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Physical Function, Cognitive Function, and Depressive Symptoms in Elderly Women with Dysmobility Syndrome

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Abstract

The objective of this study was to examine the relationship between physical and cognitive functions and depressive symptoms in elderly women with dysmobility syndrome. For this study, data on 6,070 elderly women were used and 43 of these women had dysmobility syndrome. The tools used in this study were the Physical Functioning (PF) Scale, Mini-Mental State Examination-Korean Version (MMSE-K), and the Center for Epidemiological Studies Depression Scale (CES-D)-short form. The level of physical function was significantly lower in the dysmobility syndrome group than in the normal group equivalents. Depressive symptoms were significantly negatively correlated with physical function and each of its sub-categories in the dysmobility syndrome group. Multiple regression analysis results indicated that the only predictor of depressive symptoms among elderly women with dysmobility syndrome was PF 5 (the muscle strength of the upper limbs, β = -3.031, P = 0.004), which explained 41.4% of the variance in depressive symptoms (F = 6.985, P < 0.001). The analysis of newly suggested dysmobility syndrome-related factors is expected to help assess health status of elderly people

Keywords: *Cognitive function, Depressive symptoms, Disability, Physical activity*

1. Introduction

Recently, dysmobility syndrome was proposed as an approach to evaluate the musculoskeletal health status of elderly persons by some clinicians and researchers [1]. Dysmobility was defined as having at least three of the following six conditions: high body fat, osteoporosis, low muscle mass, low muscle strength, slow gait speed, and risk of falling [2]. According to a study that examined the relationship between dysmobility and mortality among adults over the age of 50 according to age, sex, and race or ethnicity using 1999–2002 data of the National Health and Nutrition Examination Survey (NHANES) [1], higher mortality was associated with dysmobility syndrome, age over 70 years, female gender, and deficiency in physical activities according to age and gender.

According to a prospective cohort study of the residents of an area in Italy [3], the subjects with depressive symptoms showed significantly worse results in all of the physical function tests (physical performance, muscle strength, and functional status). In

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the survey on depressive symptoms and cognitive function in community-dwelling living-alone elderly women, the level of depressive symptoms was higher when cognitive functions were poor [4]. Depressive symptoms in older persons represent a major issue because of their relative prevalence and the association with higher risk of adverse health-related events [3].

So far, the factors found to have an influence on depressive symptoms include age, gender, activity of daily living, and many others. Thus, with regard to the newly emerging concept of dysmobility syndrome, this study attempted to examine the relationship between physical and cognitive functions and depressive symptoms in elderly women with the syndrome. The reason for limiting the subjects of this study to elderly women is that, according to the results of Looker [1] who analyzed based on the data of the National Health and Nutrition Survey on American people, the prevalence of the syndrome was higher in elderly women than in elderly men among those over the age of 70. Assessing these relationships may help to evaluate the utility of this new proposed syndrome and may provide insight on ways to further refine it.

2. Methods

2.1. Data Collection and Participants

The data were obtained from the Korean Elderly Adults Survey conducted by the Korea Institute for Health and Social Affairs (KIHASA). Written approval was obtained from KIHASA for the use of the survey data. Original data were stratified by the seven metropolitan cities and nine provinces of Korea. Nine of the provinces were further divided into 18 classes by division into dongs (neighborhoods) and eups/myeons (towns/townships) for data collection. The Korean Elderly Adults Survey is conducted every three years in Korea, and the scope of the survey in 2011 was determined by responses from a panel of households surveyed in 2008. The original data were collected through three telephone surveys and one face-to-face interview. Those who died or were admitted to hospitals or long-term care facilities during the period of the survey for these original data (from April 2011 to April 2012) were excluded. The data were collected from 2011 to 2012. Thus, after excluding those with missing data from a total of 10,674 community dwelling elders, we identified 6,070 elderly women and 43 of these were subjects with dysmobility syndrome who met all of the inclusion criteria (i.e. high body fat, fall experience in the previous two years, osteoporosis).

2.2. Measurements

2.2.1. Physical Function: Physical function was assessed using the Physical Functioning Scale (PF) [5], which consists of a total of five questions (two for upper limb functioning and three for lower limb functioning). Upper limb functioning was determined by measuring the flexibility (PF 4) and muscular power of shoulder joints (PF 5), and lower limb functioning was determined by assessing endurance (PF 2), balance and walking ability (PF 1), as well as flexibility of lower limbs (PF 3). The items were scored from 0 to 3. The total score was divided by the number of questions and by the highest score, which was 3 points. Then, the upper limb score was multiplied by 40 and the lower limb score was multiplied by 60 to make the total possible scores on upper limb and lower limb questions equal to 100 points. Higher scores indicated better functioning. As to limitations in physical function, those who answered “Somewhat difficult” for one or more of the surveyed items were considered to have a functional limitation. The internal consistency (Cronbach’s α) was 0.87 in the study of Lee et al. [5] and was 0.87 in the present study.

2.2.2. Cognitive Function: To measure cognitive function, we used the Mini-Mental State Examination (MMSE) developed by Folstein et al. [6] and translated and modified by Kang et al. [7]. The tool assigned 1 point when the instructions of each item were followed correctly and 0 points for all other cases. The Korean version of the MMSE comprises 30 items providing information about orientation to time (5), orientation to place (5), registration (3), attention and calculation (5), recall (3), language (5), complex command (3), and spatiality (1). The score ranged from 0 (lowest) to 30 (highest). A high score indicated high cognitive capability. Total scores from 24–30 indicated no cognitive impairment. The internal consistency (Cronbach's α) was 0.85 in the study of Kang et al. [7] and 0.81 in this study.

2.2.3. Depressive Symptoms: Depressive symptoms were measured with the short-form of the Center for Epidemiological Studies Depression Scale (CES-D), which simplified Radloff's [8] CES-D into 10 questions for the KIHASA. This tool included questions regarding the subjects' feelings for the last week and the total score ranged from 0 to 10, with a score $\geq$4 considered an indication of "depressive symptoms" (Irwin et al. [9]). The internal consistency (Cronbach's α) was 0.92 in the study of Irwin et al. [9] and 0.90 in this study.

2.3. Data Analysis

Data were analyzed using SPSS for Windows version 18.0 (SPSS, Chicago, IL, USA). A T-test and chi-square test were used to verify the homogeneity of the sociodemographic characteristics of the subjects. To assess whether physical functioning, cognitive function, and depressive symptoms differed, an independent-samples t-test was performed. Correlations between these variables were calculated using Pearson's correlation coefficient. Each variable that significantly correlated with depressive symptoms was regarded as an independent variable in a regression analysis. A simultaneous data entry method was used. The threshold of significance was set at $P < 0.05$.

3. Results

3.1. Sociodemographic Characteristics

The subjects' mean age was 74.14 years (SD: 6.36), 29.5% (n = 1793) of the subjects lived alone, 8.6% (n = 525) were from a low-income class, 21.1% (n = 1282) had diabetes mellitus, and 59.3% (n = 3602) had hypertension. There were no statistically significant differences in sociodemographic characteristics between the dysmobility syndrome group and the normal group; therefore, we deemed the study population homogeneous (Table 1).

3.2. Factors Affecting the Level of Depressive Symptoms

Table 2 shows the differences in the depression level according to the subjects' personal characteristics. Significant differences were observed according to age (t = -13.256, P < 0.001), whether the subject lived alone (t = 8.905, P < 0.001), and income level (t = 18.019, P < 0.001). Among health-related characteristics, the level of depressive symptoms were significantly different between those with and without diabetes mellitus (t = 6.690, P < 0.001) and hypertension (t = 4.308, P < 0.001). Moreover, significant differences in depressive symptoms were also observed according to physical function limitation (t = -28.413, P < 0.001) and cognitive function impairment (t = -16.826, P < 0.001).

Table 1. Sociodemographic Characteristics (*n* = 6070)

Variables	Total (*n* = 6070)	Dysmobility syndrome group (*n* = 43)	Normal group (*n* = 6027)	t/χ^2 (*P*)
Age (y), mean ± SD	74.14 ± 6.36	75.38 ± 4.40	74.13 ± 6.37	1.859 (0.070)
Living alone				0.111 (0.739)
Yes	1793 (29.5)	14 (32.6)	1779 (29.5)	
No	4277 (70.5)	29 (67.4)	4248 (70.5)	
Low income†				0.876 (0.349)
Yes	525 (8.6)	2 (4.7)	523 (8.7)	
No	5545 (91.4)	41 (95.3)	5504 (91.3)	
Diabetes mellitus				0.226 (0.635)
Yes	1282 (21.1)	19 (44.2)	1263 (21.0)	
No	4788 (78.9)	24 (55.8)	4764 (79.0)	
Hypertension				0.099 (0.754)
Yes	3602 (59.3)	32 (74.4)	3570 (59.2)	
No	2468 (40.7)	11 (25.6)	2457 (40.8)	

Values are expressed as n (weighted %), unless otherwise indicated. †Fisher's exact test; SD, standard deviation

3.3. Differences in Function and Symptoms between Normal Subjects and those with Dysmobility Syndrome

Regarding the differences in each variable between the dysmobility syndrome group and the normal group (Table 3 and Figure 1), statistically significant differences were observed with respect to physical function (t = -4.939, P < 0.001). The level of physical function was significantly lower in the dysmobility syndrome group (58.14 ± 23.42) than in the normal group equivalents (75.64 ± 23.23).

All of the sub-factors of physical function were significantly different between the two groups. In both of the groups, moreover, PF 4 (flexibility of the upper limbs) was the highest and PF 3 (flexibility of the lower limbs) was the lowest of the PF scores.

3.4. Correlations between Depressive Symptoms and other Variables in the Dysmobility Syndrome Group

The correlations between depressive symptoms and other variables in elderly women with dysmobility syndrome are shown in Table 4. Depressive symptoms were significantly negatively correlated with physical function (r = -0.644, P < 0.001) and each of its sub-categories (r = -0.616 to -0.307) but were not significantly correlated with cognitive function (r = -0.032, P = 0.838) in the dysmobility syndrome group.

Table 2. Factors Affecting the Level of the Depressive Symptoms (*n* = 6070)

Categories	Variables	Depressive symptoms	t (*P*)
Age (y)	Young-old	4.84 ± 4.43	-13.256 (<0.001)
	Old-old	6.41 ± 4.59	
Living alone	Yes	6.32 ± 4.72	8.905 (<0.001)
	No	5.15 ± 4.46	
Low income	Yes	8.86 ±4.31	18.019 (<0.001)
	No	5.18 ± 4.46	

Diabetes mellitus	Yes	6.27 ± 4.69	6.690 (<0.001)
	No	5.29 ± 4.51	
Hypertension	Yes	5.71 ± 4.59	4.308 (<0.001)
	No	5.19 ± 4.52	
Physical function limitation	Yes	6.28 ± 4.57	-28.413 (<0.001)
	No	2.99 ± 3.53	
Cognitive function impairment	Yes	6.73 ± 4.56	-16.826 (<0.001)
	No	4.72 ± 4.40	

Table 3. Differences in Function and Symptoms between Normal Subjects and those with Dysmobility Syndrome (n = 6070)

Variables	Dysmobility syndrome group (n = 43)	Normal group (n = 6027)	t (P)
Physical function total scores	58.14 ± 23.42	75.64 ± 23.23	-4.939 (<0.001)
PF 1 (range: 0−3)	1.56 ± 0.85	2.26 ± 0.85	-5.372 (<0.001)
PF 2 (range: 0−3)	1.69 ± 0.76	2.04 ± 0.91	-2.548 (0.011)
PF 3 (range: 0−3)	1.34 ± 0.95	2.03 ± 0.96	-4.699 (<0.001)
PF 4 (range: 0−3)	2.18 ± 0.92	2.69 ± 0.64	-3.655 (0.001)
PF 5 (range: 0−3)	1.95 ± 1.07	2.33 ± 0.90	-2.316 (0.025)
Cognitive function (range: 0−30)	23.33 ± 4.05	23.58 ± 4.43	-0.370 (0.711)
Depressive symptoms (range: 0−10)	6.83 ± 4.93	5.49 ± 4.56	1.925 (0.054)

All values are expressed as mean ± standard deviation. PF, physical function

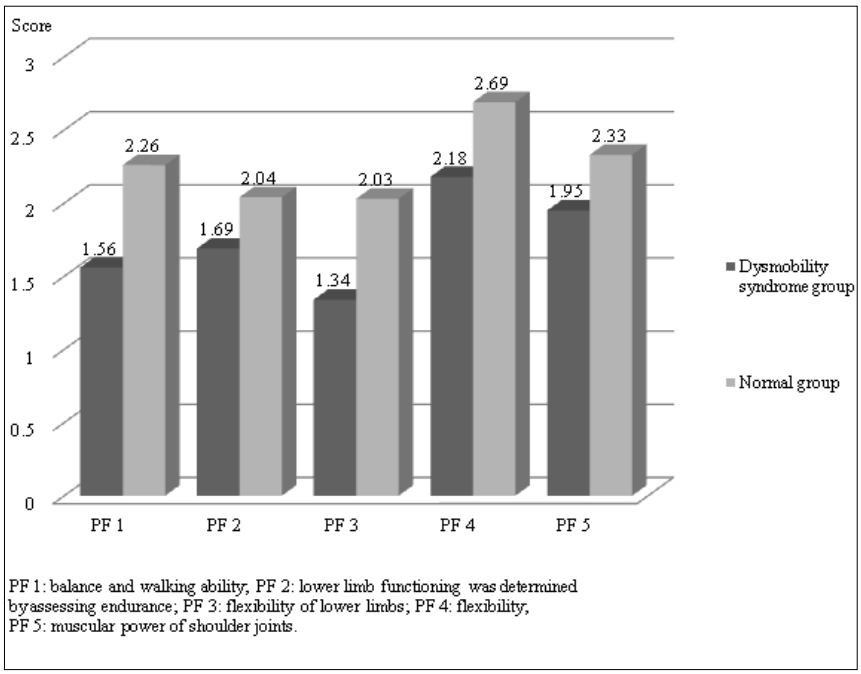

Figure 1. Mean Score Difference in Physical Function by Group

Table 4. Correlations between Depressive Symptoms and other Variables in the Dysmobility Syndrome Group (n = 43)

Variables	Depressive symptoms					
	Physical function (r = -0.644, P < 0.001)					Cognitive function
Sub-categories	PF 1	PF 2	PF 3	PF 4	PF 5	
	-0.571 (<0.001)	-0.458 (0.002)	-0.517 (<0.001)	-0.307 (0.044)	-0.616 (<0.001)	-0.032 (0.838)

Values are expressed as r (P-value). PF, physical function

3.5. Physical Function Factors Influencing Depressive Symptoms

Multicollinearity, residuals, and singular values were examined to verify the assumptions of regression analysis for independent variables. In accordance with the analysis on the multicollinearity among independent variables, the correlation was between -0.616 and -0.307. As there were no explanatory variables with a correlation greater than 0.800, the predictors were verified to be independent. The Durbin–Watson statistics were 2.160 in elderly women. Thus, there were no autocorrelation problems. Tolerance was 0.286–0.535 (i.e., <1.0) for subjects. The variance inflation factor was 1.868–3.502 for subjects; as this did not exceed 10, the standard level, there were no problems with multicollinearity. In accordance with the verification to satisfy the assumptions of residuals, the assumptions of linearity, regularity of error term, and homoscedasticity were satisfied. The maximum value of Cook's distance to verify the singular value was 0.076 for subjects; no values exceeded 1.0. Therefore, the regression analysis results are reliable, because all assumptions in the regression equation were satisfied.

The predictors of depressive symptoms among elderly women with dysmobility syndrome are shown in Table 5. Only PF 5 (β = -3.031, P = 0.004) was a significant predictor of depressive symptoms in the dysmobility syndrome group and it explains 41.4% of the variance in depressive symptoms (F = 6.985, P < 0.001).

Table 5. Physical Function Factors Influencing Depressive Symptoms (n = 43)

Variables	Sub-categories	Depressive symptoms	
		β	t (P)
Constant			5.529 (<0.001)
Physical functioning	PF 1	-0.229	-1.176 (0.247)
	PF 2	-0.193	-0.875 (0.387)
	PF 3	-0.340	-1.607 (0.117)
	PF 4	-0.115	-0.687 (0.496)
	PF 5	-0.487	-3.031 (0.004)
	Adj. R^2	0.414	
	F (P)	6.985 (<0.001)	

PF, physical function

4. Discussion

This study was conducted in order to examine the relationship between physical and cognitive functions and depressive symptoms in elderly women with dysmobility syndrome and to explore individual factors related to dysmobility syndrome.

Those with physical function limitations showed a higher level of depressive symptoms (6.28) than those with normal physical function (2.99). As it was difficult to find studies that examined the differences in depression levels using the same tool as used in this study (CES-D and PF), this study was compared with a comparative study on depressive symptoms according to physical activity level [10] in which the level of depression symptoms was significantly higher in the inactive group than in the group of subjects who had a high activity level without discomfort. Because physical activity is less expensive, has fewer harmful side effects, and is less burdensome than other depression therapies [11], it is necessary to publicize the importance of physical activity and to encourage physical activity to reduce elderly depression.

Those with cognitive function impairment showed a higher level of depressive symptoms (6.73) than those with normal cognitive function (4.72). In a previous study focusing on the differences in the levels of depressive symptoms between a mild cognitive impairment group and a normal cognitive function group that had been matched based on age and education, the authors found a significantly greater level of depressive symptoms in the mild cognitive impairment group [12]. According to Shin [13], however, the depression level was higher in those with mild cognitive function impairment than in the normal group, but the difference was not statistically significant. Shin's study [13] verified the homogeneity of the participants in terms of activities of daily living, which is one of the major variables affecting elders' depression, in addition to age and education, which might contribute to the differences between the two studies. In general, however, those with cognitive function impairment and disability have higher levels of depression than normal subjects. Therefore, the relationship between cognitive function and depressive symptoms should be investigated further from various viewpoints.

The dysmobility syndrome group showed significantly lower levels of endurance, balance and walking ability, flexibility of the lower limbs, flexibility of the upper limbs, and muscle strength of the upper limbs compared to the normal group. Moreover, the dysmobility syndrome group's overall mean physical function was 58.14, which was far lower than the mean score of the normal group, 75.64. The physical function score was also lower than the result of a previous study (72.5) that measured the physical performance of 199 Korean community-dwelling elders using the same tool [5]. The dysmobility syndrome group in this study also met the criteria for dysmobility suggested by Binkley et al. [2], which include high body fat, osteoporosis, and risk of falling, and therefore, they are believed to be exposed to a higher risk of recurring falls or fracture than those without dysmobility syndrome. Accordingly, attention should be paid to enhancing the quality of life and lowering mortality in those with dysmobility syndrome through preventive medical treatment and continuous management.

In the subjects with dysmobility syndrome, depressive symptoms were negatively correlated with physical function. According to a previous study of 317 low-income elders who live alone that measured their depressive symptoms and physical function using the same tools [14], there was a negative correlation between the two variables in both male and female elders, supporting the results of this study. Lee [15] investigated the relationship between physical fitness and depressive symptoms by applying the Senior Fitness Test (SFT) Manual [16] to 117 elders aged over 60 who did not have any particular medical disease, were able to perform the activities of daily living, and were using welfare and convenience facilities for the elderly; this study reported that depressive symptoms were significantly negatively correlated with strength and cardio-respiratory endurance and significantly positively correlated with agility and dynamic balance. According to Song [17] who studied the relationship between rural elderly women's depressive symptoms and physical fitness, depressive symptoms showed a weak negative correlation only with flexibility of the upper limbs among the sub-categories of physical function but no correlation with other sub-categories of physical function or with body

composition such as body mass index, body fat percentage, and muscle mass. Bang [11] surveyed community-dwelling elders who were able to walk and had normal cognitive functions concerning their participation in physical activities and the relationship between their depressive symptoms and physical functions; depressive symptoms were negatively correlated with muscle strength of the upper limbs but not with that of the lower limbs or with balance. Previous studies on the relationship between depressive symptoms and the sub-factors of physical function have not shown consistent results. This is probably because of variation in the subjects' basic physical fitness level and variables affecting depression. Thus, it is considered necessary to conduct research on the relationship between physical function and depressive symptoms with subjects whose homogeneity has been tested in terms of the factors that may influence their physical function.

Among the sub-factors of physical function that may influence depressive symptoms in those with dysmobility syndrome, the muscle strength of the upper limbs was found to have the greatest effect. In a study surveying physical activity level, fear of falling, depressive symptoms, and physical function among 153 community-dwelling elders [10], the muscle function of the lower body was poorer than the muscle function of the upper body or the flexibility of the shoulder joints, which was consistent with the results of this study. The finding that, among the physical functions of the upper body that are generally better than those of the lower body, the muscle strength of the upper limbs was the most influential on depressive symptoms suggests that minimal self-care is possible using the only upper body, but those with dysmobility syndrome may have difficulty with these functions, considerably impacting their depressive symptoms.

The decline in muscle strength is much greater than the decline in muscle mass according to data from the Baltimore Longitudinal Study [18]. Impaired muscle strength is highly predictive of incident disability and all-cause mortality in the elderly [19]. As the quality of muscle deteriorates with aging, it is necessary to measure the mass and functions of the muscles because this may be related to secondary damage caused by muscle weakness. Physical dysfunction is predicted better by muscle strength than by muscle mass [20], and although the importance of muscle mass was emphasized in earlier research, the focus is now being moved to muscle weakness [21, 22].

Muscle, bone, and fat are intertwined [2]. The decline in muscle and bone, both in terms of mass and quality that has been observed with aging, likely reflects shared mechanisms [2]. Efforts are required to reduce the risk of falls through effective treatment of osteoporosis. The assessment of factors related to dysmobility, as in this study, will contribute to the evaluation of the newly suggested concept of dysmobility syndrome and will provide insights for further improvement.

5. Limitations

As the findings of this study are relevant only to those with dysmobility syndrome, it may be unreasonable to generalize the findings to all elders over the age of 65. This study investigated Korean elders who had high body fat, had fallen in the previous two years, and had osteoporosis among the diagnostic criteria of dysmobility syndrome, and there should be continuous research on the validity of the diagnostic criteria according to gender, race, and region.

6. Conclusion

The level of physical function was lower in the dysmobility syndrome group than in the normal group. In both of the groups, PF 4 (flexibility of the upper limbs) was the highest and PF 3 (flexibility of the lower limbs) was the lowest of the PF scores. Only PF 5 (muscular power of shoulder joints) was a significant predictor of depressive symptoms in

the dysmobility syndrome group and it explained 41.4% of the variance in depressive symptoms.

"Dysmobility syndrome" is a potential diagnostic approach that has been raised as a new issue among clinicians and researchers. Particularly in Korean society where the population is aging, assessment of dysmobility diagnosis is expected to be helpful for the elderly to recognize their problems, take interest in the treatment of osteoporosis, manage sarcopenia, reduce high body fat percentage, etc., and consequently reduce falls and fall-related side effects. In order to reduce the risk of falling and resultant fractures and disabilities among elders and to lower the mortality and readmission rates, we need to reach a consensus for diagnosis through research on 'dysmobility syndrome' from various viewpoints. It is unquestionable that diagnosis and assessment of dysmobility syndrome will increase people's interest in preventive programs and therapies and this, in turn, will reduce social and economic costs.

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