Effectiveness of Wheelchair Usage and Related Factors for Elderly with Disabilities in Nursing Homes

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Abstract The purpose of the study was to investigate effectiveness of wheelchair usage and related factors for 44 elderly with physical disabilities in 2 nursing homes in Tokyo. A principal factor analysis revealed two common factors, "Decreasing Care Burden" and "Increasing Independent Living", from 9 indexes of wheelchair effectiveness. Using sample scores for each of the two factors as dependent variable, the effectiveness of wheelchair usage was examined in relation to the following independent variables: Age, Gender, Motor Functional Impairment, Location of Wheelchair Usage, Frequency of the Wheelchair Usage, Basic ADL, and Wheelchair Maneuverabilities. A series of stepwise regression analysis found a wheelchair maneuverability as a strong predicting variable for "Decreasing Care Burden" factor. No significant relationship was found between those variables and "Increased Independent Living" factor. The present article discussed methodological issues and psycho-social issues regarding the evaluation of wheelchair usage by the elderly.

Key words : wheelchair, elderly with disabilities

Introduction

The Health and Welfare Statistics Association (1993) predicts that by the year of 2025, 25.8% of the total population will be above 65 years old in Japan. With the advancement of medical science and the dramatic changes in life style in general, the longevity of Japanese has become the number one in the world, however, it also means that there will be a large number of dependent elderly who needs support either at home or institutions.

One such support can be provided through the effective usage of rehabilitation equipment or assistive devices. As one of the representative rehabilitation equipment, wheelchairs have played an important role for individual process of rehabilitation. Although there has been numerous literature regarding wheelchairs (Higgs, 1983; Horvat, Golding, Beutel-Horvat, & McConnell,1984; Liu, Ishida, & Chino, 1984; Ohkawa, Ito, Tanaka, & Iijima, 1987) as well as evaluating assistive devices (Brooks & Hoyer,1989; Brown & Lavanchy, 1990; McGrath, Goodman, Cunningham, MacDonald, Nichols, & Unruh, 1985) and rehabilitation engineering services (Caudrey & Seeger, 1983), a limited studies is available regarding effectiveness of wheelchair usage and related factors for the elderly with disabilities. For example, relevant studies analyzed factors for manipulating wheelchairs for adults with cerebral palsied (Nitta & Nakajima, 1992) and motions for wheelchair transfer (Nitta, Nakajima, Matsuura, & Hamada, 1992). Other studies, not limited to wheelchairs, used different methodologies for evaluation. These include a Delphi Method to identify consumer-based criteria for evaluating assistive devices (Batavia and Hammer,1990), an experimental design

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to compare effectiveness of assistive devices such as Environmental Control System between two groups (Efthimiou, Gordon, Sell & Stratford, 1981; Mann, 1992), and a comparative case study for examining device effectiveness and QOL factors (Scherer, 1987). However, those studies were not directed at quantifying the effectiveness.

While daily usage of wheelchairs continues to grow among the elderly population, more and better wheelchairs that meet the individualized needs should be developed in the future. In order to develop such wheelchairs, it becomes necessary to evaluate what constitutes the wheelchair effectiveness, and what kind of factors are involved in evaluating them. Such evaluation data should be taken into a consideration when developing or designing wheelchairs so that it would reflect the needs of the daily wheelchair users. The purpose of the study is to investigate the effectiveness of wheelchair usage and related factors for the elderly with disabilities.

Methodology

Participants. Participants of the study consisted of 44 individuals who had responded for a survey conducted in 1993 (Takayama, 1993) and met the following criteria; 1) ages above 65 years old, 2) cerebrovascular accident, 3) medically diagnosed as physical disability, and 4) daily wheelchair users.

Research Variables. The research variables included; 1) Age, 2) Gender, 3) Motor Functional Impairment, 4) Location of Wheelchair Usage, 5) Frequency of the Wheelchair Usage , 6) Basic ADL, 7) Wheelchair Maneuverabilities, and 8) Wheelchair Effectiveness. These data were taken from the previous study (Takayama, 1993).

Followings are the operational definitions for the variables:

1) Age was measured by respondent's biological age at the time of the survey;
2) Gender was measured by 1 for male and 2 for female;
3) Motor Functional Impairment was measured by the presence and absence of the location of the impairment (upper extremities, lower extremities, or both extremities);
4) Location of Wheelchair Usage was measured by where he/she mainly uses the wheelchair (1=Inside, 2=Outside, and 3=Both);
5) Frequency of Wheelchair Use was measured by the number of daily usage of the wheelchair per week;
6) Basic ADL was measured by (a) Toilette with three levels (1=Independent, 2=Partially Independent, and 3= Dependent) , (b) Bathing with three levels (1= Independent, 2=Partially Independent, and 3=Dependent), (c) Walking with three levels (1=Independent, 2= Partially Independent, and 3= Dependent) , (d) Transferring with three levels (1=Independent, 2=Partially Independent, and 3= Dependent) , (e) Seating and Positioning with two levels (1=Independent and 3=Dependent), and (f) Motivation with three levels (1= High, 2= Medium, and 3= Low);
7) Wheelchair Maneuverabilities consisted of 12 components with 5 levels (1= Very Bad, 2= Bad, 3= Somehow Good, 4= Good, 5= Very Good) . Those 12 components were; (a) Bed Transfer, (b) Floor Transfer, (c) Gap maneuverability, (d) Slope maneuverability, (e) Corner maneuverability, (f) Narrow Space maneuverability, (g) Rough Road maneuverability, (h) Tilted Road maneuverability, (i) Automatic Door Entrance, (j) Elevator Use, (k) Road Crossing, and (l) Rail Crossing.
8) Wheelchair Effectiveness was measured by the 9 indexes with 5 levels (1= No Change, 2= Neither Effective or Ineffective, 3= Somehow Effective, 4= Effective, 5= Strongly Effective). Those 9 indexes were; (a) expanded the sphere of my daily activities, (b) expanded my personal relationships, (c) gave me a sense of independence, (d) decreased the physical burden of care provid-

ers, (e) decreased the psychological burden of care providers, (f) increased my autonomy, (g) increased my level of activities of daily living, (h) increased my motivation for rehabilitation, and (i) gave me a hope for the future.

Research Questions. There are two research questions for this study:

(1) What is the effectiveness of wheelchair usage for elderly with disabilities in nursing homes?

(2) Do the age, gender, motor functional impairment, frequency of the usage, location of the usage, ADL conditions, and wheelchair maneuverabilities significantly predict the effectiveness of wheelchair usage for the elderly with disabilities?

Data Analysis Method. First, descriptive statistics was used for demographic characteristics of the participants and other research variables. Second, a principal factor analysis was used in order to reduce some ambiguous nature of the data and to identify the meaningful common factors. Following the factor analysis, sample scores were calculated for each factor. Third, with those sample scores being the dependent variable, a series of stepwise regression analysis with forward method was conducted in order to examine the predicting variables affecting the wheelchair effectiveness. The missing values were treated by using cases with complete data for the pair of correlated variables.

Results

Demographic Characteristics of the Participants. The demographic characteristics of the participants were as follows:

(1) Of the 44 participants, 86.4% (n= 38) was female while 13.6% (n=6) was male;

(2) the mean age of the respondents was 84.04 (S.D.=6.67);

(3) 11.4% of the participants had impairment with upper extremities, 38.6% had impairment with lower extremities, and 50% had impairment with both

Table 1. ADL Conditions (%)

levels	Independent	Partially Ind.	Dependent	n
Toilette	19(45.2)	11(26.2)	12(28.6)	42
Bathing	3(7.0)	27(62.8)	13(30.2)	43
Walking	3(7.0)	27(62.8)	13(30.2)	43
Transferring	4(9.1)	31(70.5)	9(20.5)	44
Seating	22(50.0)	0(0.0)	22(50.0)	44
Motivation	18(40.9)	19(43.2)	7(15.9)	44

Table 2. Frequency of Wheelchair Maneuverability (%)

	Very Bad	Bad	Somehow Good	Good	Very Good	n
Bed Transfer	3(7.7)	3(7.7)	11(28.2)	7(17.9)	15(38.5)	39
Floor Transfer	1(5.6)	2(11.1)	3(16.7)	2(11.1)	10(55.6)	18
Gap	10(29.4)	10(29.4)	4(11.8)	1(2.9)	9(26.5)	34
Slope	3(9.4)	8(25.0)	3(9.4)	4(12.5)	14(43.8)	32
Corner	2(5.0)	8(20.0)	12(30.0)	4(10.0)	14(35.0)	40
Narrow Space	3(13.0)	3(13.0)	4(17.4)	1(4.3)	12(52.2)	23
Rough Road	3(15.0)	1(5.0)	7(35.0)	9(45.0)	0(0.0)	20
Tilted Road	2(10.5)	1(5.3)	7(36.8)	9(47.4)	0(0.0)	19
Automatic Door	0(0.0)	1(2.9)	7(20.0)	20(57.1)	7(20.0)	35
Elevator	1(2.7)	8(21.6)	9(24.3)	1(2.7)	18(48.6)	37
Road Crossing	0(0.0)	3(15.8)	1(5.3)	13(68.4)	2(10.5)	19
Rail Crossing	3(21.4)	4(28.6)	1(7.1)	1(7.1)	5(35.7)	14

extremities;

(4) 60.5% of the participants used their wheelchair inside of the facility while the 32.6% use it outside, and the 7% reported their usage both inside and outside;

(5) more than 3/4 used their wheelchairs everyday (79.5%);

(6) table 1 shows the ADL condition of the participants;

(7) table 2 shows the wheelchair maneuverabilities; and

(8) table 3 shows the wheelchair effectiveness.

Factor Analysis on Wheelchair Effectiveness. Factor Analysis (Statistical Analysis System, 1993) was utilized to identify major common factors in wheelchair effectiveness. The 9 indexes for wheelchair effectiveness were intercorrelated, then factored using squared multiple correlation as the estimates of commonality (Gorsuch, 1983). The resulting factor matrix was rotated orthogonally to the varimax criterion in order to maximize the independence between factors and homogeneity within the factors. The Kaiser-Guttman criterion of an eigenvalue cutoff score of 1.0 or greater (Kim & Mueller, 1978) as well as a scree test were utilized to determine the number of factors to be retained.

As a result, 2 factors were retained and those were conceptually interpretable. The eigenvalue of the first factor was 2.18 and its proportion was 24.21%. The first factor included "decreased the physical burden of care providers" and "decreased the psychological burden of care providers" and named as "Decreasing Care Burden". The eigenvalue of the second factor was 1.59 and its proportion was 17.74%. The second factor included "increased my autonomy" and "increased my level of activities of daily living" and named as "Increased Independent Living". Table 4 shows coefficient correlations for the 9 indexes, and Table 5 shows the result of the 2 factor solution.

Multiple Regression Analysis. In order to examine the significant predicting variables for wheelchair effectiveness, a series of multiple regression

Table 3. Wheelchair Effectiveness (%)

Effectiveness	No Change	Either Way	Somehow	Effective	Strongly	n
Activities	8(18.6)	0(0.0)	7(13.6)	5(11.6)	23(53.5)	43
Relationships	21(48.8)	7(16.3)	6(14.0)	5(11.6)	4(9.3)	43
Independence	15(34.9)	9(20.9)	10(23.3)	6(14.0)	3(7.0)	43
Physical Care Burden	10(23.3)	11(25.6)	3(7.0)	10(23.3)	9(20.9)	43
Psych. Care Burden	9(20.9)	13(30.2)	3(7.0)	10(23.3)	8(18.6)	43
Autonomy	23(53.5)	4(9.3)	10(23.3)	4(9.3)	2(4.7)	43
ADL	18(41.9)	3(7.0)	10(23.3)	6(14.0)	6(14.0)	43
Rehabilitation	28(66.7)	11(26.2)	3(7.1)	0(0.0)	0(0.0)	42
Hope	27(62.8)	8(18.6)	4(9.3)	3(7.0)	1(2.3)	43

Table 4. Correlation of Coefficiencies for Wheelchair Effectiveness

Effectiveness	1)	2)	3)	4)	5)	6)	7)	8)	9)
1) Activities	1.000	0.378	0.286	0.461	0.476	0.246	0.339	0.216	0.180
2) Relationships		1.000	0.256	0.241	0.219	0.376	0.141	0.049	-0.076
3) Independence			1.000	0.548	0.425	0.447	0.452	0.223	0.546
4) Physical Care Burden				1.000	0.883	0.237	0.246	0.156	0.295
5) Psycho. Care Burden					1.000	0.246	0.222	0.130	0.235
6) Autonomy						1.000	0.659	0.221	0.148
7) ADL							1.000	0.320	0.150
8) Rehabilitation								1.000	0.492
9) Hope									1.000

Table 5. Results of 2 Factor Solution (Varimax)

Variable	Factor1	Factor2
1) Activities	0.4303	0.2184
2) Relationships	0.2096	0.2985
3) Independence	0.4528	0.4640
4) Physical Care Burden	0.9227	0.1232
5) Psycho. Care Burden	0.8978	0.1030
6) Autonomy	0.1474	0.7749
7) ADL	0.1428	0.7367
8) Rehabilitation	0.0873	0.1917
9) Hope	0.1946	0.1987
Eigenvalue	2.1792	1.5972
Proportion (%)	24.2131	17.7468
Cumulatives (%)	24.2131	41.9600

analysis was utilized using sample scores for each of the 2 factors as dependent variable, and age, gender, frequency of the usage, location of the usage, ADL conditions, and wheelchair maneuverabilities as independent variables. The stepwise regression analyses with forward method found one variable, "Tilted Road Maneuverability [TRM] ", to be predictive of "Decreasing Care Burden" [DCB] factor. No predicting variables were found for the "Independent Living" factor. The resulting equation for the prediction of "Decreasing Care Burden" factor was as follows:

$$DCB = -0.721\ [TRM] + 2.31.$$

The formula accounted for 44.03% of the variance in the DCB (Multiple R=.66, F=7.868, d.f.=1,10, $p < .05$).

Discussion

The present study utilized a quantifying method in evaluating wheelchair effectiveness through multivariate analyses. The resulting formula indicates that the wheelchair effectiveness (Decreasing Care Burden) is predictable by looking at one's level of wheelchair maneuverability with a "Tilted Road". An important implication from the result is that the elderly with wheelchairs with lower maneuverability showed more appreciation towards care providers. The result supports the idea that many elderly are feeling guilty for receiving support from care providers every day. When one attempts to evaluate a wheelchair or any assistive devices, it has often been the case that only a mechanical aspect of a wheelchair is focused and not a psycho-social aspect of the elderly. The result implies a need for a future research examining more psycho-social aspects of the elderly who receive social services including assistive technology services.

The purpose of the present study was not only to investigate the relationships between the wheelchair effectiveness and related factors from a user perspective, but also to apply a quantifying methodology to measure the effectiveness of a wheelchair. However, generalization of the results is limited due to the sampling procedure as well as sampling adequacy. Limitations for the study included an issue of quantifying the qualitative data such as measuring motor functional impairment with two levels (presence v.s. absence), which should be avoided preferably in the future research. Also, a question like "How much level of comprehension does an individual have when evaluating his/her own assistive devices?" should be considered carefully before evaluating the effectiveness. Future studies should note those limitations when conducting systematically designed studies for a quantitative evaluation of wheelchairs or any other assistive devices.

Wheelchairs are just one of those large number of assistive devices that support one's process of rehabilitation or independent living. Clarifying the related factors affecting effective usage of assistive devices is a necessity as well as a start for the maximum usage of assistive technology services. Multivariate analysis is said to be a valid statistical tool for identifying those factors. These efforts and results should in turn guide us to provide a more efficient and effective services for people with disabilities including the elderly.

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特別養護老人ホーム入所者の車椅子使用における効果とその関連要因の分析

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要旨　本研究は東京都内の特別養護老人ホーム２ヶ所に入所中の脳血管後遺症による高齢障害者44名を対象とした調査資料を用い、車椅子の使用による効果とその関連要因を多変量解析を用いて検討した。主因子分析により抽出された車椅子使用上の効果を示す、「(移動に関する) 介護を受けることに対する負担感の軽減」及び「自立生活向上」という２因子のサンプルスコアを従属変数とし、年齢、性別、運動機能障害、基本的なＡＤＬ、車椅子使用場面、車椅子使用頻度、車椅子操作性を独立変数としたステップワイズ重回帰分析（変数増加法）を行った結果、「(移動に関する) 介護を受けることに対する負担感の軽減」に車椅子操作性の程度が強く関連していることが明らかにされた。なお「自立生活の向上」に関する要因については明らかにされなかった。以上の結果に基づき、本研究においては、車椅子等の福祉用具に関する導入効果測定にかかわる調査方法の改善点や高齢者の社会心理的な問題点等について考察した。

キーワード：車椅子、高齢障害者