

## Original Article

# Relative handgrip strength in relation to depressive mood and suicidal ideation in Koreans using the 2015 KNHANES data

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**Abstract**

**Objectives:** This study aimed to examine the association of relative handgrip strength (RHGS) with depressive mood and suicidal ideation. **Methods:** A cross-sectional study was conducted among 2167 men and 2643 women (aged 50.9 years  $\pm$  16.7 years) who participated in the 2015 Korean National Health and Nutrition Examination Survey. RHGS was defined by the handgrip strength/body mass index (BMI) ratio. Depressive mood and suicidal ideation were assessed using self-reported questionnaires. Logistic regression analysis was conducted after adjusting for sex, concurrent illness, age, education, income, smoking status, alcohol use, physical activity, and depressive mood (in the analysis for suicidal ideation). **Results:** Among participants, 4.0% men and 5.7% women reported serious suicidal ideation while 9.5% men and 16.0% women reported serious depressive mood. After adjusting for confounding factors, RHGS was associated with depressive mood (odds ratio [95% confidence interval] per RHGS [kg/BMI], 0.82 [0.69–0.99]) and suicidal ideation (0.73 [0.54–0.99]). In sex-specific relationship, RHGS was associated with depressive mood and suicidal ideation in women (0.71 [0.55–0.93] and 0.54 [0.34–0.85], respectively) but not in men. **Conclusions:** Poorer RHGS indicates higher risk of depressive mood as well as suicidal ideation regardless of depressive mood among women.

**Keywords:** Depressive Mood, Suicidal Ideation, Handgrip Strength, Sex, Cross-sectional Study

**Introduction**

Suicide is an important cause of death among the Organization for Economic Cooperation and Development (OECD) countries, accounting for over 150000 deaths in 2013. Suicide is a leading cause of death in South Korea, and it received the highest ranking among OECD countries with nearly 30 deaths per 100000 people<sup>1</sup>. Multifactorial mechanisms underlying social, biological, psychological, and demographic factors could influence suicidal behaviors. Suicidal ideation may be part of a constellation

of suicidal behaviors that culminates in suicide<sup>2</sup>. According to population-based studies, depressive mood; family history of psychiatric illness; excessive anger<sup>3</sup>; being younger, widowed, or divorced; concern for others<sup>2</sup>; being a woman; and having a psychiatric diagnosis<sup>4</sup> were associated with suicidal ideation.

Handgrip strength is accepted as an easily accessible and objective indicator to estimate future health, including functional capacity and mortality<sup>5,6</sup>. In addition, handgrip strength was found to be inversely associated with depressive mood<sup>7-12</sup>. Cross-sectional studies showed that women with depressive disorders had lower handgrip strength than those without depression<sup>10</sup> and significant correlation between handgrip strength and depression subscale of Profile of Mood States in breast cancer survivors<sup>12</sup>. In longitudinal studies, depressed mood or depression was reported to be associated with a steep decline in handgrip strength in older men with low body weight<sup>7</sup> and poor handgrip strength in women<sup>8</sup>. Conversely, lower handgrip strength was found to predict the persistence of depressive disorder<sup>9</sup> and development of depressive symptoms over time<sup>11</sup>.

In contrast, studies on the relationship between handgrip

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strength and suicidal behavior are scarce. In elderly Koreans, sarcopenia was known to be associated with suicidal ideation in men but not in women<sup>13</sup>. Given the evidence for poor handgrip strength as an indicator of sarcopenia<sup>14</sup> and depressive mood<sup>7-10</sup>, poor handgrip strength would be related to suicidal ideation.

Considering the evidence for relative handgrip strength as a tool to measure weakness and low lean mass<sup>15</sup>, this study aimed to assess the relationship of relative handgrip strength with depressive mood and suicidal ideation in a representative population of Korean adults.

## Materials and methods

### Study population

The 2015 Korean National Health and Nutrition Examination Survey (KNHANES) was a cross-sectional, nationally representative survey of individuals from the non-institutionalized civilian population of South Korea using a rolling sampling design that involves a complex, stratified multistage probability cluster survey<sup>16</sup>. In this survey, health interview and health examination were performed by trained medical staff and interviewers at the mobile examination centers<sup>17</sup>. The inclusion criteria for this study were participants' data with handgrip strength, body mass index (BMI), suicidal ideation, depressive symptoms, concurrent illness (cardiovascular disease, osteoarthritis, rheumatoid arthritis, osteoporosis, depression, stomach cancer, colon cancer, and lung cancer), personal behaviours (physical activity, alcohol drinking, and smoking status), and sociodemographic factors (age, educational level, and household income level). The exclusion criteria were incomplete data for handgrip strength, BMI, suicidal ideation, and depressive symptoms. Therefore, among the 5945 adults aged 19 to 80 years, the current study included 4810 participants (2167 men, 2643 women, 50.9±16.7 years old) whose complete datasets for handgrip strength, body mass index, suicidal ideation, and depressive symptoms were available. Compared with the excluded subjects, those included were less likely to have suicidal ideation (10.7% vs. 4.9%,  $p<0.001$ ) and depressive symptoms (22.4% vs. 13.0%,  $p<0.001$ ). This study follows the principles of the Declaration of Helsinki. The study was classified into an exemption category for ethical review by the law of Bioethics and Safety.

### Handgrip strength and anthropometric measurements

Handgrip strength was examined three times in each hand using a digital grip strength dynamometer (TKK 5401; Takei Scientific Instruments Co., Ltd., Tokyo, Japan). All subjects were instructed to hold the dynamometer with an upright standing position to keep their arms at their sides. The subjects squeezed the dynamometer with maximum effort, which was maintained for about 3 seconds. The mean of three trials of grip strength in each hand was used<sup>18</sup>. Weight and height while wearing light-clothing without shoes, were measured and their body mass index (BMI) was calculated

by dividing weight (kg) by squared height (m). Relative handgrip strength, defined as the summation of both hands' grip strengths divided by BMI, was used to reflect muscle strength. Relative handgrip strength was a recommended tool to measure weakness and low lean mass<sup>15</sup> and improved the accuracy of the cardiovascular risk estimation model in predicting cardiovascular and all-cause mortality<sup>19</sup>.

### Suicidal ideation, depressive mood, and other factors

Self-reported questionnaires were used to determine suicidal ideation, depressive mood, any concurrent illness, personal behaviours, and sociodemographic factors. Suicidal ideation was assessed using one question, 'During the past year, did you ever seriously think about suicide?' Depressive mood was assessed using one question: 'During the past year, did you ever feel so sad or hopeless for 2 weeks or more in a row that you stopped performing usual activities?' The validity of the single-item questions regarding depressive mood was evaluated using previous studies<sup>20,21</sup>. Responses to those questions were 'no' and 'yes'. Presence of concurrent illness was identified when there was any diagnosis for cardiovascular disease, osteoarthritis, rheumatoid arthritis, osteoporosis, depression, stomach cancer, colon cancer, and lung cancer.

Age group (<60 years vs. ≥60 years), education level (<graduated high school vs. ≥graduated high school), household income level (<2<sup>nd</sup> quartile vs. ≥2<sup>nd</sup> quartile), aerobic physical activity (yes vs. no to engaging in high-intensity activity for >75 min/week or moderate-intensity activity for >150 min/week or a combination of both-intensity activity [1 min of high-intensity activity equals 2 min of moderate-intensity activity]), frequency of drinking alcohol ≥one/month in the past year (yes vs. no), and current smoking status (smoker vs. non-smoker) were determined.

### Statistical analysis

The relationships of sex-specific quartiles of relative handgrip strength with suicidal ideation, depressive mood, concurrent illness, personal behaviour, and sociodemographic factors were analyzed using chi-square test for trends. A logistic regression analysis was conducted for the relationships of depressive mood and suicidal ideation with relative handgrip strength, concurrent illness, personal behaviour, and sociodemographic factors. With respect to the analysis of the relationship with suicidal ideation, depressive mood was additionally included as an independent factor. To find sex differences in those relationships, a sex-specific logistic regression analysis was conducted. Data were analyzed using IBM Statistical Package for the Social Sciences (SPSS) software version 24 (IBM Corp., Armonk, NY, USA).

## Results

In this representative Korean population, 4.0% men and 5.7% women reported they had serious suicidal ideation

**Table 1.** Characteristics according to sex-specific quartiles of relative handgrip strength (RHGS)<sup>a</sup> (N=4810).

	Lowest 4tile (N=1201)	2 <sup>nd</sup> 4tile (N=1203)	3 <sup>rd</sup> 4tile (N=1203)	Highest 4tile (N=1203)	p for trend
Range of RHGS in men (kg/BMI)	0.52-2.69	2.69-3.13	3.13-3.60	3.60-5.49	<0.001
Range of RHGS in women (kg/BMI)	0.53-1.63	1.63-1.98	1.98-2.31	2.31-3.46	<0.001
Suicidal ideation	82 (6.8)	74 (6.2)	38 (3.2)	43 (3.6)	<0.001
Depressive mood	199 (16.6)	151 (12.6)	151 (12.6)	126 (10.5)	<0.001
Age ≥60 y	756 (62.9)	445 (37.0)	278 (23.1)	137 (11.4)	<0.001
Education (≥ high school)	486 (43.7)	746 (65.7)	866 (77.0)	967 (86.0)	<0.001
Income (≥ middle-high)	605 (50.6)	597 (50.0)	615 (51.3)	650 (54.3)	0.055
Illness <sup>b</sup>	575 (47.9)	346 (28.8)	235 (19.5)	152 (12.6)	<0.001
Current smoker	150 (12.5)	202 (16.8)	231 (19.2)	265 (22.0)	<0.001
Alcohol user	531 (44.2)	653 (54.3)	710 (59.0)	747 (62.1)	<0.001
Aerobic physical activity	423 (38.3)	521 (46.0)	573 (51.0)	618 (54.9)	<0.001

Values represent N (%).

<sup>a</sup>RHGS was computed as summation of both hands-grip strengths divided by body mass index (BMI).

<sup>b</sup>Illness was defined when there was any diagnosis for cardiovascular disease, osteoarthritis, rheumatoid arthritis, osteoporosis, depression, stomach cancer, colon cancer, and lung cancer.

**Table 2.** Relationships of suicidal ideation and depressive mood with RHGS<sup>a</sup>, sex, concurrent illness, personal behaviour, and sociodemographic factors (N=4810).

	Depressive mood		Suicidal ideation		
	Crude	Model I	Crude	Model I	Model II
RHGS (per kg/BMI)	0.65 (0.58-0.73)	0.82 (0.69-0.99)	0.62 (0.52-0.74)	0.69 (0.52-0.91)	0.73 (0.54-0.99)
Depressive mood (yes vs. no)	-	-	19.51 (14.59-26.10)	-	16.75 (12.28-22.86)
Women vs. men	1.82 (1.52-2.17)	1.57 (1.17-2.10)	1.47 (1.12-1.92)	1.07 (0.68-1.66)	0.79 (0.49-1.27)
Age ≥ 60 y vs. <60 y	1.36 (1.14-1.61)	0.92 (0.72-1.18)	1.45 (1.11-1.88)	0.76 (0.53-1.11)	0.80 (0.54-1.19)
Education (≥ high school vs. < high school)	0.52 (0.43-0.62)	0.70 (0.55-0.88)	0.44 (0.33-0.57)	0.61 (0.43-0.87)	0.75 (0.51-1.09)
Income (≥ middle-high vs. <middle-high)	0.58 (0.49-0.69)	0.65 (0.54-0.79)	0.56 (0.43-0.73)	0.63 (0.47-0.83)	0.76 (0.56-1.04)
Illness (yes vs. no) <sup>b</sup>	1.90 (0.59-2.26)	1.59 (1.28-1.98)	2.19 (1.68-2.85)	1.79 (1.28-2.49)	1.44 (1.01-2.04)
Current smoker (yes vs. no)	1.03 (0.83-1.29)	1.63 (1.25-2.13)	1.52 (1.12-2.07)	2.24 (1.53-3.29)	1.83 (1.22-2.75)
Alcohol user (yes vs.no)	0.79 (0.67-0.94)	1.07 (0.88-1.30)	0.84 (0.64-1.08)	1.16 (0.85-1.57)	1.10 (0.80-1.52)
Aerobic physical activity (yes vs. no)	0.90 (0.76-1.08)	1.09 (0.91-1.31)	0.70 (0.53-0.92)	0.86 (0.65-1.15)	0.81 (0.59-1.10)

Values represent odds ratio (95% confidence interval) using logistic regression analysis; Model I included all independent variables except for depressive mood, while model II included all independent variables including depressive mood.

<sup>a</sup> RHGS (Relative handgrip strength) was computed as summation of both hands-grip strengths divided by body mass index.

<sup>b</sup> Illness was defined when there was any diagnosis for cardiovascular disease, osteoarthritis, rheumatoid arthritis, osteoporosis, depression, stomach cancer, colon cancer, and lung cancer.

over the past year while 9.5% men and 16.0% women reported serious depressive mood over the past year. Sex-specific quartiles of relative handgrip strength tended to be inversely associated with suicidal ideation, depressive mood, age, and concurrent illness while they tended to be positively associated with education level, current smoking, drinking alcohol, and physical activity (Table 1). In multivariate models, depressive mood was inversely associated with

relative handgrip strength and education and income levels while being positively associated with concurrent illness and current smoking. Suicidal ideation also had an inverse association with relative handgrip strength and positive associations with concurrent illness and current smoking even after adjusting for depressive mood (Table 2). When those relationships were stratified by sex, depressive mood and suicidal ideation were inversely associated with relative

**Table 3.** Sex-specific relationships of RHGS<sup>a</sup> with depressive mood and suicidal ideation.

	Depressive mood		Suicidal ideation		
	Crude	Model I	Crude	Model I	Model II
<b>Men (N=2167)</b> RHGS (per kg/BMI)	0.79 (0.64-0.99)	0.96 (0.74-1.24)	0.69 (0.50-0.95)	0.89 (0.61-1.29)	0.95 (0.63-1.44)
<b>Women (N=2643)</b> RHGS (per kg/BMI)	0.64 (0.52-0.79)	0.71 (0.55-0.93)	0.43 (0.61-0.61)	0.49 (0.32-0.76)	0.54 (0.34-0.85)

*Values represent odds ratio (95% confidence interval) using logistic regression analysis after adjusting for age, education, income, illness, smoking status, alcohol drinking, and physical activity (Model I); covariates in Model 1 and depressive mood (Model II).*

<sup>a</sup> RHGS (Relative handgrip strength) was computed as summation of both hands-grip strengths divided by body mass index.

handgrip strength in women but not in men after adjusting for concurrent illness, sociodemographic factors, and personal behaviour. Furthermore, the relationship with suicidal ideation was independent of depressive mood (Table 3).

## Discussion

The beneficial effects of stronger handgrip strength on cognition, mobility, functional status, and mortality in elderly populations<sup>5</sup> as well as mortality in younger populations<sup>6</sup> have been well established. In contrast, handgrip strength in relation to depressive mood has been less demonstrated<sup>7-12</sup>, and its relationship with suicidal ideation has not been reported. In this cross-sectional population-based study, women with higher relative handgrip strength were less likely to have depressive mood and suicidal ideation while these relationships were not observed in men.

These findings may imply that poorer relative handgrip strength indicates higher risk of depressive mood as well as suicidal ideation regardless of depressive mood among women. Consequently, monitoring relative handgrip strength may be important to identify women with depressive mood and suicidal ideation. Considering that in terms of suicide, Korea has ranked the highest among OECD countries for several years, this finding would be novel in demonstrating relative handgrip strength as a potential tool for identifying depressive mood and suicidal ideation. To the best of our knowledge, this study is the first to examine relative handgrip strength in relation to suicidal ideation in a representative general population.

The current findings of sex differences are consistent with those of previous studies in which a negative association between handgrip strength and depressive disorder was found in women but not in men<sup>10</sup>. In a longitudinal study, current but not remitted depression was found to be associated with poor handgrip strength over 6 years in women but not in men<sup>8</sup>. This sex difference could be due to differences in the severity of depressive mood and sensitivity of relative handgrip strength for assessment of muscle strength and physical function<sup>10</sup> and their relationships with measured and unmeasured confounding factors. Alternatively, there may be a true sex difference, and thus, relative handgrip strength may

be more related to depressive mood in women than men. As explained in a previous study, hormonal differences in sexes may influence different physiological reactions to depressive mood<sup>10</sup>. As far as we know, there are no directly comparable studies for handgrip strength in terms of suicidal ideation. Although death wishes were associated with lower muscle mass in elderly people<sup>13</sup> and functional disability in elderly people<sup>22</sup> and middle-aged adults<sup>23</sup>, there are no available studies on the link between handgrip strength and suicidal ideation. Further prospective studies will be necessary to examine the mechanisms underlying the relationship of handgrip strength with suicidal ideation, independent of depressive mood.

Potential mechanisms for explaining poor handgrip strength in relation to higher odds for depressive mood and suicidal ideation may be complicated. Considering that relative handgrip strength is a valid predictor of functional change and mortality<sup>5,6</sup>, higher mortality risk of clinical and subclinical depression<sup>24</sup>, and functional decrement as one of depression symptoms, depressive mood and suicidal ideation may be intermediate factors in the link of handgrip strength with functional change and mortality. Further, given the evidence for current and not remitted depressive disorder as a predictor of poor handgrip strength<sup>8</sup> and poor handgrip strength as a predictor of depressive disorder<sup>9,11</sup>, current relationships may be bidirectional. Although sociodemographic factors, health behaviors, and concurrent somatic and psychiatric diseases were controlled in examining the current relationships, unadjusted behavioral and environmental factors such as nutritional status and other somatic and psychiatric disorders may contribute to the current associations. On the other hand, an underlying biological pathway may be involved in the current relationships. Studies have demonstrated that inflammatory pathways for the development of depressive mood such as pro-inflammatory cytokines induced hyperactivity of the hypothalamic-pituitary-adrenal axis, that systemic inflammation induced accumulation of peripheral monocytes into the brain, and that cytokines induced change in neurotransmitter metabolism in the brain<sup>25</sup>. A difference in the neurobiology between depression and suicidal behavior has been suggested. Altered serotonergic mechanism including decreased serotonin metabolites, such as

5-hydroxyindoleacetic acid and increased serotonin receptor subtypes, abnormal receptor-linked signaling mechanisms including phosphoinositide and adenylyl cyclase signaling mechanisms, dysregulated hypothalamic-pituitary-adrenal axis, altered neurotrophins, neurotrophin receptors, and neuroimmune functions<sup>26</sup>, and dysregulation of the enzymes in the kynurenine pathway with a resulting imbalance of metabolites that modulate glutamate neurotransmission and neuroinflammation<sup>27</sup> have been indicated to explain neurobiology of suicidal behaviors. There is also evidence that increased levels of inflammatory markers such as interleukin-6 and C-reactive protein inversely predicted handgrip strength<sup>28</sup>.

There are several limitations in this study. First, the classification of individuals for depressive mood and suicidal ideation was based on a self-reported questionnaire, and thus, misclassification and heterogeneous severity could be possible, given the evidence of the possibility of misclassification and increasing likelihood of statistical decision errors of self-reported single-item question for suicidal ideation<sup>29</sup>. On the other hand, there is an evidence that a single-item self-reported question for depressive mood may be useful to identify depressive patients<sup>30</sup>. Those ultra-short questions may less likely to detect the subjects with depressive mood and suicidal ideation due to low sensitivity, but more likely to identify cases with those states due to high specificity. Therefore, the rates of depressive mood and suicidal ideation in this survey may be underestimated. Further studies using more elaborate questionnaires for depressive mood and suicidal ideation are necessary. Second, there is a possibility of measurement errors for handgrip strength, although it is the simplest method for assessment of muscle function<sup>31</sup> and measured using a standardized manual by trained assistants. Third, the cause-effect relationship is inevitably uncertain as this was a cross-sectional study. Nevertheless, the current findings from a representative Korean sample can be generalizable to the Korean population. Further prospective and intervention studies are needed to extend the current findings to prevent and detect depressive mood and suicidal ideation.

In conclusion, the present study found evidence for poor relative handgrip strength defined by handgrip strength/BMI ratio as a marker for depressive mood and suicidal ideation in women, independent of sociodemographic factors, concurrent illness, and personal behaviours. This finding highlights the importance of monitoring relative handgrip strength to detect these serious psychological problems and prevent those problems in the future by promoting relative handgrip strength.

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