



Original Article

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Grip Strength Change and All-Cause Mortality According to Grip Scale Intervals in South Korea

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Grip strength is a well-established indicator of overall health and physical function. Weaker grip strength is linked to increased mortality. However, limited research has explored how changes in grip strength over time affect mortality risk. This study analyzed data of adults, aged 45–80 years, from the Korean Longitudinal Study of Aging (KLoSA) since 2006. The participants were stratified by sex into three groups based on baseline grip strength and changes over 2 years. Cox regression analysis was performed to evaluate the association between grip strength and all-cause mortality until 2020. Among female, those in the lowest tertile (lowest baseline grip strength with a decline of ≥ 2.25 kg) had a 5.63-fold higher mortality risk than those in the middle tertile. In contrast, those in the highest tertile (highest baseline grip strength with an increase of ≥ 1 kg) had a 78% lower risk. Among male, the lowest tertile group (decline of ≥ 3.5 kg) had a 3.29-fold higher mortality risk, while the highest tertile group (increase of ≥ 0.5 kg) had a 62% lower risk compared to the middle group. Both low baseline grip strength and its further decline are strongly associated with increased mortality risks. Importantly, grip strength improvement may reduce this risk. These findings underscore the importance of monitoring grip strength over time and highlight its potential role in strategies aimed at promoting healthy aging and longevity.

Keywords: Hand strength, Muscle strength, Mortality

Introduction

The aging population is one of the most significant global social changes and has a profound impact on various sectors [1]. The increasing proportion of older adults poses major challenges to social security systems, healthcare services, economic activities, and the labor market. In particular, the healthcare sector is facing rising medical expenditures due to an elderly population. This is a critical concern for health insurance systems and medical resources [2,3].

Consequently, there is a growing need for research and a deeper understanding of the aging population. Among the various areas of interest, the relationship between health status and mortality among older adults has emerged as a particularly important topic. Given the complex interplay between factors influencing health and mortality in this population, continuous and systematic research is essential to better understand the dynamics.

Recent studies have increasingly focused on physical function assessment to accurately evaluate the health status of older adults and inform appropriate health management and preventive strategies [4]. Among various physical function measures, grip strength has garnered particular attention [5].

Grip strength is a measure of hand and wrist strength. It is a key indicator of overall physical health and functional ability. It not only reflects hand strength,

but can also serve as a proxy for the health status of other body systems. Grip strength is useful for evaluating muscle strength, endurance, and overall physical function in older adults. Moreover, a reduced grip strength is associated with a high risk of falls, which can lead to serious injuries or complications among the elderly [5-8].

Grip strength assessment is important when considering elderly healthcare. It may contribute to an improved quality of life and increased healthy life expectancies. Evaluating health status through grip strength can aid in the development of individualized health management plans and support older adults in leading healthier and more active lives.

Recent studies have reported a strong association between grip strength and mortality risk among older adults. Higher mortality is observed in those with a weaker grip strength [9,10]. Additionally, a decline in grip strength over time has been linked to increased mortality risk [11,12]. However, studies on Asian populations remain limited, and long-term follow-up studies exceeding 10 years are scarce.

This study investigated the association between grip strength and mortality using data from the Korean Longitudinal Study of Aging (KLoSA). The KLoSA is a nationally representative panel survey conducted biennially since 2006 that targets adults, aged 45 years and older, in South Korea. Using more than 16 years of follow-up data, this study aimed to explore the relationship between changes in grip strength and mortality over time.

Methods

This study analyzed data from the KLoSA conducted by the Korea Employment Information Service (KEIS) to examine the association between grip strength and mortality risk. The KLoSA was initiated in 2006 and has been conducted biennially since then. This long-term panel survey was designed to enhance the understanding of aging and social change among Koreans. We used the survey data collected between 2006 and 2020.

The KEIS conducts the KLoSA using a multistage stratified probability sampling design to establish a nationally representative sample of community-dwelling individuals, aged 45 years and older, residing in South Korea (excluding Jeju Island). Since 2006, basic surveys that focus on core items, have been conducted in even-numbered years, while since 2007, supplementary surveys cover additional thematic content, have been conducted in odd-numbered years. The analysis included data from the ninth wave of the basic survey, which

covered demographics, family structure, health, employment, income and consumption, assets, subjective expectations, and quality of life.

For the analysis, we extracted data related to mortality, body mass index, medical history, grip strength, physical activity, smoking, and alcohol consumption from the KLoSA dataset. Individuals aged 45–98 years, with no history of malignancy at baseline were included in the study.

Categorical variables were analyzed using the chi-square (χ^2) test and are presented as frequencies and percentages. Continuous variables were analyzed using independent t-tests and presented as means and standard deviations. Cox proportional hazards regression was used to compare the mortality rates. Statistical significance was set at $p < 0.05$. All statistical analyses were performed using SPSS (Statistical Package for the Social Sciences) version 27.0 (IBM Corp.).

Results

The study analyzed data from 9,421 participants (4,182 male, 5,239 female), aged 45–98 years (mean age = 66 years) in the 2006 baseline survey. Participants were categorized into three groups based on grip strength: 2,941 individuals had grip strength ≤ 20 kg, 3,726 had grip strength between 20 and 40 kg, and 2,754 had grip strength ≥ 40 kg. In the ≤ 20 kg group, the youngest participant was 45 years old and the oldest was 98 years old. The prevalence of hypertension, diabetes, heart disease, and cerebrovascular disease was highest in the lowest grip strength group (≤ 20 kg), while benign prostatic hyperplasia was most common in the intermediate group (20–40 kg). The proportion of individuals engaging in regular physical activity was highest in the ≥ 40 kg group. Interestingly, smoking and alcohol consumption rates were also highest in the ≥ 40 kg group (Table 1).

A total of 1,783 participants died during the follow-up in 2020. Compared with the grip strength ≥ 40 kg group, the grip strength ≤ 20 kg group had a 2.2-fold higher mortality rate, while those with grip strength between 20 and 40 kg had a 1.3-fold higher mortality rate (Table 2). Importantly, participants with greater decreases in grip strength (Delta Grip Strength) during the first two years had a 1.1-fold higher mortality rate than those with intermediate changes (Table 3).

Survival rates were lowest when handgrip strength decreased in the low-strength group, and highest when it increased in the high-strength group (Fig. 1).

Subgroup analyses were conducted separately for male and female, given the differences in muscle strength between the

Table 1. General characteristics in according to Initial Grip Strength

Variables		Grip strength range (kg)			p-value
		0.00–20.75 (n = 2,798)	20.75–29.50 (n = 2,850)	29.50–50.00 (n = 2,692)	
Age		64.12 ± 9.63	58.65 ± 9.61	56.50 ± 8.54	
Sex	Male	177 (6.3)	935 (32.8)	2,581 (95.9)	< 0.001 ^{a)}
	Female	2,621 (93.7)	1,915 (67.2)	111 (4.1)	< 0.001 ^{b)}
BMI		23.16 ± 3.06	23.19 ± 2.61	23.55 ± 2.41	< 0.001 ^{b)}
Hypertension		1,460 (52.2)	1,193 (41.9)	1,018 (37.9)	< 0.001 ^{b)}
Diabetes		696 (24.9)	533 (18.7)	507 (18.8)	0.001 ^{b)}
COPD		53 (1.9)	42 (1.5)	30 (1.1)	0.059 ^{b)}
Liver disease		83 (3.0)	94 (3.3)	91 (3.4)	0.652 ^{b)}
Cardiac disease		193 (6.9)	181 (6.4)	169 (6.3)	0.594 ^{b)}
Cerebro vascular disease		318 (11.4)	196 (6.9)	200 (7.4)	0.001 ^{b)}
Psychiatric disease		182 (6.5)	154 (5.4)	102 (3.8)	0.001 ^{b)}
Rheumatoid arthritis		408 (14.6)	256 (9.0)	137 (5.1)	< 0.001 ^{b)}
BPH		34 (18.7)	197 (21.1)	345 (13.4)	0.001 ^{b)}
Regular exercise		1,592 (56.9)	1,982 (69.5)	1,993 (74.0)	< 0.001 ^{b)}
Current smoker		1,120 (51.8)	1,613 (68.1)	2,017 (82.9)	< 0.001 ^{b)}
Alcohol drinker		663 (23.7)	1,172 (41.1)	2,071 (76.9)	< 0.001 ^{b)}

Values are presented as mean ± standard deviation or number (%).

BMI, body mass index; COPD, chronic obstructive pulmonary disease; BPH, benign prostatic hyperplasia.

^{a)}Analyzed by t-test.

^{b)}Analyzed by chi-square test.

Table 2. Risk of all-cause mortality in according to Initial Grip Strength (14 years follow-up)

Initial Grip Strength	All		Female		Male	
	Hazard ratio	p-value	Hazard ratio	p-value	Hazard ratio	p-value
1st Tercile	1.758 (1.535–2.015)	0.001	4.201 (3.332–5.296)	0.001	4.792 (3.842–5.978)	0.001
2nd Tercile	1.178 (1.018–1.363)	0.028	1.656 (1.273–2.155)	0.001	1.977 (1.547–2.527)	0.001
3rd Tercile ^{a)}	1.000		1.000		1.000	

Values are presented as hazard ratio (95% confidence interval). 1.000: reference. The 1st Tercile were 0.00–0.75 overall, 0.00–18.50 for female, and 0.00–30.00 for male. 2nd Tercile were 20.75–29.50 overall, 18.50–22.00 for female, and 30.00–36.00 for male. 3rd Tercile were reference for each group and 29.50–50.00 overall, 22.00–50.00 for female, and 36.00–50.00 for male.

^{a)}Reference.

Table 3. Risk of all-cause mortality in According to Δ Grip Strength (14 years follow-up)

Δ Grip Strength	All		Female		Male	
	Hazard ratio	p-value	Hazard ratio	p-value	Hazard ratio	p-value
1st Tercile	1.063 (0.900–1.256)	0.470	1.210 (0.933–1.569)	0.151	1.046 (0.838–1.305)	0.692
2nd Tercile ^{a)}	1.000		1.000		1.000	
3rd Tercile	1.136 (0.962–1.342)	0.132	1.404 (1.090–1.808)	0.009	0.973 (0.803–1.217)	0.809

Values are presented as hazard ratio (95% confidence interval). 1.000: reference. The 1st Tercile were more than 2.62 kg loss for all, more than 2.25 kg loss for female, and more than 3.50 kg loss for male.

2nd Tercile were reference for each group and –2.62 kg to +1.00 kg for all, –2.25 kg to +1.00 kg for female, and –3.50 kg to +0.50 kg for male. 3rd Tercile were more than 1.00 kg gain for all, more than 1.00 kg gain for female, and more than 0.50 kg gain for male.

^{a)}References, were set as the median of each group; Δ Grip Strength, difference between the Initial Grip Strength and 2nd Survey Grip Strength.

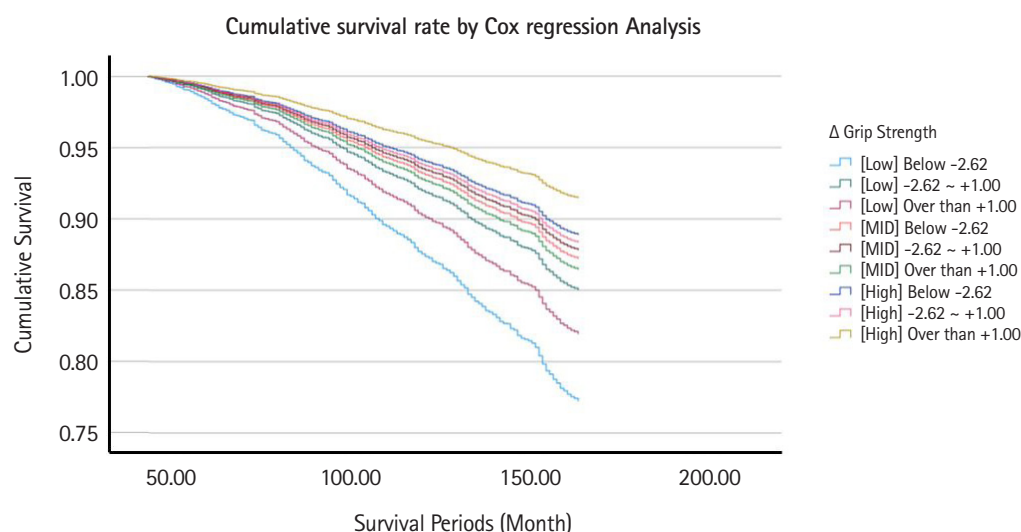


Fig. 1. Cumulative survival rate by Cox regression analysis (including data from both male and female).

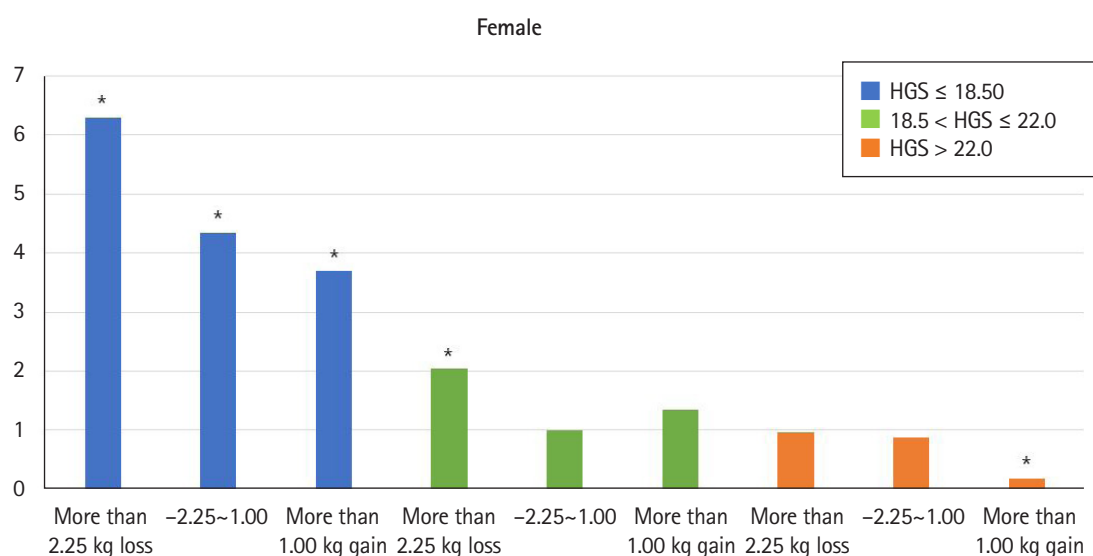


Fig. 2. Hazard ratio according to grip strength change for first 2 years by Initial Grip Strength in female (14 years follow-up mortality). The range of -2.25 to 1.00 kg was used as the reference group of hazard ratio. * means data with a p -value less than 0.05. HGS, hand grip strength.

sexes. Among female, compared to those with grip strength between 18.50–22.00 kg and a Delta Grip Strength between -2.25 kg and +1.00 kg, the group with grip strength < 18.50 kg and a decline of ≥ 2.25 kg had a 6.3-fold higher mortality rate. The group with grip strength between 18.50–22.00 kg and a decline of ≥ 2.25 kg had a 2.0-fold higher mortality rate. In contrast, among those with grip strength > 22.00 kg, even when Delta Grip Strength declined ≥ 2.25 kg, the mortality rate was only 0.96-fold (Fig. 2).

Among male, compared to those with grip strength between 30.00–30.75 kg and a Delta Grip Strength between -3.50 kg

and +0.50 kg, the group with grip strength < 30.00 kg and a decline of ≥ 3.50 kg had a 3.2-fold higher mortality rate. The group with grip strength between 30.00–30.75 kg and a decline of ≥ 3.50 kg had a 1.7-fold higher mortality rate. However, in the group with grip strength > 30.75 kg, even with a decline of ≥ 3.50 kg, the mortality rate was only 0.59-fold (Fig. 3).

Discussion

Analysis of the KLoSA data revealed that participants with higher grip strength had significantly lower mortality rates.

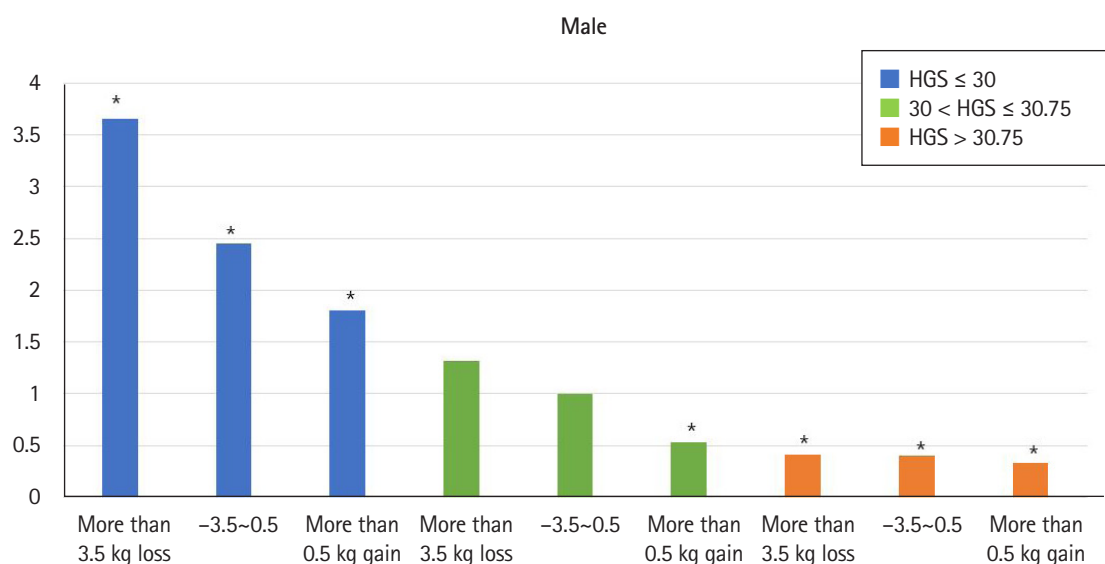


Fig. 3. Hazard ratio according to grip strength change for first 2 years by Initial Grip Strength in male (14 years follow-up mortality). The range of -3.5 to 0.5 kg was used as the reference group of hazard ratio. * means data with a p -value less than 0.05. HGS, hand grip strength.

This suggests that grip strength is an important predictor of mortality in the context of aging and overall health. The observed association between a decline in grip strength and increased mortality further underscores the role of muscle strength and physical function as key indicators of healthy aging and longevity.

Therefore, grip strength measurement can be a valuable tool for monitoring the health status of older adults and should be considered when developing timely health interventions. Strengthening muscle function in the elderly may contribute to extending healthy life expectancy and improving the quality of life through the promotion of physical activity.

Several mechanisms may explain the association between grip strength and mortality. First, a higher grip strength may reflect a generally better physical health status, which in turn may be associated with a lower risk of chronic diseases and, consequently, lower mortality. Second, higher grip strength is indicative of better maintenance of muscle mass and strength, which not only benefits other physiological systems, but also supports energy expenditure and metabolism. These factors may help with weight management and prevention of chronic illnesses.

Third, grip strength is closely associated with cardiovascular health. Greater muscle strength may contribute to better blood pressure control and more efficient blood circulation, thereby reducing the heart burden. Therefore, higher grip strength may enhance resistance to chronic diseases and lower the

mortality risk.

This study also showed that lifestyle factors, such as exercise, smoking, and alcohol consumption, may influence grip strength. Individuals with higher grip strength are more likely to engage in regular physical activity and maintain healthier lifestyles, which could enhance disease resistance and reduce mortality risk.

This aligns with findings from other Korean studies and is supported by our results. In both male and female, participants in the lowest tertile of grip strength who experienced the greatest decline had the highest hazard ratios, emphasizing the need to avoid further declines in grip strength among those with already low levels.

This study has several limitations. First, although we utilized variables available in the KLoSA dataset, factors such as socioeconomic status, nutritional status, and specific chronic conditions may not have been fully accounted for. Future research should incorporate these variables to explore the relationships more comprehensively.

Despite these limitations, our study contributes to understanding grip strength as a significant predictor of mortality in aging populations. These findings highlight the importance of developing strategies aimed at maintaining or improving grip strength, thereby, reducing mortality risk and promoting healthy aging.

In conclusion, participants with a lower baseline grip strength, who experienced a greater decline in grip strength,

had substantially higher mortality rates than those with a higher baseline strength. These findings underscore the potential importance of preserving or enhancing grip strength in older adults as a strategy to reduce mortality risk. Further longitudinal studies are needed to validate these results and investigate the underlying mechanisms of this association.

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Ethics approval

This study was approved by the Institutional Review Board of the Keimyung University (IRB No: 2021-08-115).

Conflict of interest

The authors have nothing to disclose.

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