Social isolation and loneliness as risk factors for grip strength decline among older women and men in China

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Brief summary: Our results indicate that higher levels of loneliness rather than social isolation were independently associated with decreased grip strength after 4-year follow-up for women, while only social isolation was positively associated with decreased grip strength for men.

Abstract

***Objective*:** The purpose of this study was to examine the relationships of social isolation and loneliness, both individually and simultaneously, on changes in grip strength among Chinese older adults and whether these relations vary by gender.

***Design*:** A 4-year prospective observational study.

Setting and Participants: This study used data from the China Health and Retirement Longitudinal Study (CHARLS). Analyses were conducted with data from two waves (2011 and 2015) and were restricted to those respondents aged 50 and older [n = 7,025, mean age (SD) = 61.46 (7.59); male, 48.4%].

***Methods*:** Social isolation, loneliness and grip strength were measured at baseline. Follow-up measures of grip strength were obtained 4 years later. Multiple linear regression was used to evaluate the associations between baseline isolation, loneliness, and decline of grip strength between two waves after adjustment for age, gender, education, BMI, chronic diseases, smoking and drinking status, ADL and IADL disabilities and depressive symptoms.

***Results*:** For women, baseline loneliness (β = .04, p = .035) rather than isolation (β = .03, p = .110) significantly predicted grip strength decline after 4 years when other confounding variables were taken into account. For men, baseline isolation (β = .05, p = .005) rather than loneliness (β = .01, p = .570) significantly predicted grip strength decline. No synergistic effect of isolation and loneliness on grip strength was found for either women or men.

***Conclusions and Implications*:** In this prospective study, gender differences were found for the associations of social isolation and loneliness with grip strength decline. Our results suggest that older women and men may benefit from different social enhancement strategies for prevention of physical function decline.

Keywords: social isolation, loneliness, grip strength, older adults, gender differences.

Introduction

Grip strength is a non-invasive and reliable indicator of muscular strength.[1] An extensive research literature indicates that low grip strength is a strong predictor of poor health outcomes in elderly people, including cardiovascular disease (CVD) and all-cause mortality.[1-3] Identifying factors that may help maintain muscular strength and physical capability may provide insight into strategies for enhancing healthy aging.

Social isolation and loneliness are reflections of the objective and subjective characteristics of weak social relationships. Social isolation is a state of estrangement, in which social connections are limited or absent.[4] Loneliness, on the other hand, refers to a subjective feeling of distress, arising when there is a discrepancy between desired and actual social relationships.[5] Accumulated evidence has shown that both social isolation and loneliness are associated with poorer objective or subjective assessments of physical functions.[6-9] However, in most of these studies, grip strength has been either not included [6, 8] or included as only one of the deficits for constructing a broader physical function index.[7, 9] Therefore, the specific association between social relationship factors and grip strength in older adults is not yet well understood. Contrary to subjective measures, grip strength is an objective measure that does not suffer the biases inherent to self-reports.[10] Grip strength has been proposed to be a simple but powerful predictor of future health outcomes.[2] Therefore, more knowledge about the causes of grip strength decline is important for the development of strategies for prevention of mortality and morbidity among older adults. Additionally, little research has been carried out in China, where traditional family structures and cultural valuation of the elderly are stronger than those in the West.[11]

Gender differences are of particular interest in this study. Women tend to be lonelier and slightly more socially isolated than men.[12, 13] Women have also been found to be more sensitive to the interpersonal context and prefer greater interpersonal connectedness, which may make them more sensitive than men to the negative health effects of poor social connections.[14]

Several previous studies have indicated possible gender differences in the association between social relationship factors and physical functions,[15, 16] we therefore stratified the analyses by gender in this study.

To examine the associations of social isolation and loneliness, both individually and simultaneously, with grip strength decline among older adults, we used the China Health and Retirement Longitudinal Study (CHARLS), a national, population-based study of Chinese older adults. Our secondary objective was to investigate whether gender differences exist in these associations.

Methods

Participants

Data are from CHARLS, a nationally representative longitudinal survey sampled residents from 150 counties across 28 provinces in China, with a response rate of 80.5%.[17] In the present study, we used data from two waves of the CHARLS collected in 2011 and 2015. The baseline sample included 17,708 respondents. Our analytic sample was restricted to those respondents aged 50 and older (n = 13,649). Participants with missing values on grip strength at baseline (n = 1,464) or follow-up (n = 4,571) were excluded. Participants who have missing values for any of the confounding variables at baseline were also excluded (n = 637). A total of 7,025 respondents (mean age = 61.46, SD = 7.59) were therefore included in the final analysis. Ethical approval for collecting data on human subjects was received at *** by their institutional review board (IRB).

Measures

Grip Strength

At both baseline and follow-up, grip strength (kg) was measured using a hydraulic handgrip dynamometer (Yuejian TM WL-1000 dynamometer). Two measurements were taken with each hand. The maximum value of four measurements was used in the analysis.[16, 18] Values

of zero or those above 100 kg were considered invalid. Grip strength data was normally distributed across the two waves and was used as continuous variable in subsequent analyses.

Loneliness

In our study, loneliness was measured at baseline with one single item included in the Centre for Epidemiological Studies Depression Scale (CESD): "In the last week, how often did you feel lonely?". The respondent chose among four ordinal responses scored 1 to 4. This one item measure correlates highly with multi-item loneliness scales and has been used in a number of previous studies.[19-23] Loneliness was dichotomized into 2 categories (0 [not lonely] = those who reported feeling lonely rarely or none of the time, and 1 [lonely] = those who felt lonely sometimes, occasionally or most of the time).[24]

Social isolation

Four items were combined to create a score for social isolation at baseline.[25, 26] One point was assigned if participants: being unmarried, not having any children or having less than weekly contact (face-to-face, telephone or e-mail) with children, living in the rural rather than urban areas, and not participating in any social activities over the last month (e.g., interacted with friends; played chess or cards; went to a sport, social, or other club). Scores ranged from 0 to 4, with higher values indicating greater isolation.

Confounding variables in the baseline survey

Age, education, body mass index (BMI), drinking and smoking status at baseline were viewed as potential confounding variables. Two measures of functional limitation [activities of daily living (ADL) and instrumental activities of daily living (IADL)] were also considered. Both ADL and IADL were treated as binary predictors (1 = functional limitations present; 0 = no functional limitations present) due to most respondents (ADL: 83.3%; IADL: 78.3%) reporting no limitations. Chronic diseases (including hypertension, diabetes and heart disease) and depressive symptoms were also adjusted. Depressive symptoms were measured with 10-

item CESD. In order to derive a separate depression score, modified CESD scoring was calculated as the sum of the remaining nine questions (range 0–27) by excluding the loneliness question.

Statistical Analysis

Characteristics of the overall sample at baseline were described using means and standard deviations for continuous data and percentages for categorical data. Chi-square tests or independent sample t-tests were conducted to examine differences for all variables at baseline between women and men. We used multiple linear regression to test the independent, relative, and synergistic effects of isolation and loneliness on grip strength for women and men separately. Three different models were estimated and change of grip strength (grip strength at baseline minus grip strength at follow-up) was used as the dependent variable in all models. Model 1 was constructed to examine the associations between loneliness at baseline and grip strength at follow-up by adjusting for all confounding variables including age, sex, education, BMI, chronic diseases, smoking and drinking status, ADL and IADL disabilities, and CESD-9 scores. A similar model was fitted to test the independent associations of isolation with grip strength decline (Model 2). Model 3 added both isolation and loneliness into the fully adjusted model. We also tested the interaction between isolation and loneliness on grip strength decline. For all regression analyses, unstandardized regression coefficients (B) with corresponding standard errors were reported. Standardized regression coefficients (β) were also reported as variables under study were measured on different scales. In the sensitivity analysis, to reduce the risk of reverse causation, we repeated the Model 3 after excluding the participants who have a very low level of grip strength at baseline. All analyses were conducted using IBM SPSS 20.0 (IBM, Armonk, NY, USA) and a p-value < .05 was considered statistically significant.

Results

In total, 3,625 women (51.6%) and 3,400 men (48.4%) were included in the final analysis. Of

all the included participants, the prevalence of hypertension, diabetes and heart diseases is 28.0%, 6.6% and 13.3% respectively. The mean grip strength of the included participants (SD) at baseline was 25.74 (6.81) kg for women and 38.25 (8.63) kg for men. **Table 1** shows the characteristics of the included and excluded participants at baseline. Compared with those who were excluded from the original sample (n = 6,624), participants included in the final analysis were healthier. They were less likely to have hypertension, diabetes, heart disease, ADL and IADL disabilities (all $p < .05$). In addition, individuals who were included in the analysis were more likely to feel lonely (29.4% vs 26.4%, $p < .001$) and have higher level of isolation (mean score: 1.46 vs 1.35; $p < .001$) than those who were excluded. For the enrolled participants, significant gender differences were observed in all the variables included in the regression models (all $p < .01$). Compared with men, women were more likely to feel lonely (34.2% vs 24.3%; $p < .001$) and have a higher score of social isolation (mean score: 1.49 vs 1.43; $p = .001$).

After 4 years, the mean scores on grip strength were significantly declined for both men (from 38.25 to 35.33, t = 22.41, $p < .001$) and women (from 25.74 to 23.69, t = 17.71, $p < .001$). **Table 2** show the results of multiple linear regression on women and men respectively. For women, loneliness ($\beta = .04$, $p = .025$) rather than isolation ($\beta = .26$, $p = .077$) can significantly predicted grip strength decline over 4 years when other confounding variables were taken into account. When isolation and loneliness were entered simultaneously into the model (Model 3), the regression coefficients and significance levels for both loneliness ($\beta = .04$, $p = .035$) and isolation ($\beta = .03$, $p = .110$) were almost unchanged. For men, baseline isolation ($\beta = -.05$, $p = .004$) significantly predicted decreased grip strength. In contrast, loneliness was not associated with grip strength ($\beta = .02$, $p = .399$). When baseline isolation and loneliness were entered simultaneously into the regression model, the coefficient for isolation remained significant ($\beta = -.05$, $p = .005$). Interaction effect between social isolation and loneliness was tested by including interaction term into Model 3. No significant interaction was found for

either women (β = .001, p = .881) or men (β = −.06, p = .113).

We reran Model 3 after excluding the respondents with very low grip strength (bottom 10%) at the baseline survey (for women: ≤ 17.00, n = 333; for men: ≤ 27.11, n = 340), for the reasons that people with very impaired physical function may find it difficult to engage socially with others. The results were unchanged [for women: isolation (B (SE) = .17 (.14), β = .02, p = .218); loneliness (B (SE) = .78 (.27), β = .06, p = .004). for men: isolation (B (SE) = .55 (0.16), β = .06, p = .001); loneliness (B (SE) = .23 (.34), β = .01, p = .510)].

Discussion

In this longitudinal study, higher levels of loneliness rather than social isolation were found to be independently associated with decreases in grip strength over time for women. However, for men, only social isolation was positively associated with decreased grip strength. As far as we are aware, this is the first longitudinal study to find a gender-dependent impact of isolation and loneliness on an objective index of physical function. No synergistic effects of isolation and loneliness on grip strength was found for either women or men.

Studies assessing the association between social relationships and physical functioning in older age usually focus on specific aspect of isolation and produced mixed findings. Having a large number of social ties [27] and participation in social activities have been linked with less decline in physical function in some longitudinal studies,[9, 28] with others reporting limited or no significant associations.[15, 29] Evidence on whether social isolation increases risk of grip strength decline is sparse. Our findings on social isolation and grip strength decline was consistent with those of Shankar et al.'s study with English older adults. They found that high social isolation was a risk factor for decline in gait speed, even though no gender difference was observed. [6] However, another study with the same cohort population found that high social isolation was associated with an increased risk of becoming physically frail in men, but not women.[30] Similarly, Guralnik et al. found that never married and married men who remained

childless had significantly poorer physical function when compared with married men who had children.[16] These associations were not observed among women. The results of our study along with these two studies [16, 30] indicated that the negative effect of social isolation on physical function might be more salient for men than for women.

In contrast to social isolation, loneliness was found to be associated with decreased grip strength over time among women rather than men in our study. Previous prospective findings have shown linking of loneliness with decline in gait speed[6] or mobility,[8] and increased difficulties with activities of daily life,[6] or upper extremity tasks.[8] Two studies have investigated the association between loneliness and grip strength. A recent analysis of middle-aged Danish adults found no significant association between loneliness and grip strength, which may be due to the cross-sectional design and relatively young age (mean age 54) of the study population.[31] Another longitudinal study with the oldest old in Netherlands found that lower baseline grip strength did not predict increases of loneliness.[32] Neither of these two studies found gender differences.

For the association between grip strength decline and detrimental health outcome in the older adults, such as CVD and mortality,[1-3] one would expect that interventions aimed at improving social relationships are beneficial for health in general. Those gender differences in our study for the associations of social isolation and loneliness with grip strength decline may be important for several reasons. First, previous studies showed that older women typically report greater loneliness than men,[33, 34] as was also found in our analysis. Moreover, it is thought that women are more sensitive to the interpersonal context and prefer greater interpersonal connectedness than do men.[35] Second, previous research suggests that social relationships for females are characterized by greater amounts of emotional sharing in comparison with males, for whom shared activities are more prominent.[36] Therefore, women's health might be influenced more by the emotional aspects of social relationships, while men's

health could be affected more by the objective features of social relationships.

Strengths of our study include the large sample size and the fact that CHARLS is designed to be nationally representative of the community-dwelling Chinese older adults. Although previous studies have suggested the associations between lower quality of social relationships and poorer physical function,[6-9] it should be noted that most findings are based on Western sample and hence a limited cultural context. Westerners tend to be more individualistic and have higher objective social isolation compared with non-Western populations.[37] Thus, our study expands knowledge about the health impact of social relationships in a more collectivistic culture.

The study has limitations. First, loneliness was assessed with only one direct question regarding the perception of loneliness in the last week. Despite wide use in the literature and strong correlations with several established multiple-item scales, this measure may be less reliable than a composite measure that taps multiple aspects of loneliness.[19, 38, 39] Second, the proportion of missing data in this study was relatively high, which mainly due to the missing value of grip strength. Multiple imputation was not used in this study because the data were not missing at random.[40] People excluded from the analysis tended to be unhealthier than those who were included. Our findings may therefore underestimate the true associations between loneliness or social isolation and decline in grip strength.

Conclusions and Implications

In this prospective study, higher level of loneliness rather than social isolation was associated with decreased grip strength for women. By contrast, social isolation rather than loneliness was positively associated with decreased grip strength for men. These results suggest that older women and men in China may benefit from different social enhancement strategies for prevention of their physical function decline. To improve physical function of older men, it may be beneficial to encourage greater social connectedness, whereas older women might

benefit more from decreasing subjective feelings of loneliness.

Conflicts of Interest: None

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Table 1 Baseline characteristics of the participants (n = 7,025)

Characteristic	Included (n = 7,025)	Excluded (n = 6,624)	*p* value [a]	Women (n = 3,625)	Men (n = 3,400)	*p* value [a]
Age, M(SD), y	61.46 (7.59)	63.19 (9.57)	< .001	61.21 (7.66)	61.73 (7.51)	.004
Education level, (Less than lower secondary education, %)	91.5	86.1	< .001	95.4	87.3	< .001
BMI, M (SD), kg/m^2	23.36 (3.94)	23.04 (4.04)	< .001	23.88 (4.21)	22.81 (3.54)	< .001
Hypertension, %	28.0	30.9	< .001	30.6	25.3	< .001
Diabetes, %	6.6	7.5	.015	7.5	5.8	.004
Heart disease, %	13.3	15.0	.001	14.7	11.8	< .001
Smoking, %	31.9	25.0	< .001	6.6	58.9	< .001
Drinking, %	32.5	31.9	.880	11.7	54.7	< .001
ADL disability, %	16.7	21.8	< .001	19.2	14.1	< .001
IADL disability, %	21.7	26.4	< .001	26.3	16.9	< .001
CESD-9, M (SD)	8.07 (5.84)	7.23 (5.95)	0.136	9.04 (6.09)	7.03 (5.37)	< .001
Baseline grip strength, M (SD), kg	31.80 (9.95)	30.37 (10.52)	< .001	25.74 (6.81)	38.25 (8.63)	< .001

Loneliness, %	29.4	26.4	< .001	34.2	24.3	< .001
Social isolation, M (SD)	1.46 (0.85)	1.35 (0.93)	< .001	1.49 (0.85)	1.43 (0.84)	.001
Not married, %	16.4	26.7	< .001	21.3	11.2	< .001
No child or less than monthly contact with children, %	8.5	8.2	.767	8.0	9.1	.112
Live in the rural area, %	67.5	51.9	< .001	33.6	31.3	.042
Not participate in social activities, %	53.8	46.4	.064	53.8	53.7	.942

[a] *p* value for Chi-square tests (categorical variables) or independent sample t-tests (continuous variables)

M, mean; SD, standard deviation; ADL, activities of daily living; IADL, instrumental activities of daily living; CESD, Center for Epidemiologic Studies Depression scale.

Table 2 Linear regression for the grip strength at follow-up by gender

	Women (n = 3,625)						Men (n = 3,400)					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	B(SE)	β	B(SE)	β	B(SE)	β	B(SE)	β	B(SE)	β	B(SE)	β
Age	.05 (.02) **	.05	.05 (.02) **	.05	.05 (.02)**	.05	.06 (.02) **	.06	.06 (.02) **	.06	.06 (.02)**	.06
Education	.09 (.56)	.00	.26 (.57)	.01	.23 (.57)	.01	.86 (.40) *	.04	1.00 (.40) *	.04	1.00 (.41) *	.04
BMI	.02 (.03)	.01	.03 (.03)	.02	.03 (.03)	.02	.03 (.04)	.01	.04 (.04)	.02	.04 (.04)	.02
Hypertension	.03 (.27)	.00	.04 (.27)	.00	.03 (.27)	.00	−.05 (.32)	.00	−.06 (.32)	−.00	−.06 (.32)	−.19
Diabetes	−.52 (.45)	−.02	−.49 (.45)	−.02	−.47 (.45)	−.02	−.73 (.57)	−.02	−.66 (.57)	−.02	−.66 (.57)	−.02
Heart disease	.10 (.34)	.01	.15 (.34)	.01	.14 (.34)	.01	.41 (.42)	.02	.47 (.42)	.02	.47 (.42)	.02
Smoking	−.44 (.47)	−.02	−.43 (.47)	−.02	−.44 (.47)	−.02	−.23 (.27)	−.01	−.24 (.27)	−.02	−.24 (.27)	−.02
Drinking	.58 (.36)	.03	.60 (.36)	.03	.57 (.36)	.03	.11 (.27)	.01	.13 (.27)	.01	.13 (.27)	.01
ADL disability	−.39 (.33)	−.02	−.41 (.33)	−.02	−.41 (.33)	−.02	−.18 (.41)	−.01	−.20 (.41)	−.01	−.21 (.41)	−.01
IADL disability	.01 (.29)	.00	−.01 (.30)	.00	−.02 (.30)	−.00	.21 (.38)	.01	.19 (.38)	.01	.19 (.38)	.01
CESD−9	−.02 (.02)	−.02	.00 (.02)	.00	−.02 (.02)	−.02	−.05 (.03)	−.03	−.05 (.03)	−.03	−.06 (.03)	−.04
Loneliness	**.62 (.27)** *	**.04**	-	-	**.58 (.28)***	**.04**	.28 (.34)	.02	-	-	.19 (.34)	.01
Isolation	-	-	.26 (.14)	.03	.23 (.15)	.03	-	-	**.47** ** **(.16)**	**0.05**	**.46 (.16)** **	**.05**

***, $p < .001$; **, $p < .01$; *, $p < .05$