Prevalence of frailty and its correlation with malnutrition in Chinese nursing home residents

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Abstract: **Exploring the relationship between frailty and malnutrition among nursing home residents, to provide evidence for interventions improving the frailty and malnutrition status of the residents in the nursing homes.**

Methods: A total of 192 residents aged at least 60 years were selected from nursing homes. The Frailty Phenotype (FP) was used to assess the frailty of the residents. The Mini Nutritional Assessment（MNA）was used to assess the malnutrition status of the elderly. Chi-square tests and multinomial logistic regression was used to analyze the association between nutritional and frailty status.

Results: Frailty and pre-frailty were present in respectively 50.5% and 41.7% of the residents. Frailty was associated with malnutrition status, age, education level, marital status and chronic disease number (P<0.05).In the multinomial logistic regression, the risk of malnutrition were related to a significantly increased risk of frailty (OR = 9.037, 95% CI: 2.102-38.852, P = 0.003). 8 out of the eighteen MNA items and 3 out of four subscales were significantly associated with frailty (p<0.05).

Conclusion: The prevalence of frailty in the nursing homes is high, which is urgent to pay attention to. These results underline the close association between frailty and nutritional status in elders among nursing homes, and the risk of malnutrition is an independent risk factor of pre-frailty and frailty.

Keywords: **Frailty; pre-frailty; Malnutrition; risk of malnutrition; nursing homes; Older individuals.**

I. INTRODUCTION

As the global populations are aging dramatically, people are drawing more attention to the geriatric syndrome. The geriatric syndrome refers to unique features of common conditions in the elderly, such as frailty, malnutrition, falls and incontinence, which are multifactorial and significantly associated with morbidity and negative outcomes. Frailty and malnutrition are two highly prevalent geriatric syndromes, and their occurrence is related to nutritional factors.

Frailty is defined as a geriatric syndrome characterized by decreased reserve and resistance to stressors and increased environmental vulnerability, resulting from declines in physiological reserves and accumulation of health deficits. It involves changes in multiple physiologic systems, including neuromuscular, metabolic and immune system, which increases the risk of a range of adverse health outcomes such as death, disability, falls and fracture [2].Previous studies have determined that prevalence of frailty in nursing home elderly ranged from 19.0% to 75.6%, which was markedly higher than those in the community (4.0%-59.1%). Even so, less studies have examined frailty in nursing home residents.Previous studies have indicated that frailty is associated with malnutrition, and sarcopenia, Malnutrition could accelerate the process of age-related reduction of muscle mass and strength, which is critical in the development of physical impairment and sarcopaenia, and ultimately these factors together represent substantial elements of the frailty.

It is reported that at least 40% of the elderly in nursing homes suffer from malnutrition. Malnutrition refers to the change of body composition due to the lack of intake or take of nutrition, which leads to the decline of physical and psychological function and impaired outcomes of diseases . Malnutrition has been shown to affect the health outcomes of the elderly, such as higher frequency of hospital admission, lower quality of life and mortality. Therefore, an effective tool is highly

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recommended for early screening of the elderly at the risk of malnutrition. The Mini Nutritional Assessment (MNA) is a valid tool for malnutrition screening in elderly which has been widely used in clinical practice.

A systematic review indicated that malnutrition and frailty were often coincident but not interchangeable in community-dwelling elderly. Bollwein et al. and Chang et al. also indicated a close association between frailty and nutritional status in aged adults in the community. However, few studies have investigated the relationship between frailty and malnutrition in nursing home residents.

Therefore, the present study aimed to investigate the differences in nutrition status and demographic characteristics between frail, pre-frail and robust nursing home residents. Meanwhile, the association between malnutrition and frailty status in nursing home residents was explored in more detail.

II.   BODY OF ARTICLE

Methods:

From October 2017 until January 2018，a cross-sectional study was carried out in nursing homes in Changchun City, Jilin Province, Northeastern China. Four nursing homes were selected and invited to enroll in our study. The residents who accepted to participate were asked to sign an informed consent. Finally, We recruited 192 participants who met the inclusion criteria as follows: (1) residents aged ≥60 years, (2) Having lived in the nursing homes for more than 6 months, (3) having basic communication skills and being able to complete the survey, (4) being able to walk on their own with/without walking aids, and be able to complete the walking test of this study, (5) agreed to participate in this study. Those suffering severe cognitive impairment (the Short Portable Mental Status Questionnaire score was less than 8) were excluded.

Sample characteristics were assessed in personal standardized interviews including age, sex, level of education, monthly income, marital status and number of chronic disease. The frailty status of each participant was evaluated based on Fried frailty phenotype (FP) [Error! Bookmark not defined.].It was developed by Fried in 2001, which is widely used in different primary care settings and showed excellent psychometric properties. It is composed of 5 components: unintentional weight loss, exhaustion, low physical activity, poor handgrip strength and slow gait speed. We used the same components as those in the Fried's original version except low physical activity, which was measured in our study by International Physical Activity Questionnaire-Short (IPAQ-S). The total score ranges from 0 to 5, and higher scores indicate upper level of frailty. Participants with 3 or higher are defined as frail, with 1 or 2 represents pre-frailty, and with 0 represents robust [Error! Bookmark not defined.].

The study used the MNA to screen malnutrition or the risk of malnutrition in participants. The scale was developed by Guigoz et al. in 1994 to assess the nutritional status of elderly patients. Yu Kang et al. translated it into Chinese and applied in clinical practice. It comprises 18 items: anthropometric: loss of weight, body mass index (BMI), mid-arm and calf-circumference; subjective: self-perception of nutritional and health state; general: independent living, mobility, stress or acute disease, neuropsychological problems, medication, pressure sores or skin ulcers; dietary: anorexia, number of meals, beverage intake, consumption of protein-rich foods and fruits and eating difficulties. Scores ≥ 24 indicates good nutritional status, scores of 17-23 indicates the risk of malnutrition, and scores < 17 indicates malnutrition [Error! Bookmark not defined.].

Analysis of the data was performed in the SPSS Statistics 21.0. The categorical variables were described by percentages, and continuous values were shown as mean ± standard deviation (SD). Differences among the continuous variables were tested for significance by *t*-test, and for categorial variables, a chi-square test was performed to analyze. Consequently, to explore the association between malnutrition and frailty, multinomial logistic regression was used, allowing the modeling of the pre-frail and frail status by using robust elderly as a reference group. An acceptable level of significance was established as p < 0.05.

Results:

The age of the participants ranged from 60 to 98 years old; the mean and SD of age were 77.5 and 9.3 years; 56.8% of the subjects were female and 43.2% were male; 54.1% of the subjects were primary and junior middle schools with education level; 71.3% of the participants had a monthly income between 1000 and 5000; 58.3% of the subjects were widows and 48.4% of the subjects had two or more chronic diseases.

Ninety seven (50.5%) people were frail, and eighty (41.7%) were pre-frail according to the FP. The most prevalent frailty item was'slow gait speed', which was found in 80.2% of the participants, followed by 'low physical activity' and 'poor handgrip strength' which found in 63.5% and 59.9%. 'Exhaustion' was reported as 24% and'unintentional weight loss' as 6.8%.

When frail, pre-frail and robust participants were compared in terms of their characteristics, significantly differences were found with regard to age ($p<0.001$) and marital status ($p<0.05$): With increasing numbers of frail participants were significantly older and divorced. Frail older adults had a lower educational level ($p<0.05$) and higher number of chronic diseases ($p<0.001$) than the pre-frail and robust groups (Table 1).

One hundred and twelve (58.3%) participants were identified as being at risk of malnutrition and 15 (7.8%) were malnourished. The proportion of residents who were 'malnourished' and 'at risk of malnutrition' were significantly higher among frail participants compared to the pre-frail and robust participants ($p < 0.001$) (Table 1). In contrast, the proportion of 'well-nourished' residents in the robust participants was higher compared to the frail and pre-frail participants ($p < 0.001$) (Table 1).

Table I: Main characteristics of the population in three frailty groups

Characteristics	N	robust （n=15）	pre-frail （n=80）	frail （n=97）	P
Age [years][a]	192	72.13±9.01	75.65±8.47	79.84±9.41	<0.001[b]
Sex					
Male[%]	83	7（8.4）	34（41.0）	42（50.6）	0.956[c]
Female[%]	109	8（7.3）	46（42.2）	55（50.5）	
Educational level					
Low [%]	30	1（3.3）	5（16.7）	24（80.0）	0.011
medium [%]	104	8（7.7）	50（48.1）	46（44.2）	
high [%]	58	6（10.3）	25（43.1）	27（46.6）	
Monthly income(CNY)					
0~1000 [%]	42	4（9.5）	13（31.0）	25（59.5）	0.383
1000~5000 [%]	137	11（8.0）	62（45.3）	64（46.7）	
More than 5000[%]	13	0（0）	5（38.5）	97（50.5）	
Marital status					
Married[%]	72	11（15.3）	27（37.5）	34（47.2）	0.019
Windowed/Unmarried[%]	8	1（12.5）	5（62.5）	2（25.0）	
Divorced[%]	112	3（2.7）	48（42.9）	61（54.5）	
Number of chronic disease	192	0.87±0.92	1.44±1.19	2.03±1.24	<0.001
Nutrition status					
Well-nourished[%]	65	10（15.4）	35（53.8）	20（30.8）	<0.001
Risk of malnutrition[%]	112	4（3.6）	44（39.3）	64（57.1）	
Malnourished[%]	15	1（6.7）	1（6.7）	13（86.7）	

Note: "low"= illiteracy; "medium"= elementary school or secondary school; "high"=university or higher degrees; [a] mean ± standard deviation (all continuous variables); [b] t-test (all continuous variables) ;

[c] Chi2 Test (for all ordinal variables)

Multinomial logistic regression was conducted to analyze the relationship between the variables and FP scores. This analysis indicated that age, number of chronic disease, marital status and risk of malnutrition were independently correlated with frailty, and marital status and risk of malnutrition were independently correlated with pre-frailty. The correlation between risk of malnutrition and frailty is the most significant (OR=9.037 95% CI: 2.102-38.852, P =0.003)(Table 2).

Table II: The associated factors of frail status using multiple linear regression analysis

Variables	Frail		Pre-frail	
	OR（95%CI）	P	OR（95%CI）	P
Age	1.077（1.004—1.155）	0.038	1.025（0.960—1.096）	0.458
Educational level				
High	Reference			
Low	3.140（0.298—33.116）	0.341	0.864（0.073—10.176）	0.864
Medium	2.157（0.506—9.199）	0.299	2.505（0.624—10.061）	0.196
Marital status				
Married	Reference			
Divorced	5.801（1.276—26.268）	0.023	6.931（1.582—30.360）	0.010
Windowed/Unmarried	1.313（0088—19.600）	0.843	1.648（0.153—17.796）	0.681
Number of chronic disease	2.426（1.250—4.709）	0.009	1.657（0.859—3.196）	0.132
Well-nourished	Reference			
Risk of malnutrition	9.037（2.102—38.852）	0.003	4.232（1.041—17.201）	0.044
Malnourished	5.697（0.416—77.989）	0.192	0.349（0.016—7.732）	0.505

Note: low"= illiteracy; "medium"= elementary school or secondary school; "high"=university or higher degrees

Table 3 displayed the prevalence of the single MNA items in robust, pre-frail and frail participants. The results indicated a significant association between frailty status and 8 of the 18 MNA items regarding 'Weight loss >1kg /3 months', 'Feels malnourished or is uncertain of nutritional state', 'Considers health status not better than peers', 'Impaired mobility', '> 3 drugs /day', 'Moderate or severe anorexia' , '<5 cups of fluid /day' and 'Eating dependency' . It also showed prevalence of four MNA subscales in the three frailty groups. In all subscales frail participants scored significantly lower than pre-frail and robust participants (p<0.001) except for the 'Anthropometric assessment'.

Table III: Prevalence of single MNA items and subscales below maximum score in robust, pre-frail and frail residents

Variables	Robust	Pre-frail	Frail	P
MNA items[%]				
Anthropometric				
BMI<23kg/m^2	7.5%	39.2%	53.3%	0.600
Mid arm circumference <22cm	8.4%	37.9%	53.7%	0.576
Calf circumference <31cm	6.8%	38.6%	54.5%	0.842
Weight loss >1kg /3 months	0	15.0%	85.0%	0.004
Subjective				
Feels malnourished or is uncertain of nutritional state	1.8%	26.8%	71.4%	0.001
Considers health status not better than peers	1.5%	19.1%	79.4%	<0.001
General				
Not living independently	7.2%	40.8%	52.0%	0.822
> 3 drugs /day	0	22.7%	77.3%	0.022
Stress or acute disease	0	75.0%	25.0%	0.380
Impaired mobility	0	19.6%	80.4%	<0.001
Neuropsychological problems	0	0	100%	0.560
Pressure sores or skin ulcers	7.9%	41.4%	50.8%	0.495
Dietary				
<3 full meals /day	0	50.0%	50.0%	0.745
<3 markers for protein intake	8.5%	40.4%	51.1%	0.756

<2 servings of fruit /day	7.1%	39.3%	53.6%	0.861
Moderate or severe anorexia	0	31.2%	68.8%	0.038
<5 cups of fluid /day	6.3%	42.3%	51.4%	0.041
Eating dependency	0	0	100%	0.003
MNA subscales（x ± s）				
Anthropometric	6.00±1.10	5.92±1.33	5.42±1.66	0.141
Subjective	3.83±0.65	3.49±0.85	2.47±1.31	<0.001
General	7.60±0.51	7.24±0.83	6.35±0.96	<0.001
Dietary	7.67±0.77	7.28±0.87	6.90±1.26	<0.001

Discussion:

The frequencies of frail (50.5% for frailty and 41.7% for pre-frailty according to the FP) in the present study were similar to the results of a systematic review (52.3% for frailty and 40.2% for pre-frailty)[Error! Bookmark not defined.]. While the results was a little lower than that in previous study in Chinese nursing home residents (55.7% for frailty) [Error! Bookmark not defined.], participants of which (82.89±6.91) were older than the present study (77.49±9.306). This might contribute to the difference since the prevalence of frailty increases with age [Error! Bookmark not defined.]. According to the items of FP, the main problem of the residents in the nursing homes is 'slow gait speed', followed by 'low physical activity' and 'poor handgrip strength', which might be related to the lack of muscle reserve and the decline of strength in the elderly. The results were also consistent with the current research that arcopaenia resulting from decline in muscle number and strength is the core pathological basis of frailty.

Frail participants in the present study were older than pre-frail and robust ones, which is in accordance with Fried et al [Error! Bookmark not defined.], who pointed out that frailty is a dynamic and continuous aging process, and frailty wound increase with age. Lower educational level dominating in frail individuals was similar to the previous research. Multivariate logistic regression analysis revealed that frailty was independently related to number of chronic disease, which was consistent with previous research results: Zaslavsky et al. revealed that men with frailty had higher comorbidities compared with their non-frail counterparts. Sanchez-García et al. suggested that frailty had significant correlation with the number of chronic disease.

The study found a significant association between malnutrition and frailty status. The frailty status of the residents varied with different malnutrition status, and the difference was statistically significant. Our results are generally in accordance with research of Dorner et al. that frail older adults had higher prevalence of a risk of malnutrition compared to pre-frail and robust elderly. Boulos et al. conducted that pre-frail older adults had dominating prevalence of well-nutrition [14], which was different from the present research. The possible cause of this difference may be the different ages and physical conditions of participants. In addition, the two studies were conducted in various regions, that might cause differences in prevalence rates.

Multivariate logistic regression analysis showed the risk of malnutrition was a risk factor for frailty and pre-frailty, which was consistent with the conclusions of Chang et al.[15] and Cereda et al.. The study indicated that residents at a risk of malnutrition had 4 times and 9 times higher probability to be pre-frail and frail than well-nutritional residents, higher than previous results of KIM et al., that elderly with poor nutritional status had probability to be pre-frail and frail respectively increased by 1.5 times and 3 times. The latter research investigated community elders and defined risk of malnutrition and malnutrition as poor nutritional status, which might be the cause of difference.

This study divided the MNA into 18 single items and 4 sub-scales to compare the difference between the three groups. We found the groups were significantly different for the eight MNA item: Frailty was associated with the items related to 'eating dependency' and 'moderate or severe anorexia', which was similar to the results reported by Morley et al., who have conducted that anorexia and eating dependency could be considered an early risk factor of frailty. 'Weight loss >1kg /3 months' was associated with frailty as it was in accordance with the FP item 'unintentional weight loss', and was also proved as a risk factor of frailty. The MNA item 'Impaired mobility' was similar to FP item 'low physical activity' and Impaired mobility would increase susceptibility to disease and affects appetite negatively to increase frailty [**Error! Bookmark not defined.**]. Herr M et al. found multidrug therapy was a risk factor for frailty, which was in consistent with our results that'> 3 drugs /day' was associated with frailty. 'Feels malnourished or is uncertain of nutritional state' and 'Considers health status not better than peers' indicated frail older adults experience difficulty and lack confidence in

maintaining their health and nutritional status [Error! Bookmark not defined.]. In all subscales frail participants scored significantly lower than pre-frail and robust participants except for the 'Anthropometric assessment', which was different from results of Chang et al [Error! Bookmark not defined.]. This might because the about half of the residents in our study were overweight or obesity, with the average values of BMI, mid arm circumference and culf circumference exceeding the cut-off point, and studies showed that overweight and obesity would increase the incidence of frailty. The other three subscales were significant associated with frailty, which was in accordance with previous study [Error! Bookmark not defined.].

III. CONCLUSION

The study is the first study to explore the association between malnutrition and frailty in Chinese nursing home residents. The prevalence of frailty and pre-frailty of the nursing home residents is relatively high, which is affected by age, education, marital status, number of chronic diseases. It is hoped that medical staff can pay attention to the frailty of nursing home residents and formulate relevant intervention measures according to the above factors.

This study divided the MNA into three dimensions (single item, subscale and total scores) to compare the difference among the frail, pre-frail and robust groups and explore the association between frailty and malnutrition. The results showed that the risk of malnutrition is a risk factor for frailty and pre-frailty. It is therefore crucial for the medical staff pay attention to a decline in functionality in residents with low MNA scores, and also pay particular attention to nutritional status in frail and pre-frail residents. The results also indicated that 8 MNA items and 3 subscales were associated with frailty. Therefore, medical personnel must provide nursing homes residents with relevant health maintenance plans, including adequate meals in maintaining the weight, providing help for dependence residents and providing resistance exercise interventions. According to the approach, the nutritional and frailty status of residents can be enhanced. The study indicated the potential overlap in prevalence between frailty and malnutrition. Increased attention should also be placed on intervention studies that looking at the impact on the nutrition and frailty status of the participants. It is believed that considering the correlation between malnutrition and frailty may help to improve effective interventions, such as physical activity training, to reduce the degree of both frailty and malnutrition. Meanwhile, considering malnutrition and frailty together may be the approach forward to provide effective care to residents. Future research needs to carefully formulate effective intervention, while measuring malnutrition and frailty with valid, convenient tools.

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