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ORIGINAL RESEARCH

A Preliminary Screening Tool for High-Risk Frailty in Older Adults Patients with Pulmonary Tuberculosis

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Objective: To understand the current status and analyse the factors influencing frailty in older adults patients with pulmonary tuberculosis.

Methods: This retrospective case-control study included 204 older adults patients with pulmonary tuberculosis. The enrolled patients were divided into a frailty group (n = 101) and a non-frailty group (n = 103). The study further collected and compared the data of various scores.

Results: The total frailty score among the patients ranged from 0 to 15 points, with an average score of 5.23 ± 2.31 points. The total social support score ranged from 15 to 47 points, with an average of 33.43 ± 6.11 points. The physical function level scores ranged from 10 to 100 points, with an average of 84.58 ± 14.48 points. Additionally, univariate analysis showed significant differences between the groups in terms of age, body mass index (BMI), duration of disease, types of long-term medication and the number of complications and comorbidities ($P < 0.05$). Correlation analysis revealed negative correlations of social support ($P < 0.001$) and physical function ($P < 0.001$) with the overall frailty score and a positive correlation of depression levels ($P < 0.001$) with the overall frailty score. Further regression analysis indicated that being over 80 years old, having a low BMI, long-term polypharmacy and a high depression score were risk factors. High social support and physical function scores were protective factors against frailty in older adults patients with pulmonary tuberculosis.

Conclusion: In older adults patients with pulmonary tuberculosis, the overall frailty score shows negative correlations with social support and physical function and a positive correlation with depression level.

Keywords: pulmonary tuberculosis, frailty, older adults, risk factors

Introduction

Population ageing has become the most significant medical and demographic issue worldwide. According to statistics, the proportion of older adults (≥60 years old) worldwide has elevated from 9.9% in 2002 to 13.5% in 2020, with a growth of 3.6%. It is expected that the number of older adults worldwide will exceed that of teenagers aged 10–24 by 2050 (2.1 billion vs 2 billion).[1] China has the largest number of older adults in the world and is gradually entering an aged society. According to statistics released by the National Bureau of Statistics of China in May 2021, the total population has exceeded 1.44 billion, of which 260 million are older adults aged 60 and above, accounting for 18.7% of the total population.[2]

There is a close relationship between ageing and tuberculosis.[3] As people age, the human body may inevitably undergo various degenerative changes and physiological decline in preventing tuberculosis, resulting in increased vulnerability. Moreover, individuals with worsened immune system functioning are prone to bacterial infections that cause tuberculosis.[4] According to the Fifth National Epidemiological Study of Tuberculosis in China,[5] the incidence of active pulmonary tuberculosis increases with age, with the prevalence among men and women peaking at 75–80 years.

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The overall prevalence is about 1541/100,000 cases, including 2,450/100,000 cases for men and 866/100,000 cases for women. In particular, older adults patients with pulmonary tuberculosis may experience a long duration of disease and complicated conditions, which can seriously affect their quality of life, bring significant impacts to their families and impose heavy burdens on society.

With accelerated ageing, relevant research has gradually become a focus both internationally and domestically. Frailty is a term used to describe the adverse reaction of the older adults to negative events.[6] It has been reported that, compared with young patients, the older adults are more prone to experiencing frailty-related symptoms.[7] Pooled estimates of the prevalence of frailty and pre-frailty, based on the multidimensional model of frailty, are 26.8% and 36.4%, respectively.[8] This can be explained by the decline or imbalance of physiological reserves in the older adults, resulting in increased frailty: a distinguishable physical state in which the ability to maintain internal homeostasis decreases after being subjected to stress.[9] The key factors include reduced physiological reserves or dysfunction in various systems, which can trigger adverse health events in response to minor external stimuli.[10] Critically, tuberculosis is a chronic wasting disease, and older adults patients with osteoarticular tuberculosis may often experience decreased appetite and weight loss due to prolonged bed rest and reduced physical activity,[11] leading to a higher likelihood of frailty.

It is generally recognised that the occurrence of frailty is related to social and demographic factors such as age, gender, unmarried status, living alone and unhealthy lifestyle habits.[12–14] It may also be influenced by geriatric syndromes, including polypharmacy, anxiety, depression, decreased activities of daily living, multiple comorbidities, malnutrition, sleep disorders, forgetfulness, urinary incontinence, falls and pain.[15,16] Prior research has documented that frailty is a dynamic process, and its adverse outcomes can be delayed or avoided with appropriate intervention.[17]

It is important to study and evaluate frailty in older adults patients with pulmonary tuberculosis as early as possible and implement appropriate intervention measures to delay or reverse the process. This can, to a certain extent, alleviate the economic pressure on patients' families and the medical burden on society, thereby promoting healthy ageing. This study investigates the current status and influencing factors of frailty among older adults patients with pulmonary tuberculosis in our hospital.

Participants and Methods

Participants

Using convenience sampling, this study enrolled 204 eligible older adults patients with pulmonary tuberculosis admitted to our hospital between 1 January and 1 October 2023, based on the inclusion and exclusion criteria. The inclusion criteria were as follows: (1) patients who met the diagnostic criteria for pulmonary tuberculosis according to the World Health Organisation 2019; (2) patients aged ≥60 years; (3) patients who had been diagnosed for at least 6 months; and (4) patients who could cooperate with this study. The exclusion criteria were as follows: patients with cognitive impairment, communication disorders, mental illnesses or other critical illnesses who could not cooperate with the survey.

Methods of Study

The respondents in this study were strictly screened according to the inclusion and exclusion criteria, with the consent and support of the nursing department and relevant departments of the hospital. The researchers were responsible for distributing the questionnaires to the patients and explaining the purpose of the study, precautions to be taken when answering and the principles of confidentiality to the patients and their families. Unified guidance was provided on items that were difficult for the patients to understand. The older adults were informed to independently complete the questionnaire without interference. For those who had difficulty filling out the questionnaire due to factors such as visual impairments or limited educational levels, the researchers read each item of the questionnaire in a neutral tone and obtained responses through face-to-face interviews. The researchers collected the completed questionnaires and checked their completeness on the spot. For questionnaires with unclear or incomplete answers, the relevant data were obtained from the electronic nursing records by the researcher.

Data Collection

This study collected the patients' general data (age, marital status, occupation, course of illness, comorbidities, etc)., as well as the Tilburg Frailty Indicator (TFI), the Social Support Scale (SSS), the Barthel Index (BI) rating scale and the Geriatric Depression Scale (GDS) scores, (See supplementary materials).

The TFI, proposed by the Dutch scholar Gobbens RJ,[18] includes three dimensions: physical frailty, psychological frailty and social frailty. It consists of 15 sub-items: natural weight loss, overall health status, difficulty walking, balance condition, visual acuity, hearing condition, self-reported grip strength, self-reported fatigue, memory condition, depression, anxiety, coping ability, living alone, social relationships and social support. The score on this scale ranges from 0 to 15 points, with a total score of ≥5 points potentially indicating frailty. Patients with higher scores may experience more severe frailty. This study used a Chinese version of the TFI[19] for evaluation, which had a Cronbach's α coefficient of 0.73. In addition to its good reliability and validity, it is simple and convenient to measure, making it a useful preliminary screening tool for high-risk frailty populations.

This study used the SSS designed by scholar Jie Li,[20] which included three dimensions: objective support, subjective support and the utilisation of social support. These dimensions consist of 10 sub-items, and the total score of the scale is the sum of these sub-items. Patients with higher total scores are likely to have better social support. According to a study on the scale's reliability and validity by domestic scholars,[21] Cronbach's α coefficients for the 3 dimensions and the total scale were 0.833, 0.896, 0.849 and 0.825, respectively. The scale demonstrated good reliability and can be used to evaluate the social support status of older adults patients with chronic diseases.

In 1965, the BI rating scale was officially named BI.[22] It has good reliability and validity and is widely applied today. With 10 sub-items, the scale is divided into 4 levels: <40 points indicate complete dependence, 41–59 points indicate moderate dependence and the need for assistance in daily life, 60–99 points indicate mild dependence with basic self-care ability in daily life and 100 points indicate full capability of self-care in daily life.

The GDS was developed by American psychologists Brinkt and Yesavage et al in 1982.[23] It includes 30 sub-items. Based on this, Sheikh et al established the GDS-15 (with 15 sub-items) in 1986. It is relatively simple and convenient to use, scoring with a binary "yes or no" response. Four of the 15 sub-items are reverse-scoring items (where "no" indicates the presence of depression), and 11 are positive-scoring items (where "yes" indicates the presence of depression). The scores on this scale range from 0 to 15, with a score of ≥6 points indicating the presence of depressive symptoms. Patients with higher scores may exhibit more pronounced depressive symptoms. Mei Jinrong[24] reported that the internal consistency coefficient (Cronbach's α) of the GDS-15, which has been widely used in China, was 0.82, whereas van Assen MA et al[25] reported high reliability and validity of the GDS for analysing inpatients.

Quality Control

During data collection, the researchers established good relationships with the patients and gained their trust to ensure cooperation. Data collection was completed independently by the researchers to prevent potential bias among the respondents. The researchers explained the relevant filling requirements to the respondents using unified instructions before the questionnaire completion. If any questions arose during the filling process, the researchers provided explanations using unified language. The corresponding scales and questionnaires were checked after the on-site collection of the completed forms. For questionnaires with obvious logical errors or missing items, the respondents were asked to revise and supplement them. These questionnaires were ultimately collected after confirming that there were no errors.

During data entry, the researchers checked each questionnaire after data collection. If more than 20% of the items were missing from a questionnaire, it was excluded from the data entry. The data was recorded using a real-time dual-entry method. For ease of data proofreading, it was entered in two separate batches. The original data was immediately reviewed for correction in case of any logical errors. Finally, the data was imported into the SPSS 26.0 database after being corrected and checked for errors.

Statistical Analysis

In this study, the sample size was determined using the empirical criterion of having 10 times the number of covariates to calculate the sample size in logistic and Cox regression.[26] The final plan was to include 9 variables for logistic regression analysis, resulting in a minimum sample size of 90 for each group. Each group in this study had more than 90 patients, ensuring sufficient statistical efficacy. Data processing was completed using SPSS 26.0 software. The normality of the data was examined using the Kolmogorov–Smirnov test. Measurement data that met normality requirements were expressed as mean ± standard deviation (x ± s), and categorical data were represented by frequency (n) or rate (%) and analysed using the χ^2 test. Correlation was identified using Pearson's correlation analysis, and suspected risk factors were confirmed using logistic regression analysis. A two-tailed $P < 0.05$ indicated the presence of a statistically significant difference.

Results

General Data

In this study, as shown in Table 1, the 204 respondents surveyed (133 men and 71 women) were aged 60–86 years, with an average age of 67.60 ± 6.72 years. Additionally, 53.92% of the patients had a disease course of less than 1 year, 56.37% had 1–2 complications, over 50% had received more than a single re-examination within a year and only 28.43% of the patients did not have other comorbidities.

Table 1 General Data

Items	Cases (n=204)	Proportion (%)
Age		
60–70	145	71.08
71–80	40	19.61
>80	19	9.31
Gender		
Male	133	65.20
Female	71	34.80
Degree of education		
Primary school and below	80	39.22
Middle school	84	41.18
High school/vocational school	29	14.22
College degree or above	11	5.39
Occupation		
Farmer	104	50.98
Staff	74	36.27
Self-employed person	26	12.75
Marital status		
Married	160	78.43
Divorced	31	15.20
Others	13	6.37
Source of hospitalization cost		
Self-funded	34	16.67
Medical insurance	170	83.33
Place of residence		
Town	85	41.67
Rural area	119	58.33

(*Continued*)

Table 1 (Continued).

Items	Cases (n=204)	Proportion (%)
BMI		
Thin (<18.5)	34	16.67
Normal (18.5–23.9)	135	66.18
Overweight (≥24)	35	17.16
Smoking		
No	76	37.25
Quit	84	41.18
Yes	44	21.57
Drinking		
No	95	46.57
Quit	72	35.29
Yes	37	18.14
First admission		
Yes	55	26.96
No	149	73.04
Duration of disease (years)		
0–1	110	53.92
1–3	64	31.37
>3	30	14.71
Long-term polypharmacy (types)		
0	29	14.22
1–3	90	44.12
>3	85	41.67
Complications (number)		
0	74	36.27
1–2	115	56.37
≥3	15	7.35
Re-examinations within 1 year (times)		
0–1	76	37.25
2–3	73	35.78
>3	55	26.96
Comorbidities		
0	58	28.43
1–2	69	33.82
≥3	77	37.75

Notes: BMI, Body Mass Index.

Current Status of Frailty in Older Adults Patients with Pulmonary Tuberculosis

As shown in Table 2, the total frailty score in this study ranged from 0 to 15 points, with an average score of 5.23 ± 2.31 points. Physical frailty, psychological frailty and social frailty scored 2.72 ± 2.31, 1.76 ± 1.25 and 0.75 ± 0.34 points, respectively.

Table 2 Current Status of Frailty in Elderly Patients with Pulmonary Tuberculosis

Items	Minimum	Maximum	Mean±Standard deviation
Total frailty score	0	15	5.23±2.31
Physical frailty	0	8	2.72±2.31
Psychological frailty	0	4	1.57±1.14
Social frailty	0	3	0.75±0.34

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Current Status of Social Support in Older Adults Patients with Pulmonary Tuberculosis

The total social support score for patients in this study ranged from 15 to 47 points, with an average score of 33.43 ± 6.11 points. Specifically, the scores for subjective support, objective support and the utilisation of support were 19.41 ± 4.24, 8.52 ± 2.15 and 5.42 ± 1.43 points, respectively (Table 3).

Physical Function and Depression Status in Older Adults Patients with Pulmonary Tuberculosis

The minimum and maximum scores for physical function in older adults patients with pulmonary tuberculosis were 10 and 100 points, respectively, with an average score of 84.58 ± 14.48 points. Additionally, the average depression level score was 5.13 ± 2.83 points, ranging from 0 to 15 points. Patients with scores of ≥6 points were determined to have depressive symptoms, and 87 out of 204 patients in this study had related symptoms, indicating an incidence rate of 42.6% among older adults patients with pulmonary tuberculosis.

Univariate Analysis of Frailty in Older Adults Patients with Pulmonary Tuberculosis

As shown in Table 4, there were statistically significant differences in age ($P = 0.004$), BMI ($P = 0.002$), disease duration ($P < 0.001$), long-term medication type ($P = 0.013$), number of complications ($P = 0.042$) and comorbidities ($P = 0.033$) between the groups. No statistically significant differences were observed in other factors ($P > 0.05$).

Table 3 Total Score and the Scores of All Dimensions of Social Support for Elderly Patients with Pulmonary Tuberculosis

Items	Minimum	Maximum	Mean±Standard deviation
Total social support score	15	47	33.43±6.11
Subjective support	10	31	19.41±4.24
Objective support	2	28	8.52±2.15
Utilization of support	3	12	5.42±1.43

Table 4 Univariate Analysis of Frailty in Elderly Patients with Pulmonary Tuberculosis

Items	Non-frailty group (n=103)	Frailty group (n=101)	*P* value
Age			0.004
60–70	83	62	
71–80	16	24	
>80	4	15	
Gender			0.964
Male	67	66	
Female	36	35	
Degree of education			0.778
Primary school and below	44	36	
Middle school	40	44	
High school/vocational school	14	15	
College degree or above	5	6	
Occupation			0.257
Farmer	58	46	
Staff	32	42	
Self-employed person	13	13	

(*Continued*)

Table 4 (Continued).

Items	Non-frailty group (n=103)	Frailty group (n=101)	*P* value
Marital status			0.298
Married	77	83	
Divorced	17	14	
Others	9	4	
Source of hospitalization cost			0.234
Self-funded	14	20	
Medical insurance	89	81	
Place of residence			0.554
Town	45	40	
Rural area	58	61	
BMI			0.002
Thin (<18.5)	11	23	
Normal (18.5–23.9)	66	69	
Overweight (≥24)	26	9	
Smoking			0.918
No	37	39	
Quit	43	41	
Yes	23	21	
Drinking			0.160
No	42	53	
Quit	38	34	
Yes	23	14	
First admission			0.482
Yes	30	25	
No	73	76	
Duration of disease (years)			<0.001
0–1	70	40	
1–3	24	40	
>3	9	21	
Long-term polypharmacy (types)			0.013
0	21	8	
1–3	47	43	
>3	35	50	
Complications (number)			0.042
0	41	33	
1–2	59	56	
≥3	3	12	
Re-examinations within 1 year (times)			0.143
0–1	39	37	
2–3	31	42	
>3	33	22	
Comorbidities			0.033
0	32	26	
1–2	41	28	
≥3	30	47	

Notes: BMI, Body Mass Index.

Correlation Analysis of Social Support, Physical Function and Depression with Frailty

As presented in Table 5, social support showed negative correlations with the total scores of frailty ($r = -0.498$), physical frailty ($r = -0.381$), psychological frailty ($r = -0.413$) and social frailty ($r = -0.170$) ($P < 0.05$). Physical function also had negative correlations with the total scores of frailty ($r = -0.512$), physical frailty ($r = -0.623$) and psychological

Table 5 Correlation Analysis of Social Support, Physical Function and Depression with Frailty

Items	Social support		Physical function		Depression	
	r	*P*	*r*	*P*	*r*	*P*
Total frailty score	−0.498	<0.001	−0.512	<0.001	0.549	<0.001
Physical frailty	−0.381	<0.001	−0.623	<0.001	0.377	<0.001
Psychological frailty	−0.413	<0.001	−0.217	<0.001	0.443	<0.001
Social frailty	−0.170	0.021	0.150	0.013	0.314	<0.001

frailty ($r = -0.217$) and a positive correlation with social frailty ($r = 0.150$) ($P < 0.05$). Furthermore, social support was positively correlated with the total scores of frailty ($r = 0.549$), physical frailty ($r = 0.377$), psychological frailty ($r = 0.443$) and social frailty ($r = 0.314$) ($P < 0.05$).

Logistic Regression Analysis of the Factors Affecting Frailty in Older Adults Patients with Pulmonary Tuberculosis

A logistic regression model was constructed with the occurrence of frailty as the dependent variable (occurred = 1, did not occur = 0) and factors with statistically significant differences in univariate analysis as independent variables. The grouping and assignment of variables are shown in Table 6. According to the regression analysis (Table 7), being over 80 years old (odds ratio [*OR]* = 5.129, *95% CI*: 1.125–23.375), having a low BMI (*OR* = 3.271, *95% CI*: 1.249–8.565), long-term polypharmacy (1–3 types: *OR* = 4.394, *95% CI*: 2.103–6.394; >3 types: *OR* = 5.247, *95% CI*: 3.319–7.227) and a high depression score (*OR* = 1.208, *95% CI*: 1.068–1.417) were risk factors. High social support scores (*OR* = 0.407, *95% CI*: 0.199–0.626) and high physical

Table 6 Variable Assignment

Items	Groups	Assignment
Age	60–70	1
	71–80	2
	>80	3
BMI	Thin (<18.5)	1
	Normal (18.5–23.9)	2
	Overweight (≥24)	3
Duration of disease	0–1	1
	1–3	2
	>3	3
Long-term polypharmacy (types)	0	1
	1–3	2
	>3	3
Complications	0	1
	1–2	2
	≥3	3
Comorbidities	0	1
	1–2	2
	≥3	3
Social support score	Original value input	
Physical function score	Original value input	
Depression score	Original value input	

Notes: BMI, Body Mass Index.

Table 7 Logistic Regression Analysis of Factors Affecting Frailty in Elderly Patients with Pulmonary Tuberculosis

Items	Regression coefficient	SE	Wald	*P* value	OR	95% CI
Age (60–70 as a reference)						
71–80	0.482	0.437	1.217	0.270	1.619	0.688~3.809
>80	1.635	0.774	4.462	0.035	5.129	1.125~23.375
BMI (Normal as a reference)						
Thin (<18.5)	1.185	0.491	5.823	0.016	3.271	1.249~8.565
Overweight (≥24)	0.035	0.669	0.003	0.958	1.036	0.209~3.848
Duration of disease (0–1 as a reference)						
1–3	0.425	0.512	2.558	0.110	1.134	0.537~2.976
>3	0.335	0.490	0.467	0.494	1.398	0.535~3.651
Long-term polypharmacy (0 as a reference)						
1–3	1.202	1.301	6.293	0.007	4.394	2.103~6.394
>3	1.953	0.714	7.479	0.004	5.247	3.319~7.227
Complications (0 as a reference)						
1–2	1.283	0.984	2.747	0.097	0.278	0.061~1.263
≥3	1.534	0.862	3.168	0.075	4.637	0.856~25.104
Comorbidities (0 as a reference)						
1–2	1.383	0.384	2.829	0.125	1.382	0.736~2.294
≥3	1.083	1.112	3.103	0.101	1.423	0.836~3.484
High social support score	−0.188	0.048	15.359	<0.001	0.407	0.199~0.626
High physical function score	−0.122	0.037	10.939	<0.001	0.613	0.351~0.914
High depression score	0.497	0.119	17.473	<0.001	1.208	1.068~1.417

Notes: BMI, Body Mass Index, SE, standard error; OR, odd ratio; 95% CI, 95% Confidence Interval.

function scores (*OR* = 0.613, *95% CI*: 0.351–0.914) were protective factors for frailty in older adults patients with pulmonary tuberculosis.

Discussion

In this study, the physical, psychological, social and total frailty scores of older adults patients with pulmonary tuberculosis were 2.72 ± 2.31, 1.57 ± 1.14, 0.75 ± 0.34 and 5.23 ± 2.31 points, respectively. The incidence of frailty was calculated to be 49% in older adults patients with pulmonary tuberculosis. In another study by the Dutch scholar van Calvani R.,[27] the same scales were used to study the frailty status of community-dwelling older adults, and the incidence of frailty was 25.7% in this group. There may be a milder degree of frailty in community-dwelling older adults than that in hospitalised older adults, which may be related to the decline of multiple-system functions in the latter group.

Our study concluded that being over 80 years old, having a low BMI, long-term polypharmacy and a high depression score were risk factors, whereas high social support scores and high physical function scores were protective factors for increased frailty scores in older adults patients with pulmonary tuberculosis.

Age was one of the high-risk factors for increased frailty scores in hospitalised older adults with pulmonary tuberculosis. The older adults patients had a higher risk of increased frailty scores, which was consistent with what was reported by foreign scholars Castrejon-Perez et al.[28] Moreover, Wan Jungang et al[29] further revealed that the likelihood of frailty might increase by 10% with an age increase of 1 year. Hospitalised older adults with pulmonary tuberculosis may have a higher risk of other diseases as their conditions prolong with age. The coexistence of comorbidities can induce organ damage and decrease resistance and the ability to respond to harmful external stimuli, ultimately increasing the incidence of frailty.

Furthermore, a low BMI was an independent risk factor for increased frailty scores in hospitalised older adults patients in our study. In a meta-analysis on the relationship between BMI and frailty risk among community-dwelling older adults, low body mass increased the risk of frailty in these populations.[30] In another study,[31] low body mass was also recognised to be one of the main manifestations of frailty in hospitalised older adults in China.

Polypharmacy may, to some extent, accelerate the process of increased frailty scores in older adults patients with pulmonary tuberculosis. As indicated by existing data,[32] there was a positive correlation between the occurrence of frailty in patients and their daily use of four or more medications. The result of this study was consistent with those reported internationally and domestically. Older adults patients with pulmonary tuberculosis need to receive regular and long-term anti-tuberculosis drugs throughout the entire treatment process, which can cause serious damage to other organs. The side effects of these drugs may increase the risk of frailty in these patients.

Patients with pulmonary tuberculosis who have higher social support tend to have lower frailty scores. Older adults patients with pulmonary tuberculosis often experience intense feelings such as loneliness and anxiety due to the need for regular follow-up and hospitalisation, resulting from the unstable nature of the illness and prolonged treatment duration. It may eventually result in a relatively low level of social support and a decrease in their quality of life. Literature review[33,34] suggests that satisfactory social support can enhance the patients' sense of happiness in life, improve their cognitive function, alleviate symptoms of depression and anxiety and mitigate the frailty process.

Physical function occupies an important position in the occurrence of increased frailty scores in patients with pulmonary tuberculosis. Accumulated evidence[35] supports a strong association between the occurrence of frailty in the older adults and their physical function. In most older adults patients with pulmonary tuberculosis, the occurrence of complications can accelerate the deterioration of their condition, negatively impact their daily lives and weaken their ability to perform daily activities. All these adverse events may reduce their enthusiasm for health-promoting behaviours, ultimately creating a vicious cycle that worsens their overall health status and accelerates the process of frailty.

In addition, depression contributes to the increased frailty scores in older adults patients with pulmonary tuberculosis. Patients may present primarily with an obvious and sustained depressed mood due to various external factors. Currently, there is a gradual increase in the incidence of various mental illnesses as society develops and life stress increases. Depression is a component of neurodegenerative diseases and may be an age-related comorbidity associated with frailty. Women are more vulnerable than men to the effects of depression. The incidence of depression in patients with chronic diseases has been reported to be 1.6–2 times higher than in the general population.[36] Pulmonary tuberculosis is a chronic infectious disease with a long duration, extended treatment time, high recurrence and significant impact. As a result, older adults patients with pulmonary tuberculosis are prone to various psychological issues, which can seriously delay rehabilitation and reduce their quality of life.

This study has several limitations. First, more accurate results could be obtained in a cross-sectional study with a larger sample size. This study was based on a smaller sample of 204 patients due to limited resources. Future studies should involve a larger sample size to improve result accuracy. All patients in this study were recruited from the same hospital, which introduces regional and personnel biases. Nutritional status in the older adults population is also an important factor in frailty. However, it was not included in this study. We will explore the relationship between nutritional status and frailty in older adults patients with pulmonary tuberculosis in a subsequent study.

Conclusion

To sum up, in older adults patients with pulmonary tuberculosis, their overall frailty score shows negative correlations with social support and physical function scores and positive correlations with depression levels. The risk factors for increased frailty scores in these patients include being over 80 years old, having a low BMI, long-term polypharmacy and high depression scores, whereas protective factors include high social support and high physical function scores.

Data Sharing Statement

All data generated or analysed during this study are included in this article. Further enquiries can be directed to the corresponding author.

Ethics Approval and Consent to Participate

This study was conducted in accordance with the Declaration of Helsinki and approved by the ethics committee of Wenzhou Central Hospital. Written informed consent was obtained from all participants.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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References

1. Rudnicka E, Napierała P, Podfigurna A, et al. The World Health Organization (WHO) approach to healthy ageing. *Maturitas*. 2020;139:6–11. doi:10.1016/j.maturitas.2020.05.018
2. Jizhe N. Main Data of the Seventh National Population Census. *China Statistics*. 2021(05):4–5.
3. Headley CA, Gautam S, Olmo-Fontanez A, et al. Mitochondrial Transplantation Promotes Protective Effector and Memory CD4+ T Cell Response During Mycobacterium Tuberculosis Infection and Diminishes Exhaustion and Senescence in Elderly CD4+ T cells. *Adv Sci (Weinh)*. 2024: e2401077. doi:10.1002/advs.202401077
4. Liu W, Xu Y, Yang L, et al. Risk factors associated with pulmonary hypertension in patients with active tuberculosis and tuberculous destroyed lung: a retrospective study. *Sci Rep*. 2024;14(1):10108. doi:10.1038/s41598-024-59679-z
5. Lixia W, Shiming C, Mingting C, et al. The fifth national tuberculosis epidemiological survey in 2010. *Chinese Journal of Antituberculosis*. 2012; (08):485–508.
6. Mele DM, Ragnatela DI, Romano DM, et al. Impact of frailty on outcome of elderly NSTEMI patients undergoing PCI. *Am J Cardiol*. 2024: S0002–9149(24)00618–0. doi:10.1016/j.amjcard.2024.08.016
7. Theou O, Sluggett JK, Bell JS, et al. Frailty, Hospitalization, and Mortality in Residential Aged Care. *J Gerontol a Biol Sci Med Sci*.;73 (8):1090–1096. doi:10.1093/gerona/glx185
8. Si Q, Guo J, Feng YP, Luo SR, Liu ZD, Zhou GN. Correlation between depression and adherence to respiratory function exercise in elderly frail patients with tuberculosis: a cross-sectional survey. *Medicine (Baltimore)*.;103(22). doi:10.1097/MD.0000000000038212
9. Tazzeo C, Rizzuto D, Calderón-Larrañaga A, et al. Avoidable Hospitalizations in Frail Older Adults: the Role of Sociodemographic, Clinical, and Care-Related Factors. *J Am Med Dir Assoc*. 2024:105225. doi:10.1016/j.jamda.2024.105225
10. Kume Y, Kodama A, Arai S, et al. Improvement of social frailty is associated with stability of nonparametric characteristics of the rest-activity rhythm and improvement of the usual walking ability in the elderly. *Chronobiol Int*. 2024;41:1–9. doi:10.1080/07420528.2023.2294049
11. Luger E, Dorner TE, Haider S, et al. Effects of a Home-Based and Volunteer-Administered Physical Training, Nutritional, and Social Support Program on Malnutrition and Frailty in Older Persons: a Randomized Controlled Trial. *J Am Med Dir Assoc*. 2016;17(7):671–679. doi:10.1016/j.jamda.2016.04.018
12. Porter G, Sakowitz S, Mallick S, et al. Association of Frailty With Clinical and Financial Outcomes Following Liver Transplantation. *Clin Transplant*. 2024;38(9):e15438. doi:10.1111/ctr.15438
13. Spoden M, Dröge P, Günster C, et al. A high hospital frailty risk score indicates an increased risk for complications following surgical treatment of proximal humerus fractures. *Arch Gerontol Geriatr*. 2024;128:105598. doi:10.1016/j.archger.2024.105598
14. Qi X, Jia N, Hu J, et al. Analysis of the status of social frailty in Chinese older adults with cardiovascular and cerebrovascular diseases: a national cross-sectional study. *Front Public Health*. 11;1022208. doi:10.3389/fpubh.2023.1022208
15. Lorenzo-López L, Maseda A, de Labra C, et al. Nutritional determinants of frailty in older adults: a systematic review. *BMC Geriatr*. 2017;17 (1):108. doi:10.1186/s12877-017-0496-2
16. Wang LY, Hu ZY, Chen HX, Tang ML, Hu XY. Multiple geriatric syndromes in community-dwelling older adults in China. *Sci Rep*. 14(1):3504. doi:10.1038/s41598-024-54254-y
17. Meng L, Pulin Y. The interpretation of practice guidelines for the management of frailty by British Geriatrics Society. *Chinese Journal of Geriatrics*. 2015;34(12):1300–1302. doi:10.3760/cma.j.issn.0254-9026.2015.12.006
18. Gobbens RJ, van Assen MA, Luijkx KG, et al. Testing an integral conceptual model of frailty. *J Adv Nurs*. 2012;68(9):2047–2060. doi:10.1111/j.1365-2648.2011.05896.x
19. M CR, C CH, Naarding P, et al. Physical frailty: vulnerability of patients suffering from late-life depression. *Aging Ment Health*. 2014;18 (5):570–578. doi:10.1080/13607863.2013.827628
20. Li J, Li M, Reid JK. Social support in bereavement: developing and validating a new scale. *Int J Psychol*. 2022;57(2):306–313. doi:10.1002/ijop.12816
21. Jiwen L, Li Fuye LY. Investigation of reliability and validity of the social support scale. *Journal of Xinjiang Medical University*. 2008(01):1–3.

22. Pfeufer D, Kammerlander C, Stadler C, et al. Multidisciplinary inpatient rehabilitation improves the long-term functional status of geriatric Hip-fracture patients. *Eur J Med Res*. 25(1):31. doi:10.1186/s40001-020-00433-2
23. A YJ, L BT, Rose TL, et al. Development and validation of a geriatric depression screening scale: a preliminary report. *J Psychiatr Res*. 1982;17 (1):37–49. doi:10.1016/0022-3956(82)90033-4
24. Jinrong M. A Study on the Reliability and Validity of the Elderly Depression Scale and the General Health Questionnaire (Simplified Version). *Chinese Journal of Psychiatry*. 1999(01):40–42.
25. van Assen MA, Pallast E, Fakiri FE, et al. Measuring frailty in Dutch community-dwelling older people: reference values of the Tilburg Frailty Indicator (TFI). *Arch Gerontol Geriatr*. 2016;67:120–129. doi:10.1016/j.archger.2016.07.005
26. Vittinghoff E, McCulloch CE. Relaxing the rule of ten events per variable in logistic and Cox regression. *Am J Epidemiol*. 165(6):710–718. doi:10.1093/aje/kwk052
27. Calvani R, Marini F, Cesari M, et al. Biomarkers for physical frailty and sarcopenia: state of the science and future developments. *J Cachexia Sarcopenia Muscle*. 2015;6(4):278–286. doi:10.1002/jcsm.12051
28. C C-PR, A B-YS, M G-RL, et al. Oral health conditions and frailty in Mexican community-dwelling elderly: a cross sectional analysis. *BMC Public Health*. 2012;12:773. doi:10.1186/1471-2458-12-773
29. Jungang W. Reliability and Validity Analysis of the Hospital Anxiety and Depression Scale in Inpatients of Comprehensive Hospitals. *World Latest Med Infor*. 2018;18(54):55–56. doi:10.19613/j.cnki.1671-3141.2018.54.033
30. Yuan L, Chang M, Wang J. Abdominal obesity, body mass index and the risk of frailty in community-dwelling older adults: a systematic review and meta-analysis. *Age Ageing*. 2021;50(4):1118–1128. doi:10.1093/ageing/afab039
31. Xu L, Zhang J, Shen S, et al. Association Between Body Composition and Frailty in Elder Inpatients. *Clin Interv Aging*. 2020;15:313–320. doi:10.2147/CIA.S243211
32. Eyigor S, G KY, Duran E, et al. Frailty prevalence and related factors in the older adult-FrailTURK Project. *Age (Dordr)*. 2015;37(3):9791. doi:10.1007/s11357-015-9791-z
33. Sangalang CC, Gee GC. Depression and anxiety among Asian Americans: the effects of social support and strain. *Soc Work*. 2012;57(1):49–60. doi:10.1093/sw/swr005
34. Wang B, He P, Dong B. Association between family functioning and cognitive impairment among Chinese nonagenarians/centenarians. *Geriatr Gerontol Int*. 2015;15(9):1135–1142. doi:10.1111/ggi.12410
35. Wong CH, Weiss D, Sourial N, et al. Frailty and its association with disability and comorbidity in a community-dwelling sample of seniors in Montreal: a cross-sectional study. *Aging Clin Exp Res*. 2010;22(1):54–62. doi:10.1007/BF03324816
36. Fisher L, M SM, T MJ, et al. A longitudinal study of affective and anxiety disorders, depressive affect and diabetes distress in adults with Type 2 diabetes. *Diabet Med*. 2008;25(9):1096–1101. doi:10.1111/j.1464-5491.2008.02533.x