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Feature Article

Frailty among older people in a community setting in China

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ABSTRACT

Frailty is the most common manifestation of serious health issues in the world, and it is becoming more prevalent worldwide as the aging population grows. Changes that occur in an individual during the aging process have physical, psychological, social, and environmental aspects that make an individual more frail. In China, older people may live in communities for aging individuals. This study aimed to describe the presence and severity of frailty and to analyze influencing factors among this population in China. The Frailty Index 35 (FI-35) scale, which includes 35 items in physical, psychological, social, and environmental domains, was used to investigate frailty. The FI-35 score ranges from zero to one, with a score closer to one indicating greater frailty. Biographical, socioeconomic, and lifestyle factors were measured as potential determinants of frailty. We relied on the November 2017–February 2018 waves of the Chinese cross-sectional study survey that comprised a sample of 513 adults, aged 60 or older, who were living in China. Linear regression was performed to identify factors associated with FI-35 scores. We categorized the determinants of frailty into three models: Model 1: biographical variables; Model 2: biographical and socioeconomic variables; and Model 3: biographical, economic, and lifestyle variables. Frailty scores ranged from 0.00 to 0.89, with a median of 0.31, and the prevalence of frailty was 67.6%. The final model obtained after variable selection included age, minority status, marriage status, income, diet, and exercise. The adjusted R-squared indicated that the analysis explained 13.8% of the variance in frailty scores. Adding household, marriage status, education level, medical insurance, and income as elements in Model 2 explained 25.7%. Adding diet, smoking, drinking, exercise, and hobbies in Model 3 explained 27.9%. The degree of frailty varies considerably among Chinese community-dwelling older people and is partly determined by biographical, socioeconomic, and lifestyle factors.

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Introduction

Due to the increase in life expectancy, the number of people over the age of 60 is expected to double by 2050, according to a new report by the WHO for the International Day of Older Persons¹ (WHO, 2015). China has the largest population over the age of 60 years in the world, and the average life expectancy is 73 years, with 9.2% of the older population aged 80+ years.² With increasing age, people may become increasingly frail and have a higher risk of

adverse outcomes, and frailty is becoming more prevalent as the aging population grows worldwide.^{3,4} Frailty is characterized by decreased strength and a reduced physiologic reserve that easily results in serious functional limitations and adverse health outcomes related to aging.^{5,6}

Frail individuals are highly susceptible to injury, and minor stressful events can lead to hospitalization, disability, or even death.^{3,7} Frailty is a robust predictor of subsequent mortality at older ages.^{8,9} The progression of frailty is associated with cognitive decline, such as cognitive impairment,¹⁰ mild cognitive impairment (MCI),¹¹ and Alzheimer's disease (AD).¹² Furthermore, frailty affects the quality of life of older persons as it reduces their independence, shortens their life expectancy, and increases the burden on their social network and family caregivers.^{13,14}

In the mid-1990s, slow walking speeds and weight loss were combined to form comprehensive scores to predict adverse clinical

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outcomes, which was a breakthrough in frailty measurement.^{15,16} From this first biomedical concept, a broader, biopsychosocial vision emerged in which frailty increases with the accumulation of physical, psychological, and social factors, and the concept of frailty was acknowledged as multidimensional.¹⁷

A large part of the literature on frailty is concentrated on aged persons in Western countries, whereas research in other countries is limited.¹⁸ China has a large aging population and the world's largest oldest-old population; however, little is known about frailty and its determinants. In the future, as China will face dramatic population aging, it is imperative to ascertain the influencing factors among older adult individuals in China to respond to the challenges of caring for them and enhance their healthy longevity. To date, in China, most health care professionals pay more attention to disease than frailty in the process of care.¹⁹ In recent years, several well-established frailty assessment instruments have been translated into the Chinese language, for example, the Phenotype of Frailty (FP) developed by Fried et al.²⁰ and the Frailty Index (FI) by Rockwood et al.²¹ However, these instruments were unable to fully reflect specific Chinese characteristics, as was shown in the study by Zhang et al.²² They developed a comprehensive frailty assessment tool specifically built for the Chinese population in which in addition to the three well-known domains of frailty ("physical", "psycho-cognitive" and "social"), the domain "environment" was added. This instrument is called the FI-35 and consists of 35 items covering 4 domains and 11 subdomains, enabling a much broader research perspective than was previously possible.

An interesting development is the initiation of communities for the aging population that began in the late 1980s in China. Prior to that, older persons tended to stay at home as long as possible, and care was most often provided by relatives.²³ Owing to the influence of traditional ideas, older persons in China like to be taken care of by their children. However, current family structures are forcing a change in the traditional Chinese pension model. In the next few years, the first generation of parents under the Chinese one-child policy will begin the aging process and need more professional care, but in many cases, their child will be unable to provide sufficient care due to a busy work schedule.²⁴ Therefore, this old-age model is gradually transforming into community-based care.²⁵ Community-based care and services that include living services and health care are available to these individuals during the day. It enables older adult individuals to go to the venues for activities or seek medical care while their children are not at home, and at night, they can reunite with their children. The community model can reduce the financial burden of the government and reduce the burden of care experienced by their children. Following the old-age model of transformation, there will be a period when the demand for communities for older persons will increase exponentially. Therefore, the aim of this study was to investigate frailty in persons in older adult communities in China and analyze the influencing factors of frailty. We hypothesized that age, nationality, household, marriage, income, diet, exercise would be significantly associated with frailty as measured by the FI-35.

Methods

Design and study sample

This cross-sectional study was carried out in Tianjin, China, after collecting data from November 2017 to February 2018. Convenience sampling was used to collect data in three communities in which older persons resided. The selection criteria of the sample of participants were (1) being at least 60 years of age; (2) being able to communicate and conscious, and (3) being able to voluntarily participate in the study. Persons who were unable to complete the

questionnaire, for instance, due to severe mental or physical constraints or acute illness, were not included. According to the standards, we investigated three communities in Tianjin.

The FI-35 consists of 35 items and covers four domains: 1. Physical with subdomains of nutrition, motion, strength, energy, and sleep quality; 2. Cognitive with subdomains of emotion and cognition; 3. Social with subdomains of role and social contact; and 4. Environment with subdomains of environment and adaptability.²² All of the answers from the participants were scored between 0 and 1, where 0 indicated normal function and 1 indicated the presence of frailty. A frailty score was calculated for each participant by dividing the sum of the unhealthy index by the total number of the healthy index. For example, if a person scored 12 out of 35, the FI was calculated as $12/35 = 0.34$. The closer the score was to 1, the frailer the person. According to the FRAIL scale, we combined the receiver operating characteristic (ROC) curve with the Youden index (YI) and ultimately determined the critical value of frailty to be 0.23 (frailty: frailty index ≥ 0.23 ; nonfrailty: frailty index < 0.23). According to our previous published research, the FI-35 scale has good reliability and validity.²²

Measurements

Demographic variables included basic demographic information (age, sex, nationality, marriage status, educational level, etc.) and living habits (smoking, drinking, diet, hobbies, etc.). Age was divided into five groups (60–64, 65–69, 70–74, 75–79, and >80 years). We distinguished five groups of educational levels: never went to school, primary school, junior school, high school, and college degree or above. Household indicated whether a respondent lived alone or with others. Exercise was divided into four groups: never, 1–2 times/week, 3–4 times/week, and every day. The other variables are depicted in Table 1. Factors were clustered in three domains: biographical (age, sex, nationality), socioeconomic (household, number of children, education level, medical insurance, income), and lifestyle (diet, smoking, drinking, exercise, hobbies). Before the survey, the investigator introduced the purpose of this collection. Questionnaires were dispensed during a face-to-face interview by trained interviewers. For a participant with a low education level or poor eyesight, the questions were explained by the interviewer who also filled in the answers.

Statistical analyses

We used frequencies and percentages for descriptive statistics for the quantitative data. Several linear regressions were performed to identify factors associated with the dependent variable (FI-35 score). The explanatory variables were age group, sex, minority status, household, marriage status, number of children, education level, pre-retirement occupations, medical insurance, source of finances, income, retirement adjustment time, self-care ability, diet, smoking status, drinking alcohol, exercise level, hobbies, and prescribed medications. Statistical analyses were performed using SPSS version 22.0 (IBM Corp. Armonk, NY). Statistical significance was set at $p < 0.05$.

Results

Study sample characteristics

The participants were recruited from among 600 older persons from three communities in Tianjin, from which 560 questionnaires were obtained. In cases where more than 5% of responses were missing, the questionnaires were excluded. This yielded 513 questionnaires that were included, which corresponded to an effective response rate of 91.6%. The mean (sd) age of participants was 69.6

Table 1
Demographic variables of older adults ($n = 513$).

Variable	Group	Number	%age (%)
Sex	Male	228	44.4
	Female	285	55.6
Age	60–64	134	26.1
	65–69	182	35.5
	70–74	65	12.7
	75–79	93	18.1
	>80	39	7.6
Nationality	Han	457	89.1
	Minority	56	10.9
Household	1 person	72	14.0
	≥2 persons	441	86.0
Marriage status	Married	429	83.6
	Unmarried	3	0.6
	Divorced	30	5.9
	Widowed	51	9.9
Children	No	17	3.3
	Yes	496	96.7
Education level	Never go to school	48	9.4
	Primary school	47	9.2
	Junior school	134	26.1
	High school	82	15.9
	College degree or above	202	39.4
Preretirement occupation	Worker	134	26.1
	Farmer	31	6.0
	Administrative cadres	78	15.2
	Manager	82	16.0
	Teacher	73	14.2
	Financial services	13	2.5
	Medical workers	42	8.3
	Others	60	11.7
Medical insurance	Yes	483	94.2
	No	30	5.8
Source of finances	Retired	460	89.7
	Subsidies from children	49	9.5
	Government relief	3	0.6
	Labor income	1	0.2
Income (yuan)	<1000	42	8.2
	1000–1999	53	10.3
	2000–3999	223	43.5
	≥4000	190	37.0
Retirement adjustment time	Do not have any problems	451	87.9
	Half a year	40	7.8
	A year	9	1.8
	More than two years	13	2.5
Self-care ability	Unable to function independently	26	5.1
	Partial self-care	69	13.5
	Fully self-care	418	81.5
Diet	Unhealthy food	125	24.4
	Healthy food	388	75.6
Smoking	Never smoking	382	74.5
	Give up smoking	74	14.4
	Smoking	57	11.1
Drinking	Never drinking	380	74.1
	Give up drinking	90	17.5
	Drinking	43	8.4
Exercise	Never	160	31.2
	1–2 times/week	59	11.5
	3–4 times/week	94	18.3
	Every day	200	39.0
Hobbies extensive	Yes	276	53.8
	No	237	46.2
Prescribed medication	Take medicine on time	357	69.6
	Often forget	120	23.4
	No medicine	36	7.0

(7.2) years. There was a predominance of individuals who were female (285, 55.6%), aged 65 to 69 years (182, 35.5%), Chinese Han (457, 89.1%), and married (429, 83.6%). There were 202 (39.4%) participants who had obtained a college degree or above. The vast majority of participants among the 513 (496, 96.7%) had children. In terms of “preretirement occupations”, most of the participants were

employed as workers before they retired (134, 26.1%). In total, 94.2% of the participants had medical insurance. The largest number of people were in the income group “2000–3999 yuan” (223, 43.47%), which, most often, was from retirement finances (457, 89.67%). There were 451 of the 513 older persons who indicated not having any problems in realizing a purposeful life after retirement. A total of 81.5% ($n = 418$) of the participants reported that they could fully self-care, and 86% ($n = 441$) of them were living with others, while 14% ($n = 72$) were living alone. A number of the participants had healthy eating habits and had never smoked (382, 74.5%) or ingested alcohol ($n = 380$, 74.1%). A total of 53.8% ($n = 276$) reported that they had many hobbies. There were 357 (69.59%) participants who indicated that they could take medications on time and obey the instructions from doctors. Other characteristics of the study sample are shown in Table 1.

Frailty and its factors

The FI-35 score ranged from 0.00 to 0.89, with a median of 0.31. The most important frailty dimensions were “social contact”, “role”, and “sleep”, with scores of 1.00 (0.00–1.00), 0.67 (0.00–0.67) and 0.33 (0.00–1.00), respectively. The total score on the FI-35 and the score of each dimension are shown in Table 2.

Using a cut-off score of FI ≥ 0.23 for frailty, 67.6% ($n = 347$) of individuals were considered frail. Table 3 shows the results of the linear regression for determining the relationship of the variables with frailty. Significant associations among age, nationality, and frailty were obtained in Model 1 ($p < 0.001$); the adjusted R -squared indicated that the model explained 13.8% of the frailty variance. Adding household, marriage status, education level, medical insurance, and income as elements in Model 2, the model explained 25.7% of the frailty variance, which was an increased in the explained percentage of variance equal to 11.9. There were significant associations between the variables of frailty and household, marriage status, and income ($p < 0.05$). When adding diet, smoking, drinking, exercise, and hobbies in Model 3, the model explained 27.9% of the frailty variance with an increase in the explanatory variance of 2.2% compared to Model 2. Negative (protective) significant associations were obtained between frailty and the variables diet and exercise ($p < 0.05$). The greatest increase in the explained variance was found when socioeconomic factors were added. Socioeconomic status is the most important explanatory factor in our study, followed by lifestyle. Compared with age ($\beta = 0.043$), nationality ($\beta = 0.108$) had a greater influence on frailty in Model 1. In Model 2, household ($\beta = 0.085$) was the most influential variable, followed by income ($\beta = -0.062$) and marriage status ($\beta = 0.032$). It is worth noting that the value of income was negative, indicating that older people with higher incomes had lower levels of frailty. In Model 3, a healthy diet ($\beta = -0.036$) was more influential than exercise ($\beta = -0.014$). For the results of the

Table 2
The median subdomain scores for the FI-35 scale ($n = 513$).

	Median	Interquartile range
Nutrition	0.00	0.00–0.33
Motion	0.25	0.00–0.50
Muscle strength	0.00	0.00–0.33
Energy	0.00	0.00–1.00
Sleep	0.33	0.00–1.00
Cognition	0.25	0.25–0.75
Emotion	0.00	0.00–0.33
Contact	1.00	0.00–1.00
Role	0.67	0.00–0.67
Environment	0.00	0.00–0.67
Adaptability	0.00	0.00–0.67
Total	0.31	0.23–0.46

Table 3
Regression models for frailty ($n = 513$).

Variable	Model 1		Model 2		Model 3	
	β	p	β	p	β	p
Ref	0.132		0.173		0.153	
Sex	0.002	0.895	−0.030	0.042	−0.016	0.331
Age	0.043	0.000	0.035	0.000	0.035	0.000
Nationality	0.108	0.000	0.086	0.000	0.082	0.000
Household			0.085	0.000	0.072	0.004
Marriage			0.032	0.000	0.031	0.000
Education			0.004	0.581	0.004	0.568
Medical insurance			0.025	0.468	0.033	0.354
Income (yuan)			−0.062	0.000	−0.049	0.000
Diet					−0.036	0.033
Smoking					0.014	0.314
Drinking					0.011	0.403
Exercise					−0.014	0.033
Hobbies					0.031	0.055
R^2		0.143		0.269		0.298
ΔR^2		0.138		0.257		0.279
AIC	−1854.598		−1952.896		−1936.562	
BIC	−1837.637		−1887.734		−1867.958	

Model 1: biographical variables.

Model 2: biographical and socioeconomic variables.

Model 3: biographical, socioeconomic and lifestyle variables.

three models, the Akaike information criterion (AIC) was −1854.598, −1952.896, and −1936.562 in models 1, 2, and 3, respectively. The Bayesian information criterion (BIC) was −1837.637, −1887.734, and −1867.958 for models 1, 2 and 3, respectively. Since smaller criterion values correspond to better models,²⁶ both AIC and BIC indicated that model 2 was the best. These findings indicate that socioeconomic status is the most important general factor explaining and predicting frailty, followed by lifestyle (shown in Table 3).

Discussion

We found that 67.6% of older adult individuals living in communities for older persons in China can be considered frail on the basis of the FI-35. The main related factors for frailty are age, nationality, household, marriage status, income, diet, and exercise.

We found that the majority of older persons living in communities are frail. This is comparable to a previous study in similar communities in which 63.7% were frail.²⁷ However, other comparable studies found a much lower prevalence of frailty (11.1%¹⁸ and 10.3%³⁰). Differences between studies may be the result of differences in questionnaires as well as the construct used for frailty rates.³ Ren et al.²⁸ used the SHARE-FI (Survey of Health, Ageing and Retirement in Europe Frailty Instrument), which assessed only physical function: fatigue, loss of appetite, muscle strength, difficulty walking, and low physical activity. Xi and Guo used the frailty phenotype,¹⁸ which also covers only the physical domain of frailty, which explains the significant differences between our estimations and their results. Frailty is a complex clinical syndrome, and it relates to age, physical function, disease status, psychological factors and social security, and other factors; therefore, it is necessary to use multidimensional measurements to assess frailty in old people. However, most of the multidimensional tools were designed using three general domains (physical, psychological, and social) to assess the level of frailty, for example, the Edmonton Frail Scale²⁹ and the model of frailty,³⁰ while our tool covers four domains (the fourth is 'environmental'). Environment has a great impact on health. A change in environment will contribute to the risk of functional decline, and a decline in the ability of older people to adapt to the environment will make their health problems more serious. Thus, adding the domain of "environmental" may yield a broader description of the concept of frailty. The

additional domain of "environmental" in the FI-35 could explain the higher prevalence of frailty in our study.

In our study, we ascertained significant associations between age and frailty. Namely, the prevalence of frailty became more pronounced with increasing age, a finding confirmed by many studies.^{3,4,8} Frailty is often associated with high health risks, and it combined with physiological deterioration due to aging, especially a loss of muscle mass and bone density³¹ may increase the risk of adverse events (such as hospitalizations and falls).³²

Our finding that participants were from the Han minority is in line with previous studies, revealing that ethnicity was one of the factors relate to frailty.³³ We determined that the factors contributing most to frailty are of the socioeconomic type, including household, marriage status, and income. Income was significantly and negatively associated with the FI-35 score. Household and marriage status were significantly and positively associated with the FI-35 score. Adequate income is the basic guarantee for a healthy life. Because of worry about medical expenses, aged persons may not go to the hospital in time, which leads to a deterioration in their condition and further deterioration of their health. Timely treatment or medical care may be a result of good economic support from a higher income.³²

We found that older people who are married are less frail than those who are not married. This may be explained by the relationship between frailty and psychosocial factors.³⁴ Positive emotions are a factor related to individual health, especially among this population, and spouses provide spiritual support. This may explain why the individuals who were married were less frail according to Model 2. Compared with married people, widowed or divorced individuals had different results. A previous study confirms what other studies have shown: living alone has a positive effect on frailty, and older persons living with another person are more likely to be frail compared to those living alone.^{35,36} The reason is unclear, but perhaps people who live alone are more independent and do not show frailty. Although socioeconomic factors of frailty were previously summarized,^{37–39} we did not find a relationship between frailty and the level of education in our regression models. This may be due to the high level of frailty across the education level groups at these ages.

The results of our study also suggest that lifestyle factors may contribute to the degree of frailty: exercise and diet seem to be relevant factors. These results are in accordance with previous studies indicating that avoiding going outside and disliking exercise are clinical indicators of frailty in older people when lifestyle and clinical characteristics are considered⁴⁰ and that the level of frailty is lower in older individuals who were able to walk outside and exercise than in those who were not.^{40,41} Exercise is considered a preventive or protective factor for development of frailty because it can improve the function of the central nervous, immune, endocrine, and skeletal systems and improve body functions.³² Furthermore, a recent study highlights the importance of diet in older people.⁴² Aged persons who had better nutrition and protein intakes and better adherence to healthy diets had lower rates of frailty than those with lower nutrient intakes who ate unhealthy food.⁴²

Communities for aging persons in China combine home-based care and the professional services of institutional care, improving the efficiency of social old-age care services and reducing the waste of social resources; thus, community-based old-age care has become the main mode of development in China, and most older people are inclined to move to these communities.²⁵ Our study provides evidence of risk factors for frailty in China and the application of the FI-35 scale in the Chinese population.

Limitations

Two limitations should be considered. The convenience sampling in our study was restricted to special older adult communities.

Therefore, the results cannot be generalized to the whole old population in China. Moreover, the aged communities from Tianjin seem somewhat more representative of northern China as far as lifestyle and environment is concerned. In the future, it is advised to investigate frailty of people living in communities for older individuals in other regions of China as well. The FI-35 scale is a self-reported frailty instrument with some risk of under- or overestimation by the respondents. In the future, these should be validated against more objective assessment instruments.

Conclusions

This cross-sectional study of older Chinese people living in an older adult community showed a prevalence of frailty of 67.6%, which was considerably higher than in previous research. Expected associations were found with age, ethnicity, household, number of children, income, diet, and exercise.

Since China has the largest rapidly aging population, it is imperative to face the challenges relating to health care for these older persons. The results of our study suggest explanatory factors for frailty. A consecutive comprehensive health management model is urgently needed for the purposes of early prevention and multidimensional intervention in the high-risk population of those who are frail.

Declaration of Competing Interest

All authors of this manuscript have directly participated in planning, execution, and/or analysis of this study. The contents of this manuscript have not been copyrighted or published previously. The contents of this manuscript are not now under consideration for publication elsewhere. We declare that there is no conflicts of interest in our work.

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