 751–764. doi:10.5014/ajot.63.6.751

Auger, C., Demers, L., Gelinas, I., Jutai, J., Fuhrer, M. J., & DeRuyter, F. (2008). Powered mobility for middle-aged and older adults: Systematic review of outcomes and appraisal of published evidence. *American Journal of Physical Medicine and Rehabilitation*, *87*(8), 666–680. doi:10.1097/PHM.0b013e31816de163

Batavia, A. I., & Hammer, G. S. (1990). Toward the development of consumer-based criteria for the evaluation of assistive devices. *Journal of Rehabilitation Research and Development*, *27*(4), 425. doi:10.1682/JRRD.1990.10.0425

Biddiss, E., & Chau, T. (2007). Upper-limb prosthetics: Critical factors in device abandonment. *American Journal of Physical Medicine and Rehabilitation*, *86*(12), 977–987. doi:10.1097/PHM.0b013e3181587f6c

Biddiss, E. A., & Chau, T. T. (2007). Upper limb prosthesis use and abandonment: A survey of the last 25 years. *Prosthetics and Orthotics International*, *31*(3), 236–257. doi:10.1080/03093640600994581

Borgestig, M., Sandqvist, J., Ahlsten, G., Falkmer, T., & Hemmingsson, H. (2016). Gaze-based assistive technology in daily activities in children with severe physical impairments—An intervention study. *Developmental Neurorehabilitation*, *20*(3) 129–141. doi:10.3109/17518423.2015.1132281

Boschen, K., Noreau, L., & Fougeyrollas, E. (1997). Measure of the quality of the environment: Reliability study. *Canadian Journal of Rehabilitation*, *11*, 13.

Brunner, M., Hemsley, B., Togher, L., & Palmer, S. (2017). Technology and its role in rehabilitation for people with cognitive-communication disability following a traumatic brain injury (TBI). *Brain Injury*, *31*(8) 1028–1043. doi:10.1080/02699052.2017.1292429

Cao, Y., Walker, E. A., & Krause, J. S. (2015). Environmental barriers and subjective health among people with chronic spinal cord injury: A cohort study. *Journal of Spinal Cord Medicine*, *38*(4), 526–531. doi:10.1179/2045772314y.0000000275

Dahlberg, R., Blomquist, U.-B., Richter, A., & Lampel, A. (2014). The service delivery system for assistive technology in Sweden: Current situation and trends. *Technology & Disability*, *26*(4), 191–197.

De Jonge, D. M., & Rodger, S. A. (2006). Consumer-identified barriers and strategies for optimizing technology use in the workplace. *Disability and Rehabilitation: Assistive Technology*, *1*(1–2), 79–88. doi:10.1080/09638280500167324

De Joode, E., Van Heugten, C., Verhey, F., & Van Boxtel, M. (2010). Efficacy and usability of assistive technology for patients with cognitive deficits: A systematic review. *Clinical Rehabilitation*, *24*(8), 701–714. doi:10.1177/0269215510367551

Ephraim, P. L., MacKenzie, E. J., Wegener, S. T., Dillingham, T. R., & Pezzin, L. E. (2006). Environmental barriers experienced by amputees: The Craig hospital inventory of environmental factors-short form. *Archives of Physical Medicine and Rehabilitation*, *87*(3), 328–333. doi:10.1016/j.apmr.2005.11.010

Fleming, J., Nalder, E., Alves-Stein, S., & Cornwell, P. (2014). The effect of environmental barriers on community integration for individuals with moderate to severe traumatic brain injury. *Journal of Head Trauma Rehabilitation*, *29*(2), 125–135. doi:10.1097/HTR.0b013e318286545d

Gramstad, A., Storli, S. L., & Hamran, T. (2013). "Do I need it? Do I really need it?" Elderly peoples experiences of unmet assistive technology device needs. *Disability and Rehabilitation: Assistive Technology*, *8*(4), 287–293. doi:10.3109/17483107.2012.699993

Gray, D. B., Hollingsworth, H. H., Stark, S., & Morgan, K. A. (2008). A subjective measure of environmental facilitators and barriers to participation for people with mobility limitations. *Disability and Rehabilitation*, *30*(6), 434–457. doi:10.1080/09638280701625377

Hemmingsson, H., Lidström, H., & Nygard, L. (2009). Use of assistive technology devices in mainstream schools: Students' perspective. *American Journal of Occupational Therapy*, *63*(4), 463–472. doi:10.5014/ajot.63.4.463

Hermansson, L. M. (1991). Structured training of children fitted with myoelectric prostheses. *Prosthetics and Orthotics International*, *15*(2), 88–92.

International Standards Organization (ISO). (2011). *ISO 9999:2011(en)*. Assistive products for persons with disability—Classification and terminology. Retrieved from https://www.iso.org/obp/ui/#iso:std:iso:9999:ed-5:v1:en

Janeslätt, G., Lindstedt, H., & Adolfsson, P. (2015). Daily time management and influence of environmental factors on use of electronic planning devices in adults with mental disability. *Disability and Rehabilitation: Assistive Technology*, *10*(5), 371–377. doi:10.3109/17483107.2014.917124

Judge, S., Robertson, Z., Hawley, M., & Enderby, P. (2009). Speech-driven environmental control systems—A qualitative analysis of users' perceptions. *Disability and Rehabilitation: Assistive Technology*, *4*(3), 151–157. doi:10.1080/17483100802715100

Kielhofner, G. (2007). *Model of human occupation: Theory and application* (4th ed.). Baltimore, MD: Lippincott Williams & Wilkins.

Larsson Lund, M., & Lexell, J. (2009). Associations between perceptions of environmental barriers and participation in persons with late effects of polio. *Scandinavian Journal of Occupational Therapy*, *16*(4), 194–204. doi:10.3109/11038120802676691

Lenker, J. A., Harris, F., Taugher, M., & Smith, R. O. (2013). Consumer perspectives on assistive technology outcomes. *Disability and Rehabilitation: Assistive Technology*, *8*(5), 373–380. doi:10.3109/17483107.2012.749429

Lenker, J. A., & Paquet, V. L. (2003). A review of conceptual models for assistive technology outcomes research and practice. *Assistive Technology*, *15*(1), 1–15. doi:10.1080/10400435.2003.10131885

Liao, L. R., Lau, R. W., & Pang, M. Y. (2012). Measuring environmental barriers faced by individuals living with stroke: Development and validation of the Chinese version of the Craig hospital inventory of environmental factors. *Journal of Rehabilitation Medicine*, *44*(9), 740–746. doi:10.2340/16501977-1014

Lidström, H., & Hemmingsson, H. (2014). Benefits of the use of ICT in school activities by students with motor, speech, visual, and hearing impairment: A literature review. *Scandinavian Journal of Occupational Therapy*, *21*(4), 251–266. doi:10.3109/11038128.2014.880940

Lidstrom, H., Lindskog-Wallander, M., & Arnemo, E. (2015). Using a participatory action research design to develop an application together with young adults with spina bifida. *Studies in Health Technology and Informatics*, *217*, 189–194.

Lien, W. C., Guo, N. W., Chang, J. H., Lin, Y. C., & Kuan, T. S. (2014). Relationship of perceived environmental barriers and disability in community-dwelling elderly in Taiwan—A population-based study. *BMC Geriatrics*, *14*, 59. doi:10.1186/1471-2318-14-59

Lindner, H., Hiyoshi, A., & Hermansson, L. (2017). Relation between capacity and performance in paediatric upper limb prosthesis users. *Prosthetics and Orthotics International*. First published June 22, 1–7. doi:10.1177/0309364617704802

Lindner, H. Y., Eliasson, A. C., & Hermansson, L. M. (2013). Influence of standardized activities on validity of assessment of capacity for myoelectric control. *Journal of Rehabilitation Research and Development*, *50*(10), 1391–1400. doi:10.1682/JRRD.2012.12.0231

Pless, M., & Granlund, M. (2011). *Handbok i att använda ICF och ICF-CY*. Stockholm, Sweden: Studentlitteratur.

Powell, L. E., Glang, A., Pinkelman, S., Albin, R., Harwick, R., Ettel, D., & Wild, M. R. (2015). Systematic instruction of assistive technology for cognition (ATC) in an employment setting following acquired brain injury: A single case, experimental study. *NeuroRehabilitation*, *37*(3), 437–447.

Radomski, M. V., Anheluk, M., Bartzen, M. P., & Zola, J. (2016). Effectiveness of interventions to address cognitive impairments and improve occupational performance after traumatic brain injury: A systematic review. *American Journal of Occupational Therapy*, *70*(3), 7003180050p1–7003180050p9. doi:105014/ajot.2016020776

Sörbye, R. (1980). Myoelectric prosthetic fitting in young children. *Clinical Orthopaedics and Related Research*, *148*, 131–138.

Steel, E. J., & De Witte, L. P. (2011). Advances in European assistive technology service delivery and recommendations for further improvement. *Technology & Disability*, *23*(3), 131–138.

Sveriges Riksdag. (2016). *Diskrimineringslag (2008:567)*. Retrieved from http://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/diskrimineringslag-2008567_sfs-2008-567

United Nations. (2008). *Convention on the rights of persons with disabilities and optional protocol New York*. Retrieved from https://www.un.org/development/desa/disabilities/

Wang, J., Ding, D., Teodorski, E. E., Mahajan, H. P., & Cooper, R. A. (2016). Use of assistive technology for cognition among people with traumatic brain injury: A survey study. *Military Medicine*, *181*(6), 560–566. doi:10.7205/MILMED-D-14-00704

Wessels, R., Dijcks, B., Soede, M., Gelderblom, G. J., & De Witte, L. (2003). Non-use of provided assistive technology devices, a literature overview. *Technology & Disability*, *15*(4), 231–238.

Whiteneck, G. G., Harrison-Felix, C. L., Mellick, D. C., Brooks, C., Charlifue, S. B., & Gerhart, K. A. (2004). Quantifying environmental factors: A measure of physical, attitudinal, service, productivity, and policy barriers. *Archives of Physical Medicine and Rehabilitation*, *85*(8), 1324–1335. doi:10.1016/j.apmr.2003.09.027

Widehammar, C., Pettersson, I., Janeslätt, G., & Hermansson, L. (2017). The influence of environment—Experiences of users of myoelectric arm prosthesis, a qualitative study. *Prosthetics & Orthotics International*. First published May 4, 1–9. doi:10.1177/0309364617704801

World Health Organization. (2001). *International classification of functioning, disability and health (ICF)*. Geneva, Switzerland: Author.

Zhang, L., Yan, T., You, L., & Li, K. (2015). Barriers to activity and participation for stroke survivors in rural China. *Archives of Physical Medicine and Rehabilitation*, *96*(7), 1222–1228. doi:10.1016/j.apmr.2015.01.024