Mental Health and Handgrip Strength Among Older Adults: A Nationwide Study

Yeunhee Kwak, PhD1 and Yoonjung Kim, PhD1

Abstract
Handgrip strength is used as an important indicator of health in older adults. We aimed to explore the association between stress, depression, and suicidal ideation and handgrip strength among older adults. We conducted this cross-sectional study involving 1254 individuals (aged ≥65 years), using data from the 2015 Korean National Health and Nutrition Examination Survey VI. We used logistic regression analysis to examine associations between handgrip strength and mental health. Among mental health factors, a significant difference was noted between stress and handgrip strength among the older adults. After adjusting for confounding factors, the odd ratio (OR) of stress among older adults with low handgrip strength was statistically significant in Models 1 (1.61 (95% CI: 1.01–2.57)) and 2 (1.59 (95% CI: 1.01–2.52)) but not in Model 3 (1.52 (95% CI: 0.96–2.43)). No significant association was found between depression or suicidal ideation and handgrip strength. The risk of stress was 1.59–1.61 times higher in older adults with low handgrip strength, compared to that in older adults with normal handgrip strength. It is necessary to develop strategies aimed at managing stress among older adults with low handgrip strength and educating them about the importance of handgrip strength and exercises that increase handgrip strength.

Keywords
depression, older adults, handgrip strength, stress, suicidal ideation

Introduction
Aging and an increased prevalence of chronic diseases associated with increasing age are associated with disabilities that may decrease physical function among older adults, which in turn increase the likelihood of unhealthy choices. These choices lead to further physical and mental deterioration, which are

1Red Cross College of Nursing, Chung-Ang University, Seoul, Republic of Korea

Corresponding Author:
Yoonjung Kim, Red Cross College of Nursing, Chung-Ang University, 84 Heukseok-Ro, Dongjack-Gu, Seoul 156-756, Republic of Korea.
Email: yoonjung@cau.ac.kr
associated with social isolation. Deterioration in quality of life, difficulty in living independently, and financial stress are associated with suicide among older adults.

Gradual increase in the burden of living owing to the deterioration of physical function and presence of disease is also associated with suicide. Stress and declining physical health have mutual detrimental effects, whereas stress in old age is related to mental health problems such as depression or despair. Stress threatens quality of life and induces physical or mental health problems by increasing negative emotions, including anger, anxiety, and depression.

Aging is often accompanied by general decline in physical function, resulting in the reduction of muscle mass and physical strength. Decreased muscle strength interferes with physical activity (PA), which threatens independence and is associated with increased health care costs. Furthermore, reduced PA increases the rate of depression, which affects approximately 20–50% of older adults. These health-related challenges are in turn associated with social issues such as increased burden of care associated with an aging population and high suicide rates among older adults.

Handgrip strength is commonly used to assess changes in muscle strength in large-scale research studies involving older adults because it is easy and cost-effective to measure. Handgrip strength has also been used to assess weakness and disability and has been suggested as a predictor of mortality. Reduced handgrip strength is considered the most important element that negatively affects ADLs and the capacity to work. Handgrip strength was set at <26 kg for men and 18 kg for women, as used in a previous study involving older adults of Asian descent.

The number of subjects was 1188 when the minimum sample size was obtained by logistic regression analysis using the G power 3.1.9 program, under the conditions of odds ratio = 1.3, two-tailed test, significance level α = .05, and power of .95. The inclusion criterion for this study was adults aged over 65 years, and the exclusion criterion was individuals who did not respond to questions about handgrip strength or mental health. We identified 1548 participants aged ≥65 years from the overall 2015 KNHANES VI study population (n = 7380) and excluded 294 participants with missing data. The data of the remaining 1254 participants were used in the final analysis. Therefore, the sample size of this study satisfied the minimum sample size.

Materials and Methods

Study Design and Population

The Korea Centers for Disease Control and Prevention (KCDC) has been conducting the KNHANES, a nationally representative cross-sectional survey targeting non-institutionalized Koreans, since 1998. This study used the primary data of KNHANES VI. During KNHANES VI, health and nutrition data were collected via face-to-face interviews and a self-administered questionnaire, and a specialist from the KCDC team performed health examinations. A stratified, multistage, cluster probability design was used to obtain a representative sample of the South Korean population. The number of subjects was 1188 when the minimum sample
currently smoking and “no” if not. Alcohol consumption was classified as “yes” if the participants reported consuming ≥1 alcoholic drink per month and as “no” if they reported consuming <1 drink per month. PA was categorized as “yes” if a participant engaged in moderate-intensity PA for 2 h 30 min or more per week, high-intensity PA for 1 h 15 min or more per week, or in a mix of moderate and high-intensity PA; otherwise, PA was classified as “no.” Participants were deemed to have DM or hypertension on the basis of a current diagnosis at the time of the survey.

Statistical Analysis
All data are presented as means ± standard error (SE) for continuous variables or as percentage ± SE for categorical variables. SAS software (version 9.3; SAS Institute Inc., Cary, NC, USA) was used to run a complex sample design based on data analysis from the survey data, which provided sampling weights for KNHANES VI and nationally representative estimates.

Demographic characteristics of the participants and differences in handgrip strength according to demographic characteristics and mental health were analyzed using t-test and χ² test as appropriate. Finally, to identify the association between handgrip strength and the mental health of the participants, logistic regression analysis was performed using odds ratio and 95% confidence interval, after adjusting for demographic characteristics that were clinically important for mental health. Model 1 was adjusted for age and sex. Model 2 was adjusted for age, sex, education, marital status, living alone, BMI, economic status, place of residence, occupation, smoking, alcohol consumption, and PA. Model 3 was adjusted for hypertension and DM, in addition to Model 2 variables. The significance level was set at $P < .05$ for all tests.

Results

Handgrip Strength According to General Characteristics

Differences in handgrip strength among the participants according to their general characteristics are shown in Table 1. Among all participants, 213 (17.0%) had low handgrip strength (76.1% were women). Significant differences in handgrip strength categories (ie, low and normal) were found with respect to age, sex, education, marital status, living alone, economic status, occupation, smoking, alcohol consumption, and PA. Model 3 was adjusted for hypertension and DM (P < .05). Participants with low handgrip

Table 1. Handgrip Strength of Participants According to Demographic Characteristics.

| Characteristics          | Low (n = 213) | Normal (n = 1041) | P-value |
|--------------------------|--------------|-------------------|---------|
| Age (years)              | 76.1 ± 0.3   | 71.9 ± 0.2        | <.001*  |
| Sex (%)                  |              |                   |         |
| Female                   | 77.5 (1.3)   | 50.5 (1.4)        | <.001*  |
| Elementary school or lower | 86.4 (1.6) | 55.9 (2)          | <.001*  |
| Middle school graduation | 5.6 (1.3)    | 14.2 (1.1)        |         |
| High school graduation   | 4.5 (1.2)    | 20.4 (1.5)        |         |
| Bachelor’s degree or higher | 3.5 (1.4) | 9.5 (1)           |         |
| Married (%)              |              |                   |         |
| Yes                      | 54.8 (1)     | 30.2 (1.6)        | <.001*  |
| Living alone (%)         |              |                   |         |
| Yes                      | 72.9 (1.3)   | 83.7 (1.8)        | <.001*  |
| BMI (kg/m²)              | 24.1 ± 0.3   | 24.4 ± 0.1        | .226    |
| Economic status (%)      |              |                   |         |
| Q1 (Lower 25%)           | 42.1 (1.1)   | 23.0 (1.5)        | <.001*  |
| Q2 (Lower 26-50%)        | 21.9 (6)     | 24.7 (1.7)        |         |
| Q3 (Upper 26-50%)        | 18.3 (6)     | 25.2 (1.5)        |         |
| Q4 (Upper 25%)           | 17.7 (7)     | 27.0 (1.7)        |         |
| Place of residence (%)   |              |                   | .054    |
| Rural                    | 33.9 (1.4)   | 24.6 (3.2)        |         |
| Employed (%)             |              |                   |         |
| No                       | 77.8 (1.5)   | 65.6 (2.1)        | .002*   |
| Smoking (%)              |              |                   | .076    |
| Yes                      | 6.1 (13)     | 10.0 (9)          |         |
| Alcohol consumption (%)  |              |                   |         |
| More than once a month   | 23.7 (7)     | 39.2 (1.4)        | <.001*  |
| Physical activity (%)    |              |                   |         |
| Yes                      | 16.4 (5)     | 37.2 (1.9)        | <.001*  |
| Hypertension (%)         |              |                   | .342    |
| Yes                      | 60.2 (1.1)   | 55.8 (1.7)        |         |
| Diabetes mellitus (%)    |              |                   | <.001*  |
| Yes                      | 35.6 (9)     | 17.7 (1.3)        |         |

BMI, body mass index; HGS, handgrip strength; SE, standard error.
*Statistically significant difference between the two groups.

1Economic status: monthly average gross household income/√(number of household members); expressed in quartiles.

2Physical activity: engaging in moderate-intensity activity for 2 h and 30 min or more per week, high-intensity activity for 1 h and 15 min or more, or a mix of moderate and high intensity for the time corresponding to the applicable intensity.
strength were older than subjects with normal handgrip strength and were female. Further, more participants with low handgrip strength had a low education level, with a high percentage of married individuals and a low percentage of individuals who were living alone, compared to those with normal grip strength. In addition, participants with low handgrip strength had a lower economic status than those with normal handgrip strength, had a higher current unemployment rate, lower alcohol consumption rate, lower PA percentage, and higher DM percentage.

**Mental Health According to Handgrip Strength**

Differences in mental health according to handgrip strength among older adults are shown in Table 2. High stress levels were associated with low handgrip strength ($P = .013$). However, no differences were found between levels of depression or suicidal ideation and handgrip strength.

The association between handgrip strength and mental health is shown in Table 3. Comparisons were made among participants with normal handgrip strength. After adjusting for confounding factors, we found that among the mental health factors, stress increased the risk of low handgrip strength in Model 1 (odds ratio [OR] = 1.61; 95% confidence interval [CI]: 1.01–2.57; $P < .05$) and Model 2 (OR = 1.59; 95% CI: 1.01–2.52; $P < .05$), but there was no significant association between stress and low handgrip strength in Model 3 (OR = 1.52; 95% CI: 0.96–2.43; $P = .07$). There was no significant association between low handgrip strength and depression or suicidal ideation in any of the models.

**Discussion**

In this study, older age, female sex, low socioeconomic status, living with others, drinking status, low PA, and DM were related with lower handgrip strength.
With age, muscle mass and physical strength decrease because of deterioration in overall function, and this is associated with a decrease in physical performance among older adults.6,8,9,23 Consequently, the decrease in muscle mass negatively affects the health of older adults.7,8,24

Several studies have reported deterioration in handgrip strength owing to poor nutritional management among older adults living alone, who are more likely to skip meals and take nutritional risks.12,23,26 This is different from the results of this study. Further research is required to establish behavioral patterns that may lead to deterioration in handgrip under these circumstances.

Reduced PA levels owing to aging and loss of appetite due to decreasing quantity and quality of meals accelerate loss of skeletal muscle.23,24,26 Economic status, education level, and family composition are factors that are reported to negatively affect eating habits and health in old age.2,26 Therefore, it is necessary to promote the health of older adults through the development of nutritional intake and exercise-related programs.

In Models 1 and 2 in the present study, older adults with low handgrip strength showed higher stress levels than older adults with normal handgrip strength. In Model 3, mental health did not appear to be statistically significant. Model 3 was additionally adjusted for hypertension and DM. The handgrip strength of the older adults showed statistically significant differences according to DM, and after adjustments, the association with handgrip strength, even under stress, was found to be statistically non-significant. It was found that the handgrip strength of subjects diagnosed with DM was lower than that of those without DM,27 and it was argued that handgrip strength was an independent predictor of new-onset DM in the middle-aged and older European population.28 There is a strong correlation between handgrip strength and DM, and it is considered that the relationship with stress was not statistically significant because DM was included as an adjustment variable. Therefore, it is necessary to be more careful with subjects with DM when managing stress in a group of individuals with low handgrip strength.

The decrease in muscle strength in older adults interferes with PA, affecting independent living, with a very low frequency of outdoor activities and a high probability of living in isolation,9,23 which negatively affects mental health.

On the basis of the present results, we could not determine whether physical function deteriorated because of high stress levels or whether high stress levels developed owing to poor physical function. However, physical illness among older adults negatively affects stress levels, nutritional status, and competency in ADLs, and it is also significantly associated with depression.30 The deterioration of physical function owing to decreased handgrip strength appears to be related to mental health.

In some studies, reduced handgrip strength affected cognitive decline and depression.15,31 In participants aged 85 years, low handgrip strength was correlated with poorer scores in functional, psychological, and social health domains.15 Stress, which tends to be elevated in older adults with illnesses and limitations in ADLs, is an important indicator of progression to depression.3,30 Because of the close association between physical and mental health, careful evaluation and active application of nursing interventions are needed to protect the mental health of older adults who have difficulties with PA.

Depression or suicidal ideation did not show any statistically significant results in this study. This may be linked to our measurement of mental health in this study; using one sentence to measure mental status may have been too superficial. However, we recommend that further research be conducted to investigate how mental health varies according to handgrip strength and to determine the effect of handgrip strength on depression and suicidal ideation when stress acts as a mediator.

While a strength of this study was its use of a large, nationally representative sample, this study had some limitations. First, the defining cut-off point for low handgrip strength among the older adults was not clear, and further research is needed to establish this. Second, we could not determine causality owing to the cross-sectional study design; therefore, a longitudinal study is suggested to further elucidate the relationship between handgrip strength and mental health. Lastly, although this study used a tool with good reliability and validity that verified mental health status, it is necessary to measure mental health from multiple perspectives. Nevertheless, despite these limitations, this is the first study to clearly identify an association between handgrip strength and mental health among older South Korean adults.

Conclusion
This study confirmed an association between stress levels in older Korean adults and handgrip strength. Although it was not statistically significant in the final model, we confirmed that the risk of stress increased in older adults with low handgrip strength. Handgrip strength is an important predictor of strength in older adults. Therefore, it is necessary to develop a strategy to educate older adults with weak handgrip strength on the importance of stress management and exercises for improving handgrip strength.

Acknowledgments
We thank the KCDC, which conducted the KNHANES, and all participants in the present study for their generous cooperation.

Author Contributions
The first author designed the study, analyzed and interpreted the data, and wrote the article. The corresponding author provided assistance in the interpretation of the data and preparation of the manuscript. All authors read and approved the final version of the article.
References

1. Russell D, Taylor J. Living alone and depressive symptoms: The influence of gender, physical disability, and social support among Hispanic and non-Hispanic older adults. J Gerontol B Psych Sci Social Sci. 2009;64:95-104.

2. Suh KH, Kim TM, Son S, et al. The roles of self-disclosure and downward social comparison in stresses and mental health/suicidal ideation in the elderly. Korea J Health Psych. 2013;18:379-402.

3. Cheung G, Merry S, Sundram F. Late-life suicide: Insight on motives and contributors derived from suicide notes. J Affect Disord. 2015;185:17-23.

4. Fujino Y, Mizoue T, Tokui N, Yoshimura T. Prospective cohort study of stress, life satisfaction, self-rated health, insomnia, and suicide death in Japan. Suicide Life-Threatening Behav. 2005;35:227-237.

5. Son J, Suh SR, Kim M. Factors related to depression of rural elders. J Korea Gerontol Nurs. 2015;17:56-64.

6. Visser M, Schaap LA. Consequences of sarcopenia. Clin Geriatr Med. 2011;27:378-399.

7. Ferreira RS, Coqueiro RD, Barbosa AR, Pinheiro PA, Fernandes MH. Relationship between BMI and physical performance among older adults. Geriatr Nurs. 2013;34:465-468.

8. No JK. Evaluation of dietary intake and exercise in the elderly according to hand grip strength. Korea J Obesity. 2013;22:243-250.

9. Prado CMM, Wells JCK, Smith SR, Stephan BC, Siervo M. Sarcopenic obesity: A critical appraisal of the current evidence. Clin Nutr. 2012;31:583-601.

10. Park EA, Lee IS. Factors affecting the depression of the elderly women in poverty. J Agric Med Communit Health. 2009;34:256-266.

11. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, et al. European working group on Sarcopenia in older people. Sarcopenia: European consensus on definition and diagnosis: Report of the European working group on Sarcopenia in older people. Age Ageing. 2010;39:412-423.

12. Kaur M. Age-related changes in hand grip strength among rural and urban Haryanvi Jat females. Homo J Compar Hum Biol. 2009;60:441-450.

13. Jakobsen LH, Rask IK, Kondrup J. Validation of handgrip strength and endurance as a measure of physical function and quality of life in healthy subjects and patients. Nutrition. 2010;26:542-550.

14. Harris JE, Eng JJ. Paretic upper-limb strength best explains arm activity in people with stroke. Phys Ther. 2007;87:88-97.

15. Taekema DG, Gussekloo J, Maier AB, Westendorp RG, de Craen AJ. Handgrip strength as a predictor of functional, psychological and social health. A prospective population-based study among the oldest old. Age Ageing. 2010;39:331-337.

16. Korea Centers for Disease Control and Prevention. Korea Health Statistics. Korea National Health and Nutrition Examination Survey (KNHANES VI-3). knhanes.cdc.go.kr/knhanes/index.do. 2015. (Accessed 10 August 2018).

17. Chen LK, Liu LK, Woo J, et al. Sarcopenia in Asia: Consensus report of the Asian working group for Sarcopenia. J Am Med Dir Assoc. 2014;15:95-101.

18. Lee ES, Shin HC, Yang YJ, Cho JJ, Ahn KY, Kim SH. Development of the Stress Questionnaire for KNHANES. Report of Scientific Study Service. South Korea: Korea Centers for Disease Control and Prevention; 2010.

19. Gigantesco A, Morosini P. Development, reliability and factor analysis of a self-administered questionnaire which originates from the World Health Organization’s Composite International Diagnostic Interview–Short Form (CIDI-SF) for assessing mental disorders. Clin Pract Epidemiol Ment Health. 2008;4:1-10.

20. Gaynes BN. Screening for suicide risk in adults: A summary of the evidence for the US preventive services task force. Ann Intern Med. 2004;140:822-835.

21. Oh JY, Yang YI, Kim BS, et al. Validity and reliability of Korean version of international physical activity questionnaire (IPAQ) short form. J Korea Acad Fam Med. 2007;28:532-541.

22. Sim JM, Jeon HG, Lee KC. Comparative analysis of the effect of physical activity and stress experience on the vitamin D deficiency according to occupations: Results from KNHANES dataset for 2008-2013. J Korea Contents Assoc. 2015;15:505-518.

23. Frontera WR, Reid KF, Phillips EM, et al. Muscle fiber size and function in elderly humans: A longitudinal study. J Appl Physiol. 1985;105:637-642.

24. Lee S, Lee KW, Oh JE, et al. Nutritional and health consequences are associated with food insecurity among Korean elderly: Based on the fifth (2010) Korea National Health and Nutrition Examination Survey (KNHANES V-1). J Nutr Health. 2015;48:519-529.
25. de Morais C, Oliveira B, Afonso C, Lumbers M, Raats M, de Almeida MD. Nutritional risk of European elderly. *Eur J Clin Nutr*. 2013;67:1215-1219.

26. Choi MK, Kang MH, Kim MH. Diet and health status of elderly women according to the family type. *Korea J Communit Nutr*. 2016;21:256-264.

27. Mainous AG III, Tanner RJ, Anton SD, Jo A. Grip strength as a marker of hypertension and diabetes in healthy weight adults. *Am J Prev Med*. 2015;49:850-858.

28. Li G, Qiao Y, Lu Y, et al. Role of handgrip strength in predicting new-onset diabetes: Findings from the survey of health, ageing and retirement in Europe. *BMC Geriatr*. 2012;21:1-9.

29. Choi K, Park E, Lee IS. Homebound status and related factors according to age in female elders in the community. *J Korea Acad Nurs*. 2012;42:291-301.

30. Sonnenberg CM, Deeg DJH, van Tilburg TG, Vink D, Stek ML, Beekman ATF. Gender differences in the relation between depression and social support in later life. *Int Psychogeriatr* 2013;25:61-70.

31. Jung JY, Kim JS, Choi HJ, Lee K-H, Park T-J. Factors associated with ADL and IADL from the third Korea national health and nutrition examination survey (KNHANES III), 2005. *Korea J Fam Med*. 2009;30:598-609.