Supported by 日本財団 THE NIPPON FOUNDATION

日中笹川医学奨学金制度
第４５期＜ポストドクターコース＞

中　間　報　告　書

2024 年 4 月～2025 年 3 月

公益財団法人　日中医学協会

目　次

日中笹川医学奨学金制度〈ポストドクターコース〉中間評価書
【指導教官用】

Supported by 日本財団 THE NIPPON FOUNDATION

第45期　　研究者番号：　P4511

氏名	焦 丹丹	JIAO DANDAN	性別	F	生年月日	1985/12/21

中国所属機関（役職）	河南科技大学第一附属医院護理部（主管看護師）
日本研究先機関名・部署	筑波大学大学院人間総合科学研究科 生命システム医学専攻　国際発達ケア: エンパワメント科学研究室
指導教官氏名・役職	安梅 勅江　教授
研究テーマ（日本語）	エンパワーメントに基づく看護師主導の慢性閉塞性肺疾患合併症患者の過渡期ケアモデルの構築と応用
研究テーマ（英語）	An empowerment-based nurse-led transitional care program for patients with chronic obstructive pulmonary disease-multimorbidity and their family caregivers

研究者評価（指導教官記入欄）

進捗状況	優・良・可・不可から選択してください⇒	優	パーセンテージ⇒	70　%
研究者本人が行った研究の概要	焦丹丹氏はエンパワメントの技術を活用し、地域在住高齢者の健康増進に向けた促進因子を明らかにする研究を実施しました。健康習慣に加え社会とのかかわりが、高齢者の健康状態維持に大きく貢献する要因であることを明らかにしました。			
総合評価	【良かった点】 1.学際チームワーク技術を習得しました。 2.プロジェクトマネジメントを体験し習得しました。			
	【改善すべき点】 さらに高度な統計スキルを学ぶことで解析の幅が広がります。			
	【今後の目標】 リーダーとしての資質を発揮し、国際的学際的なプロジェクトを企画し、日中の懸け橋となっていただくことを期待しています。			
研究計画書に記載の研究計画の進捗状況	①予想以上に進捗している　(②)おおむね順調　③やや遅れている　④大幅に遅れている			
進捗が進んでいる内容と遅れている内容及びその理由				
現在の進捗状況を踏まえた目標達成見込	焦丹丹氏は、ポスドク取得見込です			
評価者（指導教官記名）	安梅勅江	作成日：	2025年　2　月　28　日	

日中笹川医学奨学金制度<ポストドクターコース>中間報告書
【研究者用】

Supported by 日本財団 THE NIPPON FOUNDATION

第45期　　研究者番号：P4511　　作成日：2025年3月10日

氏名	焦 丹丹	JIAO DANDAN	性別	F	生年月日	1985/12/21
中国所属機関(役職)	河南科技大学第一附属医院護理部（主管看護師）					
日本研究先（指導教官）	筑波大学大学院人間総合科学研究科 生命システム医学専攻　国際発達ケア: エンパワメント科学研究室（安梅 勅江　教授）					
研究テーマ(日文)	エンパワーメントに基づく看護師主導の慢性閉塞性肺疾患合併症患者の過渡期ケアモデルの構築と応用					
Research theme	An empowerment-based nurse-led transitional care program for patients with chronic obstructive pulmonary disease-multimorbidity and their family caregivers					

1．研究概要（1）

1）目的（Goal）

Chronic obstructive pulmonary disease (COPD) is the most common chronic respiratory disease in China, characterized by high prevalence, high mortality, and a significant disease burden. The increasing severity of COPD prevention and control may be closely related to an aging population, widespread exposure to smoking and secondhand smoke, and air pollution. In recent years, the prevention and management of COPD and other chronic respiratory diseases have gained increasing national attention, leading to the introduction of various supportive policies Despite multiple government interventions, the burden of COPD remains substantial. A multi-center study conducted in China in 2007 reported that the prevalence of COPD among individuals aged 40 and above was 8.2% . With the COPD patient population expanding year by year, strengthening long-term disease management and health interventions has become an urgent priority for the public health and healthcare systems.The COPD population has been expanding continuously, making disease management for patients particularly important. Pulmonary rehabilitation is recognized as the primary non-pharmacological treatment method for COPD.However, the compliance of pulmonary rehabilitation is poor, especially for patients at home. How to improve the pulmonay rehabilitation compliance is necessary.

Empowerment theory is to give people dreams and hopes, encouragethem, and bring out the wonderful power of life that they originally have.There are three types of empowerments: self-empowerment, peer empowerment, and communityempowerment. This theory would guide the transitional care model properly and suitably.Empowerment theory is suitable to guide the practice.

According to the empowerment theoty, this study aims to construct and evaluate the transitional model of COPD patient when they dischage from hospital. The model will focus on patients and their primary caregivers as a dyad for disease intervention to improve the compliance of pulmonary rehabilitation of COPD patients.

2）戦略（Approach）

A mixed research design will be conducted. Questionnaire survey was conducted in the quantitave phase. Individual and focus group interview will be conducted in the qulitative phase.

3）材料と方法（Materials and methods）

Quantitative section

Participants: A convenience sampling method was used to select COPD patients admitted to the Department of Respiratory and Critical Care Medicine of a tertiary hospital.

Inclusion Criteria: ① Patients meeting the diagnostic criteria of the Guidelines for the Diagnosis and Treatment of Chronic Obstructive Pulmonary Disease (2024 Revised Edition); ② Patients in the stable phase of COPD.Patients able to cooperate in completing relevant scale assessments;③Patients who voluntarily participate in the study and sign the informed consent form.

Exclusion Criteria:① Individuals with visual, hearing, or cognitive impairments that prevent normal communication;②Patients with a history of psychiatric disorders who are unable to cooperate;③Patients with end-stage comorbidities, such as severe organic heart disease, malignant tumors, or hepatic and renal dysfunction.

Measurements:① A self-designed questionnaire was developed based on relevant literature and the study objectives. It includes information on age, sex, primary caregiver, marital status, education level, employment status, health insurance type, monthly household income per capita, health behavior factors (e.g., smoking and alcohol consumption), hospitalization frequency, COPD disease duration, and comorbidities.

② Exercise Benefits/Barriers Scale This scale was developed by Sechmrist et al. and consists of 43 items, with 29 items measuring exercise benefits and 14 items assessing exercise barriers. Each item is scored on a 4-point Likert scale ranging from 1 to 4, where 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree. A higher total score indicates greater perceived benefits and better exercise-related behaviors. The Cronbach's α coefficient of this scale is 0.86, indicating good reliability.

1．研究概要(2)

4)実験結果(Results)

①A review titled Factors Influencing Exercise Adherence in Patients with Chronic Obstructive Pulmonary Disease (COPD): A systematic review of qualitative studies has been finished.

②Questionnaires survey collected data from 100 participants. The survey was still ongoing.

5)考察(Discussion)

Empowerment theory emphasizes patient autonomy, self-efficacy, and active participation in healthcare decision-making, which can significantly influence pulmonary rehabilitation compliance in COPD patients. By fostering a sense of control and self-management, empowerment interventions — such as shared decision-making, personalized goal-setting, and health education — enhance patients' motivation and adherence to PR programs. Studies suggest that COPD patients who feel empowered are more likely to engage in sustained exercise routines, effectively manage symptoms, and overcome psychological barriers like anxiety or depression, which often hinder PR adherence. Additionally, healthcare providers play a crucial role in facilitating empowerment by offering tailored support, promoting collaborative care, and addressing individual concerns, thereby strengthening long-term commitment to rehabilitation. Future research should explore tailored empowerment strategies to optimize PR compliance and improve patient outcomes.

The qulitative review revealed that from the self-empowerment level,disease knowledge,perception of safety,sense control of rehabilitation, goal setting are factors related to the complicance of pulmonary rehabilitation. From the peer empowerment, lack of knowledge, support and understanding from the caregiver,as well as the inspecton from the caregiver are important factors. From the orgnization level, the fundamental instruction, human resources from the community, remote support from hospital, mutidepartment cooperation, attitude of the professionals and the timely information convey from hospital are main factors.Based on the review results. Furtre intervention should consider the related main facoters to constuct an effective support model for COPD patients.

6)当初の研究計画と比し、現在の進捗状況の自己評価 (Self-assessment of the current progress compared to the initial research plan.)

①予想以上に進捗している(Progressing more than expected.)

(②)おおむね順調 (Mostly on track)

③やや遅れている (Slightly behind schedule)

④大幅に遅れている(Significantly behind schedule)

7)計画より進んでいる内容と遅れている内容、及びその理由

(Contents that are ahead of schedule and those that are behind schedule, along with the reasons.)

Mostly on track.

8)参考文献(References)

[1]Soriano J B, Kendrick P J, Paulson K R, et al. Prevalence and attributable health burden of chronic respiratory diseases, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017[J]. The Lancet Respiratory Medicine, 2020, 8(6):585-596.

[2]Huang K, Zheng Z, Li W, et al. Sociodemographic correlates with prevalence of comorbidities in patients with chronic obstructive pulmonary disease: a study from a Chinese National Survey[J]. The Lancet Regional Health-Western Pacific, 2023, 42:100937.

[3]Wang C, Xu J, Yang L, et al. Prevalence and risk factors of chronic obstructive pulmonary disease in China (the China Pulmonary Health [CPH] study): a national cross-sectional study[J]. The Lancet, 2018, 391(10131):1706-1717.

[4]Yin P, Wu J, Wang L, et al. The burden of COPD in China and its provinces: findings from the global burden of disease study 2019[J]. Frontiers in Public Health, 2022, 10:859499.

[5]Skou S T, Mair F S, Fortin M, et al. Multimorbidity[J]. Nature Reviews Disease Primers, 2022, 8(1):48.

[6]Stenlund, T., Karlsson, Å., Liv, P. et al. Short-term effects on physical activity level with web-based self-management support in people with COPD: a randomised controlled trial. npj Prim. Care Respir. Med. 34, 32 (2024).

[7]Maddocks S, Camp P, Tang C. Engaging ethnically diverse populations in self-management interventions for chronic respiratory diseases: a narrative review[J]. Pulmonary Therapy, 2023, 9(2): 195-206.

[8] Janjua S, Banchoff E, Threapleton C J D, et al. Digital interventions for the management of chronic obstructive pulmonary disease[J]. Cochrane Database of Systematic Reviews, 2021 (4).

[9]Tokie Anme.Creating Empowerment in Communities: Theory and Practice from an International Perspective (Social Issues, Justice and Status),2019.

[10] Wang C, Xu J, Yang L, et al. Prevalence and risk factors of chronic obstructive pulmonary disease in China (the China Pulmonary Health [CPH] study): a national cross-sectional study[J]. The Lancet, 2018, 391(10131):1706-1717.

2. 執筆論文 Publication of thesis ※記載した論文を添付してください。Attach all of the papers listed below.

論文名 1 Title	Social Frailty and Functional Status in Japanese Older Adults: The Mediating Role of Subjective Cognitive Function					
掲載誌名 Published journal	J Am Med Dir Assoc					
	2024 年 7 月	25 巻(号)	104971 頁 ～ 頁	言語 Language	English	
第1著者名 First author	Cui Mingyu	第2著者名 Second author	Jiao Dandan	第3著者名 Third author	Miura KumiWatanabe	
その他著者名 Other authors	Liu Y, Li X, Zhu Z, Sawada Y, Watanabe T, Tanaka E, Anme T					
論文名 2 Title	Longitudinal assessment of the relationship between frailty and social relationships among Japanese older adults: a random intercept cross-lagged panel model					
掲載誌名 Published journal	BMC Public Health					
	2024 年 5 月	24 巻(号)	706 頁 ～ 頁	言語 Language	English	
第1著者名 First author	Cui Mingyu	第2著者名 Second author	Jiao Dandan	第3著者名 Third author	Liu Y	
その他著者名 Other authors	Zhu Y, Li X, Zhu Z, Zhang J, Alpona AB, Wang Y, Qian M, Sawada Y, Miura KW, Watanabe T, Tanaka E, Anme T					
論文名 3 Title	The trajectory of functional status among older adults with chronic diseases and the association with social relationships					
掲載誌名 Published journal	Under revision (Fronteris in Pulic Health)					
	年 月	巻(号)	頁 ～ 頁	言語 Language		
第1著者名 First author	Jiao Dandan	第2著者名 Second author	Yantong Zhu	第3著者名 Third author	Zhu Zhu	
その他著者名 Other authors	Xiang Li, Jinrui Zhang, Mingyu Cui, Yang Liu , Munenori Matsumoto, Yuko Sawada, Kumi Watanabe Miura,Taeko Watanabe, Tokie Anme					
論文名 4 Title						
掲載誌名 Published journal						
	年 月	巻(号)	頁 ～ 頁	言語 Language		
第1著者名 First author		第2著者名 Second author		第3著者名 Third author		
その他著者名 Other authors						
論文名 5 Title						
掲載誌名 Published journal						
	年 月	巻(号)	頁 ～ 頁	言語 Language		
第1著者名 First author		第2著者名 Second author		第3著者名 Third author		
その他著者名 Other authors						

3. 学会発表　Conference presentation　※筆頭演者として総会・国際学会を含む主な学会で発表したものを記載してください。

※Describe your presentation as the principal presenter in major academic meetings including general meetings or international meetings.

学会名 Conference							
演　題 Topic							
開催日 date	年	月	日	開催地 venue			
形式　method	□　口頭発表　Oral	□　ポスター発表　Poster		言語　Language	□　日本語	□　英語	□　中国語
共同演者名 Co-presenter							
学会名 Conference							
演　題 Topic							
開催日 date	年	月	日	開催地 venue			
形式　method	□　口頭発表　Oral	□　ポスター発表　Poster		言語　Language	□　日本語	□　英語	□　中国語
共同演者名 Co-presenter							
学会名 Conference							
演　題 Topic							
開催日 date	年	月	日	開催地 venue			
形式　method	□　口頭発表　Oral	□　ポスター発表　Poster		言語　Language	□　日本語	□　英語	□　中国語
共同演者名 Co-presenter							
学会名 Conference							
演　題 Topic							
開催日 date	年	月	日	開催地 venue			
形式　method	□　口頭発表　Oral	□　ポスター発表　Poster		言語　Language	□　日本語	□　英語	□　中国語
共同演者名 Co-presenter							

4. 受賞（研究業績）　Award (Research achievement)

名　称 Award name					
	国名 Country		受賞年 Year of award	年	月
名　称 Award name					
	国名 Country		受賞年 Year of award	年	月

5. 本研究テーマに関わる他の研究助成金受給 Other research grants concerned with your resarch theme

受給実績 Receipt record	☐ 有　　■ 無
助成機関名称 Funding agency	
助成金名称 Grant name	
受給期間 Supported period	年　　月 ～　　年　　月
受給額 Amount received	円
受給実績 Receipt record	☐ 有　　■ 無
助成機関名称 Funding agency	
助成金名称 Grant name	
受給期間 Supported period	年　　月 ～　　年　　月
受給額 Amount received	円

6. 他の奨学金受給 Another awarded scholarship

受給実績 Receipt record	☐ 有　　■ 無
助成機関名称 Funding agency	
奨学金名称 Scholarship name	
受給期間 Supported period	年　　月 ～　　年　　月
受給額 Amount received	円

7. 研究活動に関する報道発表 Press release concerned with your research activities

※記載した記事を添付してください。Attach a copy of the article described below

報道発表 Press release	■ 有　　☐ 無	発表年月日 Date of release	2024年12月27日
発表機関 Released medium	大河報		
発表形式 Release method	・**新聞**　・雑誌　・Web site　・記者発表　・その他（　　）		
発表タイトル Released title	从饮食到运动：慢性呼吸系统疾病患者的全方位护理策略（From diet to exercise: the care strategies of chronic obstuctive disease）		

8. 本研究テーマに関する特許出願予定 Patent application concerned with your research theme

出願予定 Scheduled application	☐ 有　　■ 無	出願国 Application	
出願内容（概要） Application contents			

9. その他 Others

指導責任者（記名） Tokie Anme

JAMDA xxx (2024) 1–6

JAMDA

journal homepage: www.jamda.com

Original Study

Social Frailty and Functional Status in Japanese Older Adults: The Mediating Role of Subjective Cognitive Function

Mingyu Cui PhD [a], Dandan Jiao PhD [a,b], Kumi Watanabe Miura PhD [c], Yang Liu PhD [a], Xiang Li PhD [a], Zhu Zhu PhD [a], Yuko Sawada PhD [d], Taeko Watanabe PhD [e], Emiko Tanaka PhD [f], Tokie Anme PhD [g,*]

[a] *School of Comprehensive Human Science, University of Tsukuba, Tsukuba, Japan*
[b] *Department of Nursing, The First Affiliated Hospital and College of Clinical Medicine of Henan University of Science and Technology, Luoyang City, Henan Province, China*
[c] *RIKEN, Center for Advanced Intelligence Project, Nihonbashi, Tokyo, Japan*
[d] *Department of Physical Therapy, Morinomiya University of Medical Sciences, Osaka, Japan*
[e] *Faculty of Nursing, Shukutoku University, Chiba, Japan*
[f] *Faculty of Nursing, Musashino University, Tokyo, Japan*
[g] *Faculty of Medicine, University of Tsukuba, Tsukuba, Japan*

Keywords:
Older adults
social frailty
cognitive impairment
disability

A B S T R A C T

Objective: This study aimed to explore the direct and indirect effects of social frailty on functional state trajectories mediated by subjective cognitive function in older adults.
Design: Longitudinal study.
Setting and Participants: Overall, 514 adults aged ≥65 years living in a suburban area of central Japan were included in this study.
Methods: Five-item social frailty index (going out, visiting, feeling helpful, living alone, and talking to others), subjective cognitive function from the Kihon Checklist, and instrumental activities of daily living disability. Latent growth curve models were applied to examine the longitudinal relations among the variables.
Results: During the 6-year follow-up in latent growth curve models, the initial level of social frailty in older adults was negatively associated with that of functional status ($\beta = -0.53$, $P < .001$), and the rate of change in social frailty was negatively associated with that in functional status ($\beta = -0.78$, $P < .001$). In the mediation model, the indirect effect from the social frailty level to functional status level through subjective cognitive function level was significant ($\beta = -0.14$, 95% CI −0.29, −0.09); the rates of change in subjective cognitive function mediated the relationship between those in social frailty and functional status ($\beta = -0.35$, 95% CI −0.46, −0.25).
Conclusions and Implications: This study found that there is an association between social frailty and functional status in Japanese older adults. Subjective cognitive function mediated this relationship. Hence, additional research is required to investigate additional potential factors linking social frailty and functional status in order to gain a better understanding of the underlying mechanisms.

For older adults, functional disability represents a lack of physical and mental skills in performing activities of daily living (ADL) independently.[1] Generally, the instrumental ADL (IADL) is considered a measure of functional status, as IADL requires more complex physical and cognitive performance and occurs earlier than ADL disability and dementia.[2-4] According to the 2010 estimates by the World Health Organization, more than 1 billion individuals worldwide (approximately 15% of the population) may have significant functional disabilities. People with disabilities are at a higher risk of depression, and stroke, among others, and have more difficulty using transportation than fully functioning people. Additionally, people with disabilities face stigma, discrimination, poverty, and unfair exclusion from education and employment.[5] As the world's population ages, the number of people with disabilities increases.[6] Early identification of people

Funding: This work was supported by JSPS KAKENHI (grant number JP21K18449), and JST SPRING (grant number JPMJSP2124).
* Address correspondence to Tokie Anme, PhD, Medical Science Innovation Bldg., Room 205, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8577, Japan.
E-mail address: tokieanme@gmail.com (T. Anme).

https://doi.org/10.1016/j.jamda.2024.02.009
1525-8610/

potentially at risk of disability and intervention is important in achieving healthy aging.

Studies have shown that early intervention can slow or reverse the age-related functional decline.[7] Frailty in older people is a generalized condition of vulnerability characterized by diminished physiological reserves, poor tolerance to stress, and an increased risk of negative health consequences, including disability, hospitalization, and death.[8] Previous research on frailty focused on the physical field and its effects on adverse health outcomes, particularly functional disability.[9,10] Although frailty stands acknowledged as a multidimensional construct encompassing physical, psychological, and social conditions and symptoms,[11,12] an inadequate depth of exploration has been evident within the realms of its social domain.[13] This insufficiency underscores a notable gap in comprehensive comprehension of frailty, particularly concerning aspects beyond its physical manifestations. Social frailty delineates the gradual depletion of resources, activities, or capacities necessary for engagement within society, culminating in an incapacity to fulfill fundamental social requirements.[14] As aging continues, social frailty is becoming a serious problem in older societies as older people become more dependent on their social relationships and environment.[15] Research generally supports an association between social frailty and functional disabilities. Social frailty is highly predictive of disability, particularly the impairment of ADL.[16] In addition, social frailty may negatively impact the incidence of disability by affecting the loss of muscle mass.[17]

However, the processes and ways in which social frailty affects functional disability are complex, and their mechanisms have not been fully explored. Potential mediating variables exist between social frailty and functional disabilities, such as subjective cognitive function, is yet to be investigated.[18]

Socially frail states, characterized by reduced social activity, limited engagement in social roles, and suboptimal social relationships, could potentially contribute to the onset of cognitive decline.[19,20] Simultaneously, a rapid decline in subjective cognitive function leads to increased functional disability.[21,22] Research has shown that older adults can maintain cognitive function by engaging in social activities, particularly when combined with higher levels of intelligence.[23] In addition, improvements in subjective cognitive functioning may lead to positive changes in daily activities and behaviors,[24] thus enabling older adults to engage in more complex functional activities such as strength training and balance training, which in turn may further improve cognitive performance.[25] Therefore, subjective cognitive function may be an important link between social frailty and functional status. Exploring the potential mediating role of subjective cognitive function can help elucidate the mechanisms underlying the role of social vulnerability in functional status.

Furthermore, most studies on social frailty have treated it as a static condition,[13,26,27] which has limited our understanding of whether social frailty in older adults changes over time. However, latent growth curve models (LGCMs) allow for a nuanced study of the intrinsic dynamic trajectories of social frailty and functional status, capturing the evolution of and deeper relationships between social frailty and functional status over time through the measurement of initial levels and rates of change. By employing potential growth curve modeling, researchers can better elucidate the temporal dynamics of social frailty, thereby providing a more comprehensive and accurate representation than the static frameworks used in previous studies. Therefore, we aimed to explore the direct and indirect effects of social frailty trajectories on functional status trajectories mediated by subjective cognitive function trajectories in 3 waves of data over a 6-year follow-up period. These findings are crucial for developing effective prevention and intervention strategies and health programs to improve the functional status of older adults, as they provide insight into potential turning points and mechanisms that can influence the functional status of older adults.

The objective of this study was to address the research gap by testing the following 4 research hypotheses: (1) the initial level of social frailty (ie, intercept) will correlate with the initial level of subjective cognitive function and functional status; (2) the rate of change in social frailty (ie, slope) will correlate with the rates of change in subjective cognitive function and functional status; (3) the initial level of subjective cognitive function will mediate the relationship between the initial level of social frailty and functional status; and (4) the rate of change in subjective cognitive function will mediate the relationship between the rates of change in social frailty and functional status.

Methods

Design

This longitudinal study, conducted from 2011 to 2017, was part of a project that began in 1991 in a suburban area of central Japan. This project aimed to identify factors contributing to the health, longevity, and well-being of local residents. Data were gathered through the use of a self-administered questionnaire. Initially, questionnaires were distributed to all residents and collected after 2 weeks.

Participants

In this study, individuals aged ≥65 years were selected at the baseline year. Using a longitudinal methodology, data were collected in 3 waves as follows: 2011 (T1), 2014 (T2), and 2017 (T3). Initially, we selected 1085 participants aged ≥65 years at the baseline year. After eliminating 78 people who needed support and care, 4 participants with complete missing data on social frailty, cognitive impairment, and functional status, and 22 adults with Parkinson disease and dementia, we included 981 participants and collected data regarding their social frailty, cognitive impairment, and functional status in 2014 and 2017. Of these, 218 and 249 participants could not complete the follow-up in 2014 and 2017, respectively, because of death, hospitalization, moving, or other reasons. Finally, 514 participants were included in this study.

Measures

Social frailty

We used the following 5 questions to manipulate social frailty: going out less often than last year (yes), visiting friends sometimes (no), feeling helpful to others (no), living alone (yes), and talking to others every day (no).[18] The question "talking to others every day" was a combination of "how many chances do you have to talk to families every day" and "how many chances do you have to talk to people except families every day." Higher scores indicated more serious social frailty.

Functional status

IADL were assessed with the IADL subscale of the Tokyo Metropolitan Institute of Gerontology Index of Competence[28] and includes the following items: taking public transportation, grocery shopping, preparing meals, paying bills, and accessing funds. Negative answers to each item were given 0 points. Higher scores indicated better functional status.

Subjective cognitive function

Subjective cognitive function was assessed from the Kihon Checklist developed by the Japan Ministry of Health, Labor, and Welfare.[29] We employed the subjective cognitive function domain, which includes 3 items. Its validity[30,31] has been established and

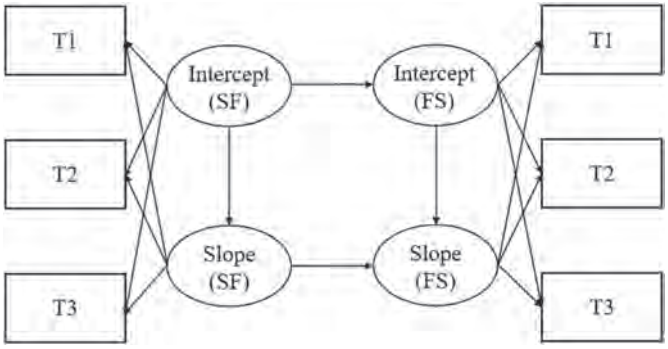

Fig. 1. Parallel-process latent growth curve model for social frailty and functional status. FS, functional status; SF, social frailty.

includes the following items: your family or your friends point out your memory loss (yes), you make a call by looking up phone numbers (yes), and you find yourself not knowing today's date (yes). A higher score indicated more subjective cognitive concern.

Covariates

Covariates were categorized into demographic factors (age: continuous variable; sex: "men/women"), behavioral factors (smoking: "smoker/nonsmoker"; alcohol consumption: "drinking every day or sometimes/not"; exercise: "exercise regularly/not"), and medical factors (chronic disease: "having any chronic disease/not").

Statistical Analysis

In our quest to better grasp the intertwined evolution of social frailty and functional status, and refine crucial theoretical frameworks, we found it essential to adopt parallel-process models. This methodologic approach allowed us to simultaneously examine the interconnected trajectories of these constructs, offering profound insights into their mutual dynamics. By incorporating a mediating variable into these models, we were able to model both its progression and the trajectory of the outcome variable.[32] This integrated approach enabled us to explore correlations between changes in the mediating variable and corresponding alterations in the outcome variable within the structural model. Such methodologic integration offers an advanced avenue for investigating the intricate mediation processes inherent in longitudinal studies, leading to a more comprehensive understanding of the dynamic relationships between variables over time. To enhance precision and reliability in our analysis, particularly given our limited sample size, we opted for a single mediating variable.

First, 3 LGCMs were fitted to assess changes in social frailty, subjective cognitive function, and functional status over time. The initial level (intercept), rate of change (slope), and the association between the initial level and rate of change were tested. Second, parallel process models, as illustrated in Figure 1, were run to examine the direct relation between social frailty and functional status over time. Before exploring the mediating role of changes in subjective cognitive function, we used parallel-process models to examine the relationship between social frailty and subjective cognitive function, as well as the relationship between subjective cognitive function and functional status.

Finally, a latent growth curve mediation model was used to test the potential mediating role of subjective cognitive function in the relationship between social frailty and functional status, as illustrated in Figure 2.

The model fit was estimated using the comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR).[33,34] Furthermore, acceptable model fit (CFI $>$ 0.90, SRMR/RMSEA $<$ 0.10) and good model fit (CFI/TLI $>$ 0.95, SRMR/RMSEA $<$ 0.08) were defined using standard benchmark values.[35] All analyses were performed using the Mplus version 8.6.[36] To handle missing data in Mplus, maximum likelihood estimation with robust SEs was employed.

Ethical Considerations

The affiliated university's ethical committee approved this project (approval number 1331-3).

Results

Descriptive Statistics

Table 1 presents the baseline descriptive statistics of the study sample. Among the 514 participants, the mean age at the first assessment (2011) was 73.05 years (SD, 6.45). Notably, most participants were female, had a habit of exercising, were nonsmokers/non−alcohol consumers, and had at least 1 chronic disease.

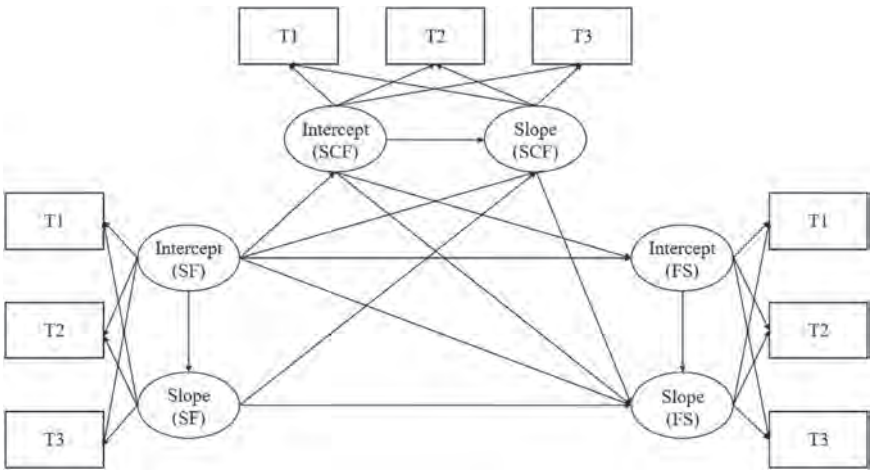

Fig. 2. Parallel-process latent growth curve mediation model for social frailty, subjective cognitive decline, and functional status. FS, functional status; SCF, subjective cognitive function; SF, social frailty.

Table 1
Baseline Characteristics of the Study Sample (n = 514)

Category	Mean ± SD or n (%)
Baseline age, y	73.05 ± 6.45
Sex	
Men	220 (42.0)
Women	294 (57.2)
Alcohol consumption	
Have	95 (18.5)
None	419 (81.5)
Smoking	
Smoker	83 (16.1)
Nonsmoker	431 (83.9)
Exercise	
Yes	335 (65.2)
No	179 (34.8)
Chronic disease	
Have	352 (68.5)
None	162 (31.5)
Social frailty	
T1	0.62 ± 0.84
T2	0.93 ± 0.94
T3	1.15 ± 1.01
Subjective cognitive function	
T1	0.19 ± 0.53
T2	0.57 ± 0.78
T3	1.06 ± 0.94
Functional status	
T1	4.75 ± 0.78
T2	4.54 ± 1.12
T3	4.22 ± 1.50

The means for social frailty, subjective cognitive function, and functional status at 3 time points are presented.

Correlation matrix was expected between social frailty, subjective cognitive function, and functional status. Statistically significant correlations were observed between the variables for each measurement wave (Supplementary Table 1).

Measurement invariance was investigated in longitudinal measurement models of social frailty, subjective cognitive function and functional status. Both constructs demonstrated acceptable model fit and achieved metric invariance over time, indicating good structural validity (Supplementary Table 2).

Univariate LGCMs

The univariate LGCMs provided a good fit for the trajectories of social frailty, subjective cognitive function, and functional status. The statistical significance of the means of the intercepts and slopes for all variables suggests a notable linear change over time. Social frailty and cognitive impairment accumulated over time, whereas functional status showed a tendency to decrease (Supplementary Table 3).

Parallel-Process Models

Table 2 displays the results for the following 3 parallel-process models, each of which demonstrates a good model fit.

Social frailty and subjective cognitive function

The association between social frailty and subjective cognitive function was determined after controlling for all covariates. The baseline levels of social frailty consistently exhibited a positive correlation with initial cognitive impairment levels, whereas similarly, their respective rates of change also demonstrated a positive association.

Subjective cognitive function and functional status

The association between subjective cognitive function and functional status was determined by controlling for all covariates. High initial levels of cognitive impairment in older adults were associated with low initial functional status, whereas an increase in cognitive impairment over time was linked to a subsequent decrease in functional status.

Table 2
Direct Effect Coefficients for Respective Parallel-Process Latent Growth Models

Model	Model Fit			I → I	S → S
	CFI	RMSEA	SRMR	β (SE)	β (SE)
SF → SCF	0.983	0.038	0.025	0.25 (0.05)*	0.37 (0.08)*
SCF → FS	0.971	0.065	0.031	−0.31 (0.06)*	−0.52 (0.08)*
SF → FS	0.991	0.034	0.023	−0.53 (0.05)*	−0.78 (0.07)*

FS, functional status; I, intercept; S, slope; SCF, subjective cognitive function; SF, social frailty.
*$P < .001$.

Social frailty and functional status

The association between social frailty and functional status was determined after controlling for all covariates. In older adults, high initial levels of social frailty correlated with low initial levels of functional status, and an increase in social frailty over time corresponded to a subsequent decrease in subjective cognitive function.

Latent Growth Curve Mediation Model

Latent growth curve mediation models were used to examine whether subjective cognitive function levels and changes mediated the association between social frailty and functional status while controlling for covariates. The results are presented in Table 3 with a good model fit: $\chi^2(41) = 103.64$, $P < .001$, CFI = 0.971, TLI = 0.937, and RMSEA = 0.055 (90% CI 0.042, 0.068). The results revealed that the indirect effect from the social frailty level to the functional status level through subjective cognitive function level was significant (β = −0.14, 95% CI −0.29, −0.09). Specifically, older adults with higher levels of social frailty tended to have higher levels of subjective cognitive function, which was associated with lower functional status. Additionally, the rate of change in subjective cognitive function mediated the relationship between rates of change in social frailty and functional status (β = −0.35, 95% CI −0.46, −0.25). Over time, our findings suggest that as levels of social frailty increase, levels of subjective cognitive function also increase, and these higher levels of subjective cognitive function are associated with a decrease in functional status.

We also conducted sensitivity analysis that included mortality data, and the results were similar to the main analyses, with subjective cognitive function remaining a significant mediator of the relationship between social frailty and functional status, whereas direct and indirect effects became stronger. Furthermore, compared with the excluded deceased individuals, participants in this analysis were younger at baseline, with lower prevalence of chronic diseases, had lower social frailty, lower cognitive impairment, and better functional status ($P < .001$ for all comparisons).

Discussion

Social Frailty and Functional Status

Using an LGCM from a sample of Japanese older adults, we demonstrated similar trajectories for social frailty and subjective cognitive function, with initial low levels and gradual accumulation of symptoms over time. Although the initial level of functional status was high and became progressively worse over time. Our findings suggest that respondents with higher levels of social frailty had lower functional status later in life, whereas those with a faster accumulation of social frailty had a faster decline in functional status. As previously

Table 3
Mediation Effect Estimates for Latent Growth Curve Mediation Model

Predictors	SCF		FS		Indirect Effects	
	Intercept	Slope	Intercept	Slope		
	β (SE)	β (SE)	β (SE)	β (SE)	β (SE)	95% CI
SF intercept	0.27 (0.09)*	0.13 (0.14)	−0.16 (0.08)*	−0.07 (0.06)		
SF slope	—	0.51 (0.15)†	—	−0.07 (0.08)		
SCF intercept	—	—	−0.48 (0.09)†	−0.13 (0.09)		
SCF slope	—	—	—	−0.69 (0.07)†		
I→I indirect pathway					−0.14 (0.06)†	−0.29, −0.09
S→S indirect pathway					−0.35 (0.05)†	−0.46, −0.25

FS, functional status; I, intercept; S, slope; SCF, subjective cognitive function; SF, social frailty.
None of the CIs contained zero, indicating a statistically significant result.
*Standardized coefficients are shown: $P < .01$.
†$P < .001$.

mentioned, greater levels of social participation have been linked to improved health status in older adults, and increased social activity is an effective means to prevent the onset of disability.[37] In a longitudinal study, it was shown that the group actively participating in outdoor social activities had a significantly lower incidence of disability, even after accounting for various health-related variables associated with the outcomes.[38] Older adults with elevated levels of social frailty generally exhibit greater social inactivity, and the reduction in daily activities is not conducive to maintaining functional status, particularly when more elaborate instrumental activities are required.[39] Moreover, having stronger social connections yields direct physiological benefits, including stress relief, enhanced resistance, and a reduced risk of inflammation, all of which indirectly contribute to the maintenance of functional status.[40]

The Mediating Role of Subjective Cognitive Function

The results of the latent growth curve mediation model indicated that subjective cognitive function was a pathway linking social frailty to subsequent functional status. Previous research has highlighted a possible dual effect between social frailty and subjective cognitive function in that the accumulation of social frailty may also be a consequence, rather than a cause, of cognitive decline.[41] Although social frailty may contribute to cognitive decline, the stigma associated with subjective cognitive function due to inadequate social engagement can lead to social withdrawal, further accelerating functional decline.[42] Other studies have suggested that cognitive decline occurs in conjunction with social frailty, which accelerates cognitive and physical decline, leading to an increased risk of disability.[18,43] On the other hand, the worse the cognitive function, the higher the risk of future functional decline. Evidence from several longitudinal studies indicated that better baseline cognitive performance significantly reduced the incidence of future IADL disability.[44,45] Additionally, a study has confirmed that cognitive decline can affect people's manipulative skills and fine control through neurologic impairment, leading to IADL disability and loss of independence and productivity.[46]

Strengths and Limitations

Our study possesses various strengths. To begin with, this longitudinal study established a dynamic relationship between social frailty and functional status trajectories in older adults through the use of parallel-process latent growth curve analysis. This approach can assist in the development of preventive and intervention strategies, allowing for early implementation to mitigate the progression of functional decline. Second, although previous studies have primarily concentrated on the direct effects of social frailty, our research bridges this gap by elucidating the mediating effects of subjective cognitive function. This enriches our comprehension of the intricate relationship between social frailty and functional status. In practice, developing interventions to improve cognitive function while improving the symptoms of social frailty in older adults can help prevent functional disabilities more effectively.

Certain limitations should be acknowledged when interpreting the findings of this study. First, it is important to recognize that the study's findings may exhibit cultural and geographical variation because the participants were exclusively from Japan. Second, the study failed to collect information on hospitalized individuals, which could have potentially affected the results. Third, poor subjective cognitive functioning may be due to negative mental health states such as loneliness and depression, whereas objective cognitive functioning may not have changed significantly over the same period of time,[47] which may have led to an overestimation of the results. Lastly, it is worth noting that there may be other variables, including physical and psychological factors, that could potentially mediate the relationship between social frailty and functional status. Consequently, future research should investigate additional potential mediators to contribute to a more comprehensive understanding of the connection between social frailty and functional status.

Conclusions and Implications

To conclude, our study furnishes evidence that increased levels of social frailty are correlated with a deterioration in later-life functional status, with subjective cognitive function playing a mediating role. These results underscore the significance of promoting social engagement and addressing social frailty to sustain the functional capabilities of older adults. Additional research is warranted to further enrich our comprehension of this intricate relationship and devise effective interventions to enhance the well-being and functional outcomes of older adults.

Disclosure

The authors declare no conflicts of interest.

Acknowledgments

We owe a debt of gratitude to all the study participants and Tobishima employees.

References

1. Kagawa CA, Corrente JE. Análise da capacidade funcional em idosos do município de Avaré-SP: fatores associados. *Revista Brasileira de Geriatria e Gerontologia*. 2015;18:577–586.

2. Shimada H, Makizako H, Lee S, et al. Impact of cognitive frailty on daily activities in older persons. *J Nutr Health Aging*. 2016;20:729–735.
3. Tsuboya T, Aida J, Hikichi H, et al. Predictors of decline in IADL functioning among older survivors following the Great East Japan earthquake: a prospective study. *Soc Sci Med*. 2017;176:34–41.
4. Azegami M, Ohira M, Miyoshi K, et al. Effect of single and multi–joint lower extremity muscle strength on the functional capacity and ADL/IADL status in Japanese community–dwelling older adults. *Nurs Health Sci*. 2007;9:168–176.
5. World health Organization & world Bank. Summary: world report on disability. 2011. https://apps.who.int/iris/handle/10665/70670
6. World Health Organization. *Disability and Health*. WHO Press; 2014.
7. Denison HJ, Cooper C, Sayer AA, et al. Prevention and optimal management of sarcopenia: a review of combined exercise and nutrition interventions to improve muscle outcomes in older people. *Clin Interv Aging*. 2015;10:859–869.
8. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci*. 2001;56:M146–M157.
9. Bergman H, Ferrucci L, Guralnik J, et al. Frailty: an emerging research and clinical paradigm issues and controversies. *J Gerontol A Biol Sci Med Sci*. 2007;62:731–737.
10. Vermeulen J, Neyens JC, van Rossum E, et al. Predicting ADL disability in community-dwelling elderly people using physical frailty indicators: a systematic review. *BMC Geriatr*. 2011;11:33.
11. Rockwood K. What would make a definition of frailty successful? *Age Ageing*. 2005;34:432–434.
12. Gobbens RJ, Luijkx KG, Wijnen-Sponselee MT, et al. Toward a conceptual definition of frail community dwelling older people. *Nurs Outlook*. 2010;58:76–86.
13. Makizako H, Shimada H, Tsutsumimoto K, et al. Social frailty leads to the development of physical frailty among physically non-frail adults: a four-year follow-up longitudinal cohort study. *Int J Environ Res Publ Health*. 2018;15:490.
14. Inoue T, Maeda K, Satake S, et al. Osteosarcopenia, the co-existence of osteoporosis and sarcopenia, is associated with social frailty in older adults. *Aging Clin Exp Res*. 2022;34:535–543.
15. Bunt S, Steverink N, Olthof J, et al. Social frailty in older adults: a scoping review. *Eur J Ageing*. 2017;14:323–334.
16. Teo N, Gao Q, Nyunt MSZ, et al. Social frailty and functional disability: findings from the Singapore Longitudinal Ageing Studies. *J Am Med Dir Assoc*. 2017;18:637.e13–637.e19.
17. Makizako H, Shimada H, Doi T, et al. Impact of physical frailty on disability in community-dwelling older adults: a prospective cohort study. *BMJ Open*. 2015;5:e008462.
18. Tsutsumimoto K, Doi T, Makizako H, et al. Association of social frailty with both cognitive and physical deficits among older people. *J Am Med Dir Assoc*. 2017;18:603–607.
19. Fratiglioni L, Wang HX, Ericsson K, et al. Influence of social network on occurrence of dementia: a community-based longitudinal study. *Lancet*. 2000;355:1315–1319.
20. Zunzunegui MV, Alvarado BE, Del Ser T, et al. Social networks, social integration, and social engagement determine cognitive decline in community-dwelling Spanish older adults. *J Gerontol B Psychol Sci Soc Sci*. 2003;58:S93–S100.
21. Rajan KB, Hebert LE, Scherr PA, et al. Disability in basic and instrumental activities of daily living is associated with faster rate of decline in cognitive function of older adults. *J Gerontol A Biol Sci Med Sci*. 2013;68:624–630.
22. Zeng Y, Feng Q, Hesketh T, et al. Survival, disabilities in activities of daily living, and physical and cognitive functioning among the oldest-old in China: a cohort study. *Lancet*. 2017;389:1619–1629.
23. Glei DA, Landau DA, Goldman N, et al. Participating in social activities helps preserve cognitive function: an analysis of a longitudinal, population-based study of the elderly. *Int J Epidemiol*. 2005;34:864–871.
24. Rebok GW, Ball K, Guey LT, et al. Ten-year effects of the ACTIVE cognitive training trial on cognition and everyday functioning in older adults. *J Am Geriatr Soc*. 2014;62:16–24.
25. Sanders LMJ, Hortobágyi T, Karssemeijer EGA, et al. Effects of low-and high-intensity physical exercise on physical and cognitive function in older persons with dementia: a randomized controlled trial. *Alzheimer's Res Ther*. 2020;12:1–15.
26. Huang CH, Okada K, Matsushita E, et al. The association of social frailty with intrinsic capacity in community-dwelling older adults: a prospective cohort study. *BMC Geriatrcs*. 2021;21:515.
27. Lee Y, Chon D, Kim J, et al. The predictive value of social frailty on adverse outcomes in older adults living in the community. *J Am Med Dir Assoc*. 2020;21:1464–1469.e2.
28. Koyano W, Shibata H, Nakazato K, et al. Measurement of competence: reliability and validity of the TMIG index of competence. *Arch Gerontol Geriatr*. 1991;13:103–116.
29. Fukutomi E, Okumiya K, Wada T, et al. Importance of cognitive assessment as part of the "Kihon Checklist" developed by the Japanese Ministry of Health, Labor and Welfare for prediction of frailty at a 2-year follow up. *Geriatr Gerontol Int*. 2013;13:654–662.
30. Hirose J, Nagata T, Ogushi M, et al. Validation of each category of Kihon Checklist for assessing physical functioning, nutrition and cognitive status in a community-dwelling older Japanese cohort. *Epidemiol Open Access*. 2017;7:326.
31. Satake S, Senda K, Hong YJ, et al. Validity of the K ihon Checklist for assessing frailty status. *Geriatr Gerontol Int*. 2016;16:709–715.
32. Cheong JW, MacKinnon DP, Khoo ST. Investigation of mediational processes using parallel process latent growth curve modeling. *Struct Equ Model*. 2003;10:238–262.
33. Kline RB. *Principles and practice of structural equation modeling*. 2nd ed. Guilford Press; 2005.
34. MacCallum RC, Austin JT. Applications of structural equation modeling in psychological research. *Annu Rev Psychol*. 2000;51:201–226.
35. Marsh HW, Hau K-T, Wen Z. In search of golden rules: comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Struct Equ Modeling*. 2004;11:320–341.
36. Muthén B, Muthén L. *Mplus handbook of item response theory*. Chapman and Hall/CRC; 2017. p. 507–518.
37. Hikichi H, Kondo N, Kondo K, et al. Effect of a community intervention programme promoting social interactions on functional disability prevention for older adults: propensity score matching and instrumental variable analyses, JAGES Taketoyo study. *J Epidemiol Community Health*. 2015;69:905–910.
38. Mendes de Leon CF, Rajan KB. Psychosocial influences in onset and progression of late life disability. *J Gerontol B Psychol Sci Soc Sci*. 2014;69:287–302.
39. Kanamori S, Kai Y, Aida J, et al. Social participation and the prevention of functional disability in older Japanese: the JAGES cohort study. *PLoS One*. 2014;9:e99638.
40. Glei DA, Goldman N, Ryff CD, et al. Social relationships and inflammatory markers: an analysis of Taiwan and the US. *Soc Sci Med*. 2012;74:1891–1899.
41. Green AF, Rebok G, Lyketsos CG. Influence of social network characteristics on cognition and functional status with aging. *Int J Geriatr Psychiatry*. 2008;23:972–978.
42. Ayalon L, Shiovitz-Ezra S, Roziner I. A cross-lagged model of the reciprocal associations of loneliness and memory functioning. *Psychol Aging*. 2016;31:255.
43. Makizako H, Tsutsumimoto K, Shimada H, et al. Social frailty among community-dwelling older adults: recommended assessments and implications. *Ann Geriatr Med Res*. 2018;22:3–8.
44. Han L, Gill TM, Jones BL, et al. Cognitive aging trajectories and burdens of disability, hospitalization and nursing home admission among community-living older persons. *J Gerontol A Biol Sci Med Sci*. 2016;71:766–771.
45. Liu Y, Yang X, Xu Y, et al. Cognitive function and depressive symptoms among Chinese adults aged 40 Years and above: the mediating roles of IADL disability and life satisfaction. *Int J Environ Res Publ Health*. 2023;20:4445.
46. Livingston G, Huntley J, Sommerlad A, et al. Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. *Lancet*. 2020;396:413–446.
47. Lee JH, Sung J, Choi MK. The factors associated with subjective cognitive decline and cognitive function among older adults. *J Adv Nurs*. 2020;76:555–565.

Supplementary Table 1
Correlation Matrix for Mean Variables

Items	1	2	3	4	5	6	7	8	9
1. Social frailty T1	—								
2. Social frailty T2	0.43*	—							
3. Social frailty T3	0.47*	0.68*	—						
4. Subjective cognitive function T1	0.21*	0.14*	0.17*	—					
5. Subjective cognitive function T2	0.16*	0.24*	0.24*	0.51*	—				
6. Subjective cognitive function T3	0.25*	0.31*	0.42*	0.31*	0.43*	—			
7. Functional status T1	−0.24*	−0.27*	−0.23*	−0.44*	−0.31*	−0.30*	—		
8. Functional status T2	−0.28*	−0.46*	−0.38*	−0.37*	−0.37*	−0.46*	0.67*	—	
9. Functional status T3	−0.25*	−0.45*	−0.50*	−0.31*	−0.38*	−0.53*	0.56*	0.78*	—

*$P < .01$.

Supplementary Table 2
Longitudinal Measurement Invariance

Model	χ^2	df	CFI	ΔCFI	RMSEA	ΔRMSEA
Social frailty						
Configural invariance	236.590	72	0.941	—	0.062	—
Metric invariance	260.481	80	0.937	−0.004	0.066	0.004
Scalar invariance	405.889	90	0.912	−0.025	0.083	0.017
Subjective cognitive function						
Configural invariance	41.537	15	0.931	—	0.058	—
Metric invariance	50.835	19	0.925	−0.006	0.062	0.004
Scalar invariance	183.630	25	0.897	−0.028	0.091	0.029
Functional status						
Configural invariance	397.139	72	0.937	—	0.074	—
Metric invariance	464.628	80	0.928	−0.009	0.079	0.005
Scalar invariance	567.419	90	0.907	−0.021	0.102	0.023

CFI, comparative fit index; df, degrees of freedom; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual.
Δ means the difference between 2 models.

Supplementary Table 3
Model Statistics for Univariate Latent Growth Curve Models

Model Statistics	SF	SCF	FS
Model fit			
RMSEA	0.044	0.065	0.071
CFI	0.998	0.992	0.997
SRMR	0.014	0.019	0.014
Mean			
Intercept	0.64 (0.04)*	0.19 (0.02)*	0.76 (0.03)*
Slope	0.28 (0.02)*	0.42 (0.02)*	−0.26 (0.03)*
Variances			
Intercept	0.28 (0.05)*	0.26 (0.04)*	0.51 (0.05)*
Slope	0.09 (0.03)*	0.10 (0.02)*	0.30 (0.04)*
Covariance	0.06†	−0.05†	0.07†

CFI, comparative fit index; FS, functional status; RMSEA, root mean square error of approximation; SCF, subjective cognitive function; SF, social frailty; SRMR, standardized root mean square residual.
SEs are in parentheses. Values are unstandardized coefficients for linear models.
*$P < .001$.
†$P < .05$.

BMC Public Health

RESEARCH Open Access

Longitudinal assessment of the relationship between frailty and social relationships among Japanese older adults: a random intercept cross-lagged panel model

Mingyu Cui[1], Dandan Jiao[1,7], Yang Liu[1], Yantong Zhu[1], Xiang Li[1], Zhu Zhu[1], Jinrui Zhang[1], Afsari Banu Alpona[1], Yanlin Wang[1], Meiling Qian[1], Yuko Sawada[2], Kumi Watanabe Miura[3], Taeko Watanabe[4], Emiko Tanaka[5] and Tokie Anme[6*]

Abstract

Objectives This study aimed to explore the bidirectional association between frailty and social relationships in older adults while distinguishing between interpersonal and intrapersonal effects.

Methods A prospective cohort study of community-dwelling older adults was conducted in Japan in three waves spanning six years with follow-ups in every three years. Random intercept cross-lagged panel model was used to explore temporal associations between frailty and social relationships.

Results Data for 520 participants (mean age 73.02 [SD 6.38] years, 56.7% women) were analyzed. Across individuals, frailty was associated with social relationships ($\beta = -0.514$, $p < 0.001$). At the interpersonal level, frailty was cross-sectionally associated with social relationships separately at T1($\beta = -0.389$, $p < 0.01$), T2 ($\beta = -0.343$, $p < 0.001$) and T3 ($\beta = -0.273$, $p < 0.05$). Moreover, social relationships were associated with subsequent increases in symptoms of frailty in all measurement waves ($\beta = -0.332$, $p < 0.001$; $\beta = -0.169$, $p < 0.01$) and vice versa ($\beta = -0.149$, $p < 0.05$; $\beta = -0.292$, $p < 0.001$).

Conclusions The results suggest that frailty was associated with lower levels of social relationships. Frailty improvement programs can be combined with interventions to enhance social relationships, which will be beneficial in preventing frailty. The results emphasize the importance of combining clinical treatments of frailty with interventions to improve social relationships.

Keywords Older people, Random intercept cross-lagged panel model, Frailty, Social relationships, Longitudinal study

*Correspondence:
Tokie Anme
anmet@md.tsukuba.ac.jp
[1]School of Comprehensive Human Science, University of Tsukuba, Tsukuba, Japan
[2]Department of Physical Therapy, Morinomiya University of Medical Sciences, Osaka, Japan
[3]RIKEN Center for Advanced Intelligence Project, Tokyo, Japan
[4]Faculty of Nursing, Shukutoku University, Chiba, Japan
[5]Faculty of Nursing, Musashino University, Tokyo, Japan
[6]Faculty of Medicine, University of Tsukuba, Tsukuba, Japan
[7]Department of Nursing, The First Affiliated Hospital, and College of Clinical Medicine, Henan University of Science and Technology, Luoyang, China

Introduction

Global aging is increasing, and frailty is putting more pressure on health care systems. Frailty in older adults is a common condition that has been gaining attention in recent years, affecting more than 25% of people over the age of 85 [1]. Frailty is an evolving concept, normally describes an altered health status following a stressful event, that leaves one vulnerable to the effects of poorly balanced resolutions in the body [2, 3], and frequently leads to negative health consequences such as decreased functional status, hospitalization, disability, and death [2, 4, 5]. Research have shown that frailty is reversible and can be improved by interventions [2, 6]. Therefore, prevention of frailty in older people is an important issue in healthy aging.

Previous studies have established an association between frailty and a number of factors, including older age [7], poor economic status [8], low educational attainment [9], depression [10] and schizophrenia [11].

In addition to these, social factors, e.g., relationships, are also important determinants of frailty. Social relationships are the associations between individuals and their social environment [12] and have a direct impact on health outcomes regardless of the individual's state of stress [13]. In recent years, a growing number of studies have begun to explore the connection between social relationships and frailty using population-based samples, however, the direction and mechanism of this connection is not fully understood [14]. For example, poor social relationships may be a risk factor for frailty; conversely, deterioration in social relationships may also lead to deterioration in health status, thereby exacerbating symptoms of frailty. It is perhaps even more likely that there is a vicious cycle in which deteriorating frailty weakens social relationships and health, which in turn exacerbates symptoms of frailty. Regardless of the cause-and-effect relationship, clarifying this relationship is critical to the clinical management of frailty patients as well as to interventions.

Previous studies revealed that social relationships predicted subsequent frailty. In a study of older Korean, frailty is more likely to occur among people who have less contact with others, as the frequency of contact with friends is most associated with frailty [15]. Similarly, in a one-year follow-up of community-dwelling older adults in China, the enrichment of social relationships positively influenced frailty by affecting the incidence of depression and physical activity [16]. However, few studies have focused on associations in the opposite direction, i.e., impact of frailty on social relationships. A small number of relevant studies exist but produce varied results. A longitudinal study in Japan showed that in the subfield of frailty, lower stepping speed and body strength were essential risk factors for subsequent declines in social relationships [17]. Whereas, a study in Amsterdam showed that the small social network of frail older adults existed at baseline and did not show an improvement across time; it was the increase of loneliness which changed the status of frailty [18]. Thus, we assumed the existence of a possible bidirectional association between social relationships and frailty which required further examination. Exploration of this relationship could help future research determine whether social relationship deficits and frailty precede each other or fall into a vicious cycle. This could help establish effective interventions for frail or socially unconnected older adults.

Cross-lagged model was used to explore the bidirectional association. Further, our study distinguished between within-person and between-person differences. The traditional cross-lagged panel model (CLPM) studies the longitudinal interrelationships between variables, and it assumes that the variables have no stable internal differences and only result in interpersonal effects, which is often unrealistic. Frailty and social relations are trait-like variables and show stable interpersonal variability over time [19, 20]. Studies have shown that conflating interpersonal and intrapersonal effects may lead to overestimation, underestimation, or even reversal of cross-lagged effects [21], and the conclusions drawn from CLPM at the interpersonal level cannot be inferred to the intrapersonal level [22]. For example, older adults with poor social relationships reporting frailty symptoms does not necessarily mean that improvement of social relationship will make them less frail [23]. The random intercept cross-lagged panel model (RI-CLPM) decomposes within-person and between-person effects in longitudinal associations between variables by including a random intercept to explain time-invariant individual differences, with less error than the traditional CLPM for within-person effects [21].

Against this background, we aimed to elucidate the longitudinal bidirectional relationship between frailty and social relationships in older adults using the RI-CLPM, taking into account the between-person effects.

Materials and methods

Design

This longitudinal study, conducted from 2011 to 2017, is a part of a project which started in 1991 in a suburban area of central Japan. This project aimed to identify the factors contributing to health, longevity, and well-being of the local residents. Data were collected using a self-administrated questionnaire. Initially, questionnaires were distributed to all residents and collected after 2 weeks. The survey was conducted every three years.

Participants

In the present study, older people aged 65 years and above were selected for the baseline year. Applying a longitudinal methodology, data from three waves were collected in 2011 (T1), 2014 (T2), and 2017 (T3). Initially, we selected 1085 participants aged ≥ 65 years at the baseline year; after eliminating 78 people needed support and care, 70 participants with complete missing data on frailty and social relationships and 22 adults with Parkinson's disease and dementia, we included 915 participants and collected data regarding their social relationships and frailty in 2014 and 2017. Of this number, 166 participants were unable to complete follow-up in 2014 and 229 participants in 2017 due to death, hospitalization, moving, etc. Finally, 520 participants were included in this study (Fig. 1).

Measures

Frailty

Frailty indicators were extracted from the Kihon Checklist (KCL), a popular frailty assessment tool [23]. The scale has been widely used in studies of frailty in the Japanese older adults and has shown sufficient reliability and validity [24, 25]. The lifestyle domain with 20 items was utilized which included activities of daily life, physical strength, nutritional status, oral function, the condition of being housebound, and cognitive function to predict frailty. Items were scored as either 0 for "good" or 1 for "poor". The total score ranged from 0 to 20. A higher score indicated more symptoms of frailty.

Social relationships

The Index of Social Interaction (ISI) was used to evaluate social relationships, which measures various aspects of social relationships in daily settings [26]. There are 18 items in this scale, classified into five domains. The independence domain explores the motivation to live and maintain a healthy and active life. The social curiosity domain includes habits of reading, using new equipment, having hobbies, and a feeling of importance in society. The interaction domain assesses how well family and non-family people communicate. The domain of participation in society assesses involvement in social and neighborhood groups, as well as assuming an active social role. Finally, the feeling of safety domain explores if participants have someone offering counselling and providing support during emergencies. For the items, positive answers (always, often, sometimes) and negative answers (rare) were given 1 and 0 points, respectively. The total score ranged from 0 to 18. The higher score the participants got, the higher level of social relationships they had.

Frailty and social relationships showed appropriate internal consistency at three time points (frailty: $\alpha = 0.83$, $\alpha = 0.88$, $\alpha = 0.90$; social relationships: $\alpha = 0.78$, $\alpha = 0.83$, $\alpha = 0.84$).

Covariates

Based on previous studies, age, gender, exercise, alcohol consumption/smoking and chronic diseases were considered as covariates at baseline [27, 28]. Age and gender were considered as continuous and categorical variables,

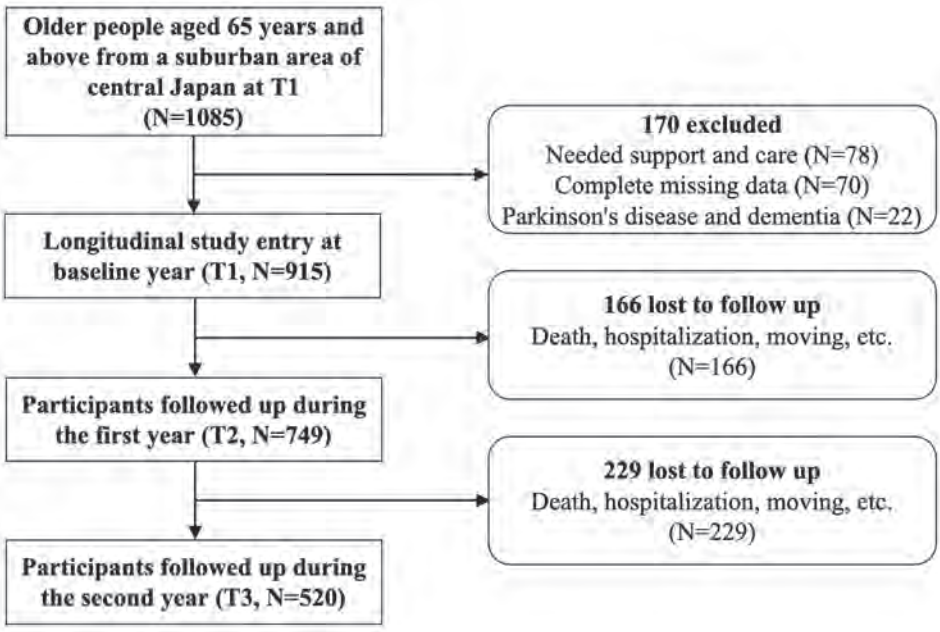

Fig. 1 Flow chart of the participants in the present study

respectively. Regarding exercise, the respondents were asked "Do you exercise?" Responses of "always", "frequently", and "sometimes" were coded as "performing exercise" whereas responses of "no" were coded as "not exercising". Regarding alcohol consumption, respondents were asked "Do you drink alcohol?" Responses of "always", "everyday", and "sometimes" were coded as "consumes alcohol" whereas responses of "hardly ever" and "do not consume alcohol" were coded as "non-consumers of alcohol". For smoking, the respondents were asked "are you an active smoker?" Responses of "everyday" and "sometimes" were coded as "actively smoking", responses of "I previously smoked but have now stopped" was coded as "former smoker", whereas "I do not smoke" was coded as "non-smoking behavior". Chronic diseases was treated as a categorical variable. Participants were classified as having at least one chronic disease or none based on the presence of the following diseases: hypertension, stroke, heart disease, diabetes, hyperlipidemia, lung disease, stomach/liver/gallbladder disorders, kidney disorders, musculoskeletal disorders, cancer, immune disease, depression, and eye and ear disorders.

Statistical analysis

Descriptive statistics and bivariate correlations among all variables were reported using SPSS. RI-CLPM was used to explore the bidirectional relation between frailty and social relationships [20]. First, we evaluated intraclass correlation coefficients (ICC) using SPSS for frailty and social relationships to understand how much of variance was explained by the differences of participants. Second, measurement invariance was used to check the equivalence of these constructs across time to ensure that effects were attributed to real changes in variables. A three-step procedure was used for measurement invariance, including configural, metric, and scalar invariances [29]. Finally, the RI-CLPM was fit to identify bidirectional and time-ordered relations between frailty and social relationships. The covariates were controlled at the level of the random intercept. The comparative fit indices (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR) were used to estimate model fit [30, 31]. Acceptable model fit (CFI > 0.90, SRMR/RMSEA < 0.10) and good model fit (CFI/TLI > 0.95, SRMR/RMSEA < 0.08) were defined using standard benchmark values [32]. The results were presented as standardized coefficients. All analyses were performed using SPSS version 27 (Armonk, NY, USA) and Mplus version 8.6 (Muthén and Muthén, Los Angeles, CA, USA). The dataset had missing values due to the longitudinal nature. Full information maximum likelihood (FIML) was used to process missing data. FIML is a maximum likelihood method for handling missing data in a single step and is extensively used in structural equation models [33].

Table 1 Baseline characteristics of the study sample ($n = 520$)

Variables	Category	n (%) or Mean ± SD
Baseline age		73.02 ± 6.38
Gender	Men	225 (43.3)
	Women	295 (56.7)
Exercise	Yes	298 (57.3)
	No	172 (33.1)
	Missing	50 (9.6)
Alcohol consumption	Have	100 (19.2)
	None	393 (75.6)
	Missing	27 (5.2)
Smoking	Smoker	53 (10.2)
	Former smoker	117 (22.5)
	Non-smoker	307 (59.0)
	Missing	43 (8.3)
Chronic disease	Have	368 (70.8)
	None	152 (29.2)
Frailty T1		2.37 ± 2.67
Frailty T2		3.69 ± 3.33
Frailty T3		5.28 ± 3.88
Social relationships T1		16.42 ± 1.51
Social relationships T2		16.02 ± 2.05
Social relationships T3		16.26 ± 1.83

Results

Descriptive statistics

Table 1 shows the descriptive statistics for the demographic characteristics of participants, age at baseline, and frailty and social relationships scores. The mean and standard deviations of age at baseline were 73.02 ± 6.38 years. Over half of the participants were women, not living alone, had high economic status, and at least one chronic disease. The mean frailty scores were 2.37 ± 2.67 in 2011, 3.69 ± 3.33 in 2014, and 5.28 ± 3.88 in 2017. The average scores of social relationships were 16.42 ± 1.51, 16.02 ± 2.05, and 16.26 ± 1.83 in 2011, 2014, and 2017, respectively. Table 2 shows the correlation matrix for frailty and ISI. The bivariate correlations among frailty and ISI were in the expected direction. At each measurement wave, frailty was negatively correlated with ISI. The ICC for frailty was 0.64, indicating that 64% of the variance was due to between-person differences and 36% due to within-person fluctuations. For social relationships, the ICC was 0.55, indicating that 55% of the variation was due to the differences among older adults, and 45% due to intrapersonal fluctuations.

Measurement invariance

To compare factors longitudinally, we investigated measurement invariance in longitudinal measurement models of frailty and social relationships, for which the

Table 2 Bivariate correlations ($n = 520$)

Measures	Frailty T1	Frailty T2	Frailty T3	ISI T1	ISI T2	ISI T3
Frailty T1	-					
Frailty T2	0.74**	-				
Frailty T3	0.67**	0.73**	-			
ISI T1	−0.49**	−0.44**	−0.41**	-		
ISI T2	−0.56**	−0.57**	−0.54**	0.71**	-	
ISI T3	−0.49**	−0.53**	−0.58**	0.58**	0.74**	-

P* < 0.05, P** < 0.01; ISI, index of social interaction

Table 3 Longitudinal Measurement Invariance

Model	χ2	Δχ2	df	Δdf	CFI	ΔCFI	RMSEA	ΔRMSEA	SRMR	ΔSRMR
Frailty										
M1: Configural invariance	404.794	-	14	-	0.957	-	0.055	-	0.035	-
M2: Metric invariance	420.636	15.942	24	10	0.947	-0.010	0.059	0.004	0.044	0.009
M3: Scalar invariance	481.773	61.137*	41	17	0.809	-0.138	0.105	0.046	0.145	0.101
ISI										
M1: Configural invariance	320.309	-	72	-	0.970	-	0.061	-	0.058	-
M2: Metric invariance	329.913	9.604	80	8	0.961	-0.009	0.069	0.008	0.079	0.021
M3: Scalar invariance	357.391	27.478*	94	14	0.891	-0.070	0.106	0.037	0.161	0.082

M = model; CFI = comparative fit index; df = degrees of freedom; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual. Δ means the difference between two models. P* < 0.05

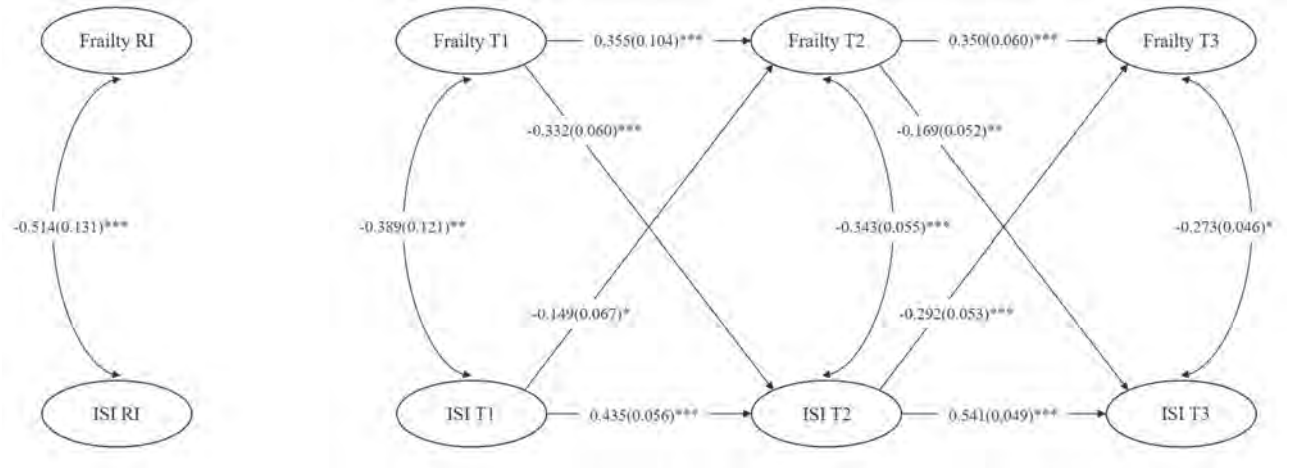

Fig. 2 Random-intercept cross-lagged panel model results. *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. RI means random intercepts. Completely standardized parameter estimates with standard errors are reported in this model and controlled for all covariates. CFI = 0.962, TLI = 0.922, RMSEA = 0.078 (95% CI, 0.064–0.095), SRMR = 0.066, $\chi^2 = 106.991$, df = 25

factor loadings must be time-invariant, at least with metric invariance across time [34, 35]. According to previous studies [36, 37], metric invariance can be established when compared with the configuration model, ΔCFI < 0.010, ΔRMSEA < 0.015, and ΔSRMR < 0.030, and scalar invariance, when, ΔCFI < 0.010, ΔRMSEA < 0.015, and ΔSRMR < 0.010. As shown in Table 3, both constructs demonstrated acceptable model fit and achieved metric invariance. Additionally, χ^2 difference tests did not yield significant result over time, indicating that frailty and social relationships can be compared across three time points.

RI-CLPM

The RI-CLPM model incorporating all covariates is depicted in Fig. 2 which indicates an acceptable model fit, χ2 = 106.991, df = 25, CFI = 0.962, TLI = 0.922, RMSEA = 0.078, SRMR = 0.066. The association between frailty and social relationships was divided into interpersonal and intrapersonal effects. At the interpersonal level, there was a strong negative association between frailty and social relationships (β = -0.514). This indicated that participants having more symptoms of frailty across the measurement waves showed lower level of social relationships and vice versa. At the individual level, social relationships and frailty had a negative cross-sectional

association separately at T1 (β = -0.389, $p<0.01$), T2 (β = -0.343, $p<0.001$) and T3 (β = -0.273, $p<0.05$). This meant that the intrapersonal changes of frailty and social relationships were correlated. The autoregressive path of frailty and social relationships were significant, indicating the severity of frailty and social relationships were carried over within-individuals to the next measurement wave. Intrapersonal cross-lagged paths from social relationships to frailty were significant at T1-T2 (β = -0.149, $p<0.05$) and T2-T3 (β = -0.292, $p<0.001$). In the opposite direction, the paths from frailty to social relationships were also significant at T1-T2 (β = -0.332, $p<0.001$) and T2-T3 (β = -0.169, $p<0.01$).

Discussion

We explored the bidirectional association between frailty and social relationships in older people through RI-CLPM, while distinguishing interpersonal and intrapersonal effects. Our results showed a significant negative correlation at within- and between-person levels. Additionally, each measurement wave revealed consistent cross-sectional correlations. To our knowledge, this is one of the first studies to examine the within-person temporal dynamics of the relation between frailty and social relationships in older adults while controlling for between-person effects. Therefore, this study will provide the basis for future intervention research.

Regarding autoregressive influences, past social relationships always have a positive impact on future social relationships. Past research has shown that active social relationships can create positive feedback, making older adults more willing to participate in social activities and having a positive effect on the development of future social relationships [38]. Likewise, the effect of frailty symptoms on their own autoregression was consistent. As previous studies have shown, frailty accumulated with the increase of chronic diseases and the deterioration of body functions, and the accumulation rate accelerated with age [39]. The ability of older people who were already in a frail state to resist external disturbances further deteriorated, which in turn would aggravate the frail symptoms [40]. This result emphasizes the importance of early intervention.

In the present study, between-person relationship revealed a robust trait effect indicating a negative association between social relationships and frailty across all three datasets. Individuals characterized by diminished social relationships exhibited a higher propensity for experiencing frailty symptoms compared to their counterparts. Consequently, these between-person findings delineate populations warranting targeted interventions. Our results offer additional elucidation on the interplay between social relationships and frailty symptoms among older adults, highlighting the heightened vulnerability of individuals with attenuated social networks to increased frailty manifestations.

After controlling for these trait effects, the within-person autoregressive path showed a vicious cycle of frailty and social relationships. Social relationships always predicted the subsequent variations of frailty. Although there were methodological differences in the assessment, similar results could be found in previous studies. A longitudinal study in the United Kingdom suggests that an increased risk of frailty is associated with reduced social relationships. Individuals with poor social relationships may experience prevalence of cardiovascular disease and exhibit worse health behaviors [3]. Because of infrequent contact with others, people with lower social relationships have reduced need for health, which may contribute to the risk of frailty. Longitudinal studies linking social relationships with walking speed, activities of daily living [41], and mobility and upper extremity strength [42] suggested that weakened social relationships might increase the risk of sarcopenia, a major factor in frailty [43], and some measures of frailty, including upper extremity strength and walking ability, were direct measures of sarcopenia. Moreover, one of the etiologies of sarcopenia is lack of physical activity [44], which could be one possible link between lack of social relationships and development of frailty. People with poor social relationships tend to be less physically active [45] which leads to an increased risk of frailty [46]. Therefore, it is advisable to include promotion of social relationships in the intervention kit for preventing or decreasing frailty.

In the opposite direction, the predictive effect of frailty on social relationships was also reflected in all measured waves, which was consistent with a few previous studies. A longitudinal study in Singapore showed association between increased social engagement and decreased frailty [47]. Symptoms of frailty increase loneliness in older people and make them inactive to participate in social activities, thus affecting social relationships. Another longitudinal study of older adults demonstrated that frailty led to reduced social activity and contact with neighbors [17]. The lack of adequate physical activity in physically-limited older adults restricts mobility in the living space, which in turn limits social relationships. Although there is not enough research on the effects of frailty on social relationships, there are many studies that report the predictive effects of subdomains of frailty on social relationships. For example, functional decline [48], poorer cognitive function [49], poor oral health [50], and cognitive decline [51] were shown to be predictors of worse social relationships. As levels of these subdomains decrease, older adults become frailer [52, 53].

In each measurement wave, frailty and social relationships had a significant cross-sectional association. Thus, better social relationships may be associated with milder

frailty symptoms and vice versa. This is consistent with the findings of Lestari et al., showing that frail older adults preferred less-active types of social relationships [4], and Tsutsumimoto et al., showing that frailty and social relationships in community-dwelling older adults were negatively correlated [54]. In a short-term Austrian study, the prevalence of frailty significantly reduced within 12 weeks after a social support intervention [6], suggesting the relatively stronger association between frailty and social relationships in the short term than in the long term. It is worth mentioning that our study also found that the lagging effect of frailty on social relationships became progressively weaker, probably due to the fact that long periods of frailty allowed older adults to adapt to physical changes and thus had the ability to maintain certain social relationships [55]. This may be related to the positive attitude of older adults towards life. In contrast, the lagged effect of social relationships on frailty became stronger. Previous studies suggested that there may be some potential mediating variables between social relationships and frailty, for example, higher levels of social relationships may be effective in reducing the risk of loneliness and depression, and thus further reducing the risk of frailty [56]. These findings may provide directions for future research.

Due to the reversible state of frailty in the older adults, the results of our study have practical implications. The importance of improving social relationships should be considered at the same time when providing care and interventions for frail older adults. Helping them to establish positive social connections such as family and friends, social networks, and some volunteer activities can be effective in improving frailty [57]. Moreover, intervention programs should be gradual, from weak to strong, because frail older adults tend to have less social participation. Some social activities, such as volunteering or physical exercise in salons often requires a higher level of functioning [58].

This study's key strength is the utilization of RI-CLPM to examine the longitudinal bidirectional relation between frailty and social relationships and detection of within-person relations while controlling the between-person effect. Another advantage is that this study confirmed the vicious circle between frailty and social relationships, so it may be more effective to consider the importance of social relationships when developing intervention programs for frail older adults.

This study has some limitations. First, the relatively small size of the study may affect the stability of the results. Second, the study's coverage was less extensive as it did not include a psychological dimension to measure frailty. Third, this study can only generalize the association between overall scores of frailty and social relationships, and cannot derive the specific effects between the sub-domains. Therefore, it is recommended that future studies subdivide frailty or social relationships to explore more in-depth mechanisms. Finally, the long span between time points and the small total number of waves in this study did not detect a more stable lag effect, which could lead to serendipity, and therefore future studies are recommended to perform more number of measurements to enhance the stability of this type of study.

Conclusion

Our findings suggest that frailty and social relations in Japanese older adults are strongly correlated between people. Within people, changes in frailty and social relationships are consistently correlated. It further suggests that there is a vicious cycle between frailty and social relationships, which means the deterioration of social relationships in older adults also increases the risk of becoming more frail and vice versa. Our results emphasized that providing the earliest possible intervention for frail older populations while maintaining certain social relationships was necessary both to improve the frailty itself and to avoid a vicious cycle of further frailty in the future.

Acknowledgements
We owe a debt of gratitude to all study participants and Tobishima employees.

Author contributions
Mingyu Cui: Conceptualization, methodology, formal analysis, original draft. Dandan Jiao, Yang Liu, Yantong Zhu, Xiang Li, Zhu Zhu, Jinrui Zhang, Afsari Banu Alpona, Yanlin Wang and Meiling Qian: Review and editing. Yuko Sawada, Kumi Watanabe Miura, Taeko Watanabe, Emiko Tanaka: Investigation and data curation. Tokie Anme: Conceptualization, methodology, investigation, reviewing and editing, project administration, funding acquisition. All authors have read and agreed to the published version of the manuscript.

Funding
This work was supported by JSPS KAKENHI Grant Number JP21K18449 and by JST SPRING, Grant Number JPMJSP2124.

Data availability
The data that support the findings of this study are available from the local government but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the local government.

Declarations

Ethics approval and consent to participate
All experimental protocols in this study have been approved by the Ethics Committee of The University of Tsukuba (approval number 1331-4, June 24th, 2022). The need for informed consent was waived by the Ethics Committee of The University of Tsukuba. All methods were carried out in accordance with declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 26 March 2023 / Accepted: 28 February 2024

Published online: 05 March 2024

References

1. Collard RM, Boter H, Schoevers RA, et al. Prevalence of frailty in community-dwelling older persons: a systematic review[J]. J Am Geriatr Soc. 2012;60:1487–92.
2. Etman A, Burdorf A, Van der Cammen TJ, Mackenbach JP, Van Lenthe FJ. Socio-demographic determinants of worsening in Frailty among Community-Dwelling Older people in 11 European Countries. J Epidemiol Community Health. 2012;66:1116–21.
3. Davies K, Maharani A, Chandola T, Todd C, Pendleton N. The longitudinal relationship between loneliness, social isolation, and Frailty in older adults in England: a prospective analysis. Lancet Healthy Longev. 2021;2:e70–7.
4. Lestari SK, Eriksson M, de Luna X, Malmberg G, Ng N. Frailty and types of Social relationships among older adults in 17 European countries: a latent class analysis. Arch Gerontol Geriatr. 2022;101:104705.
5. Song X, Mitnitski A, Rockwood K. Prevalence and 10-Year outcomes of Frailty in older adults in relation to Deficit Accumulation. J Am Geriatr Soc. 2010;58:681–7.
6. Luger E, Dorner TE, Haider S, Kapan A, Lackinger C, Schindler K. 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;17:671–e9.
7. Romero-Ortuno R, Kenny RA. The Frailty Index in europeans: Association with Age and Mortality. Age Ageing. 2012;41:684–9.
8. Avila-Funes JA, Helmer C, Amieva H, Barberger-Gateau P, Goff ML, Ritchie K, Portet F, Carrière I, Tavernier B, Gutiérrez-Robledo LM. Frailty among Community-Dwelling Elderly people in France: the three-city study. J Gerontol Biol Sci Med Sci. 2008;63:1089–96.
9. Fhon JRS, Rodrigues RAP, Santos JLF, Diniz MA, Santos EB.; Almeida, V.C.; Giacomini, S.B.L. factors Associated with Frailty in older adults: a longitudinal study. Rev Saude Publica 2018, 52.
10. Deng MG, Liu F, Liang Y, et al. Association between frailty and depression: a bidirectional mendelian randomization study[J]. Sci Adv. 2023;9(38):eadi3902.
11. Deng MG, Wang K, Liu F et al. The Relationship Between Frailty and Schizophrenia: A Genetic Association and Mendelian Randomization Study[J]. 2023.
12. Kuiper JS, Zuidersma M, Zuidema SU, et al. Social relationships and cognitive decline: a systematic review and meta-analysis of longitudinal cohort studies[J]. Int J Epidemiol. 2016;45:1169–206.
13. Holt-Lunstad J, Smith TB, Layton JB. Social relationships and mortality risk: a meta-analytic review[J]. PLoS Med, 2010, 7(7), e1000316.
14. Fried L, Prohaska T, Burholt V, Burns A, Golden J, Hawkley L, Lawlor B, Leavey G, Lubben J, O'Sullivan. R. A Unified Approach to Loneliness. 2020.
15. Chon D, Lee Y, Kim J, Lee K. The Association between Frequency of Social Contact and Frailty in Older people: Korean Frailty and Aging Cohort Study (KFACS). J Korean Med Sci 2018, 33.
16. Jin Y, Yu R, Si H, Bian Y, Qiao X, Ji L, Liu Q, Wang W, Yu J, Li Y. Effects of Social Support on Frailty trajectory classes among Community-Dwelling older adults: the mediating role of depressive symptoms and physical activity. Geriatr Nur (Lond. 2022;45:39–46.
17. Nagai K, Tamaki K, Kusunoki H, Wada Y, Tsuji S, Itoh M, Sano K, Amano M, Hayashitani S, Yokoyama R. Physical Frailty predicts the development of Social Frailty: a prospective cohort study. BMC Geriatr. 2020;20:1–8.
18. Hoogendijk EO, Suanet B, Dent E, Deeg DJ, Aartsen MJ. Adverse effects of Frailty on Social Functioning in older adults: results from the Longitudinal Aging Study Amsterdam. Maturitas. 2016;83:45–50.
19. Hoogendijk EO, Heymans MW, Deeg DJ, Huisman M. Socioeconomic inequalities in Frailty among older adults: results from a 10-Year longitudinal study in the Netherlands. Gerontology. 2018;64:157–64.
20. Azevedo RS, de Sousa JR, Araujo MT, Martins Filho AJ, de Alcantara BN, Araujo FM, Queiroz MG, Cruz AC, Vasconcelos BHB, Chiang JO. In situ Immune response and mechanisms of cell damage in Central Nervous System of fatal cases Microcephaly by Zika Virus. Sci Rep. 2018;8:1.
21. Hamaker EL, Kuiper RM, Grasman RP. A critique of the Cross-lagged Panel Model. Psychol Methods. 2015;20:102.
22. Hamaker EL. Why Researchers Should Think within-Person: A Paradigmatic Rationale. 2012.
23. Fukutomi E, Okumiya K, Wada T, Sakamoto R, Ishimoto Y, Kimura Y, Kasahara Y, Chen W-L, Imai H, Fujisawa M. Importance of Cognitive Assessment as Part of the K lhon C Hecklist developed by the J apanese M inistry of H ealth, L Abor and W Elfare for Prediction of Frailty at a 2-Year follow up. Geriatr Gerontol Int. 2013;13:654–62.
24. Sewo Sampaio PY, Sampaio RAC, Yamada M, et al. Systematic review of the Kihon Checklist: is it a reliable assessment of frailty?[J]. Volume 16. Geriatrics & gerontology international; 2016. pp. 893–902. 8.
25. Satake S, Senda K, Hong YJ, et al. Validity of the K ihon Checklist for assessing frailty status[J]. Geriatr Gerontol Int. 2016;16(6):709–15.
26. Anme T, Shimada C. Social Interaction and Mortality in a five year longitudinal study of the Elderly. Nihon Koshu Eisei Zasshi Jpn. J Public Health. 2000;47:127–33.
27. Tsutsumimoto K, Doi T, Makizako H, Hotta R, Nakakubo S, Makino K, Suzuki T, Shimada H. Cognitive Frailty is Associated with fall-related fracture among older people. J Nutr Health Aging. 2018;22:1216–20.
28. Tomioka K, Kurumatani N, Saeki K. The Differential effects of type and frequency of Social Participation on IADL declines of older people. PLoS ONE. 2018;13:e0207426.
29. Putnick DL, Bornstein MH. Measurement invariance conventions and reporting: the state of the art and future directions for psychological research[J]. Dev Rev. 2016;41:71–90.
30. Kline RB. Principles and practice of structural equation modeling 2nd Ed. N Y Guilford 2005, 3.
31. MacCallum RC, Austin JT. Applications of structural equation modeling in Psychological Research. Annu Rev Psychol. 2000;51:201–26.
32. Marsh HW, Hau K-T, Wen Z. Search of Golden rules: comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. Struct Equ Model. 2004;11:320–41.
33. Allison PD. Missing data techniques for structural equation modeling. J Abnorm Psychol. 2003;112:545–57.
34. Mulder JD, Hamaker EL. Three extensions of the random intercept cross-lagged panel model. Struct Equ Model Multidiscip J. 2021;28:638–48.
35. Kline RB. Principles and practice of structural equation modeling. Guilford; 2015.
36. Chen FF. Sensitivity of goodness of fit indexes to lack of measurement invariance. Struct Equ Model Multidiscip J. 2007;14:464–504.
37. Putnick DL, Bornstein MH. Measurement invariance conventions and reporting: the state of the art and future directions for psychological research. Dev Rev. 2016;41:71–90.
38. Curtis RG, Huxhold O, Windsor TD. Perceived control and social activity in midlife and older age: a reciprocal association? Findings from the German ageing Survey[J]. Journals Gerontology: Ser B 2018, 807–15.
39. Rogers NT, Marshall A, Roberts CH, et al. Physical activity and trajectories of frailty among older adults: evidence from the English Longitudinal Study of Ageing[J]. PLoS ONE. 2017;12(2):e0170878.
40. Hoogendijk EO, Afilalo J, Ensrud KE, Kowal. Paul and Onder, Graziano and Fried, Linda P. Frailty: implications for clinical practice and public health[J]. Lancet. 2019;394:1365–75.
41. Shankar A, McMunn A, Demakakos P, Hamer M, Steptoe A. Social isolation and loneliness: prospective associations with functional status in older adults. Health Psychol. 2017;36:179–87.
42. Perissinotto CM, Stijacic Cenzer IS, Covinsky KE. Loneliness in older persons: a predictor of functional decline and death. Arch Intern Med. 2012;172:1078–83.
43. Reginster JY, Cooper C, Rizzoli R, et al. Recommendations for the conduct of clinical trials for drugs to treat or prevent Sarcopenia. Aging Clin Exp Res. 2016;28:47–58.
44. Walston JD. Sarcopenia in older adults. Curr Opin Rheumatol. 2012;24:623–7.
45. Shankar A, McMunn A, Banks J, Steptoe A. Loneliness, social isolation, and behavioral and biological health indicators in older adults. Health Psychol. 2011;30:377–85.
46. Song J, Lindquist LA, Chang RW, et al. Sedentary behavior as a risk factor for physical frailty independent of moderate activity: results from the osteoarthritis initiative. Am J Public Health. 2015;105:1439–45.
47. Zhao Y, Liao L, Feng H, Chen H, Ning H. Correction to: enablers and barriers to implementing care quality improvement program in nursing homes in China. BMC Geriatric. 2022;22:1.
48. Hajek A, Brettschneider C, Eisele M, et al. Social support and functional decline in the oldest old. Gerontology. 2022;68:200–8.
49. Lara E, Caballero FF, Rico-Uribe LA, et al. Are loneliness and social isolation associated with cognitive decline? Int J Geriatr Psychiatry. 2019;34:1613–22.

50. Kossioni AE, Hajto-Bryk J, Janssens B, et al. Practical guidelines for physicians in promoting oral health in frail older adults. J Am Med Dir Assoc. 2018;19:1039–46.
51. Du C, Dong X, Katz B, et al. Source of perceived social support and cognitive change: an 8-year prospective cohort study[J]. Aging Ment Health. 2023;27(8):1496–505.
52. He B, Ma Y, Wang C, et al. Prevalence and risk factors for frailty among community-dwelling older people in China: a systematic review and meta-analysis. J Nutr Health Aging. 2019;23:442–50.
53. Feng Z, Lugtenberg M, Franse C, et al. Risk factors and protective factors associated with incident or increase of frailty among community-dwelling older adults: a systematic review of longitudinal studies. PLoS ONE. 2017;12:e0178383.
54. Tsutsumimoto K, Doi T, Makizako H, et al. Association of social frailty with both cognitive and physical deficits among older people. J Am Med Dir Assoc. 2017;18:603–7.
55. AAndrew MK, Dupuis-Blanchard S, Maxwell C, Giguere A, Keefe J, Rockwood K. St. John, P and Canadian Frailty Network. Social and societal implications of frailty, including impact on Canadian healthcare systems[J]. J Frailty Aging. 2018;7:217–23.
56. Wu F, Sheng Y. Social support network, social support, self-efficacy, health-promoting behavior and healthy aging among older adults: a pathway analysis[J]. Arch Gerontol Geriatr. 2019;85:103934.
57. Berkman LF, Krishna A, Kawachi I et al. 7. Social network epidemiology. Soc Epidemiol 2014, 234–89.
58. Makizako H, Shimada H, Doi T, et al. Social frailty leads to the development of physical frailty among physically non-frail adults: a four-year follow-up longitudinal cohort study. Int J Environ Res Public Health. 2018;15:490.

Publisher's Note

日中笹川医学奨学金制度<ポストドクターコース>中間評価書
【指導教官用】

Supported by 日本財団 THE NIPPON FOUNDATION

第45期　　研究者番号:　P4512

氏名	張 碧航	ZHANG BIHANG	性別	F	生年月日	1994/3/19
所属機関(役職)	自治医科大学大学院医学研究科(研究生)					
日本研究先機関名・部署	自治医科大学大学院医学研究科形成外科学講座					
指導教官氏名・役職	吉村　浩太郎　教授					
研究テーマ(日本語)	培養ヒト毛包内の異なる部分由来上皮前駆細胞及び創傷治癒に関する研究					
研究テーマ(英語)	Study on the cultured follicular epithelial cells derived from different portions of hair follicle and their effects on wound healing					

研究者評価(指導教官記入欄)

進捗状況	優・良・可・不可から選択してください⇒	良	パーセンテージ⇒	90 %
研究者本人が行った研究の概要	After developing a method to isolate FECs from different parts of hair follicle, these cells' functions and characterizations are compared in vitro and in vivo. Then the regeneration of harvested part of hair follicle is explored.			
総合評価	【良かった点】 Hard-working			
	【改善すべき点】			
	【今後の目標】 現在論文を作成中です。医師の国家試験に合格したため、4月から2年間の初期研修に入るため、研究活動は中止して、これまでの成果についての論文の作成と投稿を行う。			
研究計画書に記載の研究計画の進捗状況	①予想以上に進捗している　(②)おおむね順調　③やや遅れている　④大幅に遅れている			
進捗が進んでいる内容と遅れている内容及びその理由				
現在の進捗状況を踏まえた目標達成見込	目標達成可			
評価者(指導教官記名)	吉村浩太郎	作成日:	2025年　3　月　15　日	

日中笹川医学奨学金制度<ポストドクターコース>中間報告書
【研究者用】

Supported by 日本財団 THE NIPPON FOUNDATION

第45期　　研究者番号：P4512　　作成日：2025年3月10日

氏名	張 碧航	ZHANG BIHANG	性別	F	生年月日	1994/3/19
所属機関(役職)	自治医科大学大学院医学研究科（研究生）					
日本研究先（指導教官）	自治医科大学大学院医学研究科形成外科学講座（吉村　浩太郎　教授）					
研究テーマ(日文)	培養ヒト毛包内の異なる部分由来上皮前駆細胞及び創傷治癒に関する研究					
Research theme	Study on the cultured follicular epithelial cells derived from different portions of hair follicle and their effects on wound healing					

1．研究概要(1)

1)目的(Goal)

Human hair follicle is consistent of epithelial stem cells, progenitor cells and various lineages of keratinocytes. Follicular epithelial cells (FECs) belong to epithelial cells, as the same as epidermal epithelial cells (EECs). And it was presented that the different portions of human hair follicle showed different patterns of biomarker expressions.

2)戦略(Approach)

Firstly, we are trying to develope a method to isolate FECs from different parts of hair follicle;

Secondly, the in vitro experiments is applied to investigate different types cells' functions and characterizations;

Thirdly, the potential effects of FECs derived from different portions of hair follicle on wound healing and epithelization, compared with human epidermal progenitor cells (hEPCs) is investigated;

Then, the regeneration of excised part of hair follicle is explored.

3)材料と方法(Materials and methods)

A novel and mature isolation method of FECs from different parts, which include cells from Bulb part (BECs), lower part of outer root sheath (LECs), and upper part of outer root sheath (UECs), was established. The proliferative abilities and biomarker expressions of these cells were investigated with comparison to EECs. The effects of different portions' FECs, when compared to EECs and control group, on wound healing and epithelization were investigated with mice wound healing models. Histological examinations were applied to healed mice wound skin. The regeneration of excised part of hair follicle was explored via rat's experiments.

4)実験結果(Results)

The Bulb-FECs showed best proliferous ability in vitro, then the LORS-FECs, when compared with EPCs. Cultured Bulb-FSCs showed positive expression of CK10 and CK14, and the Bulb-FECs showed lowest positive ratio of CK10 and highest positive ratio of CK14 when compared with other types of cells. During mice wound healing experiments, FECs and EPCs all have positive effects on wound healing compared to control group of culture medium; and when compared with EPCs, the Bulb-FECs and LORS-FECs showed better enhancement on wound healing, especially the Bulb-FECs. And the harvested healed wound skin of the Bulb-FECs group showed higher percentage of TGOLN2+ and CK14+ cells. At rat's experiment, all excised Bulb part of hair follicle can regenerate after removing, while the regenerated hair shafts were thin, curve and short then original ones.

5)考察(Discussion)

In this research, the functions and effects on wound healing of 3 types of FECs (BECs, LECs and UECs) and EECs were investigated and compared: The BECs and LECs showed better proliferous abilities in vitro, when compared with EECs. And the cultured BECs contained lowest ratio of differentiated mature cells and highest ratio of proliferating progenitor cells than others. In mice wound healing models, all four types of epithelial cells had positive effects on wound healing and epithelization compared to control group. Compared with EECs, BECs and LECs showed more enhanced healing, especially the BECs which led to the best outcomes. Histological analysis of healed skin samples indicated that BECs-treated group had thinner and smaller scar tissue, suggesting better tissue regeneration after wounding. After superior therapeutic effects of BECs were suggested, we evaluated the adverse effects of sacrificing the bulb part from hair follicles using rat whiskers: the excised bulb part can regenerate itself from the left part. The FECs, especially the Bulb-FECs, could be promising tools in tissue regeneration and wound healing with lowest damage to donor sites.

6)当初の研究計画と比し、現在の進捗状況の自己評価　(Self-assessment of the current progress compared to the initial research plan.)

①予想以上に進捗している(Progressing more than expected.)
②おおむね順調　(Mostly on track)
③やや遅れている　(Slightly behind schedule)
④大幅に遅れている(Significantly behind schedule)

7)計画より進んでいる内容と遅れている内容、及びその理由
(Contents that are ahead of schedule and those that are behind schedule, along with the reasons.)

1．研究概要(2)

8)参考文献(References)

1.Singer, A. J. and Clark, R. A. Cutaneous wound healing. N Engl J Med. 341(10): p. 738-46, 1999.
2.Sousa, P., Lopes, B., Sousa, A. C., Moreira, A., Coelho, A., Alvites, R., Alves, N., Geuna, S., and Maurício, A. C. Advancements and Insights in Exosome-Based Therapies for Wound Healing: A Comprehensive Systematic Review (2018-June 2023). Biomedicines. 11(8), 2023.
3.Reinke, J. M. and Sorg, H. Wound repair and regeneration. Eur Surg Res. 49(1): p. 35-43, 2012.
4.Ma, H., Siu, W. S., and Leung, P. C. The Potential of MSC-Based Cell-Free Therapy in Wound Healing-A Thorough Literature Review. Int J Mol Sci. 24(11), 2023.
5.Las Heras, K., Igartua, M., Santos-Vizcaino, E., and Hernandez, R. M. Chronic wounds: Current status, available strategies and emerging therapeutic solutions. J Control Release. 328: p. 532-550, 2020.
6.Zhu, M., Cao, L., Melino, S., Candi, E., Wang, Y., Shao, C., Melino, G., Shi, Y., and Chen, X. Orchestration of Mesenchymal Stem/Stromal Cells and Inflammation During Wound Healing. Stem Cells Transl Med. 2023.
7.Al-Masawa, M. E., Alshawsh, M. A., Ng, C. Y., Ng, A. M. H., Foo, J. B., Vijakumaran, U., Subramaniam, R., Ghani, N. A. A., Witwer, K. W., and Law, J. X. Efficacy and safety of small extracellular vesicle interventions in wound healing and skin regeneration: A systematic review and meta-analysis of animal studies. Theranostics. 12(15): p. 6455-6508, 2022.
8.Zhu, M., Chu, Y., Shang, Q., Zheng, Z., Li, Y., Cao, L., Chen, Y., Cao, J., Lee, O. K., Wang, Y., Melino, G., Lv, G., Shao, C., and Shi, Y. Mesenchymal stromal cells pretreated with pro-inflammatory cytokines promote skin wound healing through VEGFC-mediated angiogenesis. Stem Cells Transl Med. 9(10): p. 1218-1232, 2020.
9.Weller, C. D., Team, V., and Sussman, G. First-Line Interactive Wound Dressing Update: A Comprehensive Review of the Evidence. Front Pharmacol. 11: p. 155, 2020.
10.Zhang, B., Wu, Y., Mori, M., and Yoshimura, K. Adipose-Derived Stem Cell Conditioned Medium and Wound Healing: A Systematic Review. Tissue Eng Part B Rev. 28(4): p. 830-847, 2022.
11.Saadh, M. J., Ramírez-Coronel, A. A., Saini, R. S., Arias-Gonzáles, J. L., Amin, A. H., Gavilán, J. C. O., and Sârbu, I. Advances in mesenchymal stem/stromal cell-based therapy and their extracellular vesicles for skin wound healing. Hum Cell. 36(4): p. 1253-1264, 2023.
12.Lombardi, F., Palumbo, P., Augello, F. R., Cifone, M. G., Cinque, B., and Giuliani, M. Secretome of Adipose Tissue-Derived Stem Cells (ASCs) as a Novel Trend in Chronic Non-Healing Wounds: An Overview of Experimental In Vitro and In Vivo Studies and Methodological Variables. Int J Mol Sci. 20(15), 2019.
13.Xiong, M., Zhang, Q., Hu, W., Zhao, C., Lv, W., Yi, Y., Wu, Y., and Wu, M. Exosomes From Adipose-Derived Stem Cells: The Emerging Roles and Applications in Tissue Regeneration of Plastic and Cosmetic Surgery. Front Cell Dev Biol. 8: p. 574223, 2020.
14.Fuchs, E. Scratching the surface of skin development. Nature. 445(7130): p. 834-42, 2007.
15.Ito, M., Liu, Y., Yang, Z., Nguyen, J., Liang, F., Morris, R. J., and Cotsarelis, G. Stem cells in the hair follicle bulge contribute to wound repair but not to homeostasis of the epidermis. Nat Med. 11(12): p. 1351-4, 2005.
16.Levy, V., Lindon, C., Zheng, Y., Harfe, B. D., and Morgan, B. A. Epidermal stem cells arise from the hair follicle after wounding. Faseb j. 21(7): p. 1358-66, 2007.
17.Tiwari, R. and Pathak, K. Local Drug Delivery Strategies towards Wound Healing. Pharmaceutics. 15(2), 2023.
18.Rowan, M. P., Cancio, L. C., Elster, E. A., Burmeister, D. M., Rose, L. F., Natesan, S., Chan, R. K., Christy, R. J., and Chung, K. K. Burn wound healing and treatment: review and advancements. Crit Care. 19: p. 243, 2015.
19.Green, H. Cultured cells for the treatment of disease. Sci Am. 265(5): p. 96-102, 1991.
20.Hosseini, M., Dalley, A. J., and Shafiee, A. Convergence of Biofabrication Technologies and Cell Therapies for Wound Healing. Pharmaceutics. 14(12), 2022.
21.Idrus, R. B., Rameli, M. A., Low, K. C., Law, J. X., Chua, K. H., Latiff, M. B., and Saim, A. B. Full-thickness skin wound healing using autologous keratinocytes and dermal fibroblasts with fibrin: bilayered versus single-layered substitute. Adv Skin Wound Care. 27(4): p. 171-80, 2014.
22.Auxenfans, C., Shipkov, H., Bach, C., Catherine, Z., Lacroix, P., Bertin-Maghit, M., Damour, O., and Braye, F. Cultured allogenic keratinocytes for extensive burns: a retrospective study over 15 years. Burns. 40(1): p. 82-8, 2014.
23.Auxenfans, C., Menet, V., Catherine, Z., Shipkov, H., Lacroix, P., Bertin-Maghit, M., Damour, O., and Braye, F. Cultured autologous keratinocytes in the treatment of large and deep burns: a retrospective study over 15 years. Burns. 41(1): p. 71-9, 2015.
24.Cotsarelis, G., Kaur, P., Dhouailly, D., Hengge, U., and Bickenbach, J. Epithelial stem cells in the skin: definition, markers, localization and functions. Exp Dermatol. 8(1): p. 80-8, 1999.
25.Blanpain, C. and Fuchs, E. Stem cell plasticity. Plasticity of epithelial stem cells in tissue regeneration. Science. 344(6189): p. 1242281, 2014.
26.Wang, J., He, J., Zhu, M., Han, Y., Yang, R., Liu, H., Xu, X., and Chen, X. Cellular Heterogeneity and Plasticity of Skin Epithelial Cells in Wound Healing and Tumorigenesis. Stem Cell Rev Rep. 18(6): p. 1912-1925, 2022.
27.Williams, R., Pawlus, A. D., and Thornton, M. J. Getting under the skin of hair aging: the impact of the hair follicle environment. Exp Dermatol. 29(7): p. 588-597, 2020.
28.Blanpain, C. and Fuchs, E. Epidermal stem cells of the skin. Annu Rev Cell Dev Biol. 22: p. 339-73, 2006.
29.Inoue, K., Aoi, N., Sato, T., Yamauchi, Y., Suga, H., Eto, H., Kato, H., Araki, J., and Yoshimura, K. Differential expression of stem-cell-associated markers in human hair follicle epithelial cells. Lab Invest. 89(8): p. 844-56, 2009.
30.Akiyama, M., Dale, B. A., Sun, T. T., and Holbrook, K. A. Characterization of hair follicle bulge in human fetal skin: the human fetal bulge is a pool of undifferentiated keratinocytes. J Invest Dermatol. 105(6): p. 844-50, 1995.

2. 執筆論文 Publication of thesis ※記載した論文を添付してください。Attach all of the papers listed below.

論文名 1 Title	None					
掲載誌名 Published journal						
	年 月	巻(号)	頁 ～ 頁	言語 Language		
第1著者名 First author		第2著者名 Second author		第3著者名 Third author		
その他著者名 Other authors						
論文名 2 Title						
掲載誌名 Published journal						
	年 月	巻(号)	頁 ～ 頁	言語 Language		
第1著者名 First author		第2著者名 Second author		第3著者名 Third author		
その他著者名 Other authors						
論文名 3 Title						
掲載誌名 Published journal						
	年 月	巻(号)	頁 ～ 頁	言語 Language		
第1著者名 First author		第2著者名 Second author		第3著者名 Third author		
その他著者名 Other authors						
論文名 4 Title						
掲載誌名 Published journal						
	年 月	巻(号)	頁 ～ 頁	言語 Language		
第1著者名 First author		第2著者名 Second author		第3著者名 Third author		
その他著者名 Other authors						
論文名 5 Title						
掲載誌名 Published journal						
	年 月	巻(号)	頁 ～ 頁	言語 Language		
第1著者名 First author		第2著者名 Second author		第3著者名 Third author		
その他著者名 Other authors						

3. 学会発表 Conference presentation ※筆頭演者として総会・国際学会を含む主な学会で発表したものを記載してください。

※Describe your presentation as the principal presenter in major academic meetings including general meetings or international meetings.

学会名 Conference	日本形成外科学会基礎学術集会33回							
演 題 Topic	Therapeutic Potential of Follicular Epithelial Cells Derived from Different Portions of Hair Follicle for Wound Healing and Epithelization							
開催日 date	2024 年 10 月 17 日			開催地 venue	東京			
形式 method	☑ 口頭発表 Oral	☐ ポスター発表 Poster		言語 Language	☐ 日本語	☑ 英語	☐ 中国語	
共同演者名 Co-presenter								
学会名 Conference								
演 題 Topic								
開催日 date	年 月 日			開催地 venue				
形式 method	☐ 口頭発表 Oral	☐ ポスター発表 Poster		言語 Language	☐ 日本語	☐ 英語	☐ 中国語	
共同演者名 Co-presenter								
学会名 Conference								
演 題 Topic								
開催日 date	年 月 日			開催地 venue				
形式 method	☐ 口頭発表 Oral	☐ ポスター発表 Poster		言語 Language	☐ 日本語	☐ 英語	☐ 中国語	
共同演者名 Co-presenter								
学会名 Conference								
演 題 Topic								
開催日 date	年 月 日			開催地 venue				
形式 method	☐ 口頭発表 Oral	☐ ポスター発表 Poster		言語 Language	☐ 日本語	☐ 英語	☐ 中国語	
共同演者名 Co-presenter								

4. 受賞（研究業績） Award (Research achievement)

名 称 Award name	APRAS Award - Best Paper Award			
	国名 Country	日本国	受賞年 Year of award	2024 年 10 月
名 称 Award name				
	国名 Country		受賞年 Year of award	年 月

5. 本研究テーマに関わる他の研究助成金受給 Other research grants concerned with your resarch theme

受給実績 Receipt record	■ 有　□ 無
助成機関名称 Funding agency	科研費
助成金名称 Grant name	Details Unknown
受給期間 Supported period	年　月 ～　年　月
受給額 Amount received	円
受給実績 Receipt record	□ 有　□ 無
助成機関名称 Funding agency	
助成金名称 Grant name	
受給期間 Supported period	年　月 ～　年　月
受給額 Amount received	円

6. 他の奨学金受給 Another awarded scholarship

受給実績 Receipt record	□ 有　■ 無
助成機関名称 Funding agency	
奨学金名称 Scholarship name	
受給期間 Supported period	年　月 ～　年　月
受給額 Amount received	円

7. 研究活動に関する報道発表 Press release concerned with your research activities

※記載した記事を添付してください。Attach a copy of the article described below

報道発表 Press release	□ 有　■ 無	発表年月日 Date of release	
発表機関 Released medium			
発表形式 Release method	・新聞　・雑誌　・Web site　・記者発表　・その他（　　）		
発表タイトル Released title			

8. 本研究テーマに関する特許出願予定 Patent application concerned with your research theme

出願予定 Scheduled	□ 有　■ 無	出願国 Application	
出願内容（概要） Application contents			

9. その他 Others

指導責任者（記名）　吉村 浩太郎

日中笹川医学奨学金制度〈ポストドクターコース〉中間評価書
【指導教官用】

第45期　　研究者番号：　P4513

氏名	姚 利	YAO LI	性別	F	生年月日	1990/11/20
所属機関（役職）	千葉大学大学院看護学研究院・ 高齢社会実践看護学講座（特任助教）					
日本研究先機関名・部署	千葉大学大学院看護学研究院					
指導教官氏名・役職	正木 治恵　教授					
研究テーマ（日本語）	在留中国人高齢者の老いへの準備教育アプリケーションの開発					
研究テーマ（英語）	Development of an education application on aging-related preparation for older Chinese migrants in Japan					

研究者評価（指導教官記入欄）

進捗状況	優・良・可・不可から選択してください⇒	可	パーセンテージ⇒	65　%
研究者本人が行った研究の概要	本研究は、研究者自身が博士課程で作成した在日中国人高齢者の老いへの準備教育プログラムのアプリケーション版を作成し、その活用可能性(usability)を検証することを目的とした。 当初、アプリ開発は専門業者に委託する予定であったが、本研究を遂行する過程で、自らアプリケーション開発に必要な知識を修得することの重要性を痛感した。そのため、研究者本人は日本と中国の関連会社と相談しながら、アプリ作成まで短期間で網羅的に学ぶコースを検討した。その結果、ネット上でpythonを使ったプログラミングについて学習を始め、現在はbubbleを使って、アプリケーションを作成中である。 在日中国人高齢者の老いへの準備教育プログラムのアプリケーション版については、3月末までに作成し、その後専門家等からの評価を得て、修正していく。よって、当初計画していたアプリケーションの評価については、次年度より開始となる。			
総合評価	【良かった点】 博士課程で作成した「在日中国人高齢者の老いへの準備教育プログラム」の内容をアプリケーション版にしていくことを目標にしているが、アプリケーション化を業者任せにせず、自ら製作するための基礎的能力を修得しようとした点は、高く評価できる。			
	【改善すべき点】 学修することに貪欲である点は評価するが、研究を計画通り遂行していくことには支障をきたしている。インプットとアウトプットのバランスを自らどのように取っていくか、今後の課題である。			
	【今後の目標】 修正した研究の遂行計画は以下の通りである。 ・2025年2・3月：bubbleを使ってwebやアプリケーションを作成する ・2025年4月：専門家会議開催の倫理審査の準備と申請 ・2025年5月：専門家会議開催/アプリケーションの修正 ・2025年6月：対象者検討の倫理審査申請 ・2025年7-2026年1月：対象者募集・データ収集 ・2026年2月：データ分析 ・2026年3月：結果まとめ			
研究計画書に記載の研究計画の進捗状況	①予想以上に進捗している　②おおむね順調　③やや遅れている　④大幅に遅れている			
進捗が進んでいる内容と遅れている内容及びその理由	本人は、米国留学も視野に入れて、ITエンジニア領域の学修を強化することを考えている。看護学を専門とする者が、その分野の基礎知識を持つことは有益であると考えられる。ただ、様々学修したい気持ちが優先しており、当初計画の遂行が遅れがちになっている。しっかり自分の目標を見据えて、学修のみならず、研究の遂行力を身に着けてほしい。			
現在の進捗状況を踏まえた目標達成見込	何事にも精力的に取り組んでいるため、自身の研鑽を積みながら、研究を遂行し、目標はほぼ達成できると考える。			
評価者（指導教官記名）	正木治恵	作成日：	2025年　3　月　8　日	

日中笹川医学奨学金制度<ポストドクターコース>中間報告書
【研究者用】

Supported by 日本財団 THE NIPPON FOUNDATION

第45期　　研究者番号：P4513　　作成日：2025年3月10日

氏名	姚 利	YAO LI	性別	F	生年月日	1990/11/20
中国所属機関(役職)	千葉大学大学院看護学研究院・高齢社会実践看護学講座(特任助教)					
日本研究先(指導教官)	千葉大学大学院看護学研究院(正木 治恵　教授)					
研究テーマ(日文)	在留中国人高齢者の老いへの準備教育アプリケーションの開発					
Research theme	Development of an education application on aging-related preparation for older Chinese migrants in Japan					

1．研究概要(1)

1)目的(Goal)
　自分が博士課程で構築した在留中国人高齢者の老いへの準備教育プログラムのアプリケーション版を作成し、その活用可能性(usability)を検証する。

2)背景
【在留中国人高齢者とその家族が直面する介護が必要となる生活の課題】
在留中国人高齢者とその家族は、言語の障壁で日本の介護保険制度の認知度が低いことに加え、母国に介護保険制度はなく、高齢者の介護は外部の支援を得ず家庭内で担うといった文化の違いがあるため、介護保険サービスの理解や利用に困難がある(大浦ら, 2020; 辻村ら, 2014)。また、老いに伴う「母国語がえり」現象(日本語の忘れが多く、母国語での会話が増えること)によって、専門職との意思疎通はさらに困難である(文, 2009)。加えて、行政やケア提供側も、文化・言語の障壁があるため、外国人高齢者のケアニーズや意思の把握に困難を抱えている(李ら, 2018; 大浦ら, 2020)。そこで、これから要介護生活を迎える在留中国人高齢者およびその家族が、いざとなったとき困難に陥らず自分が望んだ要介護生活や介護に関する意思を専門職に伝え、適時に専門的な支援を得るための準備が必要である。

【外国人高齢者向けの支援政策の現状】
WHOは高齢者とその家族、そして高齢者が暮らすコミュニティの生活の改善を目指した「Decade of Healthy aging」(2021～2030年)を推進し、高齢者が機能的能力を維持しながら尊厳をもって生活できるように、介護サービスへのアクセスの提供に主張している。また、日本は「誰ひとり取り残さない」持続可能な経済社会システムを作るため、外国人が必要とする情報に迅速・円滑にアクセスでき、抱える困りごとを迅速に解決できることを目指して多文化共生社会の構築を取り組んでいる(SDGs推進本部, 2023)。外国人高齢者を中心とした支援方法は主に要介護制度に関する多言語対応版リーフレットによる情報の提供・発信である(外国人財の受け入れ・強制に関する関係閣僚会議, 2022)。しかし、これらの情報は,

文化のギャップに生じた要介護生活のイメージ形成とその支援政策の理解に限界がある。高齢者は将来のケアニーズの予測困難、ケアに関する資源・情報の欠如、計画を組み立てる自信がないなどが将来のケアニーズの準備に影響を与えると報告されている(Sörensenら、2000)。彼らは情報の入手困難及び文化の違いに生じたケアや処置に関する理解、意思疎通やケアアクセスの困難を改善するため、省略した情報の提供よりも、老いと共に変化した生活及びその支援政策を理解しイメージできる支援が重要である。しかし、申請者のデータベース検索結果では、文化の視点から在留中国人高齢者向けの老いに伴う変化の理解、また、変化した生活を支援するケアや介護サービス等の認識をイメージ形成できるまでの教育支援は見当たらない。そして、中国の文化を配慮した要介護生活に焦点を当てた老いへの準備支援が必要と考える。

【高齢者におけるICTの利活用の現状】
近年、他者との繋がりや情報検索のためにスマートフォン等のICT機器・サービスの利用経験や実績のある高齢者が増えている(総務省, 2021)。また、超高齢化社会の突入に伴い、医療分野のデジタル化が進み、保険・医療情報(介護含む)の利活用が積極的に推進されることで、今後、患者・国民自らの医療情報の管理・活用による健康への関心の高まりや健康増進が期待されている(厚生労働省, 2022)。それに対して、国も高齢者に優しいデジタル環境の構築に力を入れている。総務省(2022)はデジタル社会の実現のため、高齢者を中心とするデジタル活用に不安のある方々の解消に向けてデジタル活用支援推進事業を全国の携帯ショップ等で実施している。さらに、高齢者 ICT 利活用の推進では、加齢に伴う様々な条件の変化によらず、高齢者が学びやすく、使いやすい ICT、支援者がサポートしやすい ICT の開発・提供も求められている(総務省, 2015)。今後、高齢者の健康管理もスマートフォン等を利活用し、デジタル化が進行していくと推察できる。
よって、高齢期の特徴と中国の文化を配慮した在留中国人高齢者の老いへの準備教育アプリケーションの開発が必要と考える。

１．研究概要（2）

3）材料と方法（Materials and methods）（進行中）

本研究は、自分が構築した老いへの教育プログラムのアプリケーション版を作成し、heuristic evaluationとusability testingを用いて、その活用可能性（usability）を検証する。Heuristic evaluation では、情報デザインや老年学を含む7名程度の専門家に、Salmanら（2018）が開発した高齢者が使うアプリケーションの活用可能性の評価リストの回答を収集し、その結果を踏まえて意見を聴取する。その後、Usability testingでは、関東及び関西の地域で自立している30名程度の在留中国人高齢者とその家族を対象に、Health Information Technology Usability Evaluation Scale (Schnallら, 2018)及びインタビュー調査を通して、アプリケーションの活用可能性を検証する。スケールによる量的データとインタビューによる質的データは、SPSSソフトウエア及び質的帰納的分析手法を使って解析する。

5）当初の研究計画と比し、現在の進捗状況の自己評価　（Self-assessment of the current progress compared to the initial research plan.）

①予想以上に進捗している（Progressing more than expected.）
②おおむね順調　（Mostly on track）
③やや遅れている　（Slightly behind schedule）
④大幅に遅れている（Significantly behind schedule）

6）計画より進んでいる内容と遅れている内容、及びその理由

（Contents that are ahead of schedule and those that are behind schedule, along with the reasons.）

現在、アプリケーションを作成中である。計画段階では、アプリケーションのデザインを担当し、プログラミングやアプリの作成は業者に依頼する予定であった。しかし、研究が進む中で、自分にはプログラミングやアプリ作成に関する知識のギャップが、高齢者にとって使いやすいアプリのデザインにも影響を与えることを懸念した。そのため、アプリケーション作成に必要なプログラミング知識を学び、自分で作成する方向に変更した。現在、アプリケーションの作成は進行中である。

7）参考文献（References）

・辻村 真由子：中国帰国者1世・2世とその中国人配偶者に必要な看護支援の検討　A県在住者を対象とした健康状態と医療・看護・　介護ニーズの実態調査から．文化看護学会誌，6（1），12-23，2014.
・李 錦純：看護・介護職者がとらえる在日コリアン高齢者支援における特徴と困難感．兵庫県立大学看護学部・地域ケア開発研究所紀要，24105-113，2017.
・大浦 智子：特別永住者や外国系日本人における日本の高齢者介護サービスへのアクセスの現状と課題　公衆衛生モニタリング・レポート委員会報告．日本公衆衛生雑誌，67（7），435-441，2020.
・文 鐘聲：在日コリアン高齢者の認知症と言語に関する検討．太成学院大学紀要，11119-126，2009.
・Sörensen Silvia，Pinquart Martin：Vulnerability and access to resources as predictors of preparation for future care needs in the elderly．Journal of Aging and Health，12（3），275-300，2000.
・Rebecca Schnall, Hwayoung Cho, Jianfang Liu.(2018).Health Information Technology Usability Evaluation Scale (Health-ITUES) for Usability Assessment of Mobile Health Technology: Validation Study.JMIR Mhealth Uhealth. 5;6(1):e4. doi: 10.2196/mhealth.8851.

2. 執筆論文 Publication of thesis ※記載した論文を添付してください。Attach all of the papers listed below.

論文名 1 Title	Older Chinese people's experiences of relocation to long-term care facilities: A literature review of qualitative studies					
掲載誌名 Published journal	Journal of International Nursing Research https://doi.org/10.53044/jinr.2022-0038					
	2024 年 8 月	3(2) 巻(号)	1 頁 ～ 19 頁		言語 Language	英語
第1著者名 First author	Li Yao	第2著者名 Second author	Harue Masaki	第3著者名 Third author		–
その他著者名 Other authors	–					
論文名 2 Title	Effectiveness of an Aging-related Preparation Education Program for Older Chinese Immigrants in Japan					
掲載誌名 Published journal	Geriatrics & Gerontology International(投稿中)					
	年 月	巻(号)	頁 ～ 頁		言語 Language	
第1著者名 First author		第2著者名 Second author		第3著者名 Third author		
その他著者名 Other authors						
論文名 3 Title						
掲載誌名 Published journal						
	年 月	巻(号)	頁 ～ 頁		言語 Language	
第1著者名 First author		第2著者名 Second author		第3著者名 Third author		
その他著者名 Other authors						
論文名 4 Title						
掲載誌名 Published journal						
	年 月	巻(号)	頁 ～ 頁		言語 Language	
第1著者名 First author		第2著者名 Second author		第3著者名 Third author		
その他著者名 Other authors						
論文名 5 Title						
掲載誌名 Published journal						
	年 月	巻(号)	頁 ～ 頁		言語 Language	
第1著者名 First author		第2著者名 Second author		第3著者名 Third author		
その他著者名 Other authors						

3. 学会発表 Conference presentation ※筆頭演者として総会・国際学会を含む主な学会で発表したものを記載してください。

※Describe your presentation as the principal presenter in major academic meetings including general meetings or international meetings.

学会名 Conference	Gerontological Society of America 2024 Annual Scientific Meeting				
演 題 Topic	Effectiveness Of An Aging-related Preparation Education Program For Older Chinese Migrants In Japan				
開催日 date	2024 年 11 月 13-16 日	開催地 venue	シアトル・アメリカ		
形式 method	☐ 口頭発表 Oral ☑ ポスター発表 Poster	言語 Language	☐ 日本語 ☑ 英語 ☐ 中国語		
共同演者名 Co-presenter	Harue Masaki				
学会名 Conference	第44回日本科学看護学会学術集会				
演 題 Topic	Verification of the content validity and usability of the multicultural care communication tool (Chinese part) for medical institutions in Japan				
開催日 date	2024 年 12 月 7-8 日	開催地 venue	熊本市・日本		
形式 method	☑ 口頭発表 Oral ☐ ポスター発表 Poster	言語 Language	☐ 日本語 ☑ 英語 ☐ 中国語		
共同演者名 Co-presenter	Harue Masaki, Yuko Ohara, Huiching Yang, Jingwen Yang				
学会名 Conference					
演 題 Topic					
開催日 date	年 月 日	開催地 venue			
形式 method	☐ 口頭発表 Oral ☐ ポスター発表 Poster	言語 Language	☐ 日本語 ☐ 英語 ☐ 中国語		
共同演者名 Co-presenter					
学会名 Conference					
演 題 Topic					
開催日 date	年 月 日	開催地 venue			
形式 method	☐ 口頭発表 Oral ☐ ポスター発表 Poster	言語 Language	☐ 日本語 ☐ 英語 ☐ 中国語		
共同演者名 Co-presenter					

4. 受賞(研究業績) Award (Research achievement)

名 称 Award name	Academy for Gerontology in Higher Education (AGHE) Student Travel Stipend			
	国名 Country	シアトル・アメリカ	受賞年 Year of	2024 年 11 月
名 称 Award name				
	国名 Country		受賞年 Year of	年 月

5. 本研究テーマに関わる他の研究助成金受給 Other research grants concerned with your resarch theme

受給実績 Receipt record	■ 有　□ 無
助成機関名称 Funding agency	日本学術振興会
助成金名称 Grant name	科学研究費助成事業　若手研究(No.JP24K20399)
受給期間 Supported period	2024　年　4　月 ～　2026　年　3　月
受給額 Amount received	総額:3,510,000 円
受給実績 Receipt record	□ 有　□ 無
助成機関名称 Funding agency	
助成金名称 Grant name	
受給期間 Supported period	年　月 ～　年　月
受給額 Amount received	円

6. 他の奨学金受給 Another awarded scholarship

受給実績 Receipt record	□ 有　■ 無
助成機関名称 Funding agency	
奨学金名称 Scholarship name	
受給期間 Supported period	年　月 ～　年　月
受給額 Amount received	円

7. 研究活動に関する報道発表 Press release concerned with your research activities

※記載した記事を添付してください。Attach a copy of the article described below

報道発表 Press release	■ 有　□ 無	発表年月日 Date of release	
発表機関 Released medium	日本老年看護学会		
発表形式 Release method	・新聞　・雑誌　(Web site)・記者発表　・その他(　　)		
発表タイトル Released title	国際学術集会参加レポート(https://www.rounenkango.com/other/kokusaireport.html)		

8. 本研究テーマに関する特許出願予定 Patent application concerned with your research theme

出願予定 Scheduled	□ 有　■ 無	出願国 Application	
出願内容(概要) Application contents			

9. その他 Others

無

指導責任者(記名)　正木治恵

JINR
Journal of International Nursing Research
https://doi.org/10.53044/jinr.2022-0038
https://www.jinr.jsnr.or.jp/

Review Article

Older Chinese people's experiences of relocation to long-term care facilities: A literature review of qualitative studies

Li Yao, PhD, RN, and Harue Masaki, PhD, RN, PHN

Graduate School of Nursing, Chiba University, Chiba, Japan

Abstract

An aging population in China has made long-term care a prominent issue. Long-term facilities are accommodating an increasing number of older people. However, relocating to such facilities can be a stressful experience and may affect the quality of life there. Thus, this review study aimed to comprehensively determine the relocation experiences and perspectives from pre- to post-institutionalization in long-term care facilities. Six databases were examined to find pertinent research published between 2000 and 2022. The search terms were "Chinese," "aged," "long-term care facility," and "experience" for qualitative research published in English and Chinese. Meta-ethnography was applied to synthesize results from the included studies. Of the initial 2,114 studies retrieved, 25 studies were included. Seven core categories were identified as relocation experiences and perspectives: (i) decision-making and preparation for relocation, (ii) physical and psychological burden, (iii) attitude change toward relocation, (iv) self-efforts for adaptation, (v) care needs during admission, (vi) daily life becomes affluent through participation, and (vii) concerns about the future. This review study provided insights into the characteristics of subjective condition changes of relocation experiences among older Chinese people from pre- to post-institutionalization. Our results indicate that relocation support should start before admission and be smoothly delivered during the whole relocation period because of the transition concerns and subjective conditions that are connected and interrelated.

Keywords

aged, Chinese, experience, relocation, review

JINR 2024, *3*(2), e2022-0038

Introduction

Along with the global aging population, older Chinese people aged 60 years or above are increasing rapidly (National Bureau of Statistics of China, 2021). Furthermore, the number of disabled older people is predicted to rise substantially faster than the overall older population (Zeng et al., 2015); they are estimated to have experienced 7.44 years of living with a disability in 2030, which will increase to 11.45 years in 2050 (Luo et al., 2021). With the rising need for long-term care, the challenge of the aging population has become a prominent issue in China. Furthermore, family structures have changed due to the one-child policy and socioeconomic development, and the average number of family members decreased from 3.10 in 2010 to 2.62 in 2020 (National Bureau of Statistics of China, 2021). These modifications directly impacted conventional family support (Cheung & Kwan, 2009; Lu et al., 2021; Qian et al., 2018).

In mainland China, as well as in Hong Kong, Macao, and Taiwan society, filial piety is an important social value that includes respecting and taking care of the old parents at home, and this affects older people's care preferences and

Correspondence: L. Yao. Email: yaoli134193@chiba-u.jp
Received: October 25, 2022, Accepted: February 7, 2024, Advance Publication: August 6, 2024, Published: August 25, 2024

decision-making regarding relocation (Lu et al., 2021). However, the perceptions about filial piety and care preferences shifted in the twenty-first century (Lu et al., 2021; Ng et al., 2002), resulting in an increasing number of older Chinese people living in long-term care facilities since they can no longer care for themselves at home (Lin et al., 2018; Shi & Hu, 2020). Therefore, different types of long-term care facilities with diverse functions have rapidly increased to care for older people (National Bureau of Statistics of China, 2021). In this study, we define a long-term care facility as one that offers health and/or personal care services for older people to residents instead of living at home, including all types of nursing homes, long-term care, and residential institutions.

However, relocating to a long-term care facility has been reported as a stressful experience for older people, possibly leading to physiologic and psychosocial disorders (Chen et al., 2020; Kao et al., 2004; Walker et al., 2007; Wang et al., 2021; Yang et al., 2021) and affecting adaptations and quality of life in the facility (Koppitz et al., 2017; O'Neill & Ryan, 2020; Yong et al., 2021). Travie and McAuley (1998) and McAuley et al. (1997) identified older people's relocation process into three stages, pre-institutionalization, immediately after institutionalization, and post-institutionalization, and the threat of relocation stress syndrome can occur multiple times during the course of older people's long-term care stay (Kao et al., 2004). Moreover, planned and voluntary admission and involvement during decision-making were related to a sense of self-control and autonomy, which markedly contributed to psychological adjustment and acceptance of relocation (Brownie et al., 2014; Koppitz et al., 2017; Polacsek & Woolford, 2022). Staffing, hardware facility, elderly service guarantee, and environment are key elements that influence facility quality and satisfaction (Wan et al., 2019). The relocation experiences and perspectives were also influenced by the length of stay (Sun et al., 2020).

In this study, the relocation experiences and perspectives focused on the three stages of the relocation process as defined by Travie and McAuley (1998) and McAuley et al. (1997). To integratively clarify the relocation experiences and perspectives in pre-institutionalization, immediately after institutionalization, and post-institutionalization stages, older Chinese people who lived at home in a community or living in long-term care facilities were included.

Varying experiences and viewpoints have been reported in qualitative research, because of the variable focal points connected to facility adjustment, acceptance, and satisfaction (Brownie et al., 2014; Koppitz et al., 2017; Wan et al., 2019; Sun et al., 2020; Polacsek & Woolford, 2022). These primary qualitative studies were conducted individually, and the findings of such studies are limited in scope by themselves. To the best of our knowledge, little is known regarding relocation experiences from pre- to post-institutionalization in the Chinese context. To help older Chinese people successfully adjust to the new environment after moving from home to a long-term care facility, it is necessary to surmise a body of knowledge related to relocation experiences and characteristics throughout the entire relocation process.

Meta-ethnography is the synthesis of primary interpretive studies. This approach seeks to go beyond single studies to reveal the analogies between the studies and develop an inductive and interpretive form of knowledge synthesis, which can be used to understand the nature of interpretive explanations of relocation experiences through a narrative literature review (Noblit & Hare, 1988).

Therefore, in this study, we intended to clarify the relocation experiences and perspectives of older Chinese people by evaluating primary qualitative research focusing on the relocation process from pre- and post-institutionalization to long-term care facilities. For this review study, PICo was constructed as follows:

P: Older Chinese people aged 60 years or above without cognitive impairment living at home in a community or a long-term care facility, based on the definition of older people in mainland China.

I: Relocation experiences and perspectives in pre-institutionalization, immediately after institutionalization, and post-institutionalization stages.

Co: Long-term care facilities for older people to reside in and provide health and/or personal care services in the Chinese context, including mainland China, Hong Kong, Macao, and Taiwan.

Methods

This narrative review study was conducted and reported following the eMERGe guidance (France et al., 2019), including search strategy, data extraction, and meta-ethnography synthesis as specified by Noblit and Hare (1988).

Search Strategy

The search strategy was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2020 statement (Page et al., 2021). With China becoming an aging society in 2000, issues of long-term care for older people arose rapidly and studies focusing on these issues increased. We searched and retrieved studies published between January 1, 2000, and August 31, 2022, from electronic databases including MEDLINE, CINAHL, Web of Science, CNKI (China National Knowledge Infrastructure) Database, CSTJ (China Science and Technology Journal) Database, and China Wanfang Digital Database. The search strategies were identified (using the contributing author's knowledge and discussions, along with advice from a specialist health science librarian) as follows:

Table 1. Eligibility criteria for study selection.

Inclusion criteria	Exclusion criteria
- Chinese older people aged 60 years or above	- Chinese older people who were living overseas or with cognitive impairment
- Raw data including older people's narratives about their perceptions and experiences of relocating to a long-term facility	- Primary studies without narratives of Chinese older people themselves
- Peer-reviewed primary qualitative research	- Published as conferences, reviews, case studies, or intervention studies
- Published in English and Chinese after January 2000	

(1) aged, (2) experience, (3) long-term care facility, and (4) Chinese, including synonyms and related terms. Supplementary File 1 lists the search strategies of CINAHL. The studies were selected according to the inclusion and exclusion criteria (Table 1). References of the included studies that meet the inclusion criteria are also included.

Data Extraction and Synthesis

This review study used the reciprocal translation approach of meta-ethnography to inductively synthesize the findings of included studies, following the sequential process of phases 3-6 of meta-ethnography (Noblit & Hare, 1988).

Initially, the reviewer repeatedly read the included studies and extracted the data. The following data were extracted to describe the characteristics of the included studies: authors, date, country, aim, methods, setting and sampling, and findings. Synthesis data consisted of the first- and second-order constructs from the findings of the included studies. The first-order constructs are raw data assertions from older Chinese people. The second-order constructs are interpretations identified from primary data by the authors of the included studies. The first- and second-order constructs that reflected the same meaning of perspectives or experiences related to relocation were extracted as a single-meaning unit. The meaning units list was then constructed.

Next, included studies with common objectives or focuses on examining the experiences and perceptions of relocation were grouped to determine the relevance of included studies.

Then, the third-order constructs were synthesized by grouping the common concepts of each meaning unit to interpret the included studies' findings further. The third-order constructs were synthesized after the following procedures sequentially: identifying subcategories, categories, and core categories from meaning units. Subcategories were synthesized within formed groups to translate one study into another. Categories and core categories were synthesized across the formed groups to develop new interpretations from subcategories.

This review study utilized Microsoft Excel to handle the data. Additionally, EndNote Basic was utilized to manage the included studies. From searching to synthesis, the coauthor rechecked, discussed, and refined the content to reach a consensus.

Results

A total of 2114 studies were found during the first search. Following the removal of duplicates (n = 342), the title and abstract of 1772 studies were screened. Thirty-nine studies were selected for full-text review, of which 20 were included in the review. Furthermore, five studies were included through a citation search (Figure 1).

Characteristics of the Included Studies

The aim of the included studies focused on the perspectives and decision-making of relocation [n = 5] (Chen, 2011, 2015; Cheng et al., 2012; Tao et al., 2016; Zhang, 2019), relocation reaction [n = 7] (Jin et al., 2021; Lan et al., 2020; Lee, 2001; Sun et al., 2021; Wu & Rong, 2020; Xing et al., 2020; Zhan et al., 2008), perspectives and experiences of living in long-term care facility [n = 5] (Han et al., 2017; Jing et al., 2016; Song et al., 2018; Tse, 2007; Wang et al., 2017), care needs during admission [n = 4] (Chen et al., 2017; Chen et al., 2021; Chuang et al., 2015; Shen et al., 2021), perception about the quality of care [n = 1] (Chao & Roth, 2005), social participation [n = 1] (Pan et al., 2020), and family members' involvement [n = 2] (Lao et al., 2019; Wang et al., 2020) in the facility. The research field was conducted in Hong Kong [n = 2] (Lee, 2001; Tse, 2007), Macao [n = 1] (Lao et al., 2019), Taiwan [n = 3] (Chao & Roth, 2005; Chuang et al., 2015; Wu & Rong, 2020), and mainland China [n = 19] (Chen, 2011, 2015; Chen et al., 2017; Chen et al., 2021; Cheng et al., 2012; Han et al., 2017; Jin et al., 2021; Jing et al., 2016; Lan et al., 2020; Pan et al., 2020; Shen et al., 2021; Song et al., 2018; Sun et al., 2021; Tao et al., 2016; Wang et al., 2017; Wang et al., 2020; Xing et al., 2020; Zhan et al., 2008; Zhang, 2019).

Participants of two studies lived at home in a community (Tao et al.,2016; Tse, 2007), whereas others lived in long-term care facilities. The studies comprised 665 older people, including independent and dependent older people. The length of residency was more than 1 month. Several studies did not describe the sampling gender [n = 1] (Zhang, 2019), active daily living [n = 14] (Chao & Roth, 2005; Chen, 2011, 2015; Chen et al., 2021; Cheng et al., 2012; Chuang et al., 2015; Jin et al.,2021; Lee, 2001; Pan et al., 2020; Sun et al., 2021; Tao et al., 2016; Tse, 2007; Zhan et al., 2008;

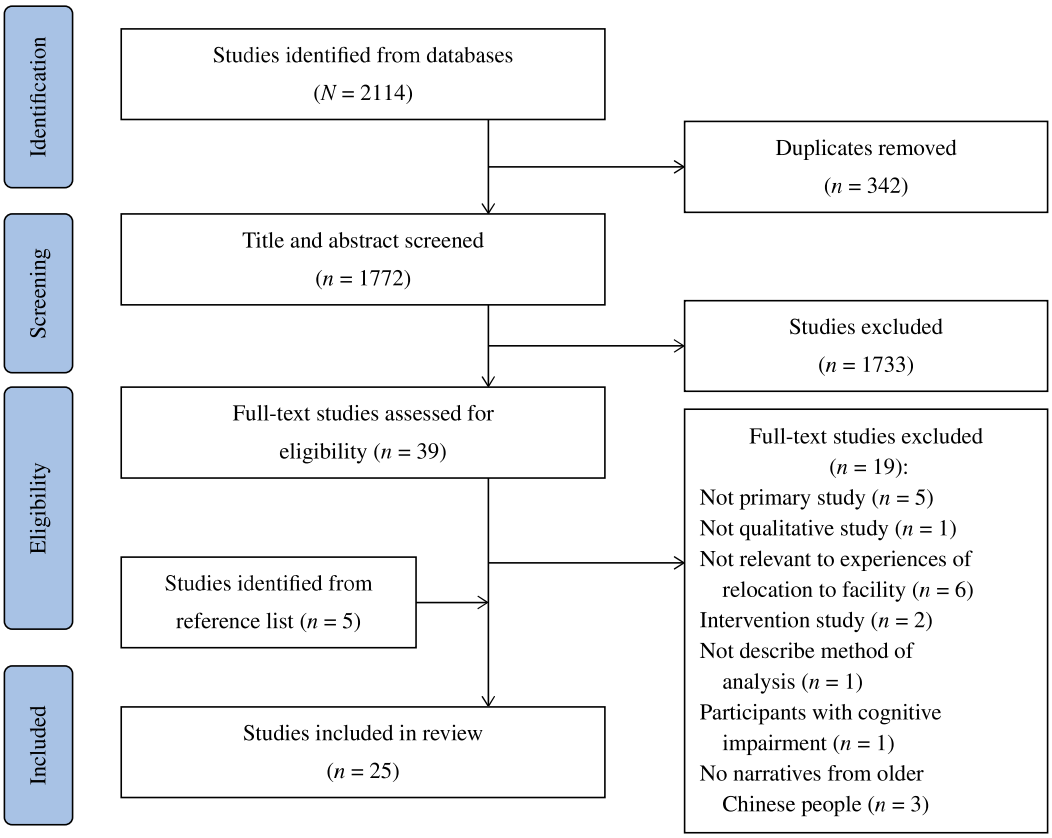

Figure 1. The process of searching strategies conducted according to preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram.

Zhang, 2019), or length of residency [*n* = 3] (Cheng et al., 2012; Lan et al., 2020; Lee, 2001).

Methods of data collection of included studies included individual interviews and group interviews. Content analysis, Colaizzi's analysis, thematic analysis, grounded theory, category analysis, and qualitative and inductive analysis were utilized to analyze the data (Table 2).

Synthesis Findings

Our research clarified the relocation experiences and perspectives of older Chinese people from pre- to post-institutionalization. Seven core categories were identified (Table 3). Core categories were (i) decision-making and preparation for relocation, (ii) physical and psychological burden, (iii) attitude change toward relocation, (iv) care needs during admission, (v) self-efforts for adaptation, (vi) daily life becomes affluent through participation, and (vii) concerns about the future.

(i) Decision-making and Preparation for Relocation

Three studies (Chen, 2011; Cheng et al., 2012; Tao et al., 2016) discussed the "attitude toward relocation." Older people voluntarily relocated to facilities because of the expectation of more personal time, self-control, and perceived change in filial piety. However, some older people still resisted admission to facilities because of negative preconceptions and the stress of being regarded as unfilial or having poor family relationships.

Eight studies (Chen 2011, 2015; Cheng et al., 2012; Jin et al., 2021; Lan et al., 2020; Wu & Rong, 2020; Xing et al., 2020; Zhang, 2019) explained the "reason for relocation." Several reasons prompted the decision to relocate. Not only were care needs unmet at home because of deterioration in physical condition, poor family relationships, insecurity, and difficulty living alone, but they were also related to a sense of control and reduced care burden on family members.

Ten studies (Chao & Roth, 2005; Chen, 2011; Chen et al., 2017; Chen et al., 2021; Cheng et al., 2012; Chuang et al., 2015; Jing et al., 2016; Shen et al., 2021; Wang et al., 2017; Wu & Rong, 2020) covered the "facility selection criteria." Older people prioritized a secure environment, including constant availability of professional care workers and building designs tailored to older people (like barrier-free areas). In addition, they preferred facilities close to or with easy access to their adult children's homes. Additionally, clean, warm, and homey facilities were more welcoming.

One study (Tse, 2007) described the "preparation before relocation," including consultation with family members about the decision to relocate, requests after admission, and preparation of personal possessions and admission fees.

Table 2. Characteristics of included studies.

Author(s). Year. Location	Aim	Methods	Setting and sampling	Findings
Lee (2001). Hong Kong, China	– To explore the process through which Chinese elders adjust following residential care placement	– Semi-structured interview – Constant analysis of the grounded theory	– Setting: (n = 1) Residential care home – Older participants: (n = 18) – Gender: M = 9, F = 9 – Mean age: 79.2 years (range = 70–86 years)	– Two topics were identified: 1. The process of adjustment 2. The normalizing experiences
Chao & Roth (2005). Taipei, Taiwan	– To determine residents' perceptions of quality of care in nursing homes in Taiwan	– Semi-structured interview – Content analysis	– Setting: (n = 4) Public nursing homes = 1 Private nursing homes = 3 – Older participants: (n = 22) – Gender: M=10, F=12 – Mean age: 72 years (range = 61–86 years) – Average length of residency: 1.36 years (range = 6 months to 2 years)	– Six major dimensions of quality care were identified: 1. A caring attitude 2. Respect for individual preferences 3. Emotional support 4. Social interaction 5. Supportive environment 6. Accessible care
Tse (2007). Hong Kong, China	– To explore nursing home-related beliefs of Hong Kong Chinese older persons	– Semi-structured group interview – Content analysis	– Setting: Community day center – Older participants: (n = 118) – Gender: M = 57, F = 61 – Mean age: 75 years (range = 60–89 years)	– Two themes and 3 subthemes were identified: 1. Perceptions of nursing home admission: impressions of and feelings about personal life in a nursing home, facilities in the nursing home, positive impressions of nursing home placement 2. Making the nursing home a better place
Zhan et al. (2008). Nanjing, China	– To examine the changing attitudes toward institutional care in China, using Nanjing as an example	– Semi-structured interviews – Constant analysis of the grounded theory	– Setting: (n = 6) Government institution = 2 Community institution = 2 Privately owned institution = 2 – Older participants: (n = 20) – Gender: F = 13, M = 7 – Mean age: 81 years (range = 68–97 years) – Range of residency = 1 month to 4 years	– Acceptance of institutional care was commonly demonstrated, interpretation of "xiao" as below: 1. High level of satisfaction with elder care homes and frequent visit of adult children shaped the elderly residents' understanding of filial piety 2. Care institutions provided better care than family members 3. Care institutions provided a place for same stage of life and health status to elderly to communicate and share life experiences 4. Elderly prefer living at home; decision of placement was made by children 5. Reticent about telling friends and neighbors that they moved to a nursing home

Table 2. Characteristics of included studies (continued).

Author(s). Year. Location	Aim	Methods	Setting and sampling	Findings
Chen (2011). Shanghai, China	– To understand elder residents' perspectives on decision-making processes around institutionalization and the evolving concepts of filial piety during this process	– Semi-structured interview – Category analysis	– Setting: (n = 1) Government-supported institution – Older participants: (n = 11) – Gender: F = 9, M = 2 – Age range: 70–92 years – Average length of residency: 6 months to 9 years	– Decision-making process 1. Caregiving crises occurred 2. Residents' suggestions 3. Children's reactions and negotiations 4. Filial piety redefined
Cheng et al. (2012). Beijing, China	– To discuss how a sample of older people and their family members made the decision to move to a specific RCF and what factors influenced the decision-making process in the socioeconomic and cultural context of Beijing	– Semi-structured interview – Constant comparative method (Grounded Theory)	– Setting: (n = 6) Private RCF = 1 Community RCF = 3 Public-owned private-run RCF = 2 – Elderly participants: (n = 27) – Gender: F = 17, M = 10 – Average age = 80 years	– Five components were identified about accessibility to a resident facility: 1. Geographical access 2. Information access 3. Economic access 4. Sociocultural access 5. Socio-managerial environment
Chuang et al. (2015). Taiwan	– To explore the care needs of older nursing home residents from their own viewpoints	– Unstructured in-depth interview – Thematic analysis	– Setting: (n = 2) Public nursing home = 1 Private nursing home = 1 – Older participants: (n = 18) – Gender: F = 3, M = 15 – Mean age: 80.7 years – Average length of residency: 32.5 (±20.5) months	– Six themes and ten subthemes relating to the care needs were identified: 1. Body: assistance for ADLs; skilled nursing care 2. Economics: financial support 3. Environment: environmental hygiene, space 4. Mind: emotional support care needs; psychological care needs 5. Preparation for death: discussion and arrangement of matters related to death 6. Social support: activities; relationships
Chen (2015). Shanghai, China	– To describe Shanghai elders' and their children's experiences of deciding to institutionalize	– Semi-structured interview – Qualitative and inductive analyses	– Setting: (n = 1) Government-sponsored institution – Older participant: (n = 12) – Gender: F = 9, M = 3 – Age: 80 years + – Length of residency: 3 years +	– Four themes and seven subthemes were identified: 1. Etiology of family caregiving: the unexpected reality of family caregiving, familial discordance regarding the caregiving tradition 2. Two players in one game: seizing the remaining decision-making autonomy, preempting caregiving depletion 3. The last straw 4. Spatially situated decision-making: proactive decision to meet psychosocial needs, proactive decision to meet instrumental needs, reactive decision to meet instrumental needs

https://doi.org/10.53044/jinr.2022-0038