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Use of the frailty index in evaluating the prognosis of older people in Beijing: A cohort study with an 8-year follow-up

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ABSTRACT

Objective: Frailty is a significant healthcare challenge in China. However, the relationship between frailty and the prognosis of older people in China remains unclear. The present study aimed to evaluate the prevalence of frailty and determine if the frailty index, a comprehensive geriatric assessment, was associated with the prognosis of older people in a Chinese population.
Methods: Data were drawn from the Beijing Longitudinal Study of Aging, a representative cohort study with an 8-year follow-up. Evaluations based on the use of the frailty index were performed in a cohort of 1808 people aged 60 years and over residing in Beijing urban and rural areas. The initial survey was conducted in 2004, with follow-up surveys at 3, 5, and 8 years. Mortality data for all individuals were collected and analyzed.
Results: The frailty index and the age of individuals showed the same trend, with a higher frailty index expected as age increased. Respondents with the same frailty index level differed across factors such as sex and location. Male individuals, rural dwellers, and older individuals showed higher frailty rates than female individuals, urban dwellers, and younger individuals.
Conclusions: Frailty is a condition associated with problems across multiple physiological systems. The frailty index increases with age, and may be a significant tool for evaluation of the prognosis of older people in China.

1. Introduction

The increasing number of older people in China poses a significant public health challenge, particularly with regard to improving healthcare and social outcomes in older populations (Yao et al., 2014). Aging people show increasing morbidity, dependence, and vulnerability (Boeckxstaens et al., 2014). Clinical tools such as comprehensive assessments are an important part of providing effective healthcare for older populations. For example, the choice of medication or surgical methods based on a comprehensive assessment in patients with tumors could reduce the incidence of adverse drug reactions and operation risk (Kim et al., 2011; Kristjansson et al., 2010; Rybicki et al., 2015). Comprehensive assessment can be used to inform specific treatment for older patients with chronic disease, slowing the decline of physical functioning and improving quality of life (Parlevliet et al., 2012; Teymoortash et al., 2014). Comprehensive assessment also improves accuracy of diagnosis, personnel allocation, functional and cognitive status, as well as reducing the care burden on families, medical expenses, and mortality rates (Aucella et al., 2012).

Frailty is a common and important geriatric syndrome characterized by age-associated declines in physiologic reserve and functioning across multiorgan systems. Frailty leads to increased vulnerability for adverse health outcomes such as falls, disability, hospitalization, and mortality (Bortz, 2010; Brown, Sneed, Rutherford, Devanand, & Roose, 2014; Vairaktarakis et al., 2015). The prevalence of frailty has been reported to be between 4% and 59% in studies with participants aged 65 years or over (Collard, Boter, Schoevers, & Oude Voshaar, 2012). As a predictor of

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comorbidities, falls, the use of healthcare services, health conditions, institutionalization, impairment, stroke and cardiovascular disease (CVD), poor quality of life, and mortality, frailty is a particularly relevant field of study for public health (Melin et al., 2014; Nichols, Varadarajan, Bock, & Blumin, 2014; Pegorari & Tavares, 2014; Ramsay et al., 2014; Woo, Goggins, Sham, & Ho, 2005). However, a standardized definition of frailty has not yet been established. The frailty index (FI) was proposed by Rockwood in 2008 (Rockwood, Mogiher, & Mitnisk, 2004) as a method for the comprehensive assessment of the health of older individuals. A comprehensive geriatric assessment focuses on the assessment of the physiological, psychological, and functional status of older individuals (Collard et al., 2012). The FI is an important method for evaluating frailty, as it evaluates the health status of older individuals using a cumulative calculation method, and can predict long-term prognosis. While there is an increasing recognition of frailty and its consequences in older populations, there are few initiatives implemented that systematically manage this condition (Ramsay et al., 2014). Therefore, the present study aimed to evaluate the prevalence of frailty and to determine if the FI as a comprehensive geriatric assessment was associated with prognosis in the Beijing Longitudinal Study of Aging, a study of community-dwelling older people.

2. Material and methods

2.1. Study design

The Beijing Longitudinal Study of Aging was a cross-sectional study comprising 1865 people dwelling at home, drawn from the general Beijing population in 2004 aged 60 years or over. Separate follow-up studies were conducted in 2007, 2009, and 2012, and mortality data for all individuals were collected and analyzed (Zhe et al., 2013). Of the initial sample of 1865 older people, 57 refused to complete the survey, and there were 629 cases of death, providing a baseline sample of 1808. Instances of death or loss for the follow-up surveys were confirmed through family members, or the neighborhood or village committee.

2.2. Data collection

The assessments were completed by trained staff using standard survey instruments. During person-to-person interviews, data were collected regarding many aspects such as demographic characteristics, physical health, mental health, chronic disease, economic conditions and so on. Physical examination includes blood pressure, height, weight, waist circumference and hip circumference. All the subjects were signed the informed consent. The number of death or loss in follow-up surveys were confirmed through the family member, neighborhood or village committee. The causes of lost includes out, refused to check and demolition.

2.3. Evaluation of the FI

The FI was evaluated by the cumulative decline in older individuals (Bortz, 2010). In the present study, 68 parameters were drawn from six variables: demographic characteristics, physical health, physical function, living behavior, social function, mental health, and cognitive function. The parameters were chosen according to the selection principle proposed by Rockwood in

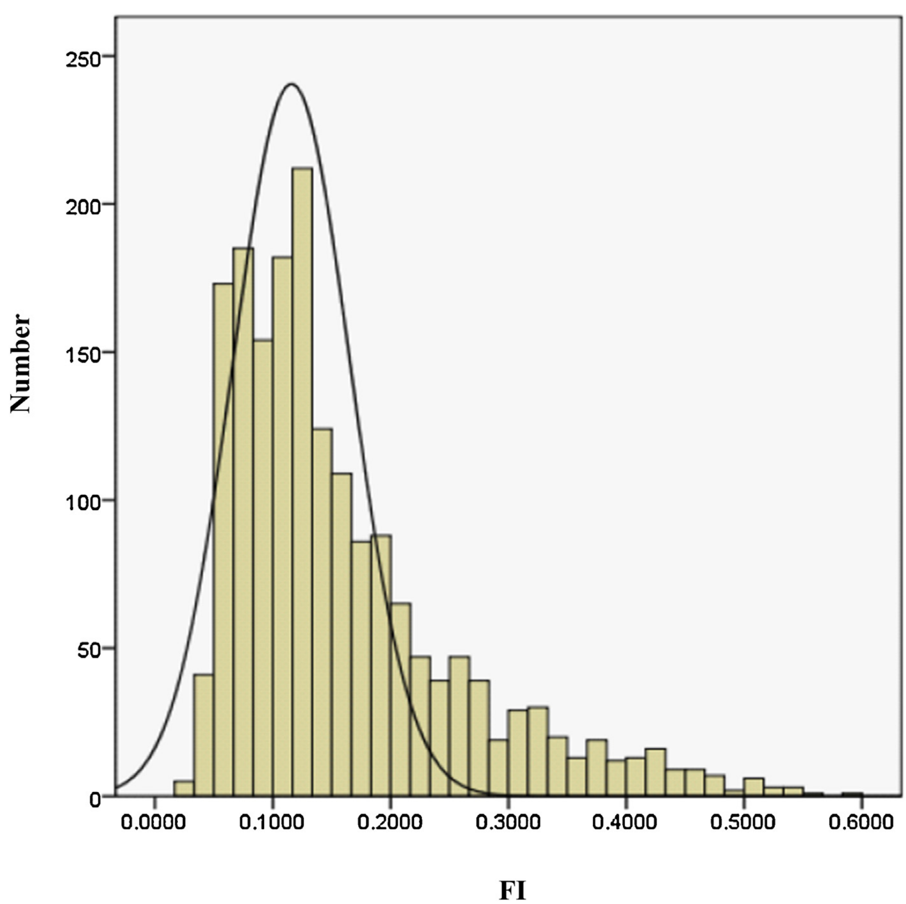

Fig. 1. Frequency distribution of FI ($n = 1808$). Mean = 0.16, Std. Dev. = 0.099.

2008 and supported by expert opinion (Zhe et al., 2013). Each variable contains an evaluation index, with each index scored 1 if a deficit was present or 0 if no deficit was present. For some variables the index was scored according to the degree of deficit. For example, the Center for Epidemiologic Studies Depression Scale (CES-D) was scored as normal (0), mild depression (0.5), and severe depression (1). Those who did not complete the evaluation were recorded as a 0 score. The FI was defined as the cumulative sum of the score of each index divided by the number of indexes. The FI range was 0–1.

Physical health covered items such as common disease symptoms, syndromes, and systemic disease. The diagnosis for chronic disease was based on that made by the district hospital. For mental health, the CES-D scale was used to assess depressive symptoms, with <16 recorded as 0 (normal), 16–19 recorded as 0.5 (mild depression), and a score of more than 20 recorded as 1 (severe depression). Cognitive function was measured with the Mini Mental State Examination (MMSE) scale with 11 items; possible scores ranging from 0 to 30. Participants were stratified by educational level to determine thresholds for cognitive function. The thresholds for those who were illiterate, or attended at most primary school, middle school, or university were ≤17, ≤20, ≤22, and ≤24, respectively. Participants who scored below the threshold value for their education group were recorded as cognitive dysfunction. Cognitive dysfunction is 1 points and normal cognitive function is 0 point. Functional status was based on activities of daily living (ADL) and the instrumental ADL (IADL). The ADL and IADL consist of 14 items, and the performance of each activity is rated as performed with independence (score of 1), partial dependence (score of 0.5), or complete dependence (score of 0). Similarly, assessment of life satisfaction, based on the individual's current life, was divided into general (0), satisfied (0.5), and not satisfied (1). Assessment of social function includes several aspects: For smoking and drinking, response options were "yes" (1), "once" (0.5), or "no" (0); for participation in social activities, physical exercise, work, and doing the housework, possible responses were "yes" (1), "occasionally" (0.5), or "no" (0); while for sleep quality, responses were recorded as poor quality (1) or good quality (0).

2.4. Statistical methods

All statistical analyses were performed using SPSS software. Linear correlation analysis was used to examine the relationship between age and the FI. Measurement data were compared by *t*

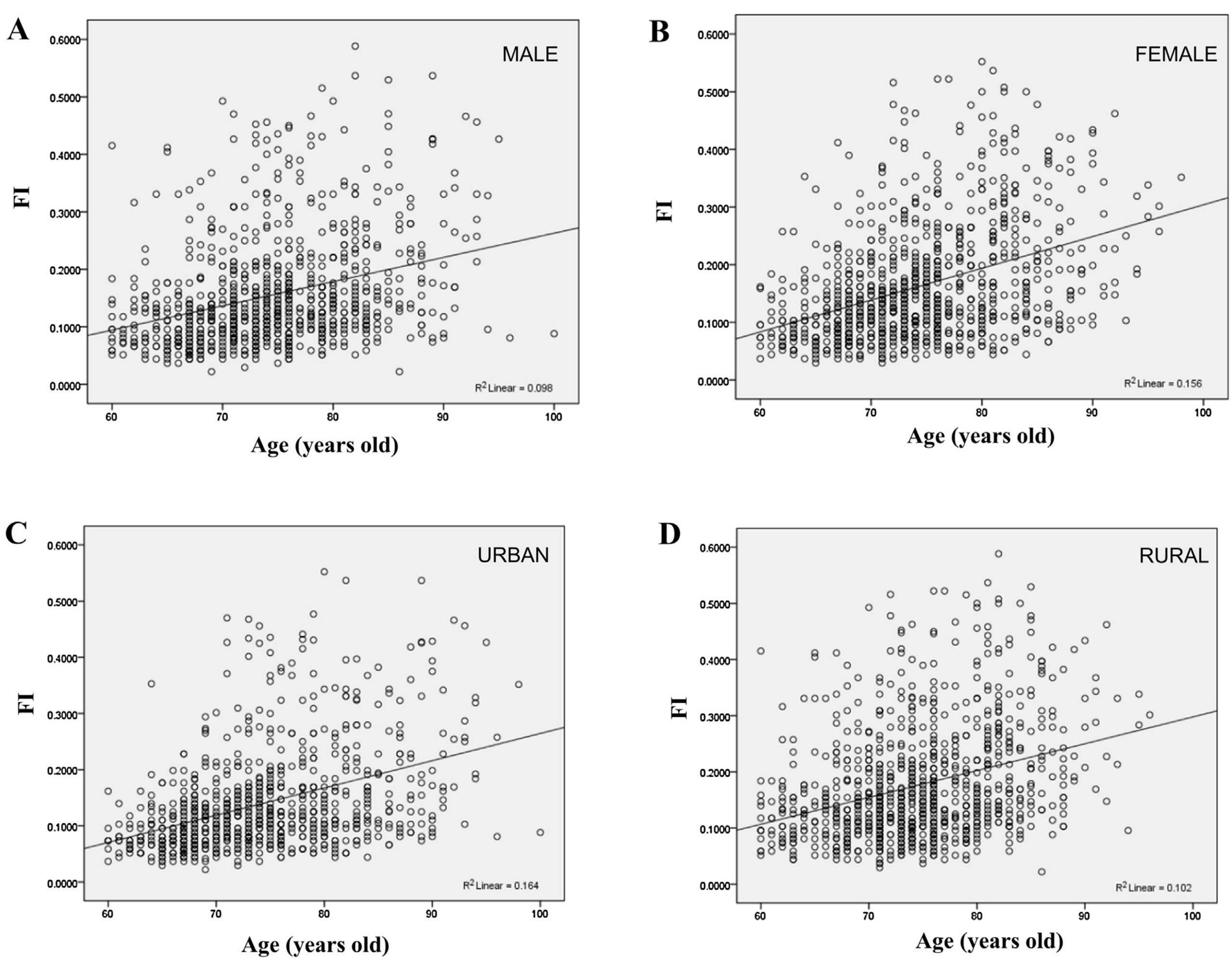

Fig. 2. The correlation of FI and age in different gender and area. (A) The distribution of FI and the correlation between FI and age in male patients ($n = 872$). $R = 0.314$, R square = 0.098, Adjusted R square = 0.097, $F = 20.968$, $P = 0.004$. (B) The distribution of FI and the correlation between FI and age in female patients ($n = 936$). $R = 0.395$, R square = 0.156, adjusted R square = 0.155, $F = 172.408$, $P = 0.000$. (C) The distribution of FI and the correlation between FI and age in urban patients ($n = 847$). $R = 0.405$, R square = 0.164, adjusted R square = 0.163, $F = 165.382$, $P = 0.000$. (D) The distribution of FI and the correlation between FI and age in rural patients ($n = 961$). $R = 0.319$, R square = 0.102, adjusted R square = 0.101, $F = 109.094$, $P = 0.000$.

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tests, and rates were compared by chi-square tests. $P < 0.05$ was considered statistically significant.

3. Results

3.1. Baseline sample data

The sample population comprised 1808 older people aged 60 years or over, residing in Beijing in 2004. The sample included 872 men (48.23%) and 936 women (51.77%), with an average age of 74.5 ± 7.2 years. The sample was followed up at 3, 5, and 8 years (2007, 2009, and 2012). The cumulative follow-up mortality was 15.82% in 2007, 24.12% in 2009, and 34.79% in 2012.

3.2. The correlation of the FI and age by sex and area

The frequency distribution of the FI was a gamma distribution (Fig. 1). The FI range was 0.022–0.588, with an average FI range of 0.156 ± 0.097 for male individuals and 0.164 ± 0.100 for female individuals. The FI was found to be positively correlated with age in male individuals ($R = 0.314$, $P = 0.004$), female individuals ($R = 0.395$, $P = 0$), city-dwelling individuals ($R = 0.405$, $P = 0$), and rural older individuals ($R = 0.319$, $P = 0$). A higher FI was expected as the age increased (Fig. 2).

3.3. Mortality by sex, area, and age

Using 0.2 and 0.4 as boundaries, the FI was divided into three levels: <0.2, 0.2–0.4, and >0.4. The mortality between male and female individuals, city and rural-dwelling older individuals, and older (over 75 years of age) and younger (less than 75 years of age) individuals were compared. Results showed that mortality increased with age. The 3-, 5-, and 8-year mortality rates of male individuals in the FI <0.2 group, and the 5- and 8-year mortality rate of male individuals in the FI 0.2–0.4 group were higher than that of female individuals (Fig. 1). The 3-, 5-, and 8-year mortality rates of older people living in a rural area (village) in the FI <0.2 group were higher than those living in the city (Fig. 2). The 3-year mortality rate for older individuals in the FI 0.2–0.4 group was lower than that of the younger individuals, although it was higher for older individuals in the other two groups (Fig. 3).

4. Discussion

The present study found that the FI was positively related to age in male and female older individuals, and urban and rural older individuals, with the 3-, 5-, and 8-year morality rate in the older individuals higher than in the younger individuals. This supports the findings of Rockwood's study (Searle, Mitnitski, Gahbauer, Gill, & Rockwood, 2008). Age is of significance in predicting the risk of death; the FI increases exponentially with age and can be applied across the Chinese older population (Ellis, Whitehead, Robinson, O'Neill, & Langhorne, 2011). Abizanda suggested that health policies for older adults must primarily consider frailty and disability in subjects aged younger than 80 years and disability in those aged older than 80 years (Abizanda et al., 2014). Aging predisposes older people to frailty, but not all older individuals are frail or pre-frail. Fulop suggests that frailty presents more accentuated characteristics than the normative physiological process of aging (Bergman et al., 2007; Fulop et al., 2010).

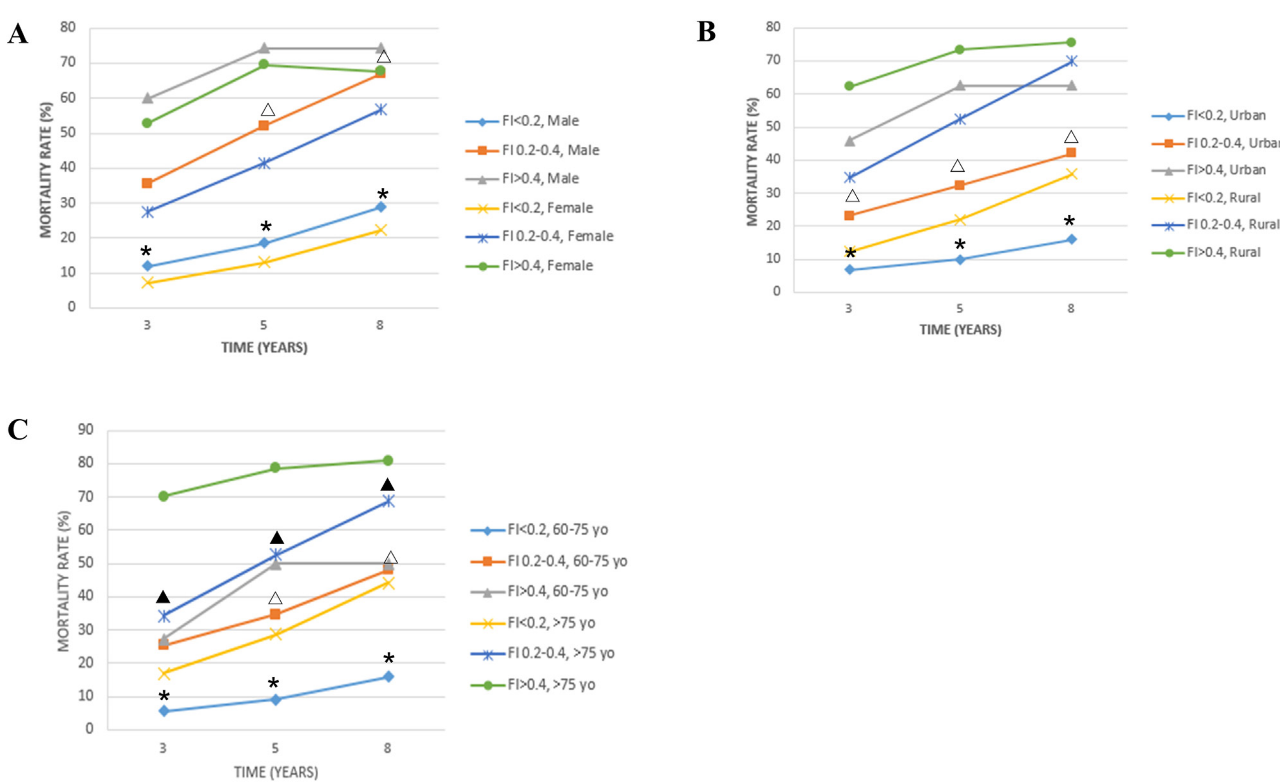

Fig. 3. Comparison of mortality between different gender, area and age. All the patients were divided into three groups according FI score: FI < 0.2 group ($n = 1359$), FI 0.2–0.4 group ($n = 380$) and FI > 0.4 group ($n = 69$). (A) Comparison of mortality between male and female among the three groups. *Significantly different from FI <0.2, female group ($P < 0.05$). △ significantly different from FI 0.2–0.4, female group ($P < 0.05$). ▲ significantly different from FI > 0.4, female group ($P < 0.05$). (B) Comparison of mortality between urban and rural area among the three groups. *Significantly different from FI < 0.2, rural group ($P < 0.05$). △ significantly different from FI 0.2–0.4, rural group ($P < 0.05$). ▲significantly different from FI > 0.4, rural group ($P < 0.05$). (C) Comparison of mortality between 60 and 75 yo and >75 yo among the three groups. *Significantly different from FI < 0.2, >75 yo group ($P < 0.05$). △ significantly different from FI 0.2–0.4, >75 yo group ($P < 0.05$). ▲ significantly different from FI > 0.4, >75 yo group ($P < 0.05$). yo: years old.

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We have already published on 8-year mortality from 2000 to 2008 under the direction of Professor Rockwood (Fang et al., 2012), and this study is based on our recent data in order to evaluate whether FI is a significant tool for evaluation of the prognosis of older people in China. Our results highlight that frailty is a condition associated with problems across multiple physiological systems. Frailty is defined as “a clinically recognizable state of increased vulnerability, resulting from aging-associated decline in reserve and function across multiple physiologic systems such that the ability to cope with every day or acute stressors is compromised” (Xue, 2011). This means frailty is a state of vulnerability to adverse outcomes. Some studies have found that cognitive functioning is worse across multiple cognitive domains in pre-frail and frail individuals aged 50 years and older (Robertson, Savva, Coen, & Kenny, 2014). Frailty was found to be an independent predictor of depressive symptoms in community-dwelling older people; depression is associated with increased mortality, and this increased mortality is strongly associated with frailty (Almeida et al., 2014; Makizako et al., 2014). In addition, frailty is an independent risk factor for 6-month mortality in hospitalized older patients (Joosten, Demuynck, Detroyer, & Milisen, 2014). The detection of incipient functional decline in older persons is not an easy task, and the FI provides a method of screening the heterogeneous population of community-dwelling senior citizens. Routine identification of frailty is also recommended in international guidance (Clegg, Rogers, & Young, 2015).

The present study shows that the FI of rural older individuals tends to be higher than that of urban older individuals, with the follow-up mortality rates for rural older individuals being higher than for urban older individuals. This may be explained by a number of factors: First, older people living in rural areas have less access to medical resources than those living in urban areas, meaning early diagnosis and treatment for many diseases is not available. Second, older people living in rural areas do not have the same health consciousness as urban citizens, meaning they are less likely to seek care early. Third, older people living in rural areas may have poor treatment compliance owing to factors such as community culture and lack of health knowledge. Last, rural older individuals tend to live in poor economic conditions and some older people may not have the resources to treat existing diseases. This difference between urban and rural areas suggests that public health services and health education in rural areas should be strengthened to improve the health of older individuals. The average FI score for female individuals was higher than that of male individuals. However, mortality rates for male individuals were higher than for female individuals, showing a statistically significant difference in the FI <0.2 group. A similar finding emerged from research with Mexican, European, and Chinese older populations (Garcia-Gonzalez, Garcia-Pena, Franco-Marina, & Gutiérrez-Robledo, 2009; Gu et al., 2009; Rockwood et al., 2004). This suggests that the FI is more sensitive in evaluating the prognosis of male than female individuals. The prognosis for male individuals is worse than that for female individuals at the same FI level, meaning that the proportion of deficit indicators relating to higher mortality is much higher for female than male individuals.

Frailty is a significant healthcare challenge. This means that developing and validating a measure to identify frail older adults is important. The FI, as a tool for comprehensive geriatric assessment, has not yet been widely applied and research in Chinese populations is in the early stages. In the present study, the 68-item, health multi-dimensional evaluation index was adopted to establish the FI assessment scale. The findings suggest that the FI evaluation has good applicability and provides a good evaluation of prognosis in older people in the Beijing area, similar to the findings of other studies (Goggins, Woo, Sham, & Ho, 2005; Romero-Ortuno & Kenny, 2012). Based on a self-administered questionnaire, the FA index allows easy screening of older persons for declining functional competence (Dapp, Minder, Anders, Golgert, & von Renteln-Kruse, 2014).

5. Conclusions

Globally, as the population ages, frailty in older adults is an increasingly serious problem for many countries, particularly as it is associated with a number of adverse health outcomes. Our study found that frailty was associated with age and prognosis in community-dwelling older adults, and the FI differed by sex, age, and living area. This may enable health practitioners to achieve early identification of frailty for increased numbers of older people in China. It also suggests that better medical services are needed for the rural older population, possibly using methods such as increasing medical investment and strengthening the health education in rural areas. This may help to narrow the gap between urban and rural medical services, improve the quality of life for older individuals, and further improve the long-term prognosis. These data could be used as the basis for developing efficient strategies aimed at diminishing functional dependence, poor self-rated health, and impaired quality of life. Further research is needed to identify how to reduce risks affect frailty and the associated poor health outcomes.

6. Limitations

Our sample was restricted to community residents in Beijing, so our result is not representative of the overall Chinese population.

Conflict of interest

There are no ethical/legal conflicts involved in the article.

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