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DEPRESSION AND HANDGRIP STRENGTH AMONG U.S. ADULTS AGED 60 YEARS AND OLDER FROM NHANES 2011–2014

J.M. BROOKS[1,2], **A.J. TITUS**[3,4], **M.L. BRUCE**[1,5], **N.M. ORZECHOWSKI**[6], **T.A. MACKENZIE**[7,8], **S.J. BARTELS**[1,5], and **J.A. BATSIS**[5,8,9]

[1]Department of Psychiatry, Geisel School of Medicine and Centers for Health and Aging, Dartmouth College, Lebanon, NH, USA

[2]Department of Rehabilitation and Health Services, University of North Texas, Denton, TX, USA

[3]Quantitative Biomedical Sciences, Dartmouth College, Hanover, NH, USA

[4]Department of Epidemiology, Geisel School of Medicine at Dartmouth College, Hanover, NH, USA

[5]The Dartmouth Institute for Health Policy & Clinical Practice, Lebanon, NH, USA

[6]Section of Rheumatology, Dartmouth-HitchcockMedical Center and Geisel School of Medicine at Dartmouth College, Lebanon, NH, USA

[7]Biomedical Data Science, Dartmouth College, Lebanon, NH, USA

[8]Department of Medicine, Dartmouth-Hitchcock Medical Center and Geisel School of Medicine, Lebanon, NH, USA

[9]Centers for Health and Aging, Lebanon, NH, USA

Abstract

Objectives—Sarcopenia is a gradual loss of muscle mass and strength that occurs with aging. This muscle deterioration is linked to increased morbidity, disability, and other adverse outcomes. Although reduced handgrip strength can be considered a marker of sarcopenia and other aging-related decline in the elderly, there is limited research on this physical health problem in at-risk groups with common biopsychosocial conditions such as depression. Our primary objective was to ascertain level of combined handgrip strength and its relationship with depression among adults aged 60 years and older.

Design—Unadjusted and adjusted linear regression models were conducted with a cross-sectional survey dataset.

Corresponding author: JessicaM. Brooks, Postdoctoral Fellow, Department of Psychiatry, 46, Centerra Parkway, Lebanon, NH. USA 03766 jessica.m.brooks@dartmouth.edu, Phone number: (603) 653-3436.

Ethical Standards: This study complied with the current laws and standards for research conducted in the U.S.

Conflict of interest: Dr. Brooks, Mr. Titus, Dr. Bruce, Dr. Orzechowski, Dr. Mackenzie, Dr. Bartels, and Dr. Batsis have nothing to disclose.

Setting—Secondary dataset from the 2011–2014 National Health and Nutrition Examination Survey (NHANES).

Participants—Community-dwelling, non-institutionalized adults ≥ 60 years old (n=3,421).

Measurements—The predictor variables included a positive screen for clinically relevant depression (referent=PHQ-9 score <10). The criterion variable of combined handgrip strength (kg) was determined using a dynamometer.

Results—Mean age and BMI were 69.9 years (51.5% female) and 28.8 kg/m2, respectively. Mean combined handgrip strength in the overall cohort was 73.5 and 46.6 kg in males and females, respectively. Three hundred thirty-six (9.8%) reported symptoms of depression. In unadjusted and fully adjusted models, depression was significantly associated with reduced handgrip strength (B = −0.26±0.79 and B = −0.19±0.08, respectively; p<0.001).

Conclusion—Our findings demonstrate handgrip strength has a significant inverse association with depression. Future longitudinal studies should investigate the causal processes and potential moderators and mediators of the relationships between depression and reduced handgrip strength. This information may further encourage the use of depression and handgrip strength assessments and aid in the monitoring and implementation of health care services that address both physical and mental health limitations among older adult populations.

Keywords

Handgrip strength; sarcopenia; depression; epidemiology

Background

Sarcopenia is defined as the gradual loss of muscle mass and strength that occurs with aging (1, 2). Every year, adults aged 60 years and older experience a decline of between 1.5% and 3.5% in muscle strength and power (3), which is even more pronounced in sedentary older adults and twice as high in men compared to women (4). This muscle deterioration can be diagnosed through the use of a combination of dual energy x-ray absorptiometry and clinical measurements such as walking speed and handgrip strength. Reduced handgrip strength strongly predicts functional impairment (5), falls (6), hospitalizations (7), disease morbidity and mortality (8) and low health-related quality of life (9). Due to the likelihood of adverse medical outcomes, lower handgrip strength places older adults at high risk for severe disability, frailty, and other health limitations.

The International Classification of Functioning, Disability and Health (ICF model) (10) conceptualizes health and function as an interaction between biological/physical, psychological, and social factors. Depression affects 5% of community-dwelling older adults (11) and remains as one of the most prevalent and disabling biopsychosocial conditions among older adults (12). Physical limitations and other physical heath components are interconnected to depression among older adults (13, 14). Impairment of lower extremity performance and activities of daily living impairment have also been found to be both risk factors for or consequences to depression (15–17), frequently leading to sedentary behavior (18) and functional dependence among older persons (16). Most recently, an accumulation

of evidence has suggested that diagnoses of sarcopenia and sarcopenia with obesity are associated with depression (19–22). However, large dataset studies have also reported findings on no associations between sarcopenia and depression (23, 24).

Despite the preliminary work on a hypothetical sarcopenia-depression link, there have been few studies using handgrip strength or other objective physical performance measures to explore strength loss alone as an indicator of aging-related functional impairment among older adults with depression and other common mental health conditions (25–29). Undertreated and potentially debilitating physical symptoms of depression can exacerbate arthritis and other aging-associated conditions (30, 31) escalate health care costs (32), and increase the risk for mortality among older adults (33). To our knowledge, only one longitudinal study observing reduced handgrip strength was weakly predictive of depression onset in adults from ages 85 to 90 (28). It is possible that depression, instead, has a bidirectional relationship with reduced physical strength and other indices of sarcopenia and frailty, given the reciprocal interactions between these overlapping physical and psychosocial factors in older adults (34).

Based on a biopsychosocial perspective of health and illness, we evaluated the potential physical health impact of the common mental condition of depression among older adults. Our specific aim is to examine level of combined handgrip strength (defined as the sum of the largest grip strength reading from right and left hands) among U.S. adults aged 60 years and older and to ascertain its relationships with depression compared to those without depression.

Methods

Survey Description

The National Health and Nutrition Examination Survey (NHANES) 2011–2014 data NHANES were fielded by the U.S. National Center for Health Statistics, a part of the Centers for Disease Control and Prevention, and surveys have been conducted annually since 1999. The NHANES is a cross-sectional survey representative of the civilian, noninstitutionalized population of the United States. The survey is a complex, multistage, stratified design, and oversamples minorities and older adults. Interviews and examinations were performed by trained staff with automated data collection. Questions were directed to the respondent or if necessary to their proxy. Other information on sampling, study design, and components are described at http://www.cdc.gov/nchs/nhanes. To obtain an adequate sample size for the analyses, we combined data from the 2011 to 2012 and 2013 to 2014 NHANES. The protocol was exempt from research review because of the de-identified nature of the data.

Study Population

A total of 11,539 participants 18 years of age and older were sampled. Of those sampled, we excluded participants <60 years of age (n=8,067). Exclusions, including those for missing data, resulted in a final analytic sample of 3,421 participants aged 60 years and older.

Primary Variables

The criterion outcome of combined handgrip strength (kg) was measured using a dynamometer. The participants were asked to squeeze a dynamometer as hard as possible using one hand in a standing position. Each hand was tested three times, alternating hands between trials with a 60-second rest between measurements on the same hand. Combined handgrip strength was the sum of the largest grip strength reading from each hand. Depressive symptoms were assessed by the Patient Health Questionnaire (PHQ-9). The PHQ-9 is a 9-item screening instrument that asks about the frequency of symptoms of depression over the past 2 weeks (35). Total PHQ-9 score ranges from 0 to 27 and based on past research, we classified clinically relevant depression as a cut-off score of ≥ 10 (36).

Sociodemographic and Health Covariates

Interviewers ascertained a participant's birthdate and other demographic data by self-report through the initial screening questionnaire. Age in years was a continuous variable and also categorized into the following groups: 60–69, 70–79, and 80 years or older. Gender was reported as male or female and race/ ethnicity was classified as non-Hispanic white, non-Hispanic black, Hispanic-American, and other.

Smoking status was established by responses to: "Do you now smoke cigarettes?" Participants who answered "some days" or "every day" were classified as current smokers. For binge drinking, participants were asked: "In the past 12 months, on how many days did you have 4 (female)/5 (male) or more drinks of any alcoholic beverage?" Participants who answered ≥ 1 were determined to have a recent binge drinking episode. Education attainment was assessed through the initial screening questionnaire and categorized as: less than high school or at least high school education.

Weight was measured on an electronic digital scale calibrated in kilograms. Height was measured with a stadiometer. Obesity was defined as a body mass index (BMI) ≥ 30kg/m2. Doctor-diagnosed medical co-morbidities, including diabetes mellitus, hypertension, cardiovascular diseases (congestive heart failure, coronary heart diseases, angina, or heart attack), and arthritis were identified by asking participants, "Have you ever been told by a doctor or health professional that you have _____."

Sedentary behavior was assessed through responses to the physical activity section of the household interview. Participants were prompted with basic information before the question: "The following question is about sitting at school, at home, getting to and from places, or with friends including time spent sitting at a desk, traveling in a car or bus, reading, playing cards, watching television, or using a computer. Do not include time spent sleeping." Participants answered with time in minutes to: "How much time do you usually spend sitting on a typical day?" Sedentary behavior time was classified into mean tertile units.

Statistical Analyses

Analyses were conducted using R (version 3.3.2; The R Foundation for Statistical Computing). Mobile Examination Center (MEC) sample weights and the appropriate home-examined sample design variables (strata, primary sampling unit) were used in the analysis

to account for the complex survey design (including oversampling) and survey nonresponse, and were post-stratified to obtain nationally representative estimates of the U.S. civilian non-institutionalized population using the R package survey ().

Sociodemographic and primary variable characteristics were analyzed using frequencies, percentages, means, and standard errors. Unstandardized regression coefficients (B) and standard errors of unstandardized regression coefficients were calculated using four different linear regression models for the combined handgrip strength outcome by depressive symptoms (referent=no clinically relevant depression), respectively. The first model was adjusted for depression, age, and female sex (Model 1); the second included depression, white race, high school education, current smoking, and alcohol intake (Model 2); and the third included depression, obesity, and co-morbidities (diabetes, hypertension, and cardiovascular disease); and the fourth model included depression, sedentary behavior, and arthritis (Model 4). The final model included depression and all of the previous sociodemographic and health covariates (Model 5). For model adjustment, relevant covariates were selected based on prior sarcopenia research (5, 8). Statistical testing was performed with an α-level of < 0.05 denoting statistical significance.

Results

Our final data set consisted of 1,761 females and 1,660 males aged 60 years and older, as indicated in Table 1. Participant mean age was 69.9 years (SE±6.9), and 1,558 (45.5%) participants identified themselves as Non-Hispanic White. A total of 773 (22.6%) and 180 participants (5.3%) reported being a current smoker and having a recent binge drinking episode, respectively. Over half of the participants completed less than a high school diploma (52.0%) and less than half were at least high school graduates (48.0%). Obesity was found in 1,264 (36.9%) participants. For co-morbidities, 978 participants (28.6%) had diabetes mellitus, 2,164 participants (63.3%) had hypertension, and 351 participants (10.3%) had cardiovascular disease. Arthritis diagnosis was disclosed by 1,677 (49.0%) participants. Sedentary behavior was reported to be 397.5 minutes (SE±195.9), or 6.63 hours, for the average participant.

Mean combined handgrip strength in the overall cohort was 73.5 and 46.6 kg in males and females, respectively (Table 2). Mean combined handgrip strength decreased in advancing age categories (80.26±16.5 to 60.30±13.5 in males; 52.44±16.5 to 37.22±9.4 in females). The prevalence of clinically relevant depressive symptoms was 207 (11.7%) for females and 129 (7.7%) for males, with a decrease in rates across older age categories (10.0% to 6.4% in males; 14.5% to 11.0% in females).

As shown in Table 3, persons with depressive symptoms had significantly reduced combined handgrip strength relative to those without depressive symptoms (B = −0.26±0.79; $p<0.001$), with even lower handgrip strength in female over male participants (B = −28.70±0.70; $p<0.001$) and in older age (B = −0.92±0.04; $p<0.001$). In Model 2, depressive symptoms remained significantly associated with reduced levels of combined handgrip strength (B = −0.48±0.15; $p<0.001$), with elevated handgrip strength among participants with higher educational status (B = −2.36±0.43; $p<0.001$). In Model 3, depressive symptoms were

significantly associated with reduced levels of combined handgrip strength (B = −0.58±0.14; p<0.001), with elevated handgrip strength in participants with obesity (B = 3.19±1.06; p<0.001) and lower handgrip strength in participants with co-morbidities (B = −3.02±0.85; p<0.001). In Model 4, only depressive symptoms (B = −0.58±0.15; p<0.001) and arthritis (B = −7.09±1.09; p<0.001) were significantly associated with lower combined handgrip strength. In the fully adjusted model, depressive symptoms remained significantly associated with reduced levels of combined handgrip strength (B = −0.19±0.08; p<0.001), with lower handgrip strength in female over male participants (B = −28.94±0.68; p<0.001), older age (B = −0.86±0.04; p<0.001), arthritis patients (B = −2.01±0.60; p<0.001), and sedentary adults (B = −0.01±0.00; p<0.001). However, in the final model, non-Hispanic whites (B = 5.79±0.78; p<0.001), persons with higher educational status (B = 0.73±0.23; p<0.001), and obese adults (B = 2.02±0.49; p<0.001) showed elevated levels of combined handgrip strength.

Discussion

Our findings provide evidence for the significant independent association between depression and reduced levels of combined handgrip strength. This research provides further support for the intersection of physical health impairment with common mental health conditions that are biopsychosocial in nature among older adults. Our work underscores the potential value of handgrip strength and depression measurements to assess both aging-related physical and mental health changes among community-dwelling older adults.

Persons with depressive symptoms had significantly reduced levels of combined handgrip strength relative to those without depressive symptoms, with even lower handgrip strength in female over male participants and in older age. This is consistent with initial studies reporting unadjusted associations between reduced handgrip strength and depression among adults aged 65 years and older (25, 28, 29). This finding is also expected given the aging-related decline in muscle strength and power after age 60 years old (3, 4). Depressive symptoms remained associated with reduced handgrip strength in other adjusted models, with elevated handgrip strength among those with higher educational status, non-Hispanic status, and obesity and lower handgrip strength with females over males, older age, arthritis, sedentary behavior, and co-morbidities. The link between higher education and greater handgrip strength might be explained by the association between lower education and increased age-related impairment (37, 38). Surprisingly, elevated handgrip strength was found in obese adults, which might be explained by its overlap with co-morbidities or due to the larger degree of muscle mass in obesity. The findings on the other sociodemographic and health characteristics associated with handgrip strength is mostly consistent with patterns documented among older adults with sarcopenia (4, 27, 39).

Similar to other research on sarcopenia in older adults (5, 8), mean combined handgrip strength was lower among participants from older age categories. Although females showed a lower combined handgrip strength, males demonstrated a sharper decline in older age group categories from 60–64 years and 80+ years, which is consistent with the literature (4, 40). The prevalence of clinically relevant depressive symptoms was very common at 9.8% and higher than the national depression estimates at 5% (11). Depressive symptoms also

occurred more frequently in females than males. In direct contradiction to the gradual decline of muscle mass and strength in older age, lower rates of depression were reported by participants across the oldest age categories. However, these findings are consistent with the broad epidemiological literature on the decline in prevalence rates of depression among the oldest-old age groups (41). The depression and reduced grip strength link may then be stronger in younger old age, given the higher rates of depression of 8.9% to 14.4% from ages 60–69 years. A possible explanation for such results include that persons in younger old age may have not yet psychologically adjusted to the aging-related decline in overall health and functioning.

Implications for Research and Practice

This study's findings indicate several directions for future research. Future longitudinal studies should investigate the causal processes between depression and reduced handgrip strength. Potential moderating and mediating biological mechanisms, such as mitochondrial dysfunction (42, 43) chronic low-grade inflammation (44, 45) hyperglycemia (46, 47), or elevated leptin secretion (48, 49), which have been found in both sarcopenia and depression among middle-aged adults and older adults should be further evaluated. Psychosocial factors, such as aging-related adjustment reaction or limited social support, that may influence the ability to cope with the mental and physical health consequences of reduced handgrip strength could also be explored.

Findings from this study also offer guidance to and the opportunity for integrated mental and physical health treatment approaches in clinical practice. Routine depression screening by geriatric health professionals (e.g., primary care providers, nurses) should be prioritized to evaluate age-related mental health issues and the potential risk for physical health decline in the elderly. Simple, efficient, and valid functional-based assessments of grip strength among older adult populations with depression need to be conducted. Compared to older adults without these biopsychosocial conditions, older adults with depression may be at a greater disadvantage for sarcopenia and other issues related to frailty from the effects of preexisting depressive symptoms, including psychomotor impairment, poor nutrition, and a lack of motivation for exercise and physical activities (34). Practitioners should consider incorporating a dynamometer to assess combined handgrip strength, which is easily performed in busy clinical practices. Other brief, objective performance measures relevant to sarcopenia, frailty, and aging-related physical impairment, such as gait speed or body composition scales, could also be utilized in clinical settings that offer health promotion interventions.

Limitations

Although this study had several strengths, including a large and nationally representative sample that provided an opportunity to investigate level of handgrip strength and its relationship with depressive symptoms among older adults, there are several limitations to consider. First, we used cross-sectional data, which reflects one point in time along the trajectory of a recurrent mental health condition or a mental health episode. Second, we were restricted to self-reported measures of depression, which may be subject to bias and have limited specificity (50). Participants reporting greater levels of depressive symptoms

may not have doctor-diagnosed depression. Persons with depression may experience motivational difficulties with completing objective assessments such as handgrip strength tests, which would interfere with the validity of this study's outcome measure. Third, this study only included only one mental health condition and future research should assess other common mental health conditions and severe mental illness potentially associated with reduced handgrip strength in older adults. Finally, the size of the depression subsample may have restricted statistical power and reduced the ability to ascertain associations.

Conclusion

In summary, these cross-sectional findings demonstrate that reduced levels of combined handgrip strength are independently associated with greater depressive symptoms among U.S. adults aged 60 years and older. These results suggest the interrelationships of biological/physical (reduced handgrip strength) and psychosocial factors (greater amount of depressive symptoms) among older adults. This study's findings highlight that future research and clinical practice should apply and test existing, convenient, and effective objective measures for physical function in older adult mental illness populations with high vulnerabilities for adverse physical and mental health outcomes. Geriatric health professionals should also consider prioritizing depression screening as a vital part of a comprehensive battery of physical and mental health functional limitation assessments in routine care.

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Table 1

Baseline Characteristics of Cohort

Variable	Overall
Age, in years	69.9±6.9
Age category	
60–69 years	1767 (51.7)
70–79 years	1012 (29.6)
80+years	642 (18.8)
Female sex	1761 (51.5)
Race	
Non-Hispanic White	1558 (45.5)
Non-Hispanic Black	827 (24.2)
Hispanic American	658 (19.2)
Other	378 (11.0)
Socioeconomic	
Current smoker, some days or every day	773 (22.6)
Alcohol intake, binge drinking episode in last year	180 (5.3)
Education	
<12 years	1779 (52.0)
>12 years	1642 (48.0)
Co-Morbidities	
Diabetes mellitus	978 (28.6)
Hypertension	2164 (63.3)
Cardiovascular disease	351 (10.3)
Obesity	1264 (36.9)
Arthritis	1677 (49.0)
Sedentary Behavior, in minutes per day	397.5±195.9

Note. Means ± standard errors (SE) are presented for continuous variables, counts (weighted percentages) for categorical variables. Obesity is defined as a BMI ≥ 30kg/m^2

Table 2

Handgrip Strength and Depressive Symptoms in Female andMale Subgroups by Total Sample and Age Categories

	Overall	60–69 years	70–79 years	80+ years
Handgrip strength (kg)				
Females	46.57±11.3	51.11±10.3	45.01±9.6	37.22±9.4
Males	73.45±17.0	79.11±16.6	71.36±14.6	60.30±13.5
Depressive Symptoms				
Females	207 (11.7)	129 (14.4)	40 (7.6)	38 (11.0)
Males	129 (7.7)	78 (8.9)	32 (6.5)	19 (6.4)

Note. Means ± standard errors (SE) are presented for continuous variables, counts (weighted percentages) for categorical variables. Clinically relevant symptoms of depression were scored ≥10 on the PHQ-9.

Table 3

Linear Regression Models for Depressive Symptoms by Handgrip Strength Outcome

		Model 1	Model 2	Model 3	Model 4	Model 5
	Rate (%)	**Beta coefficients ± standard errors**				
No Depression	3,085 (73.5)	referent				
Clinical Depression	336 (4.3)	−0.26 ± 0.79	−0.48 ± 0.15	−0.58 ± 0.14	−0.58 ± 0.15	−0.19 ± 0.08
Female Sex		−28.70 ± 0.70				−28.94 ± 0.68
Age		−0.92 ± 0.04				−0.86 ± 0.04
White Race			−0.30 ± 1.24			5.79 ± 0.78
H.S. Education			2.32 ± 0.43			0.73 ± 0.23
Current Smoking			−0.55 ± 0.54			−0.19 ± 0.44
Alcohol Intake			0.006 ± 0.005			−0.002 ± −0.006
Co-Morbidities				−3.02 ± 0.85		−0.92 ± 0.74
Obesity				3.19 ± 1.06		2.02 ± 0.49
Arthritis					−7.09 ± 1.09	−2.01 ± 0.60
Sedentary Behavior					−0.001 ± 0.002	−0.005 ± 0.001

Note. All values represented are from multivariable linear regression models (beta coefficients ± standard errors). No depression=0–9 and clinically relevant symptoms of depression were scored ≥10 on the PHQ-9. H.S. Education is at least high school education attainment. Current smoking is smoking “some days” or “every day”. Alcohol intake is measured by at least one binge drinking episode in the last year. Co-morbidities is measured by number of diagnoses for diabetes mellitus, hypertension, and cardiovascular disease. Obesity is defined as a BMI≥30kg/m2. Arthritis is self-reported doctor-diagnosed arthritis. Sedentary behavior is measured in minutes per day. Values bolded are considered statistically significant.