Autonomy and Housing Accessibility Among Powered Mobility Device Users

Cecilia Pettersson, Åse Brandt, Eva Månsson Lexell, Susanne Iwarsson

MeSH TERMS

- architectural accessibility
- housing
- personal autonomy
- spinal cord injuries
- wheelchairs

OBJECTIVE. To describe environmental barriers, accessibility problems, and powered mobility device (PMD) users' autonomy indoors and outdoors; to determine the home environmental barriers that generated the most housing accessibility problems indoors, at entrances, and in the close exterior surroundings; and to examine personal factors and environmental components and their association with indoor and outdoor autonomy.

METHOD. This cross-sectional study was based on data collected from a sample of 48 PMD users with a spinal cord injury (SCI) using the Impact of Participation and Autonomy and the Housing Enabler instruments. Descriptive statistics and logistic regression were used.

RESULTS. More years living with SCI predicted less restriction in autonomy indoors, whereas more functional limitations and accessibility problems related to entrance doors predicted more restriction in autonomy outdoors.

CONCLUSION. To enable optimized PMD use, practitioners must pay attention to the relationship between client autonomy and housing accessibility problems.

Pettersson, C., Brandt, Å., Lexell, E. M., & Iwarsson, S. (2015). Autonomy and housing accessibility among powered mobility device users. *American Journal of Occupational Therapy, 69,* 6905290030. http://dx.doi.org/10.5014/ajot.2015.015347

Cecilia Pettersson, PhD, OT (Reg.), is Lecturer, Department of Health Sciences, Lund University, Lund, Sweden; cecilia.pettersson@med.lu.se

Åse Brandt, PhD, OT (Reg.), is Senior Researcher, Office of Disability and Technology, The National Board of Social Services, Odense, Denmark, and Associate Professor, Research Unit of General Practice, Institute of Public Health, University of Southern Denmark, Odense.

Eva Månsson Lexell, PhD, OT (Reg.), is Associate Senior Lecturer, Department of Health Sciences, Lund University, Lund, Sweden, and Occupational Therapist, Department of Neurology and Rehabilitation Medicine, Skåne University Hospital, Lund-Malmö, Sweden.

Susanne Iwarsson, PhD, OT (Reg.), is Professor, Department of Health Sciences, Lund University, Lund, Sweden.

Mobility and everyday activities are often closely linked (Arthanat, Nochajski, Lenker, Bauer, & Wu, 2009), and powered mobility devices (PMDs), which include wheelchairs and scooters, can facilitate mobility, everyday activities, and participation for people with mobility limitations (Brandt, 2005). Because participation is a paramount goal in rehabilitation, knowledge concerning optimized PMD use is therefore important.

Participation is defined as involvement in a life situation (World Health Organization [WHO], 2001), and autonomy represents the personal perspective of participation, influenced by factors such as environmental characteristics (Cardol, De Jong, & Ward, 2002). *Autonomy* is defined as "the perceived capacity to control, cope and take personal decisions on how a person lives his/her daily life, following his own norms and preferences" (WHO, 2004, p. 10). To understand how to optimize PMD use with the ultimate goal of supporting participation among users of such devices, users' perceptions of their own autonomy as related to environmental components deserve more attention in research.

Among people with severe mobility limitations, the use of PMDs is common. One diagnostic group in which the majority use such devices is people with spinal cord injury (SCI; Biering-Sørensen, Hansen, & Biering-Sørensen, 2004; Pettersson et al., 2013). Therefore, we sought to study PMD use in this specific diagnostic group. Also, housing and local neighborhoods must be accessible for people using PMDs. Regarding environmental considerations, little is known about whether PMD use differs in terms of whether the device is being used outdoors versus indoors and whether specific accessibility needs can be identified.

Accessibility involves a person–environment relationship (Iwarsson & Ståhl, 2003) and thus can be operationalized by applying the concept of person–environment fit (Lawton & Nahemow, 1973). Accessibility is a characteristic of the encounter between a person, with his or her functional capacity, and the demands of the physical environment. Moreover, the term *accessibility* also refers to compliance with official norms and standards for design of the physical environment; the concept is thus primarily objective in nature. The personal component of accessibility is the combined functional limitations of the person, and *person–environment fit* is the relationship between the functional capacity of the person and environmental barriers (Iwarsson & Ståhl, 2003).

Research-based knowledge about autonomy and housing accessibility among PMD users is scarce. Additionally, little is known about which environmental barriers generate the most housing accessibility problems and how autonomy indoors and outdoors is related to different types of environmental barriers. Although autonomy (Lund, Nordlund, Bernspång, & Lexell, 2007; Lund, Nordlund, Nygård, Lexell, & Bernspång, 2005) and personal factors and environmental components (Pettersson, Iwarsson, Brandt, Norin, & Månsson Lexell, 2014; Pettersson et al., 2013) have been studied among people with SCI, to the best of our knowledge existing knowledge about autonomy as related to personal factors and environmental components among PMD users is insufficient.

In the current study, we targeted PMD users with SCI with the objective of describing environmental barriers, accessibility problems, and users' indoor and outdoor autonomy, with specific attention to location (indoor and outdoor) of PMD use. A specific aim was to describe the environmental barriers that generated the most housing accessibility problems indoors, at entrances, and in the exterior surroundings of the home. An additional aim was to examine personal factors and environmental components and their association with autonomy indoors and outdoors.

Method

Study Context

This cross-sectional study was based on data from the Swedish Aging with a Spinal Cord Injury Study (SASCIS; Lexell, Jörgensen, Norin, & Iwarsson, 2014). The inclusion criteria for the SASCIS were traumatic or nontraumatic SCI at least 10 yr previously, age of ≥50 yr, ability to understand written and oral information in Swedish, and residence in southern Sweden. The SASCIS was approved by the regional ethical review board in Lund, Sweden. Participants provided written informed consent before data collection.

Sample

Of the 123 participants in the SASCIS, 51 participants with paraplegia or tetraplegia who used a PMD were included in the current study. Of those, 3 were excluded because of failure to complete the core assessments. Thus, 48 PMD users constituted the final sample (median age = 64 yr; 33 men). Thirty-one participants used their PMD only outdoors, and 17 used their PMD both indoors and outdoors. Participant characteristics are presented in Table 1.

Data Collection Methods

Descriptive Data. Descriptive data collected using the study-specific SASCIS questionnaire (Lexell et al., 2014) included age (yr), gender, type of injury (tetraplegia or paraplegia), time living with SCI (yr), living situation (dichotomized as cohabiting or living alone; the latter included living apart, separated, divorced, and unmarried), and PMD use either both indoors and outdoors or outdoors only. Data on functional limitations were gathered through interview and observation using the Housing Enabler (Iwarsson & Slaug, 2010), which consists of 12 items scored as 1 = *present* or 0 = *not present* to generate a sum score ranging from 0 to 12 (see Table 1). In addition, the participants reported whether they received personal assistance with everyday activities (dichotomized as personal assistance or no personal assistance; the former included help with the security alarm, cleaning and household maintenance, personal care, and Meals on Wheels).

Environmental Barriers and Accessibility. Environmental barriers were assessed using the environmental component of the Housing Enabler, an assessment based on the concept of person–environment fit (Iwarsson & Slaug, 2010). The environmental component identifies the number of environmental barriers present in the exterior surroundings of the home (28 items), at entrances (46 items), and indoors (87 items). To analyze accessibility, we used a matrix that juxtaposed the profile of each participant's functional limitations with the environmental barriers found present in the dwelling. Instrument-specific software enables determination of the environmental barriers that, in combination with the presence of functional limitations, contribute the most to the magnitude of accessibility problems identified (i.e., weighted environmental barriers; Slaug & Iwarsson, 2010). This computation yields a ranking of the environmental barriers from those generating the most accessibility problems to the least. In the current study, we identified the three

Table 1. Participant Characteristics ($N = 48$)

Variable	Total Sample	PMD Use: Indoors and Outdoors (n = 17)	PMD Use: Outdoors Only (n = 31)	Mann–Whitney $U(17, 31)$	p[a]
Median age, yr (Q1–Q3)	64 (56–69)	63 (56–66)	64 (57–69)	250.5	.779
Gender, male	33	11	22		.749
Cohabiting	23	9	14		.764
Personal assistance[b]	43	16	27		.643
Type of injury, paraplegia	26	2	24		<.0005*
Median yr living with SCI (Q1–Q3)	22 (14–33)	28 (20–33)	16 (13–34)	192.5	.125
Median no. of functional limitations (Q1–Q3)	6 (4–7)	6 (5–6)	5 (4–7)	204.0	.192
Difficulty interpreting information	10	1	9		.074
Visual impairment	8	2	6		.694
Blindness	0	0	0		—
Poor balance	35	16	19		.018*
Loss of hearing	4	2	2		.607
Incoordination	45	17	28		.543
Limitations in stamina	21	7	14		1.000
Difficulty in moving head	19	6	13		.762
Reduced upper-extremity function	39	15	24		.460
Reduced fine motor skills	34	16	18		.009*
Loss of upper-extremity function	2	2	0		.121
Reduced spine or lower extremity function	48	17	31		—

Note. Functional limitations were assessed with the Housing Enabler instrument (Iwarsson & Slaug, 2010). Because no participants had the functional limitation "blindness" and all participants had "reduced spine and/or lower extremity function," it was not possible to calculate any p value. — = not applicable (no participants had the functional limitation of blindness, and all participants had reduced spine or lower extremity function); PMD = powered mobility device; Q = quartile; SCI = spinal cord injury.
[a]Fisher's exact test or Mann–Whitney U test. p values refer to the testing of the hypotheses of the equality of autonomy indoors and autonomy outdoors. For the Fisher's exact test, the test quantity is equal to the p value (the cells in the U column are left blank). [b]Personal assistance includes assisted living and or relatives.
*$p < .05$.

environmental barriers that generated the most accessibility problems for the sample and used them in further analysis.

Autonomy. Autonomy was assessed by means of the Impact on Participation and Autonomy (IPA) instrument (Cardol, de Haan, van den Bos, de Jong, & de Groot, 1999); we used the Swedish version (IPA–S; Lund, Fisher, Lexell, & Bernspång, 2007), which has shown validity and reliability equivalent to those of the original version. Consistent with the aims of the study, we used only two of the five domains of the IPA–S: autonomy indoors (7 items) and autonomy outdoors (5 items). For each item, the response options are *very good, good, fair, poor,* and *very poor*. The IPA–S items are listed in Table 2.

We dichotomized the dependent variables, autonomy indoors and autonomy outdoors, as less or more restriction in the following way before conducting the analyses: The number of ratings of *fair, poor,* and *very poor* was summed, yielding values of 0–7 for autonomy indoors and 0–5 for autonomy outdoors. Thereafter, the sums of these ratings were dichotomized at the median and recoded as *less restriction* or *more restriction* in autonomy. Because the medians differed, the coding ended up being different: Autonomy outdoors was coded as 0 if 0–1 item was rated *fair, poor,* or *very poor* (less restriction, rated by 47.9% of participants) and as 1 if 2–5 items were rated *fair, poor,* or *very poor* (more restriction, rated by 52.1%), and autonomy indoors was coded as 0 if 0–3 items were rated *fair, poor,* or *very poor* (less restriction, rated by 47.9%) and as 1 if 4–7 items were rated *fair, poor,* or *very poor* (more restriction, rated by 52.1%). The distributions of responses regarding indoor and outdoor autonomy were identical.

The independent variables were selected on the basis of the Canadian Model of Occupational Performance and Engagement (i.e., person–environment–occupation; Townsend & Polatajko, 2007) and previous research on PMD users' experience of managing everyday life (Pettersson et al., 2014). The personal factors we used as independent variables were age, gender, type of injury (tetraplegia or paraplegia), years living with SCI, living situation (cohabiting or living alone), and number of functional limitations. The social and physical environment components used as independent variables were personal assistance with everyday activities, location of PMD use (both indoors and outdoors or outdoors only), and the environmental barriers in each housing area (exterior surroundings, entrances, and indoors) that generated the most accessibility problems.

Table 2. Rankings of the Three Environmental Barriers That Generated the Most Accessibility Problems for Participants ($N = 48$)

	No. of PMD Users Living in Dwellings With This Barrier		Ranking	
Home Area and Barrier	Indoors and Outdoors ($n = 17$)	Outdoors Only ($n = 31$)	Indoors and Outdoors ($n = 17$)	Outdoors Only ($n = 31$)
Exterior surroundings				
Mailbox difficult to reach	13	16	1	2
Trash receptacle difficult to reach	6	16	2	3
Irregular or uneven surface	15	29	3	1
Entrances				
High thresholds or steps	9	20	1	1
Doors that cannot be fastened in open position	15	27	2	3
Doors that do not stay in open position or close quickly	10	18	3	2
Indoors				
Wall-mounted cupboards and shelves placed high (kitchen)	13	17	1	1
Controls in a high or inaccessible position (kitchen)	17	31	2	3
Controls in a high or inaccessible position (not in kitchen or bathroom area)	17	30	3	5
Storage areas can only be reached via stairs or threshold or other difference in level	12	25	7	2

Note. No significant differences were found between subgroups in occurrence of environmental barriers.

Statistical Analyses

Descriptive statistics were used to describe the total sample of people with SCI using PMDs and two subgroups, (1) PMD users both indoors and outdoors and (2) PMD users outdoors only. The environmental barriers that generated the most accessibility problems in the three different housing areas were identified for the two subgroups. Differences between occurrences of environmental barriers were tested using Fisher's exact tests.

Frequencies were used to describe autonomy indoors and outdoors and the distribution of personal and environmental variables on less and more restriction of autonomy indoors and outdoors. Fisher's exact tests for dichotomized data and the Mann–Whitney *U* test for interval-scale data were applied.

Two logistic regression analyses applying a backward stepwise strategy (Hosmer & Lemeshow, 2004) were performed to examine whether personal factors and environmental components were associated with autonomy indoors and autonomy outdoors. The two dichotomized variables of less and more restriction in autonomy were used as the dependent variables in the two regression models.

Significance was set at $p < .05$. IBM SPSS Statistics Version 21 (IBM Corporation, Armonk, NY) was used for all computations.

Results

Participant Characteristics

Among participants with tetraplegia, more PMD users used their device both indoors and outdoors than only outdoors ($p < .0005$, Fisher's exact test). The functional limitation of reduced fine motor skills was present in nearly all who used a PMD both indoors and outdoors but was significantly lower in prevalence among those who used a PMD outdoors only ($p = .009$, Fisher's exact test). Likewise, the functional limitation of poor balance was present in nearly all who used a PMD both indoors and outdoors but significantly lower in prevalence among those who used a PMD outdoors only ($p = .018$, Fisher's exact test). For further data on participant characteristics, see Table 1.

Environmental Barriers and Accessibility Problems

The three environmental barriers that generated the most accessibility problems in exterior surroundings and at entrances were the same for PMD users both indoors and outdoors and PMD users outdoors only but were ranked in a different order. Indoors, the environmental barrier ranked 1 (high thresholds or steps) was the same for the two subgroups, but the environmental barriers ranked 2 and 3 were different. Table 2 lists the highest ranked environmental barriers in all three dwelling areas.

Autonomy Indoors and Outdoors

Participants perceived less restriction in autonomy indoors and more restriction in autonomy outdoors. Five participants perceived autonomy in "getting around indoors where one wants" and "getting around indoors when one wants" as poor or very poor. The most restriction was perceived in going on trips and vacations when one wants (autonomy outdoors). Participants' ratings of their level of autonomy on the IPA–S are listed in Table 3.

Table 3. Participant Ratings of Level of Autonomy Indoors and Outdoors Using the Impact on Participation and Autonomy Assessment (N = 48)

	Level of Autonomy				
Item	Very Good	Good	Fair	Poor	Very Poor
Autonomy indoors					
Getting around indoors where one wants	17	11	16	2	2
Getting around indoors when one wants	20	9	14	2	3
Washing, dressing, and grooming the way one wants	11	12	18	4	3
Washing, dressing, and grooming when one wants[a]	10	14	19	2	2
Going to bed when one wants	14	10	15	4	5
Going to the toilet when one needs[b]	15	12	13	3	2
Eating and drinking when one wants	30	8	8	2	0
Autonomy outdoors					
Visiting friends when one wants	6	11	14	10	7
Going on trips and vacations when one wants	4	1	17	10	16
Spending leisure time the way one wants	10	13	12	8	5
Frequency of social contacts[a]	7	9	12	15	4
Living life the way one wants	4	12	14	11	7

[a]N = 47. [b]N = 45.

The distribution of personal and environmental variables on less and more restriction of autonomy indoors and outdoors showed that years living with SCI was significantly associated with autonomy indoors; the more years living with SCI, the less restriction in autonomy indoors. Moreover, the number of functional limitations was significantly associated with autonomy indoors and outdoors, implying that the greater the number of functional limitations, the greater the restriction in autonomy indoors and outdoors. Regarding the top three environmental barriers generating accessibility problems, the only significant association was between entrance doors that do not stay in the open position or close quickly and autonomy outdoors. Location of PMD use was not significantly associated with autonomy either indoors or outdoors. Further details are provided in Table 4.

Because of multicollinearity among the independent variables, type of injury (tetraplegia or paraplegia) was excluded from the multivariate multiple regression analyses because it strongly correlated with PMD use. The regression model with restriction in autonomy indoors as the dependent variable identified years living with SCI as the only significant predictor (odds ratio [OR] = 0.94, 95% confidence interval [CI] [0.89, 0.99], p = .030 applying a backward stepwise strategy). That is, participants who had lived more years with SCI were more likely to experience less restriction in autonomy indoors (explained variance, Nagelkerke's R^2 = 14.1%). Regarding restriction in autonomy outdoors, the regression model showed that more functional limitations were significantly predictive of more perceived restriction in autonomy (OR = 1.641, 95% CI [1.069, 2.519], p = .024), as was living in a dwelling with entrance doors that do not stay in open position or close quickly (OR = 4.087, 95% CI [1.09, 15.329], p = .037; explained variance, Nagelkerke's R^2 = 31.8%).

Discussion

This study is a first attempt to describe objectively assessed housing accessibility problems, both indoors and outdoors, and perceptions of autonomy both indoors and outdoors for people with SCI using PMDs. The results highlight environmental design features that often are not optimally designed to accommodate PMD use, with negative influences on the autonomy of users. As we expected on the basis of acquired experience, people with more functional limitations perceived more restriction in autonomy both indoors and outdoors (Table 4). Likewise, participants with more functional limitations used PMDs more often both indoors and outdoors, and more functional limitations predicted more restriction in autonomy indoors. Thus, the results of the study contribute to the evidence base in this field. Moreover, the results indicate that both personal factors and environmental components contributed to restricted autonomy, but further research is needed to explain such dynamics in more detail.

The participants rated autonomy according to the items of the IPA–S that address daily activities. As a whole, these PMD users perceived their autonomy indoors as very good or good, although some participants perceived it as only fair (Table 3). This finding is in accordance with the perceptions of people with late effects of polio (Lund & Lexell, 2009) and stroke

Table 4. Distribution of Participants' Personal and Environmental Variables on Less and More Restriction of Autonomy Indoors and Outdoors ($N = 48$)

	Autonomy Indoors				Autonomy Outdoors			
Variable	Less Restriction ($n = 17$)	More Restriction ($n = 31$)	Mann–Whitney $U(17, 31)$	p	Less Restriction ($n = 23$)	More Restriction ($n = 25$)	Mann–Whitney $U(23, 25)$	p^a
Gender, men/women	12/5	21/10		1.0	18/5	15/10		.221
Median age, yr	62	64	211.5	.262	64	60	259.0	.556
Type of injury, tetraplegia/paraplegia, *n*	7/10	15/16		.765	12/11	10/15		.563
Median yr living with SCI	28	17	168.5	.040*	26	21	266.5	.664
PMD use both indoors and outdoors/PMD use outdoors only, *n*	7/10	10/21		.547	10/13	7/18		.367
Autonomy: IPA–S responses								
Cohabiting/living alone, *n*	7/10	16/15		.547	14/9	9/16		.173
Personal assistance/no personal assistance, *n*	17/0	26/5		.146	21/2	22/3		1.00
Median no. of functional limitations	5	6	22.5	.040*	5	6	168.5	.013*
Barriers: Housing Enabler responses, yes/no								
Environmental barriers indoors								
Wall-mounted cupboards and shelves placed high	11/6	19/12		1.0				
Controls in a high or inaccessible position	17/0	31/0		—				
Storage areas can only be reached via stairs or threshold or other difference in level	15/2	22/9		.284				
Environmental barriers outdoors								
Mailbox difficult to reach					14/9	15/10		1.0
Irregular or uneven surface					21/2	23/2		1.0
Trash receptacle difficult to reach					10/13	12/13		.780
Environmental barriers at entrances								
Doors that cannot be fastened in open position					18/5	24/1		.091
High thresholds or steps at entrance					13/10	16/9		.769
Doors that do not stay in open position or close quickly					9/14	19/6		.018*

Note. Autonomy according to the Impact of Participation and Autonomy (IPA–S; Lund, Fisher, et al., 2007) and environmental barriers according to the Housing Enabler instrument (Iwarsson & Slaug, 2010). — = not applicable; PMD = powered mobility device; SCI = spinal cord injury.
*$p < .05$.
[a]Fisher's exact test or Mann–Whitney *U* test. *p* values refer to the testing of the hypotheses of the equality of autonomy indoors and autonomy outdoors. For the Fisher's exact test, the test quantity is equal to the *p* value (the cells in the *U* column are left blank).

(Fallahpour, Tham, Joghataei, & Jonsson, 2011). The fact that living more years with SCI predicts less restriction in autonomy indoors is noteworthy but well in line with previous research on people with SCI showing that many adapt to their life situation over the years (Chaves et al., 2004).

Regarding environmental barriers and accessibility, wall-mounted cupboards and shelves placed high in the kitchen generated the most accessibility problems indoors (Table 2), suggesting that participants may have had difficulty managing everyday activities in the kitchen. This barrier likely contributed to perceptions of restricted autonomy indoors. However, because the IPA–S contains no item concerning specific kitchen activities, we were unable to gather detailed information about how specific environmental barriers and accessibility problems were related to perceptions of autonomy in such activities. Nevertheless, our results are consistent with those of Reid (2004), who found that wheelchair users with stroke complained that cupboards placed high in kitchens generated problems and therefore desired a redesign of their kitchen.

Our results are also in line with a study that found that because of environmental barriers, people with SCI experienced the wheelchair itself as more limiting to participation than their functional limitation (Chaves et al., 2004). Accordingly, because PMD use involves interactions among the person, the environment, and the activity, occupational therapy practitioners need to pay increased attention to these interactions to optimize PMD use when providing such devices as a part of the rehabilitation process.

Regarding the specific environmental barriers identified in our study, almost all of the dwellings had controls in a high or inaccessible position in the kitchen and bathroom areas. This result is somewhat surprising because of widely available evidence that home modifications can facilitate PMD use indoors (Pettersson et al., 2014; Pettersson, Löfqvist, & Fänge, 2012; Reid, Angus, McKeever, & Miller, 2003).

This result indicates that home modifications either were not made or did not enable optimal participation for the PMD users.

Regarding the outdoor environment, participants perceived more restriction in autonomy outdoors compared with indoors, notably in going on trips and vacations and visiting friends (Table 3). The detailed results provided by the IPA–S (e.g., "doors do not stay in open position or close too quickly") add to the knowledge that autonomy is influenced by a complexity of factors. Specific environmental barriers that hinder the movement of PMD users in and out of their dwellings independently may lead to restriction in autonomy outdoors.

Study Strengths and Limitations

The current study is the first to use data on objectively assessed housing accessibility problems among PMD users gathered with the Housing Enabler. This instrument has a sound scientific base (Iwarsson, Haak, & Slaug, 2012), and our results are based on a valid and reliable professional assessment of accessibility problems along with the participants' own perceptions of autonomy. Therefore, the current study contributes new knowledge on accessibility and autonomy among PMD users.

Some limitations should be considered when interpreting the study's results. PMD users are a heterogeneous group (Arthanat et al., 2009), and the accessibility problems and autonomy restriction identified in our sample of people with SCI might not be generalizable to all PMD users. In addition, the ranking of the environmental barriers that generated the most accessibility problems was based on the prevalence of functional limitations in the total sample. That is, the environmental barrier item-specific score that underlies the ranking is not specific to each individual's particular profile of functional limitations (Rantakokko, Tormakangas, Rantanen, Haak, & Iwarsson, 2013).

Moreover, some of the accessibility problems identified in our study may be possible to overcome through specific functions of the PMD. For example, wall-mounted cupboards and shelves placed high would not be a problem for users whose PMD could elevate them. The fact that the environmental barriers that generated the most accessibility problems were to a great extent the same for the subgroups of PMD users may indicate that the Housing Enabler does not take specific functions and characteristics of newer PMDs into account, demonstrating the need for further methodological development of the instrument.

Consistent with the aim of the study, we used only two domains of the IPA–S—autonomy indoors and autonomy outdoors. If we had used more domains of the IPA–S, we might also have been able to evaluate the extent to which the participants experienced problems related to autonomy. Because it is important to focus on people's experience of their problems (Lund, Nordlund, et al., 2007), the fact that we did not use such data could be seen as a limitation.

Implications for Occupational Therapy Practice

The results of this study have the following implications for occupational therapy practice:

- Assessment of environmental components related to housing and of users' perceptions of autonomy is important in enabling optimized use of PMDs.
- Environmental barriers that generate accessibility problems for PMD users at entrances may be associated with restriction in their autonomy outdoors.
- By being aware of the negative influence of environmental barriers on autonomy, practitioners providing PMDs may help prevent accessibility problems and facilitate mobility, everyday activities, and participation among their clients.

Conclusion

To optimize PMD use, it is vital that practitioners take into account not only personal factors but also environmental components and location of PMD use. This study revealed new findings on autonomy and the specific environmental barriers that generate housing accessibility problems both indoors and outdoors, information important to consider when providing PMDs. Further methodological development in this field of research is needed that takes the specific functions and characteristics of newer PMDs into account. ▲

Acknowledgments

The authors are grateful to all participants. Thanks are also extended to J. Lexell, principal investigator for the SASCIS, and to S. Jörgensen and L. Norin for collecting the data. The study was financed by grants from Neuro Sweden, the Swedish Research Council, the Stohne's Foundation, the Norrbacka-Eugenia Foundation, the Ribbingska Foundation in Lund, King Gustaf V and Queen Victoria's Freemason Foundation, and the Promobilia Foundation. The study was accomplished within the context of the Centre for Ageing and Supportive Environments, Lund University, Sweden, funded by Forte: Swedish Research Council for Health, Working Life and Welfare.

Declaration of Interest

The Housing Enabler instrument is a commercial product sold by Veten & Skapen HB and Slaug Enabling Development, with Susanne Iwarsson as a copyright holder and owner. The authors alone are responsible for the content and writing of the article.

References

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

Biering-Sørensen, F., Hansen, R. B., & Biering-Sørensen, J. (2004). Mobility aids and transport possibilities 10–45 years after spinal cord injury. *Spinal Cord, 42,* 699–706. http://dx.doi.org/10.1038/sj.sc.3101649

Brandt, Å. (2005). *Outcomes of rollator and powered wheelchair interventions: User satisfaction and participation* (Doctoral dissertation). Lund University, Lund, Sweden.

Cardol, M., de Haan, R. J., van den Bos, G. A., de Jong, B. A., & de Groot, I. J. (1999). The development of a handicap assessment questionnaire: The Impact on Participation and Autonomy (IPA). *Clinical Rehabilitation, 13,* 411–419. http://dx.doi.org/10.1191/026921599668601325

Cardol, M., De Jong, B. A., & Ward, C. D. (2002). On autonomy and participation in rehabilitation. *Disability and Rehabilitation, 24,* 970–974, discussion 975–1004. http://dx.doi.org/10.1080/09638280210151996

Chaves, E. S., Boninger, M. L., Cooper, R., Fitzgerald, S. G., Gray, D. B., & Cooper, R. A. (2004). Assessing the influence of wheelchair technology on perception of participation in spinal cord injury. *Archives of Physical Medicine and Rehabilitation, 85,* 1854–1858. http://dx.doi.org/S0003999304004769

Fallahpour, M., Tham, K., Joghataei, M. T., & Jonsson, H. (2011). Perceived participation and autonomy: Aspects of functioning and contextual factors predicting participation after stroke. *Journal of Rehabilitation Medicine, 43,* 388–397. http://dx.doi.org/10.2340/16501977-0789

Hosmer, D. W., Jr., & Lemeshow, S. (2004). *Applied logistic regression.* Hoboken, NJ: Wiley.

Iwarsson, S., Haak, M., & Slaug, B. (2012). Current developments of the Housing Enabler methodology. *British Journal of Occupational Therapy, 75,* 517–521. http://dx.doi.org/10.4276/030802212X13522194759978

Iwarsson, S., & Slaug, B. (2010). *The Housing Enabler: A method for rating/screening and analysing accessibility problems in housing: Manual for the complete instrument and screening tool.* Lund and Staffanstorp, Sweden: Veten & Skapen HB and Slaug Data Management AB.

Iwarsson, S., & Ståhl, A. (2003). Accessibility, usability and universal design—Positioning and definition of concepts describing person–environment relationships. *Disability and Rehabilitation, 25*(2), 57–66. http://dx.doi.org/BFKB31E4W4ER0G65

Lawton, M., & Nahemow, L. (1973). Ecology and the aging process. In C. Eisdorfer & M. P. Lawton (Eds.), *The psychology of adult development and aging* (pp. 619–674). Washington, DC: American Psychological Association. http://dx.doi.org/10.1037/10044-020

Lexell, J., Jörgensen, S., Norin, L., & Iwarsson, S. (2014). *The Swedish Aging with a Spinal Cord Injury Study (SASCIS): Study protocol for a longitudinal cohort survey.* Manuscript in preparation.

Lund, M. L., Fisher, A. G., Lexell, J., & Bernspång, B. (2007). Impact on Participation and Autonomy questionnaire: Internal scale validity of the Swedish version for use in people with spinal cord injury. *Journal of Rehabilitation Medicine, 39,* 156–162. http://dx.doi.org/10.2340/16501977-0031

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

Lund, M. L., Nordlund, A., Bernspång, B., & Lexell, J. (2007). Perceived participation and problems in participation are determinants of life satisfaction in people with spinal cord injury. *Disability and Rehabilitation, 29,* 1417–1422. http://dx.doi.org/10.1080/09638280601029068

Lund, M. L., Nordlund, A., Nygård, L., Lexell, J., & Bernspång, B. (2005). Perceptions of participation and predictors of perceived problems with participation in persons with spinal cord injury. *Journal of Rehabilitation Medicine, 37,* 3–8. http://dx.doi.org/10.1080/16501970410031246

Pettersson, C., Iwarsson, S., Brandt, A., Norin, L., & Månsson Lexell, E. (2014). Men's and women's perspectives on using a powered mobility device: Benefits and societal challenges. *Scandinavian Journal of Occupational Therapy, 21,* 438–446. http://dx.doi.org/10.3109/11038128.2014.905634

Pettersson, C., Jörgensen, S., Mårtensson, L., Lexell, J., Slaug, B., & Iwarsson, S. (2013). Mobility device use and exploration of housing accessibility for powered mobility device users among people ageing with spinal cord injury. *Assistive Technology: From Research to Practice, 33,* 226–231.

Pettersson, C., Löfqvist, C., & Fänge, A. M. (2012). Clients' experiences of housing adaptations: A longitudinal mixed-methods study. *Disability and Rehabilitation, 34,* 1706–1715. http://dx.doi.org/10.3109/09638288.2012.660596

Rantakokko, M., Tormakangas, T., Rantanen, T., Haak, M., & Iwarsson, S. (2013). Environmental barriers, person–environment fit and mortality among community-dwelling very old people. *BMC Public Health, 13*(1), 783. http://dx.doi.org/1471-2458-13-783

Reid, D. (2004). Accessibility and usability of the physical housing environment of seniors with stroke. *International Journal of Rehabilitation Research, 27,* 203–208. http://dx.doi.org/00004356-200409000-00005

Reid, D., Angus, J., McKeever, P., & Miller, K.-L. (2003). Home is where their wheels are: Experiences of women wheelchair users. *American Journal of Occupational Therapy, 57,* 186–195. http://dx.doi.org/10.5014/ajot.57.2.186

Slaug, B., & Iwarsson, S. (2010). *Housing Enabler 2.0: A tool for housing accessibility analysis* [Software]. Lund and Staffanstorp, Sweden: Veten & Skapen HB and Slaug Data Management AB.

Townsend, E. A., & Polatajko, H. J. (2007). *Enabling occupation II: Advancing an occupational therapy vision for health, well-being and justice through occupation.* Ottawa: CAOT Publications.

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

World Health Organization. (2004). *A glossary of terms for community health care and services for older persons* (Technical Report Vol. 5, WHO Centre for Health Development Ageing and Health. WHO/WKC/Tech.Ser./04.2). Geneva: Author. Retrieved from http://whqlibdoc.who.int/wkc/2004/WHO_WKC_Tech.Ser._04.2.pdf