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Association Between Mobility, Participation and Wheelchair-Related Factors in Long-term Care Residents Who Use Wheelchairs as their Primary Means of Mobility

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Abstract

OBJECTIVES—To explore how wheelchair-related factors, mobility, and participation are associated in a sample of long-term care residents who use wheelchairs as their primary means of mobility.

DESIGN—Cross-sectional survey

SETTINGS—Eleven residential care facilities in the Lower Mainland of British Columbia Canada

PARTICIPANTS—146 self-responding residents and 118 proxy respondents: mean age 84 years (range 60–103). Most were women (69%), and a small proportion (9%) drove a power wheelchair.

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Previous Presentation

A portion of the findings from the study were presented at the 15th World Congress of the World Federation of Occupational Therapy, Santiago, Chile:

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Author Contributions:

Dr. Mortenson was involved in conceptualizing the research, recruitment of sites and participants, supervising data collection, performing data analysis and interpretation, and preparation of the manuscript.

Dr. Miller was involved in conceptualizing the research, supervising data collection, data analysis, and writing up the study findings.

Dr. Backman was involved in conceptualizing the research, data analysis and manuscript preparation.

Dr. Olfie was involved in conceptualizing the research, data analysis, and interpretation and writing up the study findings.

MEASUREMENTS—The Nursing Home Life Space Diameter Assessment was used to measure resident mobility and the Late Life Function and Disability Instrument: Disability Component was used to measure participation frequency in daily activities.

RESULTS—Path analysis indicated that wheelchair-related factors were associated with participation frequency directly and indirectly through their relationship with mobility. The final model explained 46% of the variance in resident's mobility and 53% of the variance in resident's participation frequency. Wheelchair skills, which include the ability to transfer in and out of and propel a wheelchair, were important predictors of life-space mobility and frequency of participation, and life space mobility was a significant predictor of frequency of participation. Depression was associated with decreased wheelchair skills, mobility and participation frequency. Counter intuitively, perceived environmental barriers were positively associated with frequency of participation.

CONCLUSION—The findings suggest that by addressing wheelchair-related factors resident's mobility and participation may be improved, but the efficacy of this approach needs to be confirmed experimentally.

Keywords

wheelchair; mobility; participation; nursing home

Problems with ambulation mean that most long-term care residents use wheelchairs as their primary means of mobility.¹ However, facility-related problems including inadequate selection and maintenance of wheelchairs and limited availability of staff to assist residents who are unable to self-propel their wheelchairs may negatively affect their participation in daily activities.^{2, 3}

To facilitate positive outcomes of wheelchair prescription, the Matching Person to Technology (MPT) model posits that personal, environmental and assistive technology factors need careful consideration.⁴ To date, most research investigating predictors of resident's participation has focused on personal factors.^{5,6} Earlier studies have not investigated how wheelchair-related factors contribute to residents' activity and participation.

Based on the MPT and a preliminary qualitative study⁷ we developed a model to explain the association among wheelchair-related factors, mobility, and participation. According to this model, personal factors, like cognition and depression would have a direct effect on mobility and participation. We hypothesized that wheelchair-related factors, like an individual's wheelchair skills and need for seating intervention, would affect participation directly and indirectly by influencing mobility. The aim of this study was to evaluate our model empirically.

METHODS

The study employed a cross-sectional design that was approved by the local university ethics board.⁸

Settings

Eleven of thirteen facilities within our sampling frame in a geographical portion of the Lower Mainland of British Columbia, which included long-term care facilities having at least 100 residents who used wheelchairs, agreed to participate in the study.

Study Participants

To participate, residents needed to 1) use wheelchairs to get from their beds to the common rooms on the unit, with or without the assistance of others, 2) use their wheelchairs for 2 hours per day on average, 3) speak English, and 4) be 60 years of age. Residents were excluded if they 1) were acutely ill, 2) were bed-bound, or 3) had been in the facility or using a wheelchair 1 month. Proxy respondents were used for residents cognitively unable to complete the measures. To act as a proxy, the respondent had to be in weekly contact with the participant.

Recruitment

Staff members at each facility created a list of eligible residents. A simple, random selection of residents was drawn from these lists and a third party at each facility invited selected individuals to participate directly or by a formally recognized, surrogate decision maker. This process continued until either 17 self-responding and proxy respondents from each facility had been enrolled by study investigators or until all listed persons had been asked. We anticipated enrolling 34 residents from eight facilities to meet our target sample size of 264.⁸

Measures

We selected measures for the study based on 1) the findings from a preliminary qualitative study,⁷ and 2) psychometric properties. When a proxy measure did not exist for a self-report measure, we created one by transforming first and second person pronouns to third person ones, e.g., “you” or “I” was changed to “he/she”. For all measures, higher values indicate increasing amounts of the construct being measured; see Table 1 for ranges. Two-week, test-retest coefficients were calculated for a subsample of 20 participants; all multiple item measures had intraclass correlation coefficients 0.8 and single scale measures had weighted Kappas >0.66.

Predictor Variables

Person Variables—We collected medical, financial, and demographic information including age, sex, diagnoses, length of stay in the facility, and smoking status from the participants, proxies, or the medical chart. Health status was measured using the 18-item Comorbidity Index⁹ and the general health question from the SF-12 (5-point scale).¹⁰

Three psychocognitive variables were recorded. Perceived pain interference was captured using a single question (5-point scale) from the SF-12.¹⁰ Symptoms of depression were recorded using the 15-item Geriatric Depression Scale (GDS).¹¹ For question 9, we replaced the word “home” with “nursing home” to avoid confusion. GDS scores above the cut-off value of five indicate significant depressive symptoms.¹¹ We administered the Standardized

Mini-Mental State Exam (SMMSE) to all residents in the study to measure cognitive ability¹² to ensure self-responding residents had a minimum score of 15, recommended for GDS administration.¹³

We measured three physical variables. Functional ability was measured using the Functional Independence Measure (FIM).¹⁴ Item 11, bath transfer, was omitted as household bathtubs were not present in these facilities. Raters assessed the resident's hearing and vision problems using a 4-point and 5-point single item scale, respectively, from the Minimum Data Set (2.0).¹⁵

Wheelchair-related Variables—A variety of wheelchair-related data were gathered including descriptive information about the type of wheelchair (power or manual), and ownership (resident or facility). Raters measured need for wheelchair seating intervention (e.g., problems such as sliding, leaning, pressure ulcers and difficulty propelling), using the Seating Identification Tool (SIT).¹⁶ A score of two or higher indicates the need for seating intervention. Based on our preliminary qualitative study we created a mobility-related variable entitled “wheelchair issues” by summing together five dichotomous variables (yes = 1) that were not included in the SIT: 1) inability to release their seat belt, 2) use of a lap tray, 3) sitting in a wheelchair not designed for self-propulsion, 4) inability to release both brakes, and 5) sitting on a transfer sling. We collected additional information on length of time using a wheelchair (in months), and hours per day spent sitting in a wheelchair. The resident's capacity to propel and to use the wheelchair (releasing brakes, remove footrests, transferring in and out of the wheelchair, picking up objects from the floor, etc.) was measured using the Wheelchair Skills Test – Questionnaire (WST-Q Version 3.2).¹⁷

Environmental Variables—We measured perceived environmental barriers to participation using the Craig Hospital Inventory of Environmental Factors (CHIEF).¹⁸ The word “home” was replaced with “facility” in questions 2, 12, 15, and 18 to prevent ambiguity. The four applicable CHIEF domains included attitudes, services/assistance, physical structure, and policies. The number of self-reported visits per week from friends or family were also documented.

Outcome Variables

The Nursing Home Life Space Diameter Measure (NHLSD) assesses the extent of mobility of long-term care residents during the preceding two weeks in four, concentric life spaces (weighting in parentheses): in room (1), on unit (2), within facility (3), outside facility (4); whether the participant was independent (1) or dependent (2); and the frequency (0= “never” to 5= “>3 times per day”) of mobility.¹⁹ A total score is calculated by multiplying the frequency by (in)dependence by life space weighting, summed across each life space. Participation in daily activities was determined using the Late Life Function and Disability Instrument: Disability Component (LLDI), which evaluates how often residents take part in 16 activities including visits from friends and family, organized social activities and regular fitness programs.²⁰ Frequency of participation in each activity is measured on a five point scale (1= “never” to 5= “very often”). We modified three questions to facilitate use in a residential care setting. We changed question number 5 (“Working at a volunteer job outside

your home”) to “Helping out as a volunteer in the facility.” For question 8, “taking care of the inside of your home,” we changed the word “home” to “room.” For question 11, “inviting people into your home for a meal or entertainment” we changed the word “home” to “facility.”

Data Collection

Trained raters, hired for the study, collected the data. Training involved in-depth review of the measures, viewing video examples of administration, and practice sessions. All subsequent, respondent-completed measures were administered in a random sequence to minimize order bias.

Analysis

To describe the sample, continuous variables were expressed as means and standard deviations and categorical variables were summarized as proportions. We used Pearson correlations to explore the associations between outcome variables and continuous predictor variables. To develop an empirical model, we began by including variables from each domain with the highest correlation with our outcome variables. To prevent issues with collinearity, when predictor variables were inter-correlated >0.7 , we selected only one based on the magnitude of the relationship with the dependent variables.²¹

Path analysis was used to address the study objective using AMOS 16 and SPSS 18 (SPSS Inc., Chicago, IL). We imputed missing values using expectation maximization because data were missing for less than 5% of cases for all variables and Little’s Missing Completely at Random test was not significant (Chi-Square = 258.924, DF = 253, Sig. = .386). Parameter estimates were collected using maximum likelihood. The models were tested by evaluating the significance of the estimated path coefficients and evaluating four goodness-of-fit statistics: Chi-square, minimum sample discrepancy function (CMIN/DF), root mean square error of approximation (RMSEA) and the Normed Fit Index (NFI). Generally, good fitting models should have a non-significant Chi-square and a (CMIN/DF) below 2.²² With a sample size of 250, models should have a RMSEA ≤ 0.05 and NFI ≥ 0.92 .²³

RESULTS

The 11 facilities had an average of 175 beds (SD=40). Fifty-five percent of those individuals approached consented to participate (n=264). Most surrogate respondents for proxy participants were family members (66%). Other surrogate respondents for these participants included staff members (28%), staff and family members together (3%), paid companions (3%), and friends (1%).

Of the 146 self-responding and 118 proxy participants (Table 1) most were women (69%) and a small proportion (9%) drove a power wheelchair. Fifty-two percent of participants had GDS scores above the cut-off point indicating significant depressive symptoms.

Motor function, cognition, and depressive symptoms were the personal factor variables that correlated most highly with the outcome variables (Table 2). Wheelchair skills and wheelchair issues were the wheelchair factors with the strongest correlations. Perceived

physical barriers to participation were positively correlated with participation frequency. Wheelchair issues, motor function, and wheelchair skills scores had intercorrelations >0.7 (not shown).

Depressive symptoms and cognition were included as the most important personal factors. Given high collinearity, wheelchair skills were selected as the wheelchair-related variable. The physical structural domain of the CHIEF was selected as the most important environmental factor. Paths were added among these variables based on our theoretical model and trimming was considering by the removal of non-significant structural paths. We removed one non-significant path between cognition and mobility as we reasoned that wheelchair skills likely mediated the relationship between cognition and mobility.

In the final path analysis (Figure 1), the standardized regression weights and their significance are indicated along each line. Squared multiple correlations are indicated below the lower right corner of each box. This model explained over half of the variance in frequency of participation (53%) and almost half of the variance in mobility (46%). As expected, depression had a significant negative effect on all personal and wheelchair-related variables. Wheelchair skills were the best predictor of mobility and perceived environmental barriers had a positive impact on mobility and frequency of participation. The Chi-square for this model was 5.05 with 3 degrees of freedom ($p=0.168$), the CMIN/DF was 1.686, the RMSEA was 0.05, and the NFI was 0.99. [Figure 1]

DISCUSSION

Results from the path analysis support our hypothesis that wheelchair-related factors directly and indirectly affect frequency of participation. In this regard, wheelchair skills were significant predictors of life-space mobility and frequency of participation, and life-space mobility was a significant predictor of frequency of participation. As wheelchair skills require cognitive and functional ability, including the ability to plan movements, transfer and reach, it is not surprising that they would directly affect participation and that individuals who require less assistance are likely to participate more often.

Although most residents needed wheelchair seating intervention, as indicated by SIT scores 2, these scores were not significantly correlated with frequency of participation. However, it should be noted that customized wheelchairs, which likely alleviate the need for seating intervention, have been found to improve wheelchair skills.²⁴ Therefore, there may be an indirect relationship between the need for wheelchair seating intervention and participation frequency.

Consistent with previous research of wheelchair-users in long-term care facilities, the residents with cognitive impairment (SMMSE <15) in our sample have lower levels of participation.⁵ The inverse relationship between depression and participation is logical. Our preliminary qualitative research⁶ and other studies^{2, 3, 25, 26} suggest that institutional and societal barriers limit participation among residents. Counter-intuitively, participants who reported more perceived physical structural barriers to participation, such as accessibility, had significantly higher levels of participation. This finding may indicate that, through their

engagement in activities, residents are more likely to encounter environmental barriers to participation, or better able to identify barriers, as has been suggested for individuals with spinal cord injury.²⁷

This study identified several variables associated with mobility and participation that may be amenable to intervention. Interventions that improve resident's wheelchair skills might indirectly facilitate participation by improving mobility or, more directly, facilitate participation by enhancing functional skills. As an appropriate wheelchair is necessary to enable wheelchair skills, both individualized wheelchair prescription and skill training may be necessary.²⁸

The prevalence of depressive symptoms among participants and the significant associations among depression, mobility, cognition, and participation represent another potential area for future intervention research. Even though surrogate respondents tend to rate depression higher than do self-respondents on the GDS,²⁹ the prevalence in our study of residents with significant depressive symptoms (52%) was consistent with previous research.²⁹ High prevalence of depression among participants is of particular concern given low levels of depression recognition among staff in these settings.³⁰ Intervention studies could determine whether treatment for depression increases participation among residents or conversely whether interventions to improve participation alleviate symptoms of depression.

Limitations

Several limitations are noted. The cross-sectional nature of the data prevents causal inferences. Although random sampling was attempted, the response rate indicates that participants more closely represent a sample of convenience. We modified the wording of selected items in several measures so they would make sense in these long-term care facilities; whether this change affects their validity is unknown. As well, proxy versions and validity data were unavailable for some of the measures. A more residential-care specific measure of participation may have been more responsive in this population; however, we were unable to identify such a measure that was not diagnosis specific. Many of the measures use self or proxy report, which may be affected by recall or social desirability biases. Observational measures of participation frequency and environmental barriers may produce different results. The use of proxies may be a limitation but allowed the inclusion of residents who were unable to self-respond. Furthermore, many of the constructs measured, including frequency of activity participation, mobility, and wheelchair skills, were relatively objective, which helped decrease discrepancies between self and proxy respondents.

Conclusion

This is one of the first studies to explore how wheelchair-related factors and mobility are related to the frequency of participation in everyday activities among long-term care residents. As was hypothesized, the relationship between wheelchair-related factors and frequency of participation was explained largely by resident mobility. Several potential areas of intervention were identified. By alleviating symptoms of depression, which is common among this population, improvements in cognition, mobility and participation may occur.

Similarly, wheelchair skill training may improve resident mobility and participation. However, these hypotheses need to be confirmed with additional research.

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All authors meet the criteria for authorship stated in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals.

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We certify that no party having a direct interest in the results of the research supporting this article has or will confer any benefit on us or on any organization with which we are associated. We certify that all financial and material support for this research are clearly identified in the title page of the manuscript.

Conflict of Interest

Dr. Mortenson has no real or perceived financial or personal conflicts of interest.

Dr. Miller has no real or perceived financial or personal conflicts of interest.

Dr. Backman has no real or perceived financial or personal conflicts of interest.

Dr. Oliffe has no real or perceived financial or personal conflicts of interest.

Conflict of Interest Checklist: Below is the table for all authors to complete and attach to their papers during submission.

Elements of Financial/Personal Conflicts	*Author 1 Mortenson		Author 2 Miller		Author 3 Backman		Etc. Oliffe	
	Yes	No	Yes	No	Yes	No	Yes	No
Employment or Affiliation		x		x		x		x
Grants/Funds		x		x		x		x
Honoraria		x		x		x		x
Speaker Forum		x		x		x		x
Consultant		x		x		x		x
Stocks		x		x		x		x
Royalties		x		x		x		x
Expert Testimony		x		x		x		x

Elements of Financial/Personal Conflicts	*Author 1 Mortenson		Author 2 Miller		Author 3 Backman		Etc. Oliffe	
	Yes	No	Yes	No	Yes	No	Yes	No
Board Member		x		x		x		x
Patents		x		x		x		x
Personal Relationship		x		x		x		x

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Figure 1.

Path Analysis with Standardized Regression Weights and Squared Multiple Correlations

*= $p < 0.05 > 0.01$, **= $p < 0.01 > 0.001$, ***= $p < 0.001$

Note: Values along lines indicate standardized regression weights. Values below the lower right corner of each box indicate the squared multiple correlation explained for that variable. Cognition= Standardized Mini-Mental State Examination, Depression=Geriatric Depression Scale, Mobility= Nursing Home Life Space Diameter, Participation= Late Life Function and Disability Instrument, Perceived environmental barriers= Craig Hospital Inventory of Environmental Factors, Wheelchair skills = Wheelchair Skills Test Questionnaire

Table 1

Descriptive Data for Categorical and Continuous Variables

Variable (range for continuous scales)	Mean/(number)	Std. Deviation/(%)
Personal Factors		
Age	84.18	8.64
Comorbidity (0–18)	3.07	1.94
Daily rate (\$)	42.60	15.64
Female (N/%)	(182)	(68.9%)
FIM Motor (12–84)	34.64	17.82
GDS Total (0–15)	5.07	3.50
Hearing (0–3)	.54	.82
Health (1–5)	1.92	1.08
Length of stay (mos)	32.25	34.96
Pain interfere with activities (0–4)	.91	1.10
SMMSE(0–30)	15.48	10.73
Vision (0–4)	.78	1.09
Wheelchair-Related Factors		
Hours in w/c/day	8.87	3.64
Length of wheelchair use (mos)	44.44	67.60
Owns WC (N/%)	(86)	(32%)
Power WC (N/%)	(24)	(9%)
SIT total score (0–15)	2.13	1.80
WC issues (0–5)	.85	1.15
WST-Q (0–100)	30.76	.22
Environmental Factors		
CHIEF-attitudes (0–40)	2.35	4.37
CHIEF-physical (0–40)	4.17	5.18
CHIEF-policies (0–24)	1.54	3.39
CHIEF-services (0–56)	5.44	7.11
Visits from family, friends/wk	3.38	3.28
Mobility		
NHLSD (0–100)	41.15	19.25
Participation		
LLDI (16–80)	32.77	10.00

CHIEF = Craig Hospital Inventory of Environmental Factors FIM = Functional Independence Measure, GDS=Geriatric Depression Scale, LLDI = Late Life Function and Disability Instrument: Disability Component NHLSD = Nursing Home Life Space Diameter, mos= months, SMMSE = Standardized Mini-Mental State Examination, SD= Standard Deviation, WC= wheelchair, WST-Q = Wheelchair Skills Test Questionnaire

Table 2

Correlation Matrix with Predictor and Outcome Variables

	NHLSD	LLDI
NHLSD	1	.552 **
LLDI	.552 **	1
Personal Factors		
Comorbidity	.090	.167 **
Daily rate	-.060	-.037
FIM Motor	.541 **	.531 **
GDS	-.335 **	-.464 **
Health	.180 **	.195 **
Pain Interfere	-.084	.003
SMMSE	.491 **	.606 **
Vision	-.161 **	-.228 **
Wheelchair-Related Factors		
Hours in WC	.127 *	.145 *
Length of wheelchair use (m.)	.198 **	.209 **
SIT	-.124 *	-.041
WC issues	-.458 **	-.518 **
WST-Q	.661 **	.583 **
Environmental Factors		
CHIEF-attitudes	.033	.129 *
CHIEF-services	-.055	.076
CHIEF-physical	.102	.229 **
CHIEF-policies	.095	.192 **
Visits/week	.083	.043

CHIEF = Craig Hospital Inventory of Environmental Factors FIM = Functional Independence Measure, GDS=Geriatric Depression Scale, LLDI = Late Life Function and Disability Instrument: Disability Component NHLSD = Nursing Home Life Space Diameter, m= months, SMMSE = Standardized Mini-Mental State Examination, SD= Standard Deviation, WST-Q = Wheelchair Skills Test Questionnaire.

* p<0.05>0.01,

** p 0.01