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Sex-related differences in the association between grip strength and depression: Results from the Irish Longitudinal Study on Ageing

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ABSTRACT

Muscular strength is a modifiable protective factor for mental health across aging populations. Evidence of sex-related differences in its associations with mental health is limited. Therefore, the purpose of this study was to examine sex-related differences in cross-sectional and prospective associations between grip strength and depressive symptoms and status. Participants were community dwelling adults (N = 4505; 56.5% female), aged ≥50 years. As a measure of muscular strength, grip strength (kg) of the dominant hand was assessed using a hand-held dynamometer at baseline. Participants were divided into sex-specific tertiles. The Center for Epidemiological Studies Depression Scale assessed depressive symptoms at baseline and two years later; a score of ≥16 defined caseness of depression. Depressive symptoms were significantly higher among females at baseline ($p < 0.001$). Prospective models were adjusted for age, sex, waist circumference, social class, smoking, and health status. Among males, the middle and high strength tertiles were non-significantly associated with 32.9% ($p = 0.21$) and 9.9% ($p = 0.74$) reduced odds of developing depression, respectively. Among females, the middle and high strength tertiles were non-significantly associated with 28.5% ($p = 0.13$) and significantly associated with 43.4% ($p = 0.01$) reduced odds of developing depression, respectively. In the total sample, the middle and high strength tertiles were significantly associated with 31.5% ($p = 0.04$) and 34.1% ($p = 0.02$) reduced odds of developing depression, respectively. The interaction between sex and strength was not statistically significant ($p = 0.25$). The present findings indicated that grip strength was inversely associated with incident depression in older adults, with stronger associations observed among females than males.

1. Introduction

Depression is identified by the World Health Organization (WHO) as one of the greatest contributors to overall global disease burden, affecting an estimated 350 million people worldwide (WHO, 2012). Depression is a critically important public health problem, particularly among older adults, that is associated with an increased risk of morbidity and suicide (Chapman and Perry, 2008) and decreased physical, social, and cognitive functioning (Blazer, 2003). Additionally, the financial burden associated with depression continues to grow, accounting for at least 1% of the total European economy (Sobocki et al., 2006).

Despite the clear negative consequences of depression, just 56.4% of 12-month cases of *DSM-IV* mood disorders had received some treatment in the past 12 months (Wang et al., 2005b); however, the vast majority of people with lifetime disorders eventually make treatment contact (Wang et al., 2005a). Among those who do make treatment contact, delays range from six to eight years (Wang et al., 2005a), depression persists in approximately 70% after first-line treatment, and at least 30% remain depressed after four rounds of distinct treatments (Gaynes et al., 2008). Thus, there is a continued need to identify risk factors for depression that can be targeted for prevention.

Engagement in physical activity has been associated with the prevention of late-life depression (Chang et al., 2016), although most examinations of the protective effects of specific physical activity modes focus on aerobic exercise (e.g., walking) and not resistance exercise. On the basis that the quantification of cardiorespiratory fitness is more objective than physical activity, there has been some interest in the predictive role of aerobic fitness for depression (Åberg et al., 2012; Sui et al., 2009). Similarly, research has examined the benefits of maintaining strength, as measured by grip strength, in older age (Arvandi et al., 2016; Peterson et al., 2017). Grip-strength tests are convenient, safe, and reliable, do not require large or expensive equipment, and minimise the burden placed on participants (Leong et al., 2015). Consequently, they are commonly used as an indicator of muscular strength (Bohannon, 2008; Cooper et al., 2010). Grip strength has predicted

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cardiometabolic disease risk, physical disabilities, and mortality in older adults (Arvandi et al., 2016; Peterson et al., 2017). Some studies have demonstrated the protective influence of grip strength on depression and depressive symptoms (Fukumori et al., 2015; Hamer et al., 2015; Taekema et al., 2010; Veronese et al., 2017), with stronger associations reported among females than males (Veronese et al., 2017); however, these sex-related findings were derived from somewhat small sample sizes and, as the data analysed were collected over 20-years ago, there is a need to demonstrate the replicability of these findings using more recent data from larger population samples.

Therefore, the key objectives of the study reported here was to investigate (1) associations between grip strength and both concurrent depressive symptoms and depression status and the development of depressive symptoms and depression two-years later, and (2) sex-related differences in these associations using data from the Irish Longitudinal Study on Ageing (TILDA). It was hypothesised that grip strength would be associated with lower odds of depression, and this association would be stronger among females than males.

2. Methods

This study used STROBE recommendations to guide reporting (Von Elm et al., 2008).

2.1. Study population

TILDA is an ongoing cohort study that contains a nationally representative sample of community dwelling adults aged ≥50 years, and their partners of any age, resident in the Republic of Ireland. An initial multi-stage probability sample of addresses was chosen by means of the RANSAM sampling procedure (Whelan, 1979), with District Electoral Divisions selected at the first stage and household addresses selected at the second stage. The response rate was 62.0%. For the present analyses we report data from Wave 1 (2009–2010) (Barrett et al., 2011) and Wave 2 (2012–2013) (Nolan et al., 2014). Complete data for grip strength at Wave 1 and depression measures at Waves 1 and 2 were available for 5396 respondents. After 891 respondents were excluded for incomplete covariate data, cross-sectional analyses included 4505. Participants who reported depression at baseline (n = 401) were excluded from longitudinal analyses, resulting in a sample size of 4104 depression-free older adults included in longitudinal analyses. Participants provided full informed consent to participate in the study and ethical approval was obtained from the Trinity College Dublin Faculty of Health Sciences Research Ethics Committee.

2.2. Study measures

2.2.1. Grip strength

Grip strength was measured with a Baseline (Fabrication Enterprises Inc., White Plains, NY) hydraulic hand dynamometer. Respondents with swelling, inflammation, severe pain, or recent injury to their hand/wrist, and those with surgery to their hand/wrist in the last six months were excluded. The grip strength test was explained and demonstrated before the test was performed. Large rings were removed and the handle was set to a comfortable grip ensuring that the grip rested on the middle phalanx of the four fingers. The upper arm was kept tight against the trunk and the forearm was kept at a right angle to the upper arm. If the respondent found the dynamometer too heavy to hold in this position, either they or the nurse used their free hand to support the dynamometer. The test was performed standing; if this was not possible, the respondent sat in an upright chair. If necessary, a table was used for arm support ensuring the forearm was still at a right angle to the upper arm. The respondent was asked to squeeze the handle with maximum force for a few seconds. The value to the nearest whole number in kilograms was recorded by viewing the scale when held at nose level. Two values were recorded for the dominant hand. Respondents were divided into sex-specific tertiles based on the mean of their two scores (i.e., Males: 0.0–29.5 kg, 30.0–37.0 kg, and 37.5–65.0 kg, respectively; Females: 0.0–17.5 kg, 18.0–21.5 kg, and 22.0–38.5 kg, respectively). Standardized grip strength was derived by dividing a respondent's mean grip score by the sex-specific sample standard deviation.

2.2.2. Depression

At Waves 1 and 2, symptoms of depression were assessed using the Center for Epidemiological Studies Depression Scale (CES-D) (Radloff, 1977). Reliability coefficients of the CES-D are high (0.85–0.91) among older adults (Radloff and Teri, 1986). A score of ≥16 defined caseness of depression (Radloff, 1977). Respondents above this cut-off score are referred to as depressed throughout the current manuscript; however, they are at increased risk of depression but do not have clinically diagnosed depression. A cut-score of ≥16 demonstrates 100% sensitivity and 87.6% specificity in older populations (Beekman et al., 1997). Positive predictive values can be low (13.2%) and negative predictive values can be high (99–100%) (Beekman et al., 1997).

2.2.3. Covariates

Age was divided into four categories (i.e., 50–59 years, 60–69 years, 70–79 years, and 80+ years). Waist circumference was classified as low- or increased-risk according to WHO guidelines (i.e., Males: > 94 cm; Females > 80 cm) (Grundy et al., 2005; WHO, 2011). Social class was defined according to the European Socioeconomic Classification (ESeC) scheme (Rose and Harrison, 2007). The ESeC classifies people according to their positions within labour markets and with special attention to their employment relations. To improve sample coverage, those who were not in paid employment were allocated to a “Not Working” group (n = 1227). Current smoking status was self-reported. Health was determined by self-reported doctor diagnosis of at least one of angina, arthritis, cancer/malignant tumour, diabetes/high blood sugar, hypertension, osteoporosis, or stroke.

2.3. Statistical analysis

Statistical analyses were conducted using SPSS Version 22.0 (Armonk, NY: IBM Corp.). Chi-square tests examined differences in depression, sex, age, waist circumference, smoking status, and health status between the analytic sample and excluded (i.e., those with complete grip strength and CES-D data but missing some covariate data) respondents, and one-way ANOVAs quantified differences in strength. Among included participants, Chi-square tests examined differences in sex, age, waist circumference, social class categories, smoking status, and health status between strength tertiles. For significant Chi-square tests, *Z* tests were calculated for column proportions for each row in the Chi-square contingency table and adjusted using a Bonferroni correction (Sharpe, 2015).

One-way ANOVAs and Fisher's LSD planned contrasts quantified differences in Wave 1 and Wave 2 depressive symptoms between sexes and strength tertiles, respectively. Two-way ANOVAs examined variation in Wave 1 and Wave 2 depressive symptoms by strength tertiles, sex, and their interaction. Hedges' *d* effect sizes and associated 95% confidence intervals (95%CI) were calculated to quantify the magnitude of differences in depressive scores (Cumming, 2014). Effect sizes of 0.2, 0.5, and 0.8 can been used as indicators for small, medium, and large effects, respectively (Cohen, 1992).

Binomial logistic regression quantified associations (i.e., odds ratios (ORs)) between strength tertiles and standardized grip strength (treated as a continuous variable), and depression status at Waves 1 and 2 for males, females, and the total study population. Multivariable models were adjusted for covariates in a step-wise fashion: Model 1 was adjusted for age and sex; and Model 2 was adjusted for age, sex, social class, smoking status, and health status. The Hosmer-Lemeshow test was performed and Nagelkerke R^2 calculated to assess the goodness-of-