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ORIGINAL ARTICLE

Association between low handgrip strength and incontinence among Chinese middle-aged and older people: A cross-sectional study

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Abstract

Objective: Incontinence seriously affects the lives of middle-aged and older people. Pelvic floor muscle assessment is very important for incontinence, and handgrip strength can be used as an auxiliary diagnostic tool. Our study aims to find new cutoff points of handgrip strength as early indicators of incontinence and analyze the association between low handgrip strength and incontinence among Chinese middle-aged and older people.

Methods: Participants were recruited from the 2015 China Health and Retirement Longevity Study. Receiver operating characteristic (ROC) curves were used to find the handgrip strength cutoff point. Logistic regression analysis was performed to explore other incontinence-related risk factors.

Results: The study included 10,229 middle-aged and older people. Compared with normal handgrip strength participants, medium strength participants had 1.510 [men, 95% confidence interval (CI) = 1.017–2.243] and 1.792 (women, 95% CI = 1.294–2.480) times greater risk of incontinence, and low strength participants had 2.420 (men, 95% CI = 1.787–3.277) and 1.516 (women, 95% CI = 1.130–2.032) times greater risk of incontinence. Trend test results showed that the risk of incontinence increased with decreasing handgrip strength in middle-aged and older people.

Conclusions: Our study suggests that handgrip strength < 31 kg in men and < 20.5 kg in women is significantly associated with higher risk of incontinence in Chinese middle-aged and older people. The risk of incontinence increases with decreasing handgrip strength. Handgrip strength should be measured in routine physical examinations in middle-aged and older people for timely assessment and intervention in incontinence.

KEYWORDS
cutoff points, handgrip strength, incontinence, middle-aged, older

Lin Li and Feilong Chen contributed equally to this work and share first authorship.

1 | BACKGROUND

With the improvement of social living standards, the negative effect of incontinence on the quality of life and social dignity of the middle-aged and older population has become a serious medical and social problem.[1] Incontinence mainly includes urinary incontinence (UI) and fecal incontinence (FI). The International Continence Society (ICS) defines UI as the complaint of any involuntary leakage of urine, which brings inconvenience to patients in social activities and negatively affects personal hygiene.[2] Studies have found that the global incidence of UI in men is 5.4%,[3] whereas the incidence of UI in women varies from country to country. The incidence of UI in Chinese adult women is reported to be 30.9% and increases with age.[4] FI is defined as the involuntary loss or passage of solid or liquid stools.[5] Among older Brazilian people, the incidence of FI is reported to be 4.7% in men and 7.3% in women.[6] The incidence of FI is 0.43% in Chinese women and rises to 1.28% in Chinese women over 70 years old and increases further with age.[7] Current studies show that pelvic floor muscle (PFM) weakness is one of the main pathophysiological causes of UI.[8] Injury of the internal and external anal sphincters, combined with injury of the puborectalis muscle, is an important risk factor for FI.[9] Therefore, we considered that normal functioning of the PFM was the basis for maintaining control of urination and defecation.

The PFM assessment tools are generally invasive, subjective, and technically expensive. We aimed to find a simpler, more convenient, and objective indicator to determine the functional level of the PFM. The measurement of handgrip strength has been reported to be a good indicator of overall muscle strength[10] and can be used as an auxiliary diagnostic tool for PFM disorders.[11] Previous studies have shown an association between handgrip strength weakness and incontinence in older adults.[12] Our study aims to find new cutoff points of handgrip strength as early indicators of incontinence and analyze the association between low handgrip strength and incontinence among Chinese middle-aged and older people.

2 | METHODS

2.1 | Participants and data collection

Data were obtained from the 2015 waves of the China Health and Retirement Longevity Study (CHARLS). The sampling methods and quality control measures can be found elsewhere.[13] In total, 10,229 participants were included, including 4152 men and 6077 women. The study was approved by the Biomedical Ethics Committee of Peking University (IRB00001052-11015). All participants signed a written informed consent form before participating in the survey.

2.2 | Handgrip strength measurement

Handgrip strength was measured using dynamometers. The participants were instructed to grasp the dynamometer firmly and hold it for a few seconds while the force was recorded and then release it. The handgrip strength of each hand was measured twice, and the average value for each hand was calculated. The higher average value for the two hands was used as the final handgrip strength measurement. If handgrip strength was measured on the one hand, the final result was the average value of the two measurements.

According to the Asian Sarcopenia Working Group (AWGS) consensus in 2019,[14] one of the diagnostic criteria for sarcopenia is handgrip strength below 28 kg for men and 18 kg for women. Univariate logistic regression analysis was performed and the results showed that the optimal cutoff points for handgrip strength were 31 kg for men and 20.5 kg for women based on receiver operating characteristic (ROC) curves and the highest Youden index (Figures S3 and S4). Therefore, our study classified handgrip strength into three groups: low (men = < 28 kg and women = < 18 kg), medium (men = 28–31 kg and women = 18–20.5 kg), and normal (men = >31 kg and women = >20.5 kg).

2.3 | Definition of incontinence status

In this study, incontinence status was assessed through answers to the question "Do you have any difficulties with controlling urination or defecation?" in the questionnaire. A negative answer was defined as no incontinence; having difficulty controlling or being unable to control urination and defecation was defined as having incontinence.

2.4 | Covariates

Covariates included demographic factors [age, sex, body mass index (BMI), and setting], lifestyle characteristics (smoking history and alcohol intake), physical ability (able to climb stairs or pick up small coins), and disease history (respiratory system, renal system, and mental diseases).

BMI was categorized into three groups: underweight (BMI = < 18.5 kg/m^2), normal weight (18.5 kg/m^2 ≤ BMI < 24 kg/m^2), and overweight or obesity (BMI ≥ 24 kg/m^2).[15] The setting was categorized as either city or rural. Smoking was defined as a positive answer to the question "Have you ever chewed tobacco, smoked a pipe, smoked self-rolled cigarettes, or smoked cigarettes/cigars?" Participants who had drunk any alcoholic beverages, such as beer, wine, or liquor, in the past year were defined as drinking. Participants with a history of chronic lung diseases, such as chronic bronchitis, emphysema, or asthma, were recognized as having a history of respiratory system diseases. Mental diseases included emotional, nervous, or psychiatric problems or memory-related diseases, such as Alzheimer's disease, brain atrophy, or Parkinson's disease. Renal diseases included any problems related to the kidneys. A series of questions to assess the physical activity ability of the participants in their daily life was also included in the questionnaire.

2.5 | Statistical analysis

The SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) and R version 4.2.2 MatchIt packages were used for statistical analysis. The continuous variables are described by the mean ± standard deviation, and Student's *t* test was used for comparisons between groups. Categorical data were summarized by numbers and percentages and were compared using the χ^2 test.

To clearly illustrate the association between handgrip strength and incontinence status, we modeled handgrip strength against incontinence and used a restricted cubic spline with three knots located at the 25th, 50th, and 75th percentiles to flexibly model the underlying relationship.

The logistic regression model was used to explore the association between handgrip strength and incontinence status stratified by sex. Two models were processed: model 1 did not adjust for any confounders; model 2 adjusted for age, BMI, smoking history, alcohol intake, setting, physical activity ability, and disease history, using odds ratios (ORs) and their 95% confidence intervals (CIs) to estimate their association. Additionally, trend test, which was conducted using a general linear model, was performed to examine the linear association between handgrip strength and incontinence.

A propensity score (PS) approach was used to control for observed confounding factors that might influence both exposure and outcome.[16] The PS was estimated using a logistic regression model with incontinence status as the dependent variable in relation to the following baseline characteristics: age, BMI, smoking history, alcohol intake, setting, physical activity ability, and disease history. We further performed PS matching (PSM) analysis to reconfirm the association between handgrip strength and incontinence status stratified by sex. We used a 1:4 matching ratio algorithm without replacement to match the incontinence and non-incontinence groups on PS within a caliper of 0.2 standard deviations of the logit of the PS.[17] Standard mean differences (SMDs) and *P* values were used to test the equilibrium; SMD > 0.1 and $P < 0.05$ were considered to indicate significant imbalance. Next, the same logistic regression models that adjusted all covariates were used to reconfirm the results obtained in the above model based on the PSM data set.

All tests were two-sided; *P* values less than 0.05 were considered significant.

3 | RESULTS

3.1 | Characteristics of participants

In total, 10,229 participants were included in this study, including 4152 men and 6077 women, with an average age of 62.20 years and a standard deviation of 10.05 years. Individuals aged < 45 ($n = 581$) and those with missing information on handgrip strength ($n = 2929$) and incontinence status ($n = 7323$) were excluded. The prevalence of incontinence was 7.42% (308/4152) among men and 5.41% (329/6077) among women (Figure 1). As shown in Table 1, significant differences in age were found between the incontinence and non-incontinence groups. There were statistical associations between handgrip strength and incontinence in both sexes. Additionally, there were significant differences in the distribution of different physical function indexes between the incontinence and non-incontinence groups. The prevalence of incontinence in people with good physical function was significantly lower than that in those in poor physical condition in both sexes.

3.2 | Association of handgrip strength with incontinence status by sex

A linear relationship between handgrip strength and incontinence was found both in men (*P* for nonlinearity = 0.119) and women (*P* for nonlinearity = 0.117), as shown in Figure 2.

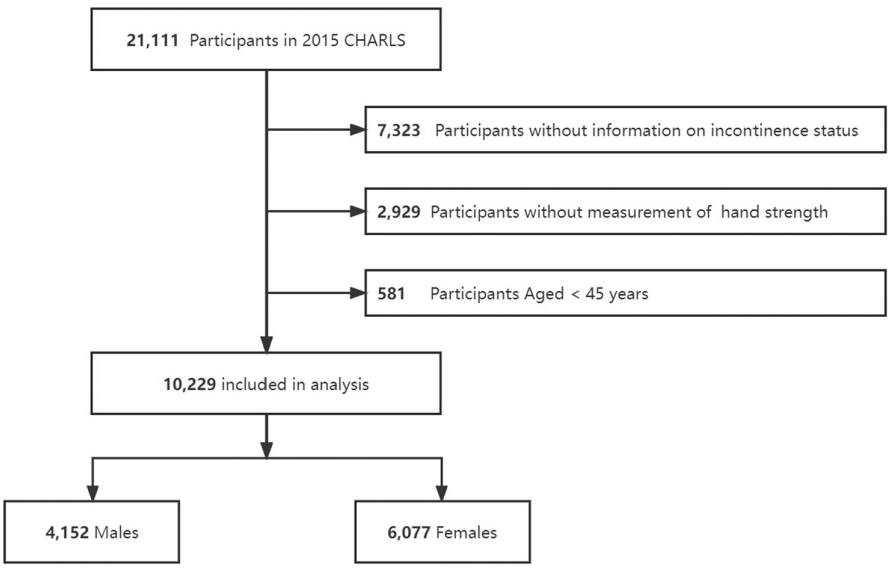

FIGURE 1 Flow chart of participant selection. CHARLS, China Health and Retirement Longevity Study.

TABLE 1 Characteristics of participants.

Variables	Male			Female		
	Not incontinence	Incontinence	*P* value	Not incontinence	Incontinence	*P* value
Total	3844	308	<0.001	5748	329	<0.001
Age, y	63.1 ± 9.85	67.5 ± 10.00		61.1 ± 9.97	65.0 ± 10.59	
Hand strength, kg	34.71 ± 8.79	28.68 ± 9.64		23.54 ± 6.71	20.50 ± 6.53	
Hand strength, kg						
Low strength	798 (84.71)	144 (15.29)	<0.001	1082 (90.85)	109 (9.15)	<0.001
Middle strength	483 (91.13)	47 (8.87)		679 (92.26)	57 (7.74)	
Normal strength	2563 (95.63)	117 (4.37)		3987 (96.07)	163 (3.93)	
Age, y						
<60	1559 (95.82)	68 (4.18)	<0.001	2830 (96.00)	118 (4.00)	<0.001
60–70	1371 (92.14)	117 (7.86)		1889 (94.83)	103 (5.17)	
≥70	914 (88.14)	123 (11.86)		1029 (90.50)	108 (9.50)	
BMI						
Emaciation	280 (88.33)	37 (11.67)	0.005	326 (91.57)	30 (8.43)	0.017
Normal	2005 (3.39)	142 (6.61)		2466 (94.99)	130 (5.01)	
Overweight or obesity	1510 (92.87)	116 (7.13)		2904 (95.06)	151 (4.94)	
Waist circumference, cm						
≥90 (male)/85 (female)	1431 (92.98)	108 (7.02)	0.450	3282 (94.80)	180 (5.20)	0.395
<90 (male)/85 (female)	2413 (92.35)	200 (7.65)		2466 (94.30)	149 (5.70)	
Smoke						
No	3409 (92.28)	285 (7.72)	0.038	5665 (94.59)	324 (5.41)	0.812
Yes	435 (94.98)	23 (5.02)		83 (94.32)	5 (5.68)	
Drink						
No	1792 (91.15)	174 (8.85)	<0.001	4935 (94.79)	271 (5.21)	0.079
Yes	2052 (93.87)	134 (6.13)		813 (93.34)	58 (6.66)	
Living area						
City	595 (94.15)	37 (5.85)	0.101	912 (96.00)	38 (4.00)	0.041
Village	3242 (92.29)	271 (7.71)		4810 (94.37)	287 (5.63)	
Marriage status						
Married	3386 (92.74)	265 (7.26)	0.379	912 (96.00)	38 (4.00)	<0.001
Divorced	53 (92.98)	4 (7.02)		4810 (94.37)	287 (5.63)	
Widow	342 (91.94)	30 (8.06)		912 (96.00)	38 (4.00)	
Unmarried	63 (87.50)	9 (12.50)		4810 (94.37)	287 (5.63)	
Able to climb several stairs						
No	620 (83.22)	125 (16.78)	<0.001	1261 (89.75)	144 (10.25)	<0.001
Yes	3169 (94.71)	177 (5.29)		4389 (96.00)	183 (4.00)	
Able to pick up a small coin						
No	77 (68.14)	36 (31.86)	<0.001	134 (74.44)	46 (25.56)	<0.001
Yes	3765 (93.29)	271 (6.71)		5600 (95.24)	280 (4.76)	
History of respiratory disease						
No	3183 (93.34)	227 (6.66)	<0.001	5126 (94.98)	271 (5.02)	<0.001
Yes	661 (89.08)	81 (10.92)		622 (91.47)	58 (8.53)	
History of renal disease						
No	3743 (93.09)	278 (6.91)	<0.001	5389 (94.84)	293 (5.16)	<0.001
Yes	101 (77.10)	30 (22.90)		359 (90.89)	36 (9.11)	

(Continues)

TABLE 1 (Continued)

Variables	Male			Female		
	Not incontinence	Incontinence	*P* value	Not incontinence	Incontinence	*P* value
History of mental disease						
No	3533 (93.34)	252 (6.66)	<0.001	5579 (94.83)	304 (5.17)	<0.001
Yes	311 (84.74)	56 (15.26)		169 (87.11)	25 (12.89)	

Abbreviation: BMI, body mass index.

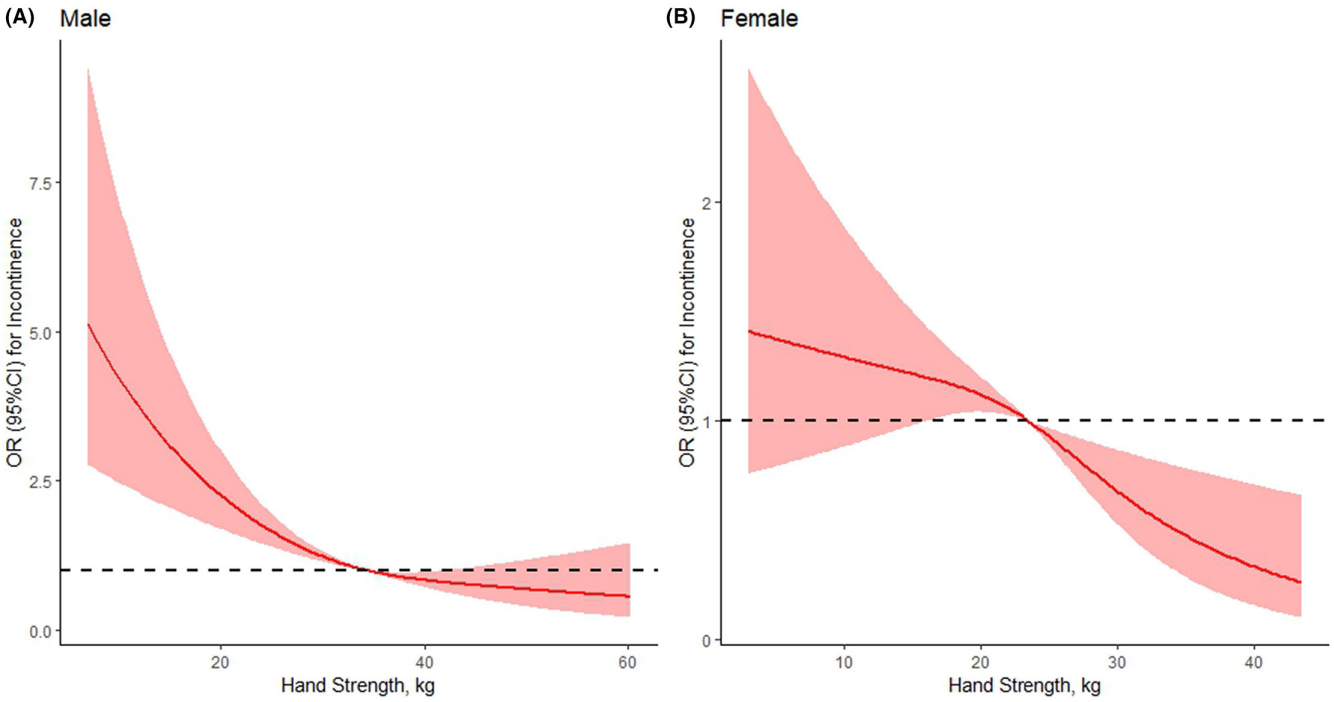

FIGURE 2 Association of calf circumference and incontinence by sex. (A) Hand strength restricted cubic spline regression with three knots in male participants; the red solid line represents association between hand strength and incontinence, and the shaded areas are 95% CIs. The *P* value is for nonlinear = 0.119. (B) Hand strength restricted cubic spline regression with three knots in female participants; the red solid line represents association between hand strength and incontinence, and the shaded areas are 95% CIs. The *P* value is for nonlinear = 0.117. CI, confidence interval; OR, odds ratio.

The logistic regression results indicated that a significant association exists between handgrip strength and incontinence status (Table 2). Univariate analysis showed that compared with participants with normal handgrip strength, the risk of incontinence for men with medium handgrip strength was increased by 107.2% (OR = 2.072, 95% CI = 1.424–2.960), and for men with low handgrip strength, the risk was increased by 286.3% (OR = 3.863, 95% CI = 2.999–4.985). For female participants, those with medium handgrip strength and low handgrip strength had a 2.053 (95% CI = 1.502–2.806) and 2.464 (95% CI = 1.916–3.169) times greater risk of incontinence, respectively, than those with normal handgrip strength. After adjusting for covariates, the ORs decreased in both men and women; however, a significant association still existed. Compared with participants with normal handgrip strength, people with medium handgrip strength had a 1.510 (men, 95% CI = 1.017–2.243) and 1.792 (women, 95% CI = 1.294–2.480) times greater risk of incontinence.

3.3 | Propensity-matched analysis

PSs were calculated for all 4152 male and 6077 female participants. The distributions of PSs are summarized in Figures S1 and S2, of which 1319 male and 1462 female participants were matched. The matched groups were found to be well balanced for all the demographic baseline variables (Tables S1 and S2).

To reconfirm the association between handgrip strength and incontinence status, we verified the results in male- and female-matched populations. Using the logistic regression method and adjusting for covariates, low (OR = 1.538, 95% CI = 1.005–2.353) and medium (OR = 2.574, 95% CI = 1.852–3.577) handgrip strength were still significantly associated with incontinence in men. Meanwhile, for women, the risk of incontinence increased by 51.8% (OR = 1.518, 95% CI = 1.106–2.984) and 112.4% (OR = 2.124, 95% CI = 1.462–3.087) in those with medium handgrip strength and low handgrip

TABLE 2 Association of hand strength and incontinence by gender.

	Normal hand strength	Middle hand strength	Low hand strength
Male overall participants			
Model 1	1 (reference)	2.072 (1.424, 2.960)[a]	3.863 (2.999, 4.985)[a]
Model 2	1 (reference)	1.510 (1.017, 2.243)[a]	2.420 (1.787, 3.277)[a]
Male matched participants			
Model 1	1 (reference)	2.366 (1.777, 3.151)[a]	1.457 (0.966, 2.197)
Model 2	1 (reference)	2.574 (1.852, 3.577)[a]	1.538 (1.005, 2.353)[a]
Female overall participants			
Model 1	1 (reference)	2.053 (1.502, 2.806)[a]	2.464 (1.916, 3.169)[a]
Model 2	1 (reference)	1.792 (1.294, 2.480)[a]	1.516 (1.130, 2.032)[a]
Female matched participants			
Model 1	1 (reference)	1.435 (1.070, 1.923)[a]	1.999 (1.401, 2.851)[a]
Model 2	1 (reference)	1.518 (1.106, 2.984)[a]	2.124 (1.462, 3.087)[a]

Note: Model 1 did not adjust any confounders. Model 2 adjusted age, BMI, smoking and drinking habits, living area, physical activity abilities (able to climb several stairs or pick up small coins) and history of diseases (including diseases of respiratory system, renal system and mental system).
Abbreviation: BMI, body mass index.

strength, respectively, compared with normal handgrip strength. The results obtained for the matching population were completely consistent with those of the original population.

4 | DISCUSSION

This study is the first to investigate the association between handgrip strength and incontinence in the Chinese middle-aged and older population. The results indicate that low handgrip strength was significantly associated with incontinence. A handgrip strength of less than 31 kg in men and less than 20.5 kg in women were identified as risk factors for incontinence. The risk of incontinence increased with the decrease in handgrip strength in middle-aged and older people.

Incontinence is a condition that increases in frequency with aging and significantly diminishes quality of life for middle-aged and older people. The etiology of incontinence is complex and varied, with vaginal delivery and aging identified as important risk factors that impair the normal function of the PFM. The PFM comprises the levator ani complex and coccygeus muscle, which can counteract gravitational force and resist intra-abdominal pressure, thereby providing support for the pelvic and abdominal viscera and aiding in urinary and fecal continence.[18] The evaluation of PFM is of great significance to the study of incontinence. Studies have shown that the loss of muscle strength with age exceeds that of muscle mass,[19] so the measurement of PFM strength is particularly important. Currently, handgrip strength is widely recognized as an evaluation index of muscle strength,[20] and studies have shown that there is a positive correlation between handgrip strength and PFM strength and that low handgrip strength may be a marker for PFM weakness.[21] Our study selected handgrip strength as a screening index, and logistic regression analysis was used to examine the association between handgrip strength and incontinence. Based on the sensitivity, specificity, and Youden index of the ROC curve, the optimal cutoff point of handgrip strength was 31 kg for men and 20.5 kg for women, meaning that the risk of incontinence in men with handgrip strength < 31 kg and women with handgrip strength < 20.5 kg was significantly higher than that in men with handgrip strength >31kg and women with handgrip strength >20.5kg. A Spanish study in older people in 2022 showed that the handgrip strength of people with UI was significantly lower than that of people without UI, which was statistically significant and consistent with our findings.[22]

Studies have shown that sarcopenia may increase older adults' susceptibility to incontinence because it causes weakness of the abdominal and pelvic floor muscles,[23] which suggests a correlation between sarcopenia and incontinence. The Chinese expert consensus on diagnosis and treatment for elderly individuals with sarcopenia (2021) indicated that low handgrip strength is essential for the diagnosis of sarcopenia, with low handgrip strength defined in men as < 28 kg and in women as < 18 kg.[20] Our study selected the above handgrip strength values as the second cutoff point. The participants were divided into three groups: low handgrip strength (men = < 28 kg and women = < 18 kg), medium handgrip strength (men = 28–31 kg and women = 18–20.5 kg), and normal handgrip strength (men = >31kg and women = >20.5kg). The results showed that, compared with the normal hand-strength group, people with medium handgrip strength had a 1.510 times (men) and 1.792 times (women) greater risk of incontinence, and people with low handgrip strength had a 2.420 times (men) and 1.516 times (women) greater risk of incontinence.

A trend test found that the risk of incontinence decreased with increasing handgrip strength in middle-aged and older people. We speculated that handgrip strength gradually declined with aging; when it declined to the first critical value (< 31 kg for men and < 20.5 kg for women), there may have been no change in PFM

mass, but PFM strength may have declined. If so, the risk of incontinence would begin to increase. Without effective muscle strength exercises, it is likely that handgrip strength would continue to decline to the second critical value (<28 kg for men and <18 kg for women), which may indicate the development of sarcopenia involving a serious loss of both PFM mass and strength and thus leading to a higher risk of incontinence. The threshold for low handgrip strength of <31 kg in men and <20.5 kg in women proposed in this study was higher than the diagnostic cutoff value of handgrip strength in sarcopenia and had more significance for the risk of incontinence in middle-aged and older people. We suggest carrying out large-scale screening of handgrip strength during physical examination of middle-aged and older people. When handgrip strength progressively declines to the first critical value, exercise interventions should be used to improve physical function; for example, resistance exercise and aerobic exercise can effectively improve muscle strength.[24] Physical activity may strengthen the PFM during training, as increased intra-abdominal pressure promotes a simultaneous precontraction of the pelvic floor, which may result in training/strengthening.[8] In addition, pelvic floor exercises, such as Kegel exercises, should be carried out to combat the occurrence of incontinence. When handgrip strength continues to decline to the second critical value, sarcopenia may be present. It is then necessary to conduct professional systematic clinical examination and treatment. Exercise combined with nutritional intervention can prevent and treat sarcopenia, as well as reduce the incidence of incontinence caused by sarcopenia.[24]

A limitation of this study is that it is cross-sectional and not specifically designed for incontinence. The incontinence-related data are incomplete, and data from the International Consultation on Incontinence Questionnaire (ICIQ) are lacking. To clarify the relationship between handgrip strength and incontinence in the middle-aged and older population, large-scale prospective longitudinal controlled studies should be designed to obtain conclusions with a higher level of evidence.

5 | CONCLUSIONS

Handgrip strength as a convenient screening index is closely related to incontinence in the Chinese middle-aged and older population. This study proposes for the first time that a handgrip strength of <31 kg in men and <20.5 kg in women is significantly associated with a higher risk of incontinence, and the risk of incontinence increases with decreasing handgrip strength. We suggest the measurement of handgrip strength in routine physical examinations of middle-aged and older people for timely assessment and intervention in incontinence.

AUTHOR CONTRIBUTIONS

Wrote the manuscript and designed the study: Li. Wrote the manuscript and performed the statistical analysis: Chen. Contributed to the conception and design of the study: Wang. Designed the study and performed the statistical analysis: Xu. Organized the database: Liu. Built the model: Gao. All the authors have read and approved the final draft.

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FUNDING INFORMATION

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CONFLICT OF INTEREST STATEMENT

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

DATA AVAILABILITY STATEMENT

The data underlying this article will be shared upon reasonable request to the corresponding author, Tao Xu (Email: xutaosd@126.com).

ETHICS STATEMENT

The study was approved by the Biomedical Ethics Committee of Peking University (IRB00001052-11015).

CONSENT TO PARTICIPATE

All participants signed a written informed consent form before participating in the survey.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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