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Hand grip strength and depression among rural older South Africans

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ABSTRACT

The study aimed to assess the relationship between hand grip strength (HGS) and depressive symptoms among ageing women and men in a longitudinal study in rural South Africa. We analyzed longitudinal data from two consecutive population-based surveys in Agincourt, South Africa, 2014/2015-2018/2019. Results indicate that in all, 835 adults of 3268 participants without depression in Wave 1 (25.0 percent) had incident depression in Wave 2, and 184 adults of 3866 participants who had depression in Wave 1 (4.8 percent) screened positive for depression at both Wave 1 and 2 (persistent depression). The prevalence of weak HGS was 51.5 percent at baseline. In the fully adjusted model, weak HGS increased the odds of incident depressive symptoms between both sexes (AOR: 1.24, 95 percent CI: 1.04-1.47) among women (AOR: 1.33, 95 percent CI: 1.05-1.68), but not among men. No models among both sexes, among men and women, showed an increased odds of weak HGS with persistent depressive symptoms. Weak HGS was independently associated with the incident, but not persistent depressive symptoms between the two sexes and between women but not between men.

Introduction

Depressive disorders, with a prevalence of 12.1% depressive symptoms, are contributing to a large extent to the worldwide disease burden, including in lower-resourced countries (Ferrari et al., 2013). In nationally representative surveys in South Africa, 9.7% of the population reported major depression in their lifetime (Tomlinson et al., 2009), and about a third of older adults (≥65 years) had depressive symptoms (CES-D scores ≥ 10) (Tomita & Burns, 2013). To deal with the high burden of depression in later life, it has been suggested, in addition to treatment, to decrease the onset of depressive disorder in the community (Almeida, 2012; Whyte & Rovner, 2006).

In this context, it would be important if, for example, muscle strength contributes to developing or maintaining depressive symptoms. Muscle strength can be objectively measured through handgrip strength (HGS) (Ashdown-Franks et al., 2019). HGS assessed during middle-age in population-based studies has been shown to predict mortality in older age (Buckner et al., 2019). A recent review of eight prospective studies (1 in China and 7 in high-income countries) found that low HGS increases the odds of depressive symptoms among men but not women (Huang et al., 2021). A prospective study among ageing adults in Ireland showed that HGS was inversely associated with incident depression among females but not males (McDowell et al., 2018). Additional studies are needed to investigate these sex differences (Huang et al., 2021). Furthermore, several studies also found a positive association between lower HGS and persistent depression (Carvalho et al., 2021). However,

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the relationship between HGS and incident and persistent depressive symptoms in Africa has not been researched. Consequently, the study aimed to assess the relationship between HGS and incident and persistent depressive symptoms among men and women in a longitudinal study in South Africa.

Method

Participants

We analyzed longitudinal data from two consecutive population-based surveys (HAALSI) in Agincourt, South Africa. Full information on the sampling methodology has been reported previously (Gómez-Olivé et al., 2018). The first survey (November 2014 to November 2015) included 5,059 individuals (≥40 years), with a response rate of 86% (Gómez-Olivé et al., 2018), and the second survey (October 2018 to November 2019) included 4,176 members of the Wave 1 HAALSI cohort (595 died during follow-up: 12%, 254 declined participation: 5%, 34 were not found: <1%, and response rate: 94%) (Kobayashi et al., 2021a).

Procedures

The study was conducted by trained field workers at the homes of the participants after written informed consent was provided. The study was approved by the "University of the Witwatersrand Human Research Ethics Committee (ref. M141159), the Harvard T.H. Chan School of Public Health, Office of Human Research Administration (ref. C13–1608–02), and the Mpumalanga Provincial Research and Ethics Committee" (Gómez-Olivé et al., 2018).

Instruments

Outcome variable

In the first and second survey depressive symptoms were assessed with the "Center for Epidemiological Studies-Depression Scale eight-item scale (CES-D 8)" (Radloff, 1977) or CES-D 20 modified to CES-D 8 (Steffick, 2000), (Cronbach's alpha .66 in the first and .79 at the second survey). Scores ≥3 on the CES-D 8 indicated depressive symptoms (Steffick, 2000).

Exposure variable

HGS was measured with the Smedley© Digital Hand Dynamometer (12–0286) (Gómez-Olivé et al., 2018), and weak HGS was defined as "<30 kg for men and <20 kg for women using the mean value of two HG measurements with the dominant hand" (Carvalho et al., 2021; Cruz-Jentoft et al., 2010).

Covariates

1. *Sociodemographic information* included country of birth, age, sex, educational level, and a quintile of asset-based household wealth.
2. Two items on current smokeless tobacco use and current tobacco use assessed current tobacco use (Gómez-Olivé et al., 2018). Using as a cut-off ≥2 affirmative responses on the 4-item CAGE scale defined alcohol dependence (A., 1984), (Cronbach's alpha was .82).
3. *Body Mass Index* (BMI) was measured and classified according to WHO criteria (WHO, 2000).
4. *Hypertension* was measured based on the last two of three blood pressure readings and classified based on National Committee criteria (Chobanian et al., 2003).

5. *Dyslipidemia* was defined as: "total cholesterol > 6.21 mmol/L, HDL-C < 1.19 mmol/L, LDL-C > 4.1 mmol/L, triglycerides >2.25 mmol/L," ever diagnosed or medication use for high cholesterol (Gómez-Olivé et al., 2018).
6. *Diabetes* was "classified with fasting glucose (defined as > 8 hours) > 7mmol/L (126 mg/dL)," ever diagnosed or medication use for diabetes (Gómez-Olivé et al., 2018).
7. *Physical activity* and its levels were assessed and classified with the "General Physical Activity Questionnaire (GPAQ)" (Armstrong & Bull, 2006; WHO, 2009).

Data Analysis

The proportion of persons with the incident and persistent depression was calculated and described. The first longitudinal logistic regression analysis excluded those with depression at baseline, including a sample of 4092 participants, to estimate incident depression, and the second logistic regression analysis estimated longitudinal persistent depression. In the logistic regression model, HGS was the main predictor, controlled for sociodemographics, substance use, physical activity, BMI, and chronic conditions. Inverse probability weights were applied to account for attrition and mortality at follow-up (Kobayashi, Morris, et al., 2021b). p <.05 was accepted as significant. All analyzes were performed with StataSE 15.0 (College Station, TX, USA).

Results

Participant characteristics by the incident and persistent depression

In total, 835 adults out of 3268 participants without depression in Wave 1 (25.0%) had incident depression in Wave 2, and 184 adults out of 3866 participants who had depression in Wave 1 (4.8%) screened positive for depression at both Wave 1 and 2 (persistent depression). The prevalence of weak HGS was 51.5%. Table 1 shows sample characteristics of participants by the incident and persistent depression.

Table 1

Sample Characteristics by the Incident and Persistent Depression, Agincourt, South Africa, 2014-2019

Baseline variables		Sample N (%)	Incident depression N (%)	Persistent depression N (%)
Age (in years)	40-49	884 (17.6)	159 (24.1)	20 (2.7)
	50-59	1358 (27.1)	221 (23.8)	47 (3.9)
	60-69	1274 (25.4)	216 (26.2)	48 (4.9)
	70-79	918 (18.3)	134 (25.0)	45 (7.0)
	≥80	583 (11.6)	70 (29.2)	22 (7.2)
Sex	Female	2713 (53.6)	457 (25.8)	107 (5.0)
	Male	2346 (46.4)	349 (24.4)	77 (4.6)
Education	None	2307 (49.1)	360 (26.7)	98 (6.1)
	1-7 years	1613 (32.0)	251 (24.3)	64 (5.0)
	8-11	537 (10.7)	89 (23.2)	12 (2.4)
	12 or more	585 (11.6)	102 (23.6)	10 (2.0)
Wealth index	Low	2047 (40.5)	329 (27.1)	80 (5.5)
	Middle	991 (19.6)	146 (23.1)	38 (5.0)
	High	2021 (39.9)	331 (24.2)	66 (4.1)
Alcohol dependence	No	4988 (98.7)	798 (25.2)	178 (4.7)
	Yes	68 (1.3)	8 (18.0)	6 (11.5)
Current tobacco use	No	4264 (84.4)	671 (24.3)	155 (4.7)
	Yes	790 (15.6)	135 (29.8)	29 (5.2)
Body mass index	Normal	1719 (36.7)	277 (24.8)	58 (4.5)
	Under	258 (5.5)	37 (29.9)	14 (9.0)
	Overweight	1328 (28.3)	206 (23.4)	51 (4.8)
	Obesity	1384 (29.5)	255 (26.2)	53 (4.5)

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Table 1 (Continue)

Sample Characteristics by the Incident and Persistent Depression, Agincourt, South Africa, 2014-2019

Baseline variables		Sample N (%)	Incident depression N (%)	Persistent depression N (%)
Hypertension	No	2052 (41.6)	340 (25.4)	63 (4.0)
	Yes	2884 (58.4)	450 (24.8)	117 (5.4)
Diabetes	No	4093 (88.0)	668 (24.9)	143 (4.5)
	Yes	559 (12.0)	86 (29.4)	31 (8.1)
Dyslipidaemia	No	2389 (56.2)	394 (25.0)	84 (4.5)
	Yes	1862 (43.8)	310 (27.0)	77 (5.5)
Physical activity	Low	2221 (44.0)	331 (25.5)	102 (6.0)
	Moderate	1143 (22.7)	202 (24.8)	34 (3.6)
	High	1674 (33.3)	300 (24.7)	63 (4.4)
Hang grip strength	Strong	2043 (50.8)	360 (23.5)	69 (4.1)
	Weak	1973 (49.2)	312 (26.5)	73 (5.4)

Associations between weak HGS and incident depression

In the fully adjusted model for individuals with no depressive symptoms at baseline, weak HGS increased the odds of incident depressive symptoms between the two sexes (AOR: 1.24, 95% CI: 1.04-1.47), and among women (AOR: 1.33, 95% CI: 1.05-1.68). No models among men showed a significant effect of weak HGS on incident depressive symptoms (see Table 2).

Table 2

Association between Hand Grip Strength and Incident Depressive Symptoms, Agincourt, South Africa, 2014-2019

Variable	Unadjusted model COR (95% CI)	Model-1 AOR (95% CI)	Model-2 AOR (95% CI)	Model-3 AOR (95% CI)
Box sexes				
Weak HGS				
No	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Yes	1.18 (1.04, 1.37)*	1.19 (1.01, 1.39)*	1.19 (1.01, 1.40)*	1.24 (1.04, 1.47)*
Male				
Weak HGS				
No	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Yes	1.12 (.90, 1.39)	1.11 (.88, 141)	1.13 (.89, 1.44)	1.14 (.88, 1.49)
Female				
Weak HGS				
No	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Yes	1.26 (1.03, 1.54)*	1.25 (1.01, 1.55)*	1.25 (1.00, 1.55)*	1.33 (1.05, 1.68)*

*p <. 05; COR=Crude Odds Ratio; AOR=Adjusted Odds Ratio

Model 1: Adjusted for age, sex, education, and wealth status. Model II: Adjusted for Model 1 variables, plus substance use, physical activity, and body mass index. Model III: Adjusted for Model I and II variables, plus dyslipidemia, hypertension, and diabetes.

Associations between weak HGS and persistent depression

Table 3 shows logistic regression models with people who had depressive symptoms at baseline and follow-up. In an unadjusted analysis between sexes and between men, weak

HGS increased the odds of persistent depressive symptoms. However, in the adjusted analysis, among both sexes, among men and women, no significant associations with persistent depressive symptoms were found (see Table 3).

Table 3
Association between Hand Grip Strength and Persistent Depressive Symptoms, Agincourt, South Africa, 2014-2019

Variable	Unadjusted model COR (95% CI)	Model-1 AOR (95% CI)	Model-2 AOR (95% CI)	Model-3 AOR (95% CI)
Both sexes				
Weak HGS				
No	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Yes	1.35 (1.02, 1.78)*	1.07 (.80, 1.45)	1.06 (.77, 1.45)	1.01 (.72, 1.42)
Male				
Weak HGS				
No	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Yes	1.59 (1.04, 2.42)*	1.21 (.76, 1.91)	1.21 (.75, 1.94)	1.12 (.67, 1.88)
Female				
Weak HGS				
No	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Yes	1.20 (.83, 1.75)	.98 (.66, 1.47)	.97 (.63, 1.48)	.94 (.59, 1.49)

*p < .05; COR=Crude Odds Ratio; AOR=Adjusted Odds Ratio
Model 1: Adjusted for age, sex, education, and wealth status. Model II: Adjusted for Model 1 variables, plus substance use, body mass index, and physical activity. Model III: Adjusted for Model I and II variables, plus dyslipidemia, hypertension, and diabetes.

Discussion

In this first longitudinal study among people 40 years and older in Africa, we found that weak HGS increased the odds of incident depressive symptoms four years later, among both sexes, among women but not among men of ageing adults in South Africa. These results are contrary to a recent review that found low HGS increases the risk of depressive symptoms among males but not females (Huang et al., 2021), but similar to a longitudinal study among older adults in Ireland (McDowell et al., 2018). Possible reasons for these sex differences may be related to the role of estrogen in affecting muscle strength (Collins et al., 2019) and the role of estradiol action in the regulation of gene expression that modulates serotonin neurotransmission implicated in depression (Gu et al., 2021; Hernández-Hernández et al., 2019). Still, further research is warranted on this issue (Gu et al., 2021).

In the unadjusted analysis, weak HGS increased the odds of persistent depressive symptoms between the sexes and between men but not women. However, no association was found in adjusted analysis between weak HGS and persistent depressive symptoms, while some other studies showed a positive association between lower HGS and persistent depression (Carvalho et al., 2021). Overall, findings partially confirm that resistance training to enhance muscle strength in ageing adults may be a beneficial adjunct to prevent depressive symptoms (McDowell et al., 2018; Straight et al., 2016). One of the possible mechanisms to explain the inverse association between HGS and depressive symptoms (Gu et al., 2021) may include that HGS reduces the risk of developing depression through enhancing muscle function that reduces inflammation and oxidative free radicals (Lindqvist et al., 2017; Vezzoli et al., 2019).

The limitations of the study include that depression was assessed with a screening questionnaire and not with a diagnostic psychiatric evaluation. Furthermore, participants who were negative for depression in wave 1 may have had depression before.

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Conclusion

Weak HGS was independently associated with the incident, but not persistent depressive symptoms between the two sexes and between women but not between men. Results suggest that improving HGS may help in reducing the development of depressive symptoms, in particular among women.

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