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RESEARCH ARTICLE

Correlation between Activity Limitations due to Musculoskeletal Reasons and Grip strength in Korean Early- stage and Late-stage Elderly

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ABSTRACT

This study aims to examine the correlation between activity limitations due to musculoskeletal issues and grip strength among early-stage and late-stage elderly individuals in Korea. Data were extracted from the 7th National Health and Nutrition Examination Survey (2016-2018) conducted by the Korea Centers for Disease Control and Prevention. The study included 8,374 adults aged 65 years or older who reported activity limitations. Activity limitations and grip strength were analyzed separately for early-stage (65-74 years) and late-stage (75 years and older) elderly individuals. Among the early-stage elderly, 15.4% reported activity limitations, while 23.1% of the late-stage elderly experienced such limitations. The most common causes of activity limitations were back and neck problems, arthritis and rheumatism, and knee and leg pain. In the early-stage elderly with activity limitations, grip strength of the dominant hand was 2.462 times lower than that of individuals without activity restrictions. For the late-stage elderly, grip strength was 1.562 times lower in those with activity limitations compared to those without. Additionally, in the late-stage elderly, grip strength was 3 times lower in cases where activity limitations were due to arthritis. Variability in grip strength based on the specific cause of activity restriction was observed, indicating inconsistencies in the relationship between activity limitations and grip strength across different age groups. The study highlights that while grip strength is generally lower in elderly individuals with activity limitations, the extent of this decrease varies by age and the specific musculoskeletal condition causing the limitation. The relationship between activity restrictions and grip strength is not uniform across all elderly populations, suggesting that activity restrictions do not uniformly lead to decreased grip strength.

INTRODUCTION

In Korea, individuals aged 65 or older are classified as elderly according to the Elderly Welfare Act (2024). Recently, there has been a growing need to further subdivide old age into early-stage old age (the young-old) and late-stage old age (the old-old). The early elderly group refers to individuals under the age of 75 who are relatively young, healthy, and lead independent lives (Do & Lim, 2015). This group maintains vitality and functional ability (Ra & Lee, 2017). In contrast, the late old age group, consisting of individuals aged 75 and older, often experiences significant impairments in physical and mental functions, leading to increased dependency on health and life support (Ra & Lee, 2017). This segmentation is based on the understanding that aging exacerbates physical, mental, and social decline, necessitating more intensive and varied services (Choi et al., 2016).

The elderly population is characterized by a high prevalence of chronic diseases and a concomitant decline in muscle strength. Grip strength is a valuable indicator of muscle strength deterioration and

overall health status in the elderly (Bohannon, 2019). It serves as a key biomarker for assessing fractures, falls, malnutrition, cognitive impairment, depression, sleep problems, diabetes, and overall quality of life (Bohannon, 2019). Grip strength also correlates strongly with overall muscle strength, upper extremity function, and bone density (Bann et al., 2015; Kim et al., 2012). Given its broad utility, grip strength is a crucial metric for evaluating health status in older adults.

Low muscle strength is associated with increased physical disability (Lima et al., 2017) and higher mortality rates (Cooper, Stamatakis, & Hamer, 2020). Moreover, activity limitations due to various diseases are strongly related to reduced grip strength. Regular physical activity is known to improve muscle strength (Lima et al., 2017), suggesting that the loss of muscle strength is exacerbated when diseases limit community or daily activities.

Major geriatric issues, such as frailty, falls, osteoporosis, sarcopenia, and mobility difficulties, are more prevalent and severe in the late-stage elderly compared to the early-stage elderly. If grip strength can serve as a predictor of health status, it could be a valuable tool for evaluating and managing individuals with complex medical problems and disabilities in an aging society (Do & Lim, 2015).

Therefore, this study aims to compare musculoskeletal health problems and grip strength that limit daily life and social activities in early and late-stage elderly individuals. By identifying differences in health problems between these age groups, this research seeks to explore the potential of grip strength as a predictor of health issues.

MATERIALS & METHODS

Research subjects and data collection methods

This study is a data analysis study to determine the prevalence of activity limitations, reasons for activity limitations, grip strength, and the relationship between reasons for activity limitations and grip strength in the elderly population aged 65 or older in Korea. This study was extracted from the raw data of the Korea Centers for Disease Control and Prevention, The 7th Korea National Health and Nutrition Examination Survey (2016-2018) (http://kostat.go.kr/portal/korea/kor_nw). The most recent 8th survey (2019-2021) was conducted, However, due to COVID-19, grip strength had to be operated manually, so grip strength was not measured to prevent the risk of infection. Therefore, this study conducted the research using data from the 7th period.

The subjects of this study were 8,374 people aged 65 or older who participated in the Korea National Health and Nutrition Examination Survey(KNHNES)conducted from January to December 2016. Data were collected using the health interview method at a mobile examination center by the 7th KNHNES(http://kostat.go.kr/portal/korea/kor_nw).

Measurement of grip strength and activity limitations

In the KNHNES, the maximum grip strength of the right and left hands was measured three times each using a Japanese digital grip strength meter(Takai TKK-5401, Takei Scientific Instruments Co., Ltd., Tokyo, Japan). In this study, the average of three measurements was used for analysis. The question regarding activity limitations was “Are you currently experiencing limitations in your daily life and social activities due to health problems or physical or mental disabilities?” They can respond “yes or no” to this, and if they answer “yes”, you can ask “what caused the limitations in your daily activities?” A total of 20 items are classified as being limitations in daily life. Among them, four items related to the musculoskeletal system (back and neck problems, arthritis and rheumatism, knee and leg pain, fractures and joint injuries) were analyzed. (http://kostat.go.kr/portal/korea/kor_nw).

Ethical considerations

The raw data used in this study were approved by the KDCA’s Institutional Review Board(2018-01-03-P-A) and were downloaded from the KNHANES website by appropriate procedures

(http://kostat.go.kr/portal/korea/kor_nw). As this study is a secondary data analysis, participants’ informed consent is not required.

Data analysis

Since the NHNES data used a complex sample design method, complex sample analysis was performed using weights according to the guidelines for using raw data from the National Health and Nutrition Examination Survey. The general characteristics of the study subjects were presented as mean and standard error for continuous variables and percentages for categorical variables. The subjects' general and health-related characteristics were analyzed using descriptive statistics, and the subjects' grip strength was compared according to activity limitations due to disease using the chi-square test. Grip strength was averaged over three measurements and analyzed for its relationship to activity limitations based on the dominant hand. General linear regression analysis was used to analyze the relationship between study subjects' activity limitations and grip strength. The statistical program SPSS 26.0 was used, and the significance level was set at $p < 0.05$.

RESULTS

Comparison of socio demographic characteristics of the subjects

The general characteristics of the participants are presented in Table 1. There were 1,251 men and 4,754 women aged 65–74, and 823 men and 1,172 women aged 75 or older. The total number of participants was 8,374 (5,830 men and 7,617 women).

In terms of marital status, living with a spouse was the most common among those aged 65–74, with 1,125 men and 1,006 women. The smallest number of separated people was 10 men and 7 women. Among those aged 75 or older, living with a spouse was the most common at 683 men and 345 women. The smallest number of separated people was 6 men and 7 women.

In terms of education level, elementary school graduates or lower were the largest group among those aged 65–74, with 437 men and 953 women. College graduates or higher were the smallest group at 197 men and 96 women. Among men aged 75 and older, elementary school graduates or lower were the largest group at 350, while middle school graduates were the smallest group at 105. Among women aged 75 and older, elementary school graduates or lower were the largest group at 912, while college graduates were the smallest group at 25.

Dominant hand of Korean elderly people

Among those aged 65 to 74, 88.2% (2814 people) used their right hand as their dominant hand, 5.4% (170 people) used their left hand as their dominant hand, and 6.4% (205 people) used both hands(Table 2). Among those aged 75 or older, 88.4% (2,107 people) used their right hand as their dominant hand, 5.4% (124 people) used their left hand as their dominant hand, and 6.2% (134 people) used both hands. Most elderly people in Korea mainly use their right hand.

Musculoskeletal problems that limit daily life and social activities

The musculoskeletal health problems that limit the daily life and social activities of the early and late elderly are as shown in Table 3.

The percentage of early elderly with activity restrictions was 15.4%. The most frequent reasons for activity limitations were back and neck problems at 36.3%, arthritis and rheumatism at 24.5%, knee and leg pain at 11.3%, and fractures and joint injuries at 3.8%.

By gender, back and neck problems were higher in women (43.3%) than in men (24.6%), while arthritis and rheumatism were higher in women (32.3%) than in men (11.6%). Knee and leg pain was higher in women (13.7%) than in men (7.4%).

The percentage of late elderly with activity restrictions was 23.1%. The most common diseases among the reasons were back and neck problems (36.5%), arthritis and rheumatism (28.7%), knee and leg pain (14.7%), and fractures and joint injuries (13%). By gender, back and neck problems were higher in women (38.6%) than in men (24.6%), while arthritis and rheumatism were higher in women (38.1%) than in men (9.1%). Knee and leg pain was higher in women (7.7%) than in men (4.7%).

Association between grip strength and health problems that limit daily life and social activities.

The relationship between grip strength and three major health problems that limit daily life and social activities was examined in early-stage elderly in Table 4 and late-stage elderly in Table 5.

Based on the grip strength of the dominant hand, the grip strength of early-stage elderly in those with limitations in daily life and social activities was -2.462 times lower than in those without limitations ($p<.001$). In arthritis, grip strength in cases with limitations in daily life and social activities was 2.849 times lower than in cases without limitations ($p<.003$). There was no statistical difference in the reasons for back pain and knee pain

The grip strength of the hand of late-stage elderly was -2.226 times lower in cases with limitations in daily life and social activities than in cases without limitations ($p<.001$). In arthritis, grip strength was -3.100 times lower in cases with limitations in daily life and social activities than in cases without limitations ($p<.003$). There was no statistical difference in the reasons for rejection. Regarding the reasons for knee-legs, those with limitations in daily life and social activities had -3.100 times lower grip strength than those with no limitations ($p<.003$)

DISCUSSION

Hand strength is an important independent parameter for assessing morbidity and mortality risks, common disabilities in old age, and future outcomes (Angst et al., 2010; Bohannon, 2019). This study examines grip strength in the dominant hands of elderly individuals with various activity limitations.

In this study, the grip strength of the hand was 2.462 times lower in the early-stage elderly with limitations in daily life and social activities compared to those without activity limitations. In cases where daily life and social activities were limited due to arthritis or rheumatism, grip strength was 2.849 times higher. There was no difference in activity limitations related to back or neck pain or knee or leg pain, regardless of whether daily life or social activities were restricted. In the late-stage elderly, grip strength was 2.226 times lower compared to the general elderly population among those with limitations in daily life and social activities ($p<.001$). When there were limitations due to arthritis or rheumatoid arthritis, grip strength was 3.100 times lower, and 1.989 times lower for those with arthritis alone ($p<.003$). These findings indicate that grip strength varies depending on age and the reason for activity limitation.

The type and intensity of physical activity typically performed during leisure time are often insufficient to increase strength. However, short-term resistance exercise training can lead to strength gains (Physical Activity Guidelines Advisory Committee Report, 2008). Upper extremity strength and its associations may change with age, and a correlation between physical activity and muscle strength is not always observed (Miller et al., 2010; Scott et al., 2011). Therefore, the results of this study suggest that the relationship between grip strength and activity limitation is inconsistent, depending on age and the reason for activity limitation, indicating that simple restrictions in daily life do not consistently lead to decreased strength (Richards et al., 1996). Regular moderate or vigorous physical activity is associated with higher muscle strength levels. Stimulation from physical activity directly impacts skeletal muscles and their responses, leading to increased muscle mass and strength (Adedoyin et al., 2009). Additionally, a study found that individuals who engaged in higher-intensity physical activity had greater muscle strength (Møller et al., 2013).

In this study, 15.4% of early-stage and 23.1% of late-stage Korean elderly individuals reported limitations in daily life and social activities. The three most common conditions leading to activity limitations were back and neck problems, arthritis and rheumatism, and knee and leg pain, observed in both early and late-stage elderly individuals. Furthermore, the proportion of elderly women experiencing activity limitations due to health problems was higher than that of elderly men. Lima et al. (2017) reported that muscle strength decreases with age and that women generally have lower grip strength than men. Physically active individuals tend to have higher grip strength compared to those who are inactive.

In this study, over 88% of Korean elderly individuals were right-handed, reflecting Korea's traditional preference for right-handedness. Grip strength measurements showed that early-stage elderly individuals had an average grip strength of 24 to 25 kg, whereas late-stage elderly individuals had an average of 18 to 20 kg, indicating a decline with age. Lima et al. (2017) also noted that muscle strength decreases with age and that women have lower grip strength than men. As we age, there is a decline in fast-twitch muscle fibers, a reduction in the total number of muscle fibers, decreased agonist activation, increased demands on antagonist muscles, and reduced ability to activate motor units (Gale et al., 2007). Men typically have more muscle mass than women (Valentine et al., 2009). Higher plasma concentrations of major anabolic hormones (testosterone, GH, and IGF-1) in men are associated with greater muscle strength compared to women (Montalcini et al., 2012).

The strengths of this study include its nationwide survey and use of composite sample statistics, which enhance the representativeness of the findings for Korea. The limitations are the environment, and posture during the grip strength test. Grip strength is affected by many factors such as muscle strength, fatigue, hand dominance, time of day, age, nutritional status, pain, patient cooperation, amputation, restricted movement, pain, and sensory loss (Incel et al., 2002). In addition, when conducting the grip strength test, the grip strength scores of individuals in the standing position are higher than those of individuals in the sitting position (Balogun et al., 1991). It is said that the activation of the alpha and gamma motor systems, which are responsible for the strong contraction of extrafusal muscle fibers, is enhanced by the synergistic effect of the lower limb muscles in the standing position (Balogun et al., 1991). While interviewers were well-trained, there may have been limitations in controlling the environment during individual visits. This study could not confirm these limitations due to a lack of detailed information on participants' posture during grip strength assessment.

CONCLUSIONS

This study finds that grip strength is significantly lower in elderly individuals with activity limitations, with a more pronounced decline observed in late-stage elderly individuals compared to early-stage ones. Activity limitations due to arthritis and knee and leg pain are correlated with reduced grip strength, suggesting potential predictive value. However, the variability in grip strength reductions across different reasons for activity limitations indicates that not all restrictions lead to decreased strength. Therefore, while grip strength is a valuable measure, its relationship with activity limitations is not consistent across all older adul

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APPENDIX

Table 1: General characteristics of subjects

			Men	Women
			N(%±SE)	
Age groups		65~74	1,251(46.9+0.6)	1,558(53.1±0.6)
		≥75	8,23(36.5±0.8)	11,72(63.5±0.8)
		Total	3,620(100)	4,754(100)
Marital status	65~74	With partner	1,125(90.8±0.6)	1,006(63.1±1.1)
		Separated	10(0.6±0.2)	7(0.6±0.2)
		Widowed	42(3.1±0.4)	450(29.6±1.2)
		Divorced	61(4.6±0.5)	80(5.6±0.6)
		Others	13(0.9±0.2)	15(1.1±0.1)
		Total	1,251(100)	4,754(100)
	≥75	With partner	683(82.2±1.0)	345(28.1±1.2)
		Separated	6(0.7±0.2)	7(0.7±0.2)
		Widowed	107(14.2±1.0)	791(68.7±1.2))
		Divorced	23(2.5±0.4)	25(2.2±0.5)
		Others	4(0.4±0.1)	4(0.4±0.2)
		Total	823(100)	1172(100)
Educational level	65~74	≤Elementary school	437(35.7±1.3)	953(62.3±1.4)
		Middle school	245(21.3±1.4)	234(15.4±0.9)
		High school	310(25.3±1.0)	210(15.2±1.0)
		≥College	197(17.7±1.3)	95(71.±0.7)
		Total	1,189(100)	1,492(100)
	≥75	≤Elementary school	350(43.8±1.8)	912(84.4±1.4)
		Middle school	105(14.9±1.4)	77(7.2±0.6)
		High school	176(23.6±1.2)	54(5.7±0.8)
		≥ College	125(17.6±1.4)	25(2.7±0.6)
		Total	756(100)	1068(100)

Table 2: Dominant hand and grip strength of Korean elderly people

Age group	Dominant hand	Men(%±SE)	Women (%±SE)	Total(%±SE)
65~74	Rt hand	1090(88.2±0.9)	1283(89.9±0.8)	2814(88.2±0.5)
	Lt hand	71(5.3±0.6)	76(4.7±0.5)	170(5.4±0.4)
	Both hand	78(6.5±0.7)	78(5.4±0.6)	205(6.4±0.4)
≥75	Rt hand	713(87.0±1.3)	1017(88.8±0.9)	2107(88.4±0.6)
	Lt hand	37(5.5±0.8)	55(5.0±0.5)	124(5.4±0.4)
	Both hand	56(7.5±1.0)	66(6.2±0.8)	134(6.2±0.5)

Table 3: Musculoskeletal health problems that limit daily life and social activities

Variables		65-75 years old			≥75 years old		
		Men (%±SE)	Women (%±SE)	Total (%±SE)	Men (%±SE)	Women (%±SE)	Total(%±SE)
Limit	none	1038 (87.6±1.0)	1207 (81.9±1.0)	2245 (84.6±0.)	602 (79.4±1.3)	814 (75.4±1.3)	1416 (76.9±0.9)
	have	161 (12.4±1.0)	293 (18.1±1.0)	454 (15.4±0.8)	161 (20.6±1.3)	272 (24.6±1.3)	436 (23.1±0.9)
Fractures, joint injuries		5 (2.3±0.8)	14 (4.7±1.1)	19 (3.8±0.7)	7(3.6±1.1)	6 (2.4±1.1)	13 (2.8±0.8)
Arthritis, rheumatism		22 (11.6±2.3)	91 (32.3±2.4)	113 (24.5±1.7)	20 (9.1±1.8)	101 (38.1±2.4)	121 (28.7±1.6)
Back and neck problem		41 (24.6±3.7)	130 (43.3±2.3)	171 (36.3±2.0)	36 (25.3±2.5)	112 (38.6±2.9)	174 (36.5±2.4)
Knee and leg pain		11 (7.4±2.2)	37 (13.7±2.2)	48 (11.3±1.6)	9 (4.8±1.8)	21 (7.7±1.2)	67 (14.7±1.8)

Table 4: Correlation between health problems and disabilities that limit daily life and social activities of Korean early-stage elderly and grip strength

				95% % Confidence interval			
	R^2	Estimate	SE	Lower	Upper	t	p
Activity limits	.010	-2.462	.456	-3.361	-1.562	-5.397	.000
Arthritis, rheumatism	.022	2.849	.945	.982	4.716	3.016	.003
Back and neck problem	.010	1.711	.870	-.008	3.430	1.967	.051
Knee and leg pain	.000	-.535	1.229	-2.964	1.895	-.435	.664

Table 5: Correlation between health problems and disabilities that limit daily life and social activities of Korean late-stage elderly and grip strength

				95% % Confidence interval			
	R^2	Estimate	SE	Lower	Upper	t	p
Activity limits	.015	-2.226	.421	-3.055	-1.396	-5.290	.000
Arthritis, rheumatism	.036	-3.100	.583	1.948	4.252	5.319	.000
Back and neck problem	.000	.296	.579	-.847	1.440	.512	.609
Knee and leg pain	.011	2.171	1.071	.055	4.288	2.028	.044