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Cognitive function moderates the mediation of resilience in the relationship between perceived receipt of filial piety and loneliness among community-dwelling older adults with multiple long-term conditions

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Given the rapidly aging population and the changes in traditional family bonds, new challenges arise for filial piety in the loneliness among older adults with multiple long-term conditions (MLTCs). This study aimed to examine the PRFP-loneliness relationship, explore whether resilience mediates the association between PRFP and loneliness, and investigate whether cognitive function moderates the indirect or direct effects of the mediation model among Chinese older adults with MLTCs. A total of 635 older adults with MLTCs were recruited in Shenyang City, China. Participants completed self-report questionnaires on PRFP, resilience, loneliness and cognitive function. A moderated mediation model was conducted using Hayes' PROCESS macro for SPSS. PRFP had a significant negative effect on loneliness and resilience partially mediated the PRFP-loneliness relationship. Cognitive function moderated the indirect effect of PRFP on loneliness via resilience. Specifically, the conditional indirect effect of PRFP on loneliness diminished as the level of impaired cognitive function increased. Interventions aimed to improving resilience and cognitive function may help strengthen the link between PRFP and loneliness among older adults with MLTCs. However, we should suggest a cautious application of this research when translated to the geographic and cultural diversity of older adults.

Keywords Older adults with multimorbidity, Filial piety, Resilience, Loneliness, Cognitive function, Moderated mediation model

Abbreviations

MLTCs	Multiple long-term conditions
PRFP	Perceived receipt of filial piety
CHARLS	China health and retirement longitudinal study
PRFPS	Perceived receipt of filial piety scale
RS-14	The 14-items version of resilience scale
UCLA-LS3	The University of California, Los Angeles, Loneliness Scale-Version 3
AD-8	The 8-item ascertain dementia
BCa 95%CI	The bias-corrected and accelerated 95% confidence interval

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SD	Standard deviation
ANOVA	Analysis of variance

Public health relevance of multiple long-term conditions (MLTCs)

MLTCs, defined as the coexistence of two or more long-term conditions within an individual, encompass physical or mental diseases, ongoing conditions (e.g., learning disability), symptom complexes (e.g., chronic pain, fatigue, insomnia), and sensory impairment (sight or hearing loss)[1]. The global prevalence of MLTCs across 54 countries has recently been estimated at 37.2%, with more than half of the population aged > 60 years and older living with MLTCs[2]. More critically, as the global population ages rapidly and life expectancy continues to rise, the prevalence of multimorbidity has shown a significant upward trend[1–4]. Parallel to this unprecedented aging profile, China's population aged 60 years and above reached 264 million accounting for 18.7% of the total population according to the 2020 census[4], and this proportion is expected to exceed 30% in 2050[5]. Findings from the China Health and Retirement Longitudinal Study 2018 (CHARLS 2018) indicated that the prevalence of MLTCs had exceeded 50% for middle-aged and older adults across 28 provinces[6,7]. MLTCs are associated with elevated mortality, healthcare utilization (including outpatient and inpatient visits), reduced functioning, and poor quality of life[1–4,8], which lead to greater economic and physical burden, and make the older adults suffer from more psychosocial distress as a result of dependence and disability.

Impact of loneliness in MLTCs

Individuals living with MLTCs are especially vulnerable to experiencing loneliness due to life circumstances changes (e.g., death of loved ones, retirement, poorer health and mobility), which is a serious threat to public health policies worldwide[9]. Loneliness is a subjective and distressing feeling of alienation resulting from a discrepancy between one's desired and actual social relationships[1]. A qualitative systematic review showed that older people with MLTCs suffered from unmet social needs of loneliness[10]. Furthermore, a recent scoping review highlighted a significant cross-sectional association of MLTCs with loneliness[1]. Regarding biological mechanisms, Freilich et al. found the potential role of epigenetic age acceleration in explaining older individual variations in the loneliness-MLTCs association[11]. Particularly, because of the one-child policy and the engagement in education and career for younger couple, Chinese society is shifting from a joint to a nuclear family system[12], which may be less efficient in taking care of the increasing aging relatives. Data from CHARLS 2018 indicated that 28.2% of community-dwelling older adults with MLTCs reported experiencing loneliness[13]. Given the adverse impact of loneliness on older adults with MLTCs[3,11,14–16], it is important to identify the factors contributing to loneliness and explore the underlying mechanisms of these factors on loneliness, thereby making it a major goal of Healthy China 2030[17].

Filial piety and loneliness: prior evidence

Filial piety, rooted in Confucian philosophy, refers to a complex set of values and a range of supportive behaviors that adult children are expected to provide to their aging parents[18]. With the context of family interdependence, filial piety represents an important virtue and responsibility in parent-child relationship and prescribes that adult children reciprocate care for their parents[19], which may play an essential role in the psychosocial adaptation of older parents. Given its cultural importance, filial piety, particularly from the perspectives of adult children, has been shown to buffer against depression and loneliness among older Chinese adults[19,20]. However, due to the discrepancy about filial respect and care between adult children and their parents[18], perceived receipt of filial piety (PRFP) of older parents should gain more social and academic interest in preventing loneliness, particularly in term of Chinese modernization and social changes. According to Stress and Coping Model[21], PRFP may be considered as a significant source of sociocultural support in the conceptualization of loneliness resulted by the MLTCs, further leading to a conceptual model of the interplay of indirect factors on the PRFP-loneliness association. Nevertheless, there is a paucity of empirical research investigating the underlying mechanisms (mediators and moderators) between PRFP and loneliness among older adults with MLTCs.

PRFP, resilience, and loneliness

Resilience represents an individual's capacity to successfully recover from and adapt to adversities, maintaining psychosocial well-being. It is considered as a positive psychological resource for adults facing traumatic events[22]. Theoretically, based on the Stress and Coping Model[21], resilience as a personality trait may appear to be an important protective mechanism that explains the effect of PRFP on loneliness related with MLTCs. Empirically, our previous study found that resilience resisted psychological disorders in cancer patients[22]. Resilience has been shown to significantly predict lower total and sub-scale scores for loneliness[23]. Through the overview of existing literature on resilience as a mediator, growing evidence has shown that resilience mediated the cross-sectional or longitudinal relationships between social support and mental health outcomes[24,25]. For instance, Li et al. emphasized the mediating role of resilience in the connection between social participation and depression among Chinese older adults[26]. Similarly, a cross-sectional study revealed that higher family communication resulted in greater resilience, thus associated with better mental health in hemodialysis patients[27]. Given the importance of adult children's support in the social networks of Chinese parents, resilience may mediate the association between PRFP and loneliness among the older people with MLTCs.

Moderated role of cognitive function

Cognitive function is another focus in the study of crucial factor for loneliness[28]. Several studies established a positive association of impaired cognitive function with poor psychosocial functioning[29,30], specifically with loneliness of older adults[30,31]. According to emotion regulation theory, cognitive function may interact with an individual's capacity (e.g., PRFP and resilience) to reappraise negative emotions (e.g., the experience of

loneliness)[32]. Most of older adults with MLTCs exhibited some degree of cognitive impairment and suffer from psychological distress[28], suggesting that cognitive function may moderate the protective impact of a supportive environment. Empirical findings reported that impaired cognitive function impaired the perceptive function needed to maintain social relationships[31,33]. Based on a strong theoretical basis and empirical evidence, cognitive function may moderate the association of PRFP and resilience, as well as the relationship between PRFP and loneliness. Furthermore, based on the Big Five model, cognitive function has been linked to changes in personality traits relevant for loneliness[34]. A longitudinal study of community-dwelling older people found that cognitive function influenced the predictive role of resilience in loneliness as well[23]. However, the investigation of cognitive function as a direct or indirect moderator of the beneficial impact of PRFP on loneliness has been scarcely studied among older adults with MLTCs.

The current study

The above literature suggested the conceptual model for our study (see Fig. 1), whereby PRFP may decrease vulnerability to loneliness. Additionally, our model incorporates resilience as a mediator that may reduce feelings of loneliness in older adults with MLTCs. Based on the literature review[23–26,31–34], cognitive function, resilience and loneliness are theorized to be interrelated in such a way that cognitive function could influence changes in resilience relevant to loneliness. Thus, we also anticipate that cognitive function will either directly or indirectly buffer the PRFP-loneliness association. Due to the theoretical and empirical evidence summarized above, the research hypotheses are as follows:

H1 PRFP is negatively associated with loneliness in older adults with MLTCs.

H2 Resilience mediates the relationship between PRFP and loneliness.

H3 Cognitive function may moderate the direct (path c') and/or indirect association (path a and path b) between PRFP and loneliness, respectively.

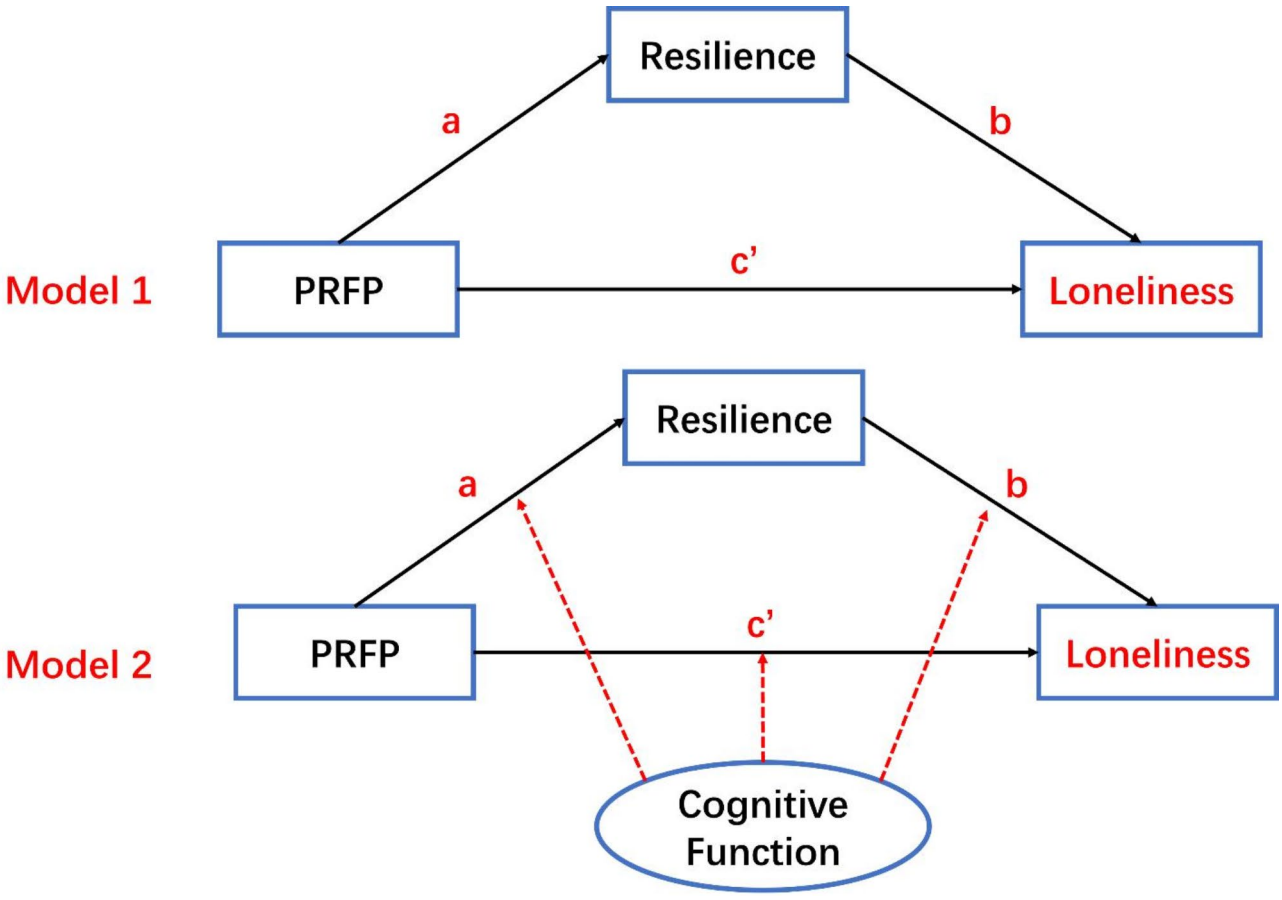

Fig. 1. Conceptual framework of the moderated mediation model: Resilience as a mediator and Cognitive Function as a moderator.

Methods

Ethical approval statement

This study was approved by the Ethics committee on Human Experimentation of Shenyang Mental Health Center (reference number: 2024004) and complied with the 1964 Helsinki Declaration and its later amendments. All participants provided informed written consent prior to participation. Identity information of participants was kept strictly confidential and was not disclosed to members outside the study team.

Study design

This cross-sectional study was conducted as part of the 2022 Health Promotion Project for Older Adults in Shenyang, China, which aimed at assessing various health-related factors among older adults. According to the unified requirements and deployment of the National Health and Wellness Commission, the study samples adopted the method of multistage stratified cluster random sampling.

Participants

We selected older adults with MLTCs for further analysis, chosen to represent equally significant chronic conditions, rather than secondary diseases to the primary disease. The inclusion criteria were as follows: (1) aged 60 or older; (2) two or more medically diagnosed chronic conditions; (3) ability to provide clear responses; (4) lived in the community; and (5) having at least one child. The exclusion criteria were as follows: (1) not able to provide informed consent; (2) life expectancy < 3 months in terminal illness at admission; (3) undergoing psychotherapy; and (4) suffering from neuropsychiatric disease (e.g., dementia).

Data collection

A total of 13 sample sites (9 urban districts and 4 rural counties) were selected. One community is selected from each district, and one village is used for each country. Communities and villages were selected based on demographic representation, ensuring a mix of urban and rural settings. More than 100 older adults were selected from each community or village. Data were collected through structured interviews using standardized questionnaires administered by trained investigators to ensure reliability and validity. A total of 2730 older people were investigated, and the final sample size included 700 participants with MLTCs. After excluding questionnaires with logical errors and those with missing values, 635 valid questionnaires were recovered (effective rate: 90.7%).

Measures

Sociodemographic characteristics

Data on age, gender, marital status, length of education, number of MLTCs, residence style, religious affiliation, parent-child relationship and life satisfaction were collected in the present study.

PRFP

The Perceived Receipt of Filial Piety Scale (PRFPS), a 10-item scale, was adopted to measure how often Chinese parents perceive their child(ren) engage in filial pious behaviors[18]. Specifically, the 10 itemized statements are designed to evaluate the extent to which Chinese parents perceive their child/children to perform pragmatic obligations and engage in compassionate reverence via using concrete anchors to avoid any ambiguity. Response to each item is measured on a 7-point Liker-type scale from 1 (Never/0% of the time) to 7 (Every time/100% of the time). Higher total scores represent higher levels of PRFP. Huang and Fiocco found that the PRFPS is a reliable and valid measure (single-factor structure) of PRFP among Chinese parents[18], and its Cronbach's alpha for our study was 0.957.

Resilience

The 14-items version of Resilience Scale (RS-14), which is a shortened version of the original Resilience Scale (RS-25), was employed to measure resilience[22]. The RS-14 consists of 14 items rated on a 7-point scale, ranging from 1 (strongly disagree) to 7 (strongly agree). The total score ranges from 14 to 98, with higher scores indicating higher resilience. Both an adequate construct validity and an excellent degree of reliability were reflected in the Chinese version of RS-14[35]. In this study, the Cronbach's alpha was 0.965.

Loneliness

To assess the feeling of loneliness, we used the University of California, Los Angeles, Loneliness Scale-Version 3 (UCLA-LS3), which is a 20-items self-report assessment tool rated on a 4-point Likert scale ranging from 1 (never) to 4 (always)[36]. The scale (9 positively worded and 11 negatively worded) evaluates the individuals' global and prolonged (dispositional) perceived sense of loneliness. A general dimension of "dispositional" loneliness is calculated as the sum of all 20 items (scoring is reversed for positively worded items), with higher scores indicating the presence of a greater feeling of loneliness. In this study, the UCLA-LS3 had excellent internal consistency (Cronbach's alpha = 0.86).

Cognitive function

Cognitive function was assessed by the self-rating 8-item Ascertain Dementia (AD-8), which measures self-rated changes (yes or no) in cognitive performance using 8 questions covering 4 cognition-related domains (memory, problem-solving, orientation, and daily activities)[37]. The self-reported AD-8 is a brief questionnaire used to assess changes in cognitive function and early mild dementia in Chinese population[38,39]. It gains a score from 0 to 8 by the number of positive answers, with a higher score indicating potentially more severe subjective cognitive impairment. The Cronbach's alpha for this study was 0.784.

Statistical analysis

Descriptive statistics were calculated for obtaining detail information regarding study variable within the total sample. Statistical analyses were conducted using SPSS 24.0 and PROCESS macro program for SPSS. The PROCESS macro program was performed to run a regression-based path analysis[40], which verified the mediation and moderated mediation model. The bias-corrected and accelerated 95% confidence interval (BCa 95%CI) was calculated using 5000 bootstrapping resamples.

We started with examining the simple mediation model of resilience by Model 4 in PROCESS. If the BCa 95%CI of the indirect effect (path a* b) did not contain 0, indicating the significant mediating effect. Once the simple mediation model was confirmed, Model 59 was used to examine the moderated mediation model, examining whether cognitive function moderated the direct and indirect effects of PRFP on loneliness (see Fig. 1). Likewise, if the BCa 95%CI of the interaction did not contain 0, a significant moderated mediation role could be established. Simple slope analysis was further conducted to explore the moderation effect.

Statistical significance was defined as a two-tailed p-value of < 0.05. All models were controlled for covariates significantly related to loneliness or resilience in the univariate analysis, and our study variables were all centralized.

Results

Differences of loneliness and resilience in sociodemographic characteristics

The categorical data and the distribution of loneliness/resilience were indicated in Table 1. The mean age of participants was 69.94 years (SD = 6.29), ranging from 60 to 95 with 424 females (66.8%) and 211 males (33.2%). Most older people with MLTCs were married (78%), living with family members (86.6%) and nonreligious (87.6%). After analyzing data, we found the differences of loneliness and resilience in parent-child relationship and life satisfaction. By comparison of the means using ANOVA, the UCLA-LS3 score was lowest when parent-child relationship and life satisfaction of older people was very satisfied. The older people whose parent-child relationship and life satisfaction were very satisfied presented the highest RS-14 scores.

Variables	*N* (%)	Loneliness Mean ± SD	F/t[a]	Resilience Mean ± SD	F/t[a]
Gender			1.59		− 0.419
Male	211 (33.2)	37.91 ± 10.01		77.38 ± 17.42	
Female	424 (66.8)	36.55 ± 10.29		77.98 ± 16.86	
Marital status			− 1.394		0.182
Married/cohabitation	495 (78)	36.7 ± 10.25		77.85 ± 16.88	
Single/widowed/divorced	140 (22)	38.06 ± 9.99		77.55 ± 17.64	
Number of MLTCs			− 0.206		− 0.274
2	365 (57.5)	36.93 ± 10.19		77.62 ± 17.07	
≥ 3	270 (42.5)	37.1 ± 10.24		78 ± 17.02	
Residence style			1.128		− 0.905
With family members	550 (86.6)	36.82 ± 10.15		78.02 ± 16.81	
Alone	85 (13.4)	38.16 ± 10.57		76.22 ± 18.48	
Religious affiliation			− 0.503		0.153
Yes	79 (12.4)	37.54 ± 10.69		77.51 ± 15.62	
No	556 (87.6)	36.93 ± 10.14		77.82 ± 17.24	
Parent–child relationship			24.3***		19.424***
Very unsatisfied	30 (4.7)	36.2 ± 10.05		78 ± 17.77	
Relatively unsatisfied	11 (1.7)	45.73 ± 5.69		57.64 ± 21.13	
General	37 (5.8)	44.19 ± 8.37		63.86 ± 19.71	
Relatively satisfied	172 (27.1)	40.6 ± 9.23		73.56 ± 15.35	
Very satisfied	385 (60.6)	34.52 ± 9.99		81.56 ± 15.81	
Life satisfaction			33.688***		16.791***
Very unsatisfied	23 (3.6)	39.87 ± 10.42		74.22 ± 25.53	
Relatively unsatisfied	22 (3.5)	45.59 ± 7.89		63.18 ± 17.64	
General	65 (10.2)	44.48 ± 8.38		67.71 ± 16.87	
Relatively satisfied	247 (38.9)	38.75 ± 9.02		76.48 ± 15.84	
Very satisfied	278 (43.8)	32.79 ± 9.82		82.74 ± 15.38	

Table 1. Sociodemographic characteristics and the distribution of loneliness and resilience ($N = 635$). *MLTCs* multiple long-term conditions, *SD* standard deviation. [a]Independent sample t-test and one-way ANOVA were used. ***$p < 0.001$.

Variables	Mean ± SD	Sample range	1	2	3	4	5	6
1. Age	69.94 ± 6.29	60–95	1	− 0.05	0.046	− 0.051	− 0.016	0.032
2. Education years	8.66 ± 3.04	0–25		1	− 0.009	0.045	− 0.019	− 0.084*
3. PRFP	53.17 ± 15.05	10–70			1	0.505**	− 0.397**	− 0.07
4. Resilience	77.78 ± 17.04	14–98				1	− 0.463**	− 0.162**
5. Loneliness	37.00 ± 10.21	20–57					1	0.236**
6. Cognitive function	9.46 ± 1.93	8–16						1

Table 2. Descriptive statistics and zero-order correlations (Pearson's r) among continuous variables. Higher scores of cognitive function indicate potentially more severe cognitive impairment. *SD* standard deviation, *PRFP* perceived receipt of filial piety. *$p < 0.05$; **$p < 0.01$.

	Path c		Path c′ and b		Path a		Path a*b			
Variables	β	SE	β	SE	β	SE	β	SE	LLCI	ULCI
PRFP	− 0.207***	0.026	− 0.11***	0.028	–	–	− 0.097	0.016	− 0.131	− 0.068
Resilience	–	–	− 0.19***	0.024	0.512***	0.042				
F	43.351		51.129		59.734					
R^2	0.216		0.289		0.275					
Adj. R^2	0.211		0.283		0.27					

Table 3. Results of the simple mediation model testing. Controlling for covariates significantly related to loneliness or resilience in the univariate analysis. *β* standardized coefficient, *SE* standard error, *LLCI* lower level of the confidence interval, *ULCI* upper level of the confidence interval, *PRFP* perceived receipt of filial piety. ***$p < 0.001$.

Bivariate correlations among study variables

Table 2 provided the means, standard deviations (SD), and correlations among the continuous variables. PRFP (r=− 0.397, $p < 0.01$) and resilience (r=− 0.463, $p < 0.01$) were both negatively related to loneliness. PRFP also had a significantly positive relation to resilience ($r = 0.505$, $p < 0.01$), while cognitive function was positively associated with loneliness ($r = 0.236$, $p < 0.01$).

Simple mediation model testing

The results of the simple mediation model testing were shown in Table 3. After controlling for covariates related to loneliness and resilience in the univariate analyses, the total effect (path c) of PRFP on loneliness was significant (β=− 0.207, $p < 0.001$). The coefficients for path a (β = 0.512, $p < 0.001$) and path b (β=− 0.19, $p < 0.001$) indicated significant associations of PRFP with resilience, and resilience with loneliness. A significant indirect effect of PRFP on loneliness via resilience (path a*b) was also found (β=− 0.097, BCa 95%CI: − 0.131, − 0.068), and resilience partially mediated the PRFP-loneliness relationship (path c'=− 0.11, $p < 0.001$). Besides, we estimated the effect size of the mediating pathway through the proportion of total effect of PRFP on loneliness that was mediated by resilience with the formula (a*b)/c. For older adults with MLTCs, the proportion mediated by resilience was 46.86%.

Moderated mediation model testing

The results of the moderated mediation model were presented in Table 4. Cognitive function did not significantly influence the PRFP-loneliness relationship (β=− 0.014, BCa 95%CI: − 0.041, 0.013) and the resilience-loneliness relationship (β=− 0.007, BCa 95%CI: − 0.03, 0.016), while it moderated the indirect effect of PRFP on loneliness through resilience (PRFP-resilience: β=− 0.059, BCa 95%CI: − 0.102, − 0.017). The variables above accounted for 31% for the variance in the model, and the final moderated mediation model was displayed in Fig. 2.

The nature of the PRFP*Cognitive function interaction was evaluated further by the simple slope analysis. As depicted in Fig. 3, the reduction in PRFP-resilience association strength was revealed through the increased level of impaired cognitive function. Specifically, PRFP was positively correlated with resilience when AD-8 scores were low (simple slope = 0.585, t = 12.027, $p < 0.001$), while the positive effect of PRFP on resilience was weakened when participants suffered moderate (simple slope = 0.499, t = 12.007, $p < 0.001$) and severe (simple slope = 0.384, t = 6.119, $p < 0.001$) impaired cognitive function.

The conditional indirect effect of PRFP on loneliness at different values of cognitive function was examined when the AD-8 score was at the sample mean and at plus or minus one SD. According to the results of Table 5, resilience significantly mediated the PRFP-loneliness association when the score of AD-8 was low (β=− 0.107, BCa 95%CI: − 0.146, − 0.072), moderate (β=− 0.091, BCa 95%CI: − 0.124, − 0.062) and high (β=− 0.07, BCa 95%CI: − 0.104, − 0.042). These results indicated the indirect effect of PRFP on loneliness via resilience weakened as cognitive conditions deteriorated.

Outcome	Variable	β	SE	t	LLCI	ULCI
Resilience	PRFP	0.499	0.042	12.007***	0.417	0.58
	Cognitive function	− 0.976	0.306	− 3.185**	− 1.577	− 0.374
	PRFP × cognitive function	− 0.059	0.022	− 2.748**	− 0.102	− 0.017
	F	43.452				
	R^2	0.293				
Loneliness	PRFP	− 0.121	0.027	− 4.435***	− 0.175	− 0.068
	Resilience	− 0.183	0.024	− 7.71***	− 0.229	− 0.136
	Cognitive function	0.705	0.19	3.716***	0.332	1.077
	PRFP × cognitive function	− 0.014	0.014	− 1.003	− 0.041	0.013
	Resilience × cognitive function	− 0.007	0.012	− 0.572	− 0.03	0.016
	F	35.201				
	R^2	0.31				

Table 4. Results of the moderated mediation model testing. Controlling for covariates significantly related to loneliness or resilience in the univariate analysis. Higher scores of cognitive function indicate potentially more severe cognitive impairment. *β* standardized coefficient, *SE* standard error, *LLCI* lower level of the confidence interval, *ULCI* upper level of the confidence interval, *PRFP* perceived receipt of filial piety. $^{**}p < 0.01$; $^{***}p < 0.001$.

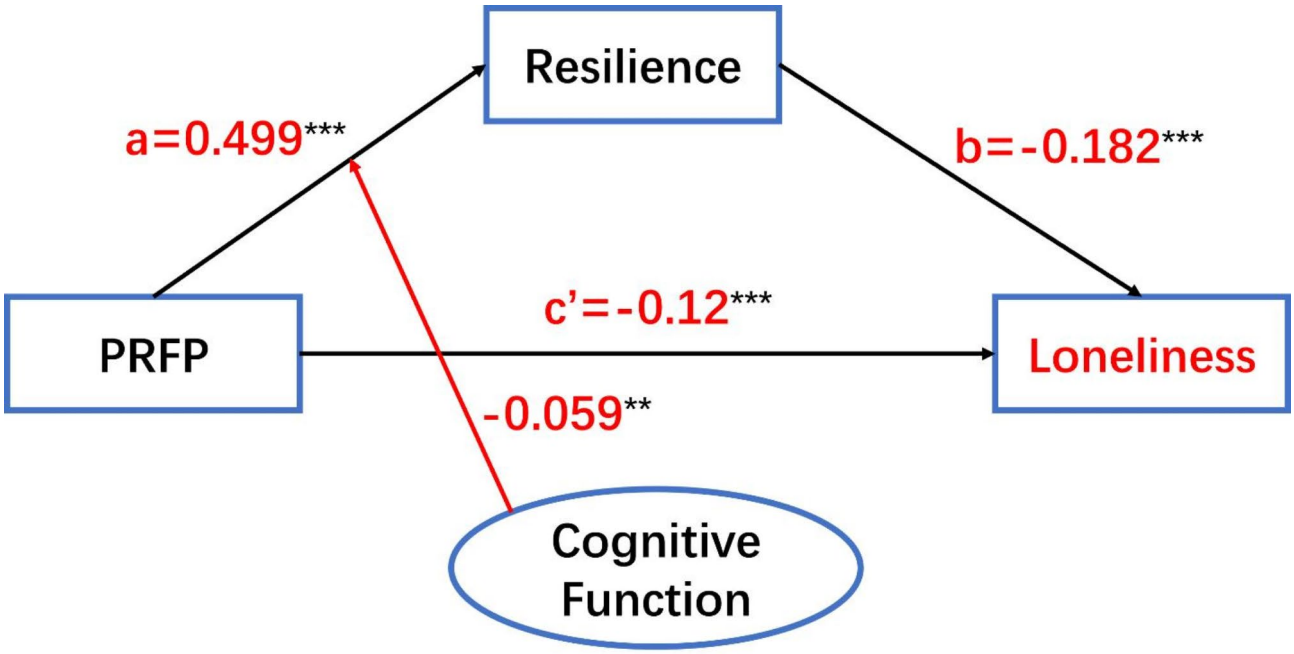

Fig. 2. The final moderated mediation model ($^{**}p < 0.01$; $^{***}p < 0.001$). Higher scores of cognitive function indicate potentially more severe cognitive impairment.

Discussion

H and H2 were confirmed: Our study found a mediating role of resilience in the negative PRFP-loneliness association for older adults with MLTCs. The Stress Coping Theory[21] suggested that individuals draw on both internal and external resources to cope with stressors, aligning with our findings that PRFP serves as an external protective factor, which possibly revealed the underlying mechanism concerning how PRFP may indirectly affect loneliness. Chinese older adults with MLTCs may experience negative events (e.g., physical limitation, retirement or widowhood), which can lead to negative self-perceptions and feelings of loneliness in an increasingly fast-paced and rapidly evolving society[41]. Shaped by social and cultural influences, Eastern culture advocates filial piety as a cornerstone of family and social order, while Western culture is relatively weaker and expresses it differently. As an important virtue in Chinese culture, PRFP acted as an external protective factor for psychological well-being[18–20], indicating that older adults with MLTCs who receive the desired level of filial respect and care experience increased social connection and lower loneliness. In addition, PRFP can be viewed as a form of perceived family social support[18]. Our previous study found that perceived social support from

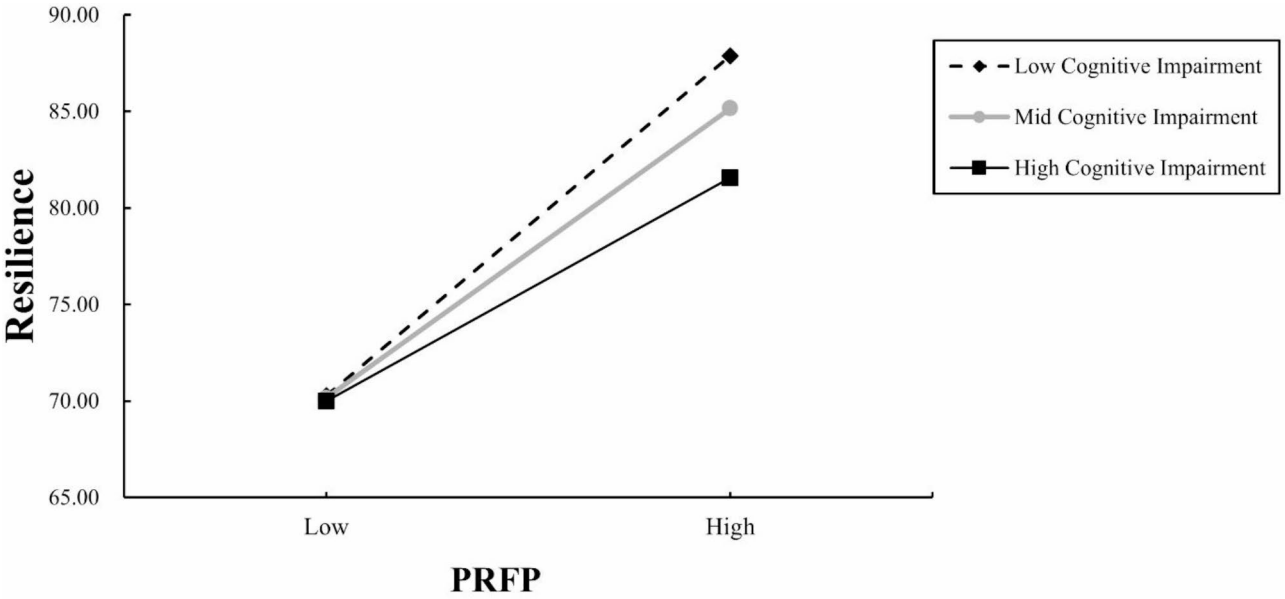

Fig. 3. The moderating effect of cognitive function on the relationship between PRFP and resilience. *PRFP* Perceived receipt of filial piety. Higher scores of cognitive function indicate potentially more severe cognitive impairment.

Level of cognitive function	Indirect effect	SE	LLCI	ULCI	Index of moderated mediation (95% CI)
− 1 SD	− 0.107	0.019	− 0.146	− 0.072	0.011 [0.001, 0.021]
Mean	− 0.091	0.016	− 0.124	− 0.062	
+ 1 SD	− 0.07	0.016	− 0.104	− 0.042	

Table 5. Conditional indirect effects of PRFP on loneliness at values of cognitive function. Controlling for covariates significantly related to loneliness or resilience in the univariate analysis. Higher scores of cognitive function indicate potentially more severe cognitive impairment. *β* standardized coefficient, *SE* standard error, *LLCI* lower level of the confidence interval, *ULCI* upper level of the confidence interval, *SD* standard deviation, *PRFP* perceived receipt of filial piety.

family was negatively associated with psychological disorders in cancer patients[22], signifying that the current sample receiving behavioral or emotional support from adult children may perceive compassion, care, and maintained contact, thereby contributing to a reduction of their loneliness.

The current study further showed that participants who perceived more PRFP tended to improve their resilience, which may lead to less subsequent loneliness. In line with our findings, previous studies have referred to resilience as a protective dynamic process with a mediating role in the feeling of loneliness[42,43]. Specially for older adults, Xie et al. provided support concerning the mediation of resilience in the link between subjective age and loneliness[44], and Zhang et al. found that resilience partially mediated the association between online engagement and loneliness[45]. Besides, resilience is considered a relatively stable (or called trait like) construct, which could be changed and learned throughout one's lifetime. Thus, we speculate that as long as older adults with MLTCs perceive higher receipt of filial piety, they may be better able to mobilize internal resources to buffer against the negative impact of stress (e.g., loneliness).

Our findings partially supported H3: Cognitive function moderated the strength of PRFP-loneliness relationship mediated by resilience. Simple slope analysis indicated a protective effect of PRFP on resilience, and this protective effect diminished with higher level of impaired cognitive function. A possible explanation is that while older adults with MLTCs may perceive more filial pious behaviors from their child(ren), impaired cognitive function may reduce the beneficial impact by damaging the perception ability of aging parents, which may amplify difficulties associated with cognitive processes to maintain their mental health in the context of MLTCs[29,30]. Contrary to our hypothesis, cognitive function only moderated the indirect link (PRFP-resilience) between PRFP and loneliness, which may be a reasonable result in consideration of changes in personality relevant for loneliness with cognitive function[34]. Given the high proportion of resilience mediation and the strength of PRFP-resilience relationship, our sample with lower cognitive function faced limitations in memory, social perception, empathy, and emotional regulation[46], which are essential for maintaining parent-child relationship and positive psychosocial adaptation. As a result, the protective effect of PRFP on resilience may be limited to some extent.

With regard to the conditional indirect effects of PRFP on loneliness at different values of cognitive function, improved cognitive function indirectly enhanced the beneficial effect of PRFP on loneliness through resilience among older adults with MLTCs. When the level of impaired cognitive function was low, resilience was more strongly affected by PRFP, thus the conditional indirect effects of PRFP on loneliness was stronger. Possible reasons contribute to this phenomenon: older adults with lower cognitive function tend to have fewer contacts with individuals of their social network [46] and are more likely to have a change in personality traits related with loneliness[23,34,47]. Therefore, cognition function is a prerequisite for maintaining social relations and positive adaptation, which buffer against loneliness, and we further highlight the adverse role of impaired cognitive function in reducing the beneficial effect of PRFP on loneliness via resilience.

Implications for theory

The present study employed resilience as a mediating variable and cognitive function as a moderating variable to construct a moderated mediation model. In addition to elucidating the PRFP-loneliness processes in older adults with MLTCs, this novel evidence provided important responses to the cognitive conditions under the "PRFP → resilience → loneliness" pathway. Especially, the indirect effect of the mediation model was moderated by cognitive function, with the beneficial effect of PRFP on loneliness being strongest among participants with low levels of impaired cognitive function. Several studies have confirmed that cognitive health functions as a crucial factor in the feeling of loneliness in older age[30,31,48]. The moderating role of cognitive function enriches our understanding of the mechanisms underlying the interplay of external/internal resources on loneliness, and highlights the exploration of the Stress and Coping Model of loneliness.

Clinical implications

Our findings provide relevant clinical and practical implications for primary care practitioners and community managers aiming to relieve loneliness among older adults with MLTCs from sociocultural and psychosocial perspectives. The current study supported the important effects of PRFP and resilience on the ability of community-dwelling older people to buffer feelings of loneliness. The assessment and intervention of PRFP should deserve sufficient attention, as it may be appealing to evaluate parents' perception of the amount of filial piety behaviors from their adult children[18]. Moreover, as described in detail previously[22], stress management and resilience training, including problem-solving ability and meaning-making interventions, could directly or indirectly promote resilience.

Future directions

In the context of modernization and social changes, changing cultural attitudes may impact the self-identity and PRFP of aging Chinese parents, besides the traditional cultural practices of adult children' filial piety. Furthermore, in highlighting social network and structure associated with cognitive function that may influence loneliness, community-based policy interventions should aim to improve the social environment (e.g., social support groups, regular speech contests, and group interaction activities) and optimize community management for cognitive impairment prevention[30].

Limitations

Several limitations should be considered in the interpretation of our findings. First, cross-sectional design precluded drawing conclusions regarding causality. For instance, our findings cannot verify the temporal sequence of the independent variable, mediator, moderator and dependent variable, suggesting that future longitudinal model are needed to examine the causalities among the variables. Second, although the scales used in this study has been validated in previous studies with satisfactory reliability and validity, all measures were based on older adults' self-report, so there may be the possibility of self-report bias. Third, the measure of cognitive function was based on self-reports and excluded participants with neurological disorders (e.g., dementia). In addition, participants who were healthy enough to complete the self-completion questionnaire were included. Future research should use informant ratings of cognitive function and include individuals with dementia. Finally, our sample was collected only from Shenyang City in China, limiting the geographic and cultural diversity of the sample. The moderated mediation model should be further replicated in other cities to ascertain its geographic and cultural diversity of the sample.

Conclusions

This research represents an important step of buffering against loneliness in older adults with MLTCs, addressing the question of how PRFP affects the loneliness based on the moderated mediation model. Resilience played a mediating role in the association of PRFP with loneliness, and cognitive function moderated the relationship between PRFP and resilience. Furthermore, the indirect effect of PRFP on loneliness via resilience was moderated by cognitive functions with higher level of impaired cognitive function more likely dampening the strength of mediation. Our findings emphasize the practical implications for interventions aimed at reducing loneliness issues, which should incorporate components of resilience and cognitive function to alleviate the feeling of loneliness among older people with MLTCs. Our contribution to the existing literature consisted in the theoretical construction of the PRFP-loneliness relationship using a moderated mediation model. However, we should suggest a cautious application of this research when translated to the geographic and cultural diversity of older adults.

Data availability

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

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Author contributions
The initial study idea was conceived, managed, and supervised by Y.L. and X.H.W. All authors then contributed to the refinement of the idea, scoping review process, and to the formal analysis of the results. M.Y.Y., M.G.Z., and X.W.H. conducted the initial and full-text screenings. M.G.Z., X.W.H. and L.L. analyzed data. Y.L.Y drafted the first version of the manuscript with significant revisions and feedback from M.Y.Y. and Y.L. X.H.W. and Y.L. contributed to the critical revision and approval of the final manuscript. All authors contributed to discussions on the direction of the scoping review, and subsequent manuscript revisions and all agreed to the final manuscript version.

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Declarations

Competing interests
The authors declare no competing interests.

Ethical approval and consent to participate
All subjects who participated in the survey signed the informed consent form. This study was approved by the Ethics committee on Human Experimentation of Shenyang Mental Health Center (reference number: 2024004) and complied with the 1964 Helsinki Declaration and its later amendments.

Additional information

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