MALNUTRITION AND PHYSICAL FRAILTY AMONG NURSING HOME RESIDENTS: A CROSS-SECTIONAL STUDY IN CHINA

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Abstract: *Objectives:* To assess the association between malnutrition and physical frailty among nursing home older adults in China. *Design and setting:* A cross-sectional study in 15 nursing homes in Changsha, China. *Participants:* A total of 705 nursing home residents who were aged 60 and older. *Measurements:* Physical frailty was identified based on the following five components: slow gait speed, low physical activity, weight loss, exhaustion, and low grip strength. Nutritional status was assessed using the Mini Nutritional Assessment. Multinomial logistic regression models were used to analyze the association between nutritional status and physical frailty. *Results:* The mean (SD) age of the participants was 82.5 (8.1) years old (range, 60-106 years), and 226 (32%) was men. Of those participants, 5.1% and 55.6% were malnourished and at risk of malnutrition, respectively; 60.3% and 36.2% were identified as being frail and prefrail, respectively. Compared with participants who were well-nourished, those who were at risk of malnutrition or malnourished were two times more likely to be physically frail (adjusted odds ratio 2.66, 95% confidence interval 1.01 to 7.00), after adjustment for age, education level, cognitive status, depressive symptoms, and disability in activities of daily living. No significant association was observed between malnutrition and physical prefrailty. *Conclusion:* Our findings suggest that poor nutritional status and physical frailty are highly prevalent in nursing home older adults in China, and that poor nutritional status is associated with increased odds of physical frailty.

Key words: Frailty, malnutrition, nursing home, older adults, Chinese.

Introduction

Physical frailty is characterized by increased vulnerability to poor resolution of homeostasis after a stressor event, which confers an increased risk of adverse outcomes, including falls, delirium, disability, and death (1-3). Physical frailty is highly prevalent among community-dwelling older adults (1) and has been reported to affect approximately 52% of nursing home residents from different countries (e.g., Brazil, Spain, Lebanon, Egypt, Poland and the Netherlands) in a systematic review and meta-analysis (4). Since physical frailty is reversible (5), identification of modifiable risk factors of physical frailty is of substantial clinical interest.

Considerable interest has been directed towards nutrition in terms of the prevention of physical frailty in older adults in recent years (6, 7). Several epidemiological studies among community-dwelling older adults have reported that malnutrition was significantly associated with increased odds of physical frailty (8, 9). Malnutrition is a state of deficiency, imbalance, or excess of protein, energy, or other nutrients that contribute to adverse health and psychosocial outcomes (10, 11). A recent meta-analysis of studies in community-dwelling older adults also reported that approximately two thirds of malnourished older adults were physically frail (9). Nevertheless, epidemiologic data investigating this association among nursing home older adults are sparse. A meta-analysis of 10 studies from different countries (e.g., Belgium, Germany, Turkey, Spain, Mexico and Russia) reported that malnutrition

was greatly associated with physical frailty (9). To the best of our knowledge, no study has investigated this association in nursing home older residents in China, a country with the rapid aging and small-scale families where older adults are known to be more likely to choose to spend their later years in the nursing homes (12, 13). Therefore, the present study aimed to investigate the association between malnutrition/nutritional risk status and physical frailty in a population of nursing home older adults in China.

Methods

Study design and Population

We conducted a cross-sectional study among older adults who were aged 60 and older and resided in 15 nursing homes in Changsha, Hunan province, China. Changsha is a middle-sized provincial city with a population of eight million in the central region of China, characterized as having low population mobility and a conventional Chinese lifestyle. During the period of January and December 2018, we administered a survey comprising a questionnaire, anthropometric measurements, and physical fitness tests. The assessments and tests were conducted by well-trained registered nurses. Before the beginning of the survey, all staffs were trained according to standard protocols for organizing the assessment measures and tests. During the survey, we contacted all the older residents by sending brochures (n = 1973). A total of 1527 residents agreed to participate, with a participating rate

77.4%. Of those, 1027 were able to complete the survey, except for those who had died or retired from those nursing homes (n = 500) when the time of baseline survey. For the present study, we excluded participants who had a history of dementia (n = 7), Parkinson's disease (n = 12), stroke (n = 78), or a Mini-Mental State Examination (MMSE) score < 18 (n = 57) from the final analyses. Of the remaining 873 participants, 168 were further excluded from the sample due to having missing data on any components of physical frailty. Thus, the final sample consisted of 705 older men and women (Figure 1). The study protocol was approved by the Institutional Review Board of behavioral and nursing research in Xiangya Nursing School of Central South University (2019008), and written informed consent was obtained from all participants.

Figure 1
Assembly of the study sample
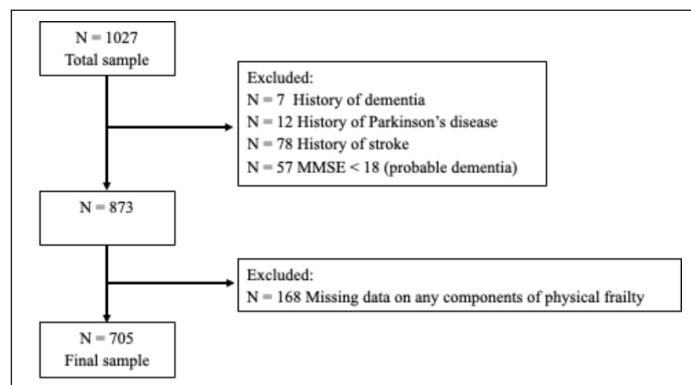
Measures

Physical frailty

The phenotype of physical frailty was operationalized according to the criteria of Fried and colleagues (2): slow gait speed, low physical activity, weight loss, exhaustion, and low grip strength. *Slowness* was determined in a 5-m walking test at maximum speed, with the results stratified by sex and standing height. For men, height less than 173 cm (≥ 7 s) and height more than 173 cm (≥ 6 s) were considered the cut-off for slowness. For women, height less than 159 cm (≥ 7 s) and height more than 159 cm (≥ 6 s) were considered the cut-off for slowness. Starting from a stationary position, the participants walked 11 m on the entire lane at maximum speed without running in two trials, and the time (sec) of gait speed was measured with a digital stopwatch between the third and eighth meters in each trial. And the final gait speed (m/sec) was calculated by dividing 5 (m) by the shortest task time in the two trials (14). *Low physical activity* (15) was calculated using a weighted score of kilocalories expended per week. The Chinese version of the Physical Activity Scale for the Elderly (PASE) questionnaire (16), consisting of nine items, was used to collect the physical activity data. This variable was stratified by sex.

For men, PASE scores less than 97.3 points was considered the cut-off for low physical activity. For women, PASE scores less than 85.4 points was considered the cut-off for low physical activity. *Weight loss* was defined as a participant losing more than 4.5 kg unintentionally (i.e., not through dieting or exercise) during the previous year. If the participant answered yes, they were considered as frail. Exhaustion was determined to ask two questions: "I felt that everything I did was an effort" (in the past month) and "I could not get going." *Exhaustion* was also determined on the basis of how participants responded to a question on how often they felt this way in the previous week. The participants answered the questions on a 4-point scale: 0 = rarely or none of the time (< 1 day), 1 = some or a little of the time (1-2 days), 2 = a moderate amount of the time (3-4 days), or 3 = most of the time. Subjects responding with a two or three to any of these questions were categorized as meeting the exhaustion criterion. *Weakness* was assessed using a handgrip dynamometer. The participants were asked to perform two squeezes with the dynamometer, using the dominant hand. The best performance, recorded as strength in kilograms per square centimeter, was used for analysis. Cut-off scores were stratified by sex and body mass index (BMI) quartiles according to the criteria of Fried and colleagues (2). For men, hand grip strength less than 29 kg (BMI ≤ 24), 30 kg (BMI = 24.1-28.0), or 32 kg (BMI > 28) was considered the cut-off for weakness. For women, hand grip strength less than 17 kg (BMI ≤ 23.0), 17.3 kg (BMI = 23.1-26.0), 18 kg (BMI = 26.1-29.0), or 21 kg (BMI > 29.0) was considered the cut-off for weakness. Subjects with three or more affected components were considered frail, those with one or two affected components were considered prefrail, and those without any affected components were considered robust.

Nutritional status

We assessed the nutritional status of the participants by using the Chinese version of the Mini Nutritional Assessment (MNA) (17, 18). The full MNA is an effective and validated screening tool for assessing the nutritional status of older people, and it can provide additional information about the causes of malnutrition in those identified as malnourished or at risk of malnutrition. The MNA takes 10-15 minutes to complete; it addresses nutritional intake, involuntary weight loss, mobility, psychological stress or acute disease, neuropsychological problems, and BMI or calf circumference. The height, weight and calf circumference were measured by trained nurses, and individual BMI was calculated according to body weight (in kilograms) divided by height (in meters) squared. The participants were divided into three categories (total score = 30): normal nutritional status (< 17), at risk of malnutrition (17-23.5), or malnourished (> 23.5). Being malnourished or at risk of malnutrition was regarded as having poor nutritional status.

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Table1
Characteristics of the sample according to the three nutritional status groups

Variables	N	Well-nourished (N=277)	At risk of malnutrition (N=392)	Malnutrition (N=36)	P-value*
Age, mean (SD), years	705	82.9 (7.1)	82.4 (8.8)	81.3 (8.6)	0.061
Gender					0.015
Men, %	226	35.0	31.9	11.1	
Women, %	479	65.0	68.1	88.9	
Living status					0.365
Living with husband/wife, %	201	28.2	27.8	38.9	
Living with alone or others, %	504	71.8	72.2	61.1	
Marital status					0.839
Married, %	146	21.7	20.4	16.7	
Widowed, %	545	76.5	77.6	80.6	
Divorce, %	7	1.1	0.8	2.8	
Others (never married), %	7	0.7	1.3	0.0	
Education level					0.004
Elementary or below, %	309	40.1	46.7	41.7	
Junior or senior high, %	278	36.5	41.3	41.7	
College or above, %	118	23.5	12.0	16.7	
Comorbidities					0.027
No comorbidity, %	35	5.1	5.1	2.8	
1-2 comorbidity, %	240	39.7	31.6	16.7	
≥3 comorbidities, %	430	55.2	63.3	80.6	
Cognitive status					0.029
Normal cognitive, %	97	18.1	11.0	11.1	
Cognitive impairment, %	608	81.9	89.0	88.9	
Depressive symptoms					<0.001
Normal, %	297	57.0	34.9	5.6	
Risk of depression, %	408	43.0	65.1	94.4	
ADL and disability					<0.001
Not disabled, %	39	11.2	2.0	0.0	
Disabled for ≥1 ADL, %	666	88.8	98.0	100.0	
Polypharmacy					<0.001
>3 medications/day, %	342	63.5	43.9	41.7	
≤3 medications/day, %	363	36.5	56.1	58.3	

Note. SD=standard deviation, ADL=activities of daily living; * The one-way analysis of variance test for continuous variables and chi-square test for categorical variables

Covariates

Sociodemographic variables were measured using the questionnaire, including age, sex, marital status, living status (e.g., living with husband/wife), and education level; physical health status was estimated according to the number of comorbidities (with the self-report of a medical disorder diagnosed and treated by a physician being recorded). Cognitive function was measured by using the Chinese version of MMSE (19). The MMSE tests were administered to the participants by well-trained nurses, with the total score < 24 indicating cognitive impairment. Depressive symptom was measured by using the Geriatric Depression Scale (GDS) (20), with a total score ≥ 11 indicating clinically significant depressive symptom. Activities of daily living (ADL) ability was measured by using

the Katz scale (21), including bathing, dressing, toileting, transferring, continence and feeding. ADL disability was defined as shaving difficulty and/or requiring assistance in ≥ 1 activities. Polypharmacy was considered to be current use of ≥ 3 prescribed medications on a regular basis. The information on history of dementia, Parkinson's disease, and stroke were collected from the medical record.

Statistical analysis

Characteristics of the sample were summarized by nutritional status groups. The values were presented as percentages for categorical variables and means (standard deviations) for continuous variables. Comparisons of the characteristics among the three groups of nutritional status were made by using the Chi-square tests for categorical variables and one-way analysis of variance for continuous variables.

Multinomial logistic regression analysis was carried out to examine the association between malnutrition and physical frailty. A multivariable-adjusted model was run to estimate the odds ratio (OR) and 95% confidence interval (CI) for the risk of physical frailty. The following covariates were entered into the multivariable model in a stepwise backward fashion: sociodemographic indicators: age (continuous), living status (living with husband/life, or living with alone or others), education level (elementary or below, junior or senior high, or college or above), cognitive impairment (yes or no), depressive symptom (yes or no), and ADL disability (yes or no). Multicollinearity between independent variables in the multivariable model was ruled out by using the variance inflation factor (VIF) test, with a value less than 2 indicating as appropriate. All statistical analyses were performed using IBM SPSS Statistics Version 24.0 (IBM; Armonk, NY, USA). All p-values were two-tailed, and p < 0.05 was considered statistically significant.

Results

The mean (SD) age of the 705 participants included in the final sample was 82.5 (8.1) years old (range 60-106) and 226 (32%) was men. Of those participants, 5.1% were malnourished and 60.7% were at risk of malnutrition. In all, 36.2% were identified as being prefrail, and 60.3% were being frail. Table 1 shows the characteristics of participants according to nutritional status subgroups. Compared with individuals who were well-nourished, those who were at risk of malnutrition or malnourished were more likely to be women, widowed, and low-educated, and had a higher rate of comorbidity, cognitive impairment, being depressed, ADL disability, and polypharmacy (Table 1).

Table 2 shows the results of multinomial logistic regression analyses on the association between nutritional status and physical frailty. Compared with participants who were well-nourished, those who were at risk of malnutrition or malnourished had a twofold higher risk of being (OR = 2.66,

95% CI = 1.01-7.00). No significant association was observed for the association between poor nutritional status and prefrailty (OR = 1.35, 95% CI = 0.52-3.53). The following variables were also significantly associated with an increased risk of being physical frail: older age, having depressive symptom, and cognitive impairment. In addition, age and ADL disability were strongly associated with high risk of being prefrailty and frailty.

Discussion

The present study observed a highly prevalent poor nutritional status and physical frailty among the nursing-home older adults in China. Our data demonstrated that malnutrition/ nutritional risk status was strongly associated with increased odds of physical frailty. In addition, cognitive impairment, depressive symptom, and ADL disability were also significantly associated with physical frailty. To the best of our knowledge, this study was one of few studies to investigate the association between malnutrition and physical frailty among nursing home older adults in China.

Prevalence of poor nutritional status and physical frailty

Our results showed that a high prevalence of poor nutritional status and physical frailty in this study. The overall prevalence of malnutrition or risk of malnutrition in this study was higher than that reported in a study of Belgium 1188 nursing-home elderly people (55.6% versus 19.4%) (22) which used the same screening measurement for malnutrition. Meanwhile, in our study, the prevalence of frailty and prefrailty were 60.3% and 36.2%, respectively. Using the Fried's criteria, in a cohort of institutionalized older adults the prevalence was of frailty was 68.8% in Spain (23) more than our study among the older people residing in nursing homes in China. Moreover, a study among the community-dwelling older people (24) reported that 7% of adults aged 60 years or older were frail by physical frailty phenotype in China. Indeed, the nursing-home population may be more frail and malnourished because of limited access to the scientific management models and the health care services in China (25, 26). Therefore, policymakers and administrators could evaluate the frail older adults' expected course based on information about the prevalence of poor nutritional status and physical frailty among the nursing-home elderly people in this study.

Association between malnutrition/nutritional risk status and physical frailty

We confirmed a strong association between poor malnutrition/nutritional risk status and physical frailty. Our results were in line with those reported by a study based on two nursing homes in Japan (27). For the community-dwelling elderly people in Singapore, two studies had suggested a significant association between nutritional status and frailty (8, 28). Moreover, for community-dwelling older adults (n = 1200) living in a rural setting, another study demonstrated that frailty

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Table 2
Variables showing statistically significant associated with prefrailty/frailty in multinomial logistic regressions models (n = 705)

Variables	Frailty Status			
	Prefrailty vs. Robust		**Frailty vs. Robust**	
	OR (95% CI)	**P**	**OR (95% CI)**	**P**
Nutritional status (MNA)				
Well-nourished	1.00 (reference)		1.00 (reference)	
At risk of nutrition & malnourished	1.35 (0.52-3.53)	0.54	2.66 (1.01-7.00)	0.05
Age (per 1 unit increment)	1.06 (1.01-1.12)	0.02	1.10 (1.04-1.16)	<0.001
Education level				
college or above	1.00 (reference)		1.00 (reference)	
Junior or senior high	1.91 (0.29-2.88)	0.87	1.76 (0.54-5.79)	0.35
Elementary or below	1.02 (0.31-3.34)	0.97	1.62 (0.48-5.44)	0.44
Cognitive function				
Normal cognitive	1.00 (reference)		1.00 (reference)	
Cognitive impairment	0.73 (0.27-1.96)	0.54	0.31 (0.11-0.86)	0.03
Depression symptoms				
No	1.00 (reference)		1.00 (reference)	
Yes	0.66 (0.24-1.83)	0.43	0.31 (0.11-0.87)	0.03
ADL disability				
No	1.00 (reference)		1.00 (reference)	
Yes	0.25 (0.09-0.70)	0.009	0.09 (0.02-0.31)	<0.001

Note. OR = Odds ratio, 95% CI = 95% confidence interval, MNA=Mini Nutritional Assessment, ADL=Activities of Daily Living.

and malnutrition were closely associated (29).

Indeed, both conditions were related, and a common phenotype in a review reported (27, 30, 31) that the loss of body weight, due to the inadequate nutrient intake and physical inactivity, resulting in muscle wasting, existed in the malnutrition and physical frailty older people.

In the current study, we demonstrated that malnutrition/ nutritional risk status was associated with increased odds of physical frailty among nursing home older adults (n = 705). So it can partly explain that frailty in the elderly people might still have inadequate intake of protein and vitamin D (32); in addition, sarcopenia might be a key element of physical frailty associated with malnutrition, such as decline of muscle mass, strength and function (33). Therefore, we should take adequate certain nutrients for older adults in nursing homes after taking the effectiveness of interventions, especially improving muscles mass and function.

Other risk factors of physical frailty
In our study, a crucial finding was that poor nutritional status and frailty had two risk factors, including cognitive impairment and depression symptoms. Previous studies had reported similar results. In a study including 6045 community-

dwelling elderly people in Singapore, comorbidities, cognitive impairment, depressive symptom, ADL/IADL and disability, and polypharmacy were strongly related to malnutrition and frailty (8). Meanwhile, for the cognitive function, previous literatures (34-37) reported that poor nutritional status was a major important determinant of both physical frailty and cognitive impairment; for the mental health, previous study (38) showed that depressive symptom was a major contributing risk factor for physical frailty, which in turn reportedly increased the risk of poor nutritional status. Therefore, it was not coincidental to find some common mental and cognitive risk factors with both malnutrition and physical frailty. In short, our results supported these previous findings, and suggested that the poor nutritional health of cognitive impairment or depressive symptom among the nursing-home older adults in frailty were more likely to deteriorate as a result of functional limitations and death in China.

Strengths and limitations
This study had several strengths. First, we objectively measured grip strength and walking speed for defining physical frailty. Second, this is the first study reporting estimates about the relationship of both those 2 conditions and associated

factors in this population. However, there were also several important limitations to be noted in our study. First, the cross-sectional design could not be used to establish causal relationships or temporality. Second, participants who didn't respond to our study or were unable to complete the physical tests due to bad physical conditions were excluded from our analyses. We could speculate that those older people might be more frail, especially those deemed malnourished and/or physically frail. Thus, such selection bias might have led to an underestimation of the association between malnutrition and physical frailty in our study. Third, because our participants were recruited from nursing homes only in one city in China, cautious should be exercised to generalize our findings to other populations.

Conclusion

In conclusion, the present study demonstrated that poor nutritional status and physical frailty were highly prevalent in nursing home older adults in China, and that poor nutritional status was associated with increased odds of physical frailty. Our findings suggest that nutrition interventions might be useful to prevent or reverse physical frailty among nursing home elderly people.

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