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Characteristics of the Personal and Environmental Components of Person-Environment Fit in Very Old Age: A Comparison between People with Self-reported Parkinson's Disease and Matched Controls

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ABSTRACT

Background and aims: To investigate differences and similarities in person-environment (P-E) fit problems between very old people with self-reported Parkinson's Disease (PD) and matched controls.

Methods: Data collected for the cross-national ENABLE-AGE Survey Study were used to identify people with self-reported PD (n=20), and to select three matched controls per individual (n=60). The matching criteria were age (mean=82 years), sex, country, and type of housing. The data analysis targeted P-E fit (i.e. accessibility) problems, including studying the personal and environmental components separately. The personal component was analysed in terms of functional limitations, and the environmental component in terms of physical environmental barriers.

Results: In comparison to the matched controls, the participants with PD had more functional limitations, used more mobility devices and were subjected to more P-E fit problems, though the number of environmental barriers did not differ from the controls. In the PD sample, P-E fit problems were significantly stronger associated with poor balance and incoordination, and the environmental barriers that generated the most severe P-E fit problems were more often located to the exterior surroundings of the housing compared to the controls.

Conclusions: The novel contribution of this explorative study is the demonstration of the type of knowledge that can be generated by unfolding and comparing the composition of P-E fit (accessibility) problems among people with self-reported PD as compared with matched controls. The knowledge thereby generated can be used to

develop more targeted rehabilitation approaches, efficient housing adaptation services and societal planning for people with neurodegenerative disorders.

INTRODUCTION

Housing in old age continues to be a burning issue throughout the world, and there is a great need for research on the housing and health situation in different groups of the population. In many countries, the trend is to support people to remain living in ordinary housing as long as possible despite frailty and need of social services and health care. This raises concerns about how to supply the optimal type of housing to senior citizens with different needs. There is a need for more nuanced and sub-group based housing policies and practices, but the scientific knowledge base for effective solutions is insufficient (1). Additional challenges for societal planning and housing development include the increasing life expectancy in most regions of the world, not only for the general population but also for those living with chronic diseases and disability (2, 3).

Disability is caused by the interaction between the consequences of a health condition and contextual factors (4), for example barriers in the built environment. The World Report on Disability (5) emphasizes the need to focus on creating environments that are accessible in order to facilitate participation in life situations. However, while most studies on ageing cover a multitude of information on the ageing person, empirical ageing research considering person and environment in a balanced manner remains rare (6, 7). Considering research in clinical neuroscience, the lack of environmental considerations is absolute. Since the existing knowledge on the complexities of home and health among older people is based solely on general population samples, there is a need to study sub-groups with specific diagnoses. Based on previous research on home and health along the process of ageing, the present study focuses on the home and health situation among very old people with self-reported Parkinson's disease (PD). Ageing with a chronic and progressive disease imposes specific challenges. Already early on during the course of PD, activity limitations are present, and gait and balance problems are common (8, 9). Since older people with PD often are excluded in research (10), little is known about their life situation.

Research on housing and health in old age is firmly linked to the Ecological Theory of Ageing (ETA) (11, 12) and to models of person-environment (P-E) fit (e.g. 13). In the ETA, the environment is defined in terms of demands (environmental press) whereas the person is defined as a set of competencies, such as functional capacity. When health declines, the environmental press often exceeds the functional capacity of the individual, resulting in more P-E fit problems and negative health outcomes. In research on housing, P-E fit problems are often studied in terms of accessibility, reflecting the interaction between functional limitations (personal component of P-E fit) and environmental barriers (environmental component of P-E fit). Accessibility refers to compliance with official standards for housing design and objective assessment of functional capacity (14).

Turning to methodology that captures P-E fit (accessibility) problems, the Housing Enabler (HE) is an acknowledged, reliable and valid instrument (15, 16). With the HE, the personal and environmental components of P-E fit as well as the magnitude of accessibility problems can be studied in depth. In order to plan for optimal housing and interventions at an individual level, knowledge on the complexity of the generation of P-E fit (accessibility) problems among specific diagnose groups is needed. This explorative study aimed to disentangle the contribution of the personal and environmental components of P-E fit to the magnitude of accessibility problems among very old people with self-reported PD versus matched controls. An additional aim was to quantify and specify possible interventions needed for very old people with PD, in order not to be subjected to a higher degree of accessibility problems than very old people in general.

METHODS

Project Context

We utilized baseline data from an existing database that comprises information gathered with people from the general population; the ENABLE-AGE Survey Study (17). The data were gathered in Sweden, Germany, the United Kingdom (UK), Hungary, and Latvia. The target sample in each country was very old people (75-89 years), living in single-person households in urban areas. The total sample included 1,918 participants (78 % women). All participants were enrolled after informed consent, following the Helsinki Declaration and the ethical guidelines of each country. After training, interviewers collected data at home visits (18). Details on the ENABLE-AGE have been published elsewhere (see 17, 19).

Study Samples

The present study is a cross-sectional comparison between two sub-samples retrieved from the cross-national ENABLE-AGE database; one sample of individuals that, responding to structured questions based on the ICD-10, reported having PD (PD sample) and a matched control sample (for characteristics, see Table 1). Twenty-one individuals with self-reported PD were identified, but one woman in the Hungarian sample was excluded due to extensive missing data. The final PD sample consisted of 20 individuals (15 women and 5 men; mean age 82 years).

Each individual with self-reported PD was individually matched with three controls (20). The matching criteria were sex, country, age (+ - one year), and type of housing (Table 1). By means of the software R version 2.12.1 (R Development Core Team, 2010), the three controls were randomly selected among all individuals fulfilling the matching criteria. The matched control sample included 60 individuals (45 women, 15 men; mean age 82 years. Descriptive information is provided in Table 1.

(Table 1 in here)

Instruments

The extensive ENABLE-AGE Survey Study Questionnaire comprised standardized instruments as well as project-specific questions, administered by means of interviews and observational assessments (17). For the current study, variables were included that targeted: functional limitations and use of mobility devices, physical environmental barriers and P-E fit (accessibility) problems in housing and close surroundings, which were assessed by a project-specific version (21) of the HE (22).

The administration of the HE instrument (22) follows three steps: 1) *Personal component of P-E fit:* Interview and observation of functional limitations (13 items) and dependence on mobility devices (2 items), dichotomously assessed and presented as a sum-score variable (range 0-13). In addition, step 1 generates information on the combination of presence or absence of functional limitations/dependence on mobility devices, the so-called functional profile. 2) *Environmental component of P-E fit:* Observation and dichotomous assessment of 188 physical environmental barriers in the home and the immediate outdoor environment, resulting in the variable number of environmental barriers (range 0-188). 3) *P-E fit (accessibility) problems:* Based on the assessments in steps 1 and 2, by means of a complex matrix procedure which juxtaposes the items of the personal component with the items of the environmental component, and where each intersection has a predefined 0-4 severity grade, P-E fit (accessibility) scores are computed. The severity grades are summed up in a total score as well as in subscores by each item of the personal component (i.e. 15 subscores) and by each item of the environmental component (i.e. 188 subscores); for details, see 22. Thus, the total scores reflect the magnitude of P-E fit (accessibility) problems generated by the case-specific combination of functional limitations/dependence on mobility devices and environmental barriers; higher scores mean more problems. That is, the score is always 0 if the individual does not have any functional limitations/dependence on mobility devices, regardless of whether environmental barriers are present or not. The theoretical maximum score is >2,000, but cannot be reached in reality, e.g. the maximum score of the ENABLE-AGE database is 670 (19).

Data analysis

In the analyses of descriptive data and comparisons of HE variables between the two samples, dichotomous variables were compared using the Mantel-Haenszel test with continuity correction, which takes the matching with multiple controls into account. These tests were performed using SPSS Statistics 18 for Windows (IBM Corporation, Somers, NY, USA). For ordinal scores we applied a version of the Wilcoxon signed rank test, extended to include the multiple controls (23). For these test, p-values were obtained using Monte Carlo simulations in the R-programming environment, version 2.12.1.

The P-E fit (accessibility) scores separating items of the personal component (functional limitations) from items of the environmental component (environmental barriers), were sorted in descending order to produce ranking lists. Both lists were indexed with the ranking order of the PD sample as the reference. For the personal component, the relative share of the total accessibility score for each item was also calculated. Given the large number of environmental barrier items (N=188), the results presented for the environmental component are based on the "top 20" barriers of the PD sample, and do not include the relative share of accessibility score for each item. The accessibility scores were compared between the two samples by means of Wilcoxon signed rank test. The order of the items in the ranking lists was qualitatively compared.

Given the exploratory nature of this study, no correction for multiple tests was applied. That is, results with p-values < 0.05 were considered statistically significant.

In a subsequent analytical step specifically targeting the environmental component of P-E fit, the interventions needed in order for the two samples to reach equality in terms of P-E fit (accessibility) problems, were quantified and specified. For this simulation, we constructed an algorithm that iteratively compared the total accessibility score of each individual in the PD sample with the average score for the matched controls. As long as there was a difference in magnitude of P-E fit (accessibility) problems, items were removed (starting with the environmental barrier that generated the highest score) until the total P-E fit (accessibility) score reached the same level for both samples. The presentation of these results was limited to the environmental barriers that would have to be removed in at least 25% of the PD sample.

RESULTS

The analyses of the characteristics of the personal component of P-E fit showed that the participants in the PD sample had significantly ($p<0.001$) more functional limitations (median 5 vs. 2) than the controls. Also, they were significantly ($p=0.018$) more dependent on walking aids (50% vs. 20%) (Table 2). No individual used a wheelchair. With regard to functional profiles, all participants in the PD sample had functional limitations that can be characterised as “limitations in movement”. That is, they had poor balance, incoordination, limitations of stamina, difficulties in moving head, and/or difficulty in bending, kneeling. Almost all of them (95%) had also additional functional limitations, most frequently in combination (70%) with upper extremity limitations, i.e. difficulty in reaching with arms, difficulty in handling and fingering and/or loss of upper extremity skills. This in contrast to controls, who had significantly ($p=0.024$) less common limitations in movement (75%), and only 32% in combination with upper extremity limitations ($p=0.010$). All in all, 95% of the PD sample had a multi-combination of functional limitations, compared to 55% of the controls ($p=0.004$).

(Table 2 in here)

Concerning the environmental component, there were no statistically significant differences in terms of number of environmental barriers between the two samples (Table 2). From the checklist of 188 potential environmental barriers, approximately 25% were present in both samples. With regard to P-E fit, the participants in the PD sample had significantly ($p<0.001$) more accessibility problems than controls. That is, their median (q1-q3) score was 192 (112-232) vs. 63 (14-28) (Table 2).

Disentangling accessibility in relation to the personal component of P-E fit (Table 3), reliance on walking aids was the single item that generated the most problems in both samples. Expressed in a different way, reliance on walking aids and poor balance represented together >45% of the total P-E fit (accessibility) score in both samples. Poor balance (ranking 2 in the PD sample vs. 3 in controls), and in particular incoordination (ranking 4 vs. 10) contributed significantly ($p<0.001$) more to the P-E fit (accessibility) problems in the PD sample than among the controls.

(Table 3 in here)

Regarding the environmental component of P-E fit (Table 4), the 20 environmental barriers that generated the most accessibility problems differed between the two samples, both in terms of ranking order and average score. Six of the environmental barriers in the top 20 list for the PD sample did not appear in the list for the controls. Three concerned exterior surroundings, one differences in level indoors, and two concerned indoor design features that require use of hands. Overall, environmental barriers in exterior surroundings, such as no/too few seating places, path surfaces not level, inadequate shelter from weather in passenger loading zone, and narrow paths appeared higher in the ranking order of the PD sample than the controls. Environmental barriers such as high kerbs, high thresholds, and lack of ramp/elevator at entrances with steps were frequent in the top 20 lists for both samples, but in terms of average scores they generated significantly more problems in the PD sample. For details, see Table 4.

(Table 4 in here)

In the PD sample, 16 out of the 20 (80%) had more P-E fit (accessibility) problems than their matched controls. The analyses indicated that in average 27% (ranging from 48 down to 35) of the environmental barriers had to be removed for each individual in the PD sample, in order not to be subjected to a higher degree of accessibility problems than their controls. Environmental barriers frequently candidates for removal were no/too few seating places (55% of the cases) and high kerbs (50% of the cases). Six of the top ten environmental barriers did concern the exterior surroundings. For further details, see Table 5.

(Table 5 in here)

DISCUSSION

The novel contribution of this explorative study is the demonstration of the type of knowledge that can be generated by comparison of the composition of P-E fit (accessibility) problems among people with PD as compared with matched controls. The fact that our study was not based on a sample with a confirmed PD diagnose must be kept in mind, but the results are useful as a starting-point for a new type of studies with potential to inform researchers and clinicians about P-E fit problems among people with PD. In the personal component of P-E fit, poor balance and incoordination seem to contribute to the significantly greater magnitude of accessibility problems among very old people with self-reported PD (Table 3). Even though there are similarities in the environmental component between the two groups of very old people under study, there are also marked differences (Table 4). That is, nearly a third of the top 20 environmental barriers that contribute the most to accessibility problems in the PD sample do not appear among the top 20 for their matched controls. Overall, the results indicate that in comparison to very old people in general, those with PD have more functional limitations, use more mobility devices, and live in housing with more P-E fit (accessibility) problems, even if the number of environmental barriers does not differ. That is, P-E fit (accessibility) problems are generated mainly by the higher number of functional limitations and more use of walking aids in people with PD.

Whereas the overall results of the present study are in accordance with previous research in the field of home and health among very old people (24), and support the basic notion of P-E fit as described in the ETA (11), in several aspects the results presented represent new knowledge. Firstly, to the best of our knowledge, the study approach and the knowledge generated is quite new for the field of PD-research. Secondly, also in the field of research on home and health among older people in general, our approach to disentangling the notion of P-E fit and thereby study the contribution of the personal and environmental components to the magnitude of accessibility problems is a novel approach. Compared to the use of the total P-E fit (accessibility) problem score produced by HE data (22) as used in previous studies (see 19, 21), the analytical approach developed for the present study represents a major methodological step towards a better understanding of P-E fit dynamics in housing.

During the work with analyses for previous studies on P-E fit dynamics and health based on the ENABLE-AGE Survey Study, we have found that most of the variance of the accessibility score is explained by the personal component of P-E fit. The overall result of this study came therefore as no surprise. That is, the significantly higher P-E fit (accessibility) problem score of the PD sample as compared to the matched controls is to a large extent explained by their higher prevalence of functional limitations and dependence on walking aids. Instead, the unique contribution of this study is the detailed and specific results on which aspects of the personal component that contribute the most to the magnitude of accessibility problems, in different groups of very old people. For example, the results display that taken together, dependence on walking aids and balance problems produce close to half of the P-E fit (accessibility) score in both samples (Table 3). Among very old people with self-reported PD, poor balance and incoordination seem to contribute more to their accessibility problems than for their matched controls. A preserved independence in walking would reduce the magnitude of accessibility problems, not only indoors but also in the exterior surroundings. Although it is well known that gait and balance problems are common among people with PD (9), the results of the present study can be used to complement interventions such as individual housing adaptations with targeted training of the most important functional limitations. Compared to no intervention, physical therapy significantly improves outcomes of gait, functional mobility and balance, although studies with longer follow-up periods are needed (25). To the best of our knowledge, no study has systematically evaluated such synchronized and combined interventions in PD rehabilitation.

Although walking aids was a major contributor to accessibility problems in this study, this may in fact only reflect the underlying functional limitations (e.g. balance problems). Within five years after attaining the PD diagnosis, 75% of the patients experience gait problems (9). Walking difficulties have furthermore been shown to be the strongest contributing factor to fear of falling in people with PD (26), and most falls occur while walking. Despite this, there is limited knowledge regarding the impact of walking aids on different aspects of everyday activities among people with PD. There is thus a need for studies that specifically evaluate the need, use and effects of walking aids in people with PD. An additional finding that needs to be highlighted is the fact that the PD sample more commonly had a multi-combination of functional limitations, i.e. 95% versus 55% among the controls. This is an important notion since many PD-studies exclude those having comorbidities, and the present finding needs to be taken into account in studies targeting very old people with PD. That is, if excluding individuals who are suffering from many limitations, it could threaten the external validity of the results of such studies.

When scrutinizing the impact of environmental barriers on P-E fit (accessibility), the results indicate that for very old people with PD, wall-mounted cupboards and shelves placed extremely high, no/too few seating places in exterior surroundings, no grab bars at shower/bath and/or toilet, high kerbs and uneven surfaces outdoors should be at target (Table 4). Reaching into cupboards and closets, walking on uneven surfaces and climbing stairs have been reported to evoke fear of falling and anxiety in people with PD (26, 27). Although some studies have suggested that environmental hazards are rarely the cause for falls in people with PD (28), the impact of environmental barriers have not been investigated systematically. A qualitative PD-study identified that an appropriately designed physical environment (e.g. with environmental aids such as reacher-grabbers, safety bars, shower benches, lift chairs etc.) is in fact important to facilitate functional performance (29). Taken together, this underlines the importance of also addressing the impact of environmental factors when investigating activity and participation in people with PD.

The simulation of a barrier intervention suggested that in average 13 environmental barriers (range 0-33) should be removed to reduce the P-E fit (accessibility) problems for the PD sample to the same level as for very old people in general (Table 5). This finding has practical implications since it indicates that people with a PD have specific needs. In a recent community-based study, PD was shown to induce a significant burden of disability that was more pronounced than in other disabled populations (30). The present findings also highlight the importance of specifically investigating the impact of ageing when having a concomitant chronic and progressive disease.

The environmental component of the HE instrument (22) is dominated by indoor barriers. It is therefore noteworthy that nine of the top 20 environmental barriers in the PD sample were related to the exterior surroundings (Table 4). Some of those may in fact evoke or worsen PD symptoms. For example, narrow paths may induce freezing of gait since this phenomenon is triggered by being in confined spaces (31). For community walking, external environmental factors seem furthermore to be more important than internal personal factors among people with PD (27). In the present study, environmental barriers in the exterior surroundings were even more striking in the analysis that attempted to specify and quantify the need for removal of environmental barriers in order to reach equality between the two samples with respect to accessibility problems (Table 5). Four out of the five top barriers did then concern the exterior surroundings. These findings demonstrate that the traditional focus on indoor environments in housing adaptation counseling might not be sufficient for very old people with PD. The performed simulation is characterized by that it examines each individual case separately by taking into account the individual functional profile including a particular environment, and it thereby proposes a solution for each specific case. Most important, this analysis helps to quantify the environmental interventions needed, in case improvements in functional capacity fail. This kind of knowledge is useful for rehabilitation staff when planning interventions (e.g. housing adaptions and training), housing provision accommodating senior citizens, and for individuals with PD that search for a more suitable accommodation. These results furthermore support the recommendations of the World Report on Disability (5), as they indicate the need of interventions targeting accessibility on societal level and in different environmental arenas, not the least in pedestrian environments.

The fact that the PD diagnosis was based on self-report is a significant study limitation, which highlights the need for future studies including those with a confirmed PD diagnosis. In addition, the original sampling in the ENABLE-AGE Project imposes some concerns for the external validity of our findings. It targeted a selected portion of people in very old age and does not represent the population in general, but rather a healthier segment in a European context. Furthermore, it aimed at reflecting the dominance of women in the very old population and consisted of 78% women. This explains the female preponderance in the present study, despite that PD is more common among men (12). The original sample only included single-living participants in ordinary housing. Since people with PD are more commonly admitted to assisted living and also at an earlier age (2), this may explain the somewhat low prevalence rate of PD (about 1% of the original cross-national database, n=1,918). As a consequence, the size of the PD sample of the present study is rather limited, which has to be taken into account when considering the results. Moreover, the distribution of the sample in countries with highly diversified cultural and socio-economic conditions must be kept in mind. For example, the ranking of most severe environmental barriers may be influenced by differences in the availability of housing options such as assisted living, or by housing design specifics related to architectural or societal traditions in the five countries included. In addition, multiple comparisons were done which warrants for cautious interpretation of our findings. This explorative study is however highly novel and contributes to the body of knowledge. Notwithstanding the limitations discussed, the ENABLE-AGE rests on solid methodology (6, 17, 19), and due to the large database available (n=1,918) we were able to apply a strong design with three matched controls per case (20).

CONCLUSIONS

In conclusion, despite similar housing environments very old people with self-reported PD have more accessibility problems than very old people in general. Additionally, this study increases the knowledge on the complex dynamics of P-E fit. Whereas P-E fit (accessibility) problems among very old people with self-reported PD to a great extent are generated by their higher number of functional limitations and more use of walking aids, not only specific environmental barriers indoors but also barriers in the external surroundings need attention. This explorative study demonstrates that research on housing and health among ageing people has potential to generate knowledge of importance for the development of more targeted rehabilitation approaches, efficient housing adaptation services and societal planning for people with neurodegenerative disorders. Larger prospective studies are needed that include people with a confirmed PD diagnose, and such studies ought to include also younger individuals.

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DISCLOSURE STATEMENT

In terms of financial interests, BS and SI are the copyright holders and owners of the Housing Enabler (HE) instrument and software, provided as commercial products (see www.enabler.nu). The third author has no competing interests.

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TABLES

Table 1. Sample characteristics, PD sample and matched controls.

Variable	PD sample (n=20)	Controls (n=60)
Age, mean (SD, min-max) [a]	82 (3.6, 76-90)	82 (3.6, 76-91)
Sex, n women / men (% men) [a]	15/5 (25)	45/15 (25)
Type of housing, n (%) [a]		
Multi-dwelling block	16 (80)	48 (80)
One-family house	2 (10)	6 (10)
Semidetached /two-family house	1 (5)	3 (5)
Other	1 (5)	3 (5)
Country, n (%) [a]		
Germany	4 (20)	12 (20)
Hungary	7 (35)	21 (35)
Latvia	4 (20)	12 (20)
Sweden	1 (5)	3 (5)
United Kingdom	4 (20)	12 (20)

PD = Self-reported Parkinson's Disease. [a] Matching variable.

Table 2. Comparison of the personal and environmental components of P-E fit (accessibility) problems between the PD sample and the matched controls.

Variable	PD sample (n=20)		Controls (n=60)		P-value [a]
Personal Component [b]					
No. of functional limitations, median (q1-q3)	5	(4-7)	2	(1-4)	**<0.001**
Dependence on walking aids [c], n (%)	10	(50)	12	(20)	**0.018**
Limitations in movement [d], n (%)	20	(100)	45	(75)	**0.024**
Limitations in movement and upper extremity [e], n (%)	14	(70)	19	(32)	**0.010**
More than one functional limitation, n (%)	19	(95)	33	(55)	**0.004**
Environmental Component [b]					
No. of barriers total, median (q1-q3)	48	(36-61)	52	(34-63)	0.727
No. of barriers exterior surroundings, median (q1-q3)	9	(7-13)	10	(7-13)	0.951
No. of barriers entrances, median (q1-q3)	11	(6-14)	10	(6-14)	0.524
No. of barriers indoor, median (q1-q3)	28	(21-37)	29	(21-35)	0.856
No. of barriers communication, median (q1-q3)	2	(1-3)	2	(1-3)	0.888
Person-Environment fit					
Accessibility [c], median (q1-q3)	192	(112-232)	63	(14-128)	**<0.001**

PD= Self-reported Parkinson's Disease. Significant P-values marked with bold. [a] A version of Wilcoxon signed rank test extended to include multiple controls was used. [b] Assessed with the Housing Enabler. [c] Higher scores denote more P-E fit (accessibility) problems (theoretical range 0 to > 2000). [d] Poor balance, incoordination, limitations of stamina, difficulties in moving head, difficulty in bending, kneeling. [e] Difficulty in reaching with arms, difficulty in handling and fingering, loss of upper extremity skills.

Table 3. Ranking of functional limitations/dependence on mobility devices [a] (personal component) in the PD sample compared with the matched controls, with respect to how much they contribute to P-E fit (accessibility) problems.

Functional limitation/ dependence on mobility device item	Ranking order		Relative share of accessibility score (%)		Average accessibility score		
	PD sample	Controls	PD sample	Controls	PD sample	Controls	P-value
Reliance on walking aids	1	1	25.1	27.1	45.2	23.6	0.098
Prevalence of poor balance	2	3	20.1	18.1	36.2	15.8	**0.005**
Limitations of stamina	3	2	14.0	21.0	25.2	18.3	0.226
Incoordination	4	10	10.4	1.5	18.7	1.3	**<0.001**
Difficulty in bending, kneeling, etc.	5	4	6.2	10.1	11.2	8.8	0.112
Difficulty in handling and fingering	6	7	5.8	4.5	10.4	3.9	0.083
Severe loss of sight	7	5	5.4	6.9	9.8	6.0	0.334
Loss of upper extremity skills	8	11	4.4	1.0	7.9	0.9	0.078
Difficulty in reaching with arms	9	6	3.7	4.9	6.7	4.2	0.295
Extremes of size and weight	10	8	1.4	2.2	2.6	1.9	0.758
Complete loss of sight	11	14	1.4	0.3	2.5	0.3	0.498
Difficulties in moving head	12	10	1.1	1.3	2.0	1.1	0.498
Difficulty in interpreting information	13	13	0.9	0.4	1.6	0.3	0.080
Severe loss of hearing	14	12	0.1	0.6	0.2	0.5	0.285

PD= Self-reported Parkinson's Disease.[a] Assessed by means of the Housing Enabler (Iwarsson & Slaug, 2001). Significant P-values marked with bold.

Table 4. The top 20 environmental barriers [a] (environmental component) that generate P-E fit (accessibility) problems in the PD sample compared with the matched controls [b].

Environmental barrier item (part of housing)	Ranking order		Average accessibility score		
	PD sample	Controls	PD sample	Controls	P-value
Wall-mounted cupboards and shelves placed extremely high (kitchen)	1	1	8.7	3.4	**0.004**
No/too few seating places (exterior surroundings)	2	3	6.6	2.9	**<0.001**
No grab bars at shower/bath and/or toilet (hygiene area)	3	2	6.0	3.1	**0.016**
High kerbs (exterior surroundings)	4	4	5.5	2.6	**0.005**
Path surfaces not level (exterior surroundings)	5	7	4.3	2.0	**0.012**
Bathtub (hygiene area)	6	8	4.3	1.9	**0.002**
High thresholds and/or steps (entrance)	7	13	4.3	1.6	**<0.001**
No handrails (entrance)	8	6	4.2	2.4	**0.035**
Inadequate shelter from weather in passenger unloading zone (exterior surroundings)	9	19	3.8	1.4	**<0.001**
Insufficient maneuvering areas (kitchen/laundry room)	10	10	3.8	1.7	**0.047**
Stairs the only route (entrance)	11	5	3.7	2.4	0.108
Refuse room/refuse bin only reached via steps (exterior surroundings)	12	16	3.5	1.5	**0.009**
Refuse bin and/or letterbox difficult to reach[b] (exterior surroundings)	13	-	3.2	-	-
Narrow paths (exterior surroundings)[b]	14	-	3.1	-	-
Use requires hands (kitchen/laundry room)[b]	15	-	3.0	-	-
Use requires hands (other than kitchen/laundry room/hygiene area)[b]	16	-	3.0	-	-
Letterbox only reached via steps/other difference (exterior surroundings)	17	12	2.9	1.6	0.057
Shelves too deep (kitchen)	18	14	2.8	1.6	0.182
Irregular walking surface (exterior surroundings)[b]	19	-	2.7	-	-
Stairs/thresholds/differences in level between rooms/floor[b] (indoor)	20	-	8.7	-	-

PD= Self-reported Parkinson's Disease. Significant P-values marked with bold. [a] Assessed by means of the Housing Enabler (Iwarsson & Slaug, 2001). [b] Six environmental barriers identified in the PD sample were not among the top 20 in the control sample.

Table 5. Barrier intervention simulation: the top environmental barrier [a] candidates for removal in order for each individual in the PD sample (n=20) not to be subjected to a higher degree of P-E fit (accessibility) problems than the matched controls.

Environmental barrier item (part of housing)	No. of cases in PD sample where barrier removed n (%)
No/too few seating places (exterior surroundings)	11 (55)
High kerbs (exterior surroundings)	10 (50)
Wall-mounted cupboards and shelves placed extremely high (kitchen)	9 (45)
Inadequate shelter from weather in passenger unloading zone (exterior surroundings)	8 (40)
Refuse room/refuse bin only reached via steps (exterior surroundings)	8 (40)
Path surfaces not level (exterior surroundings)	8 (40)
High thresholds and/or steps (entrance)	8 (40)
Letterbox only reached via steps/other difference (exterior surroundings)	6 (30)
Stairs/thresholds/differences in level between rooms/floor (indoor)	6 (30)
No grab bars at shower/bath and/or toilet (hygiene area)	6 (30)
Refuse bin and/or letterbox difficult to reach (exterior surroundings)	5 (25)
Stairs the only route (entrance)	5 (25)
No handrails (entrance)	5 (25)
Insufficient maneuvering areas (kitchen/laundry room)	5 (25)
Use requires hands (kitchen/laundry room)	5 (25)
Bathtub (hygiene area)	5 (25)

PD= Self-reported Parkinson's Disease.[a] Assessed by means of the Housing Enabler (Iwarsson & Slaug, 2001).