SSM - Population Health 27 (2024) 101703

Contents lists available at ScienceDirect

SSM - Population Health

journal homepage: www.elsevier.com/locate/ssmph

Interpersonal interactions, sense of loneliness and perceived depressive emotions among older adults: A cultural-psychological perspective from heterogeneous roles of different relationships

Chao Li [a,b,*], Xiang Li [a], Yuhan Zhang [c], Wenyu Lao [a]

[a] Business School, Shandong University, 180 Wenhuaxi Road, Weihai, 264209, China
[b] Centre for Quality of Life and Public Policy Research, Shandong University, 72 Binhai Road, Jimo, Qingdao, 266237, China
[c] HSBC Business School, Peking University, University Town, Nanshan District, Shenzhen, 518055, China

ARTICLE INFO

Keywords:
Interpersonal interactions
Depressive emotions
Healthy aging
Chinese Differential Mode of Association
Cultural-psychological perspective

ABSTRACT

In the context of the "*Chinese Differential Mode of Association*" in traditional Chinese culture, this paper examines the heterogeneous effects of interpersonal interactions in different relationships on older adults' depressive emotions from a cultural-psychological perspective. Results using data from Chinese General Social Survey demonstrate that: interactions with children are the most helpful in reducing perceived depression for the elderly, followed by communications with siblings and relatives. However, interactions with friends and other fellows do not significantly reduce older people's perceived depression. This reflects the "*Chinese Differential Mode of Association*" in interpersonal relationships. When using different perceived depression measures, and Double Debiased Machine Learning (DDML) approaches for robustness and endogeneity tests, above findings are very robust. The impact mechanism is that interactions with children and siblings reduce depressive emotions by decreasing older adults' sense of loneliness, while communications with others do not have such a significant effect. This paper further discusses the roles of different types of interactions with adult children. It is found that receiving and providing emotional support can prominently decrease depressive emotions for older people, whereas the effects of monetary support and non-material assistance are less pronounced. In addition, interpersonal interactions' impacts are more significant for those who are female, older than 75 and with poorer health, as well as older people who exercise less frequently, have higher social status, and hold more traditional beliefs. In the current context of active promotion of healthy aging, findings of this paper have important implications for a deeper understanding and scientific management of depressive emotions among the elderly.

1. Introduction

Depressive emotions are the most common mental health problem among older adults and a significant barrier to healthy aging (Shidhaye, 2022). According to The Institute for Health Metrics and Evaluation (2021), approximately 58.876 million people aged 60 and older worldwide suffer from depressive disorders, accounting for 21% of the total number of depressed people. Depression among older adults adversely affects their quality of life (Bai et al., 2023), subjective well-being (Soósová et al., 2021), and life satisfaction (Shao et al., 2021). It is also associated with other health problems such as cognitive impairment (Xiao et al., 2023), chronic diseases (He et al., 2024; Jiang et al., 2020), and functional disability (Takele et al., 2024). In severe cases, it can even lead to suicidal ideation (Escobar-Agreda et al., 2023). Additionally, depressive disorders are the major contributors to the global burden of disease (World Health Organization, 2023). Therefore, examining the factors impacting depressive emotions among older adults and exploring effective ways to help them cope with depression are crucial, especially given the rapidly aging global population.

In addition to traditional pharmacological and non-pharmacological treatments, the role of interpersonal interactions in reducing depressive emotions among older adults has received increasing attention. These interactions help avoid social isolation (Wu & Chan, 2012), buffer physical and emotional stress (Roh et al., 2015), bring social resources (Dorrance Hall et al., 2019; Xu et al., 2023), and share health knowledge (Wang et al., 2019). These functions contribute to alleviating depressive

* Corresponding author. Business School, Shandong University, No. 180 Wenhuaxi Road, Weihai, 264209, China.
E-mail address: chao_li@sdu.edu.cn (C. Li).

https://doi.org/10.1016/j.ssmph.2024.101703
Received 4 April 2024; Received in revised form 30 July 2024; Accepted 1 August 2024
Available online 3 August 2024

emotions among older adults (Bernier et al., 2019; Werner-Seidler et al., 2017). However, do interpersonal interactions in different relationships have the same effect on depressive emotions among older adults? This is an important but unanswered question. Hence, this paper aims to examine the heterogeneous effects of different interpersonal relationships on older adults' depressive emotions, from a cultural-psychological perspective. Moreover, existing research has found that interpersonal interactions play a crucial role in alleviating loneliness among older adults. For instance, interactions with family members, friends, and others provide more emotional support and social connections, thereby reducing feelings of loneliness (Hoang et al., 2022; Jong Gierveld & Havens, 2004). On the other hand, loneliness is closely associated with depression, as increased loneliness often leads to exacerbated depressive symptoms (Garabrant & Liu, 2021; Zhang et al., 2023). Therefore, this paper further examines whether loneliness mediates the impact of interpersonal interactions on depressive emotions among older adults, and based on a cultural-psychological perspective, whether its mediating effects vary across different interpersonal relationships.

A cultural-psychological perspective examines how cultural factors influence individual psychological processes and behaviors, emphasizing the importance of cultural norms, values, and beliefs in shaping cognition, emotions, and social interactions (Cohen, 2015). Hence, when investigating the psychological well-being of elderly individuals in China, it is essential to consider the Chinese cultural background. China's unique historical and cultural context results in significant differences in interpersonal networks compared to the West. The highly valued blood relationship and the Confucian culture's emphasis on "love with distinctions" have resulted in the *Chinese Differential Mode of Association*, where society is seen as a hierarchy of nonequivalent, ranked dyadic social relationships (Hamilton, 2015). To illustrate this term, Chinese folk sayings use the analogy of ripples radiating from a rock landing in a pond, signifying social relationships. Everyone is at the center of her or his own specific network of social relationships. The relationships closest to Chinese people are those within the core family and as they move further from the core family relationships – to extended family members, friends, colleagues and others – they have yet differential emotions. This pattern suggests variations in how different interpersonal interactions impact older adults' depressive emotions. Therefore, from a cultural-psychological perspective, exploring the heterogeneous impacts of interpersonal interactions in different relationships on older people's depression is of important

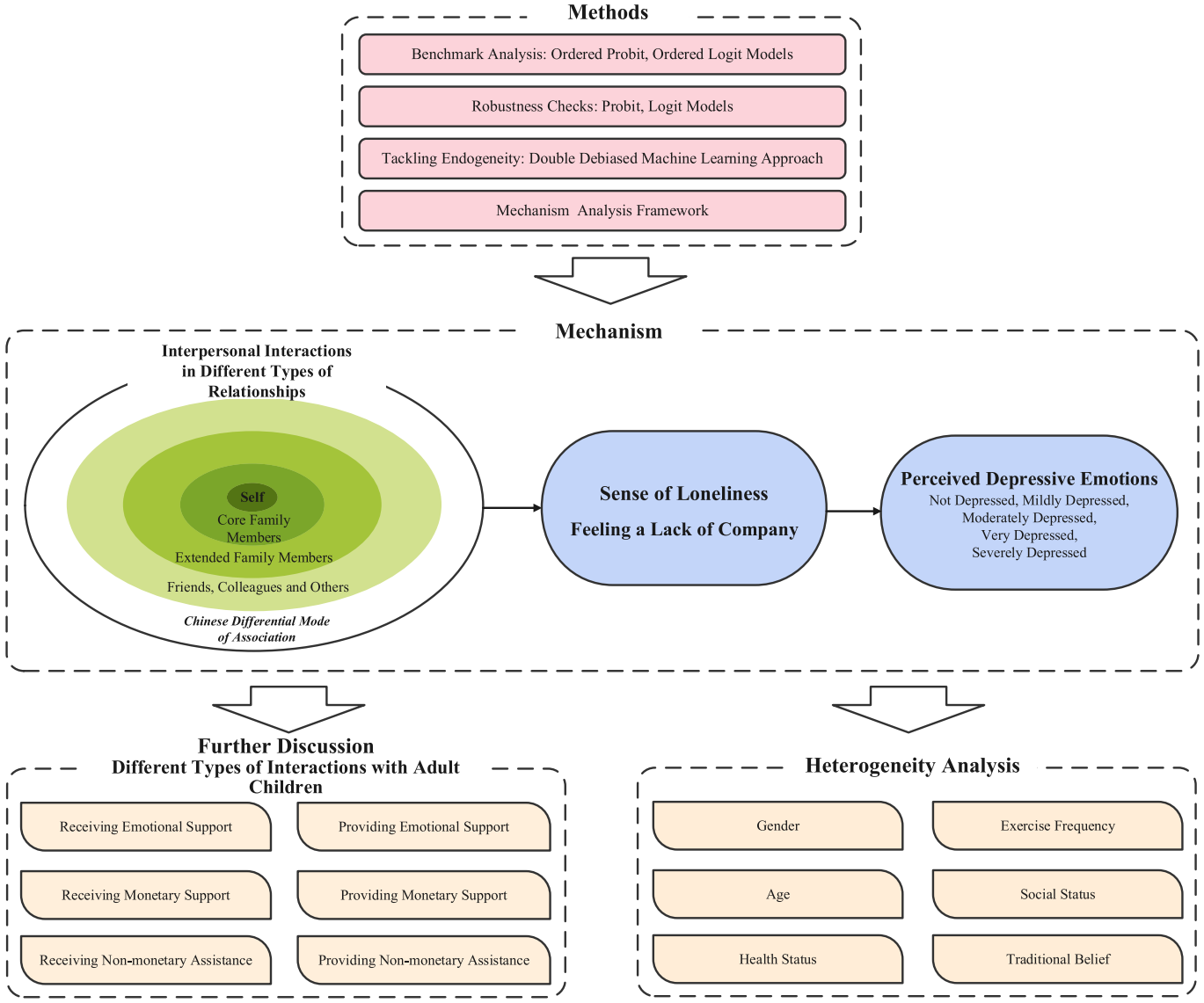

Fig. 1. Conceptual framework.

theoretical and practical value. It provides a more comprehensive understanding and scientific management of Chinese older adults' depression.

Compared to existing literature, the contributions of this paper are highlighted as follows. First, this study finds heterogeneity in the effects of interpersonal interactions in different relationships on depressive emotions among older adults. Although established literature on factors influencing depressive emotions among the elderly has investigated the role of interpersonal interactions (Bernier et al., 2019), there is a lack of research on the heterogeneous effects of different interpersonal interactions. This paper offers a valuable exploration in this regard. Second, this paper provides a cultural-psychological perspective on the influences of interpersonal interactions on the elderly's depressive emotions, proposing a novel theoretical explanation for their relationship. Analyses of interpersonal interactions' effects in previous literature have relatively overlooked cultural contextual factors. However, the pattern of interpersonal relationships varies across cultures (Hamilton, 2015), and thus the effects of interpersonal interactions may differ. Therefore, this paper contributes a novel perspective to better understand the relationship between interpersonal interactions and mental health. The conceptual framework of this paper is shown in Fig. 1.

1.1. Depressive emotions among older adults and the role of interpersonal interactions

The literature on depressive emotions among older adults has primarily focused on demographic and economic factors. Demographic characteristics are foundational factors influencing depressive emotions among older people. In terms of gender, studies find that older women are more sensitive to negative perceptions, making them more susceptible than men to common mental disorders, such as depression (Li et al., 2022; Posel & Oyenubi, 2023; Xue et al., 2021). However, women often have greater access to social capital, which can mitigate depression. As a result, the gender heterogeneity of depressive emotions among older adults remains unclear. With respect to marital status, it is shown that married older adults are less depressed than those who are widowed, unmarried, divorced, or separated (Stokes & Moorman, 2017). Regarding educational attainment, higher educational human capital is associated with higher personal income and financial well-being (Pham et al., 2024), contributing to better healthcare. Additionally, older people with higher levels of education typically have broader interests, healthier lifestyles, and thus fewer depressive emotions (Pei et al., 2020; Xue et al., 2021). Studies show that elderly migrants and ethnic minorities exhibit more depressive symptoms due to greater difficulty in accessing health services (Abbott et al., 2003), poorer socioeconomic conditions, and discrimination (Missinne & Bracke, 2010). Conversely, religious belief, acting as a buffer to prevent depressive emotions, has been found to have positive effects on mental health (Cheng et al., 2021; Murphy et al., 2000). In addition, there is also urban-rural disparity in depressive emotions among the elderly, with the likelihood of depression varying by country context (Purtle et al., 2019; Yuan et al., 2023). Moreover, depressive emotions among the elderly are strongly related to economic income. Studies consistently conclude that higher income and socioeconomic status facilitate better access to medical resources and more interpersonal resources, which can reduce depressive emotions among older people (Fang et al., 2019; Li et al., 2021; Park & Seo, 2020; Piboon et al., 2012). On the contrary, regional economic inequalities are detrimental to decreasing depressive emotions among older adults (Sánchez-Moreno & Gallardo-Peralta, 2021).

In addition, interpersonal interactions are also an important psychosocial factor influencing depressive emotions among older adults. This has been studied mainly in two aspects. First, older people tend to socialize differently from other cohorts. According to the socioemotional selectivity theory (Carstensen et al., 1999), the elderly highly value emotional satisfaction and seek to minimize their emotional risk. As such, they prefer to spend more time with close and familiar people, such as children, friends, and relatives, primarily to regulate emotions and obtain emotional satisfaction. As a result, interpersonal interactions facilitated by social networks are crucial to alleviating depressive emotions among older adults. Studies find that contact with children decreases depressive emotions more effectively than financial support (Wangliu, 2023). Older individuals who report having no interactions with friends each month have a two-fold increased likelihood of depression (Werner-Seidler et al., 2017). Besides, contact with relatives not only relieves depressive symptoms in old age but also improves their quality of life (Luna et al., 2020). Second, interpersonal interactions offer many benefits for older adults, such as avoiding social isolation, providing emotional connection, and buffering physical and emotional stress (Roh et al., 2015; Wu & Chan, 2012). Furthermore, interactions can bring social resources and support (Dorrance Hall et al., 2019; Xu et al., 2023) and share health-related knowledge (Wang et al., 2019). All of these help address the elderly's depressive emotions (Bernier et al., 2019; Schwarzbach et al., 2013; Tanaka, 2018). Conversely, a lack of interpersonal interactions may lead to a fear of missing out, which is positively correlated with depression. Additionally, interpersonal interactions, whether in-person or online, with individuals or in groups, decrease depressive emotions among older adults (Gao et al., 2024; Győri, 2023; Skałacka & Pajestka, 2021; Solomonov et al., 2019). Based on the above analysis, we can propose the following hypothesis:

Hypothesis 1. Interpersonal interactions can decrease perceived depressive emotions among older adults.

So, how do interpersonal interactions affect the perceived depressive emotions of older adults? On the one hand, research suggests that interpersonal interactions can substantially alleviate loneliness, which is defined as a sense of loss in intimate relationships or a lack of contact with others (Jong Gierveld & Havens, 2004). Increased loneliness is often associated with factors such as decreased intimate relationships, diminished social networks, and unmet desires for interpersonal connections (Lau et al., 2023). Studies suggest that an intimate and extensive network of interpersonal interactions can lead to a sense of belonging and prevent feelings of isolation (Jong Gierveld & Havens, 2004). This effect may be more pronounced for older adults who have retired and have fewer social ties. Empirical studies reveal that older adults who frequently interact with children and friends experience less loneliness (Iecovich et al., 2004), while a lower frequency of social interactions is associated with increased loneliness (Li & Tang, 2021; Yu et al., 2020). Therefore, strengthening interpersonal interactions is also considered a crucial intervention for reducing loneliness among older adults (Hoang et al., 2022; O'Rourke et al., 2018). These findings collectively underscore the importance of interpersonal interactions in mitigating loneliness among older individuals. On the other hand, loneliness is closely associated with depressive emotions in the elderly. Studies have demonstrated that loneliness is highly correlated with negative emotions such as depression, anxiety, and despair in later life (Garabrant & Liu, 2021; Zhang et al., 2023). Moreover, more literature considers loneliness as a precursor or stronger predictor of depression in old age, with depressive symptoms seen as a logical consequence of loneliness, but not vice versa (Beljouw et al., 2014; Cacioppo et al., 2010; Erzen & Çikrikci, 2018; Hsueh et al., 2019; Shrira et al., 2020). According to Gonyea et al. (2016), after controlling for other influences, loneliness explains about 23% of variance in depression among older adults. This indicates that loneliness not only significantly influences late-life depression but may also play a pivotal role in its development. Consequently, interpersonal interactions could impact the perceived depressive emotions among older adults by reducing their sense of loneliness. Based on these analyses above, the following hypothesis is formulated:

Hypothesis 2. Sense of loneliness mediates the effect of interpersonal interactions on perceived depressive emotions among older adults.

Furthermore, basic demographic characteristics such as gender, age,

and health status may lead to heterogeneities in the impact of interpersonal interactions on depressive emotions among older adults. Regarding gender, females are typically more sensitive in emotional perception and expression compared to males (Li et al., 2022; Xue et al., 2021). Consequently, interpersonal interactions may offer females more substantial emotional support, thereby reducing their susceptibility to depression. Age, as a significant demographic factor, may also influence the alleviating effects of interpersonal interactions on depressive emotions. Moreover, with advancing age, older adults are more likely to experience significant life changes, such as the loss of spouses and friends, as well as a decline in daily activities. These changes reduce the size of their social networks, further limiting their interactions (McPherson et al., 2006; Moormann et al., 2023). Therefore, more frequent social interactions may yield more positive mental outcomes for this group (Förster et al., 2018). Additionally, older adults with poorer health are more likely to experience negative emotions like depression (Kong & Zhang, 2023). Hence, social support from interpersonal interactions may be particularly effective in alleviating psychological distress for this demographic. Beyond basic demographic characteristics, other factors also influence the impact of interpersonal interactions on the elderly's depressive emotions. For instance, exercise frequency. Research suggests that individuals with less physical activity tend to exhibit higher levels of depression, indicating that the benefits of social interactions may be more pronounced (Barbour & Blumenthal, 2005; Kanamori et al., 2018). Moreover, social status is another significant factor. Older adults with higher social status are more likely to access higher-quality social support, thereby effectively reducing loneliness and stress, and decreasing their depression risk (Benca-Bachman et al., 2020). Finally, based on the research background of this paper, traditional beliefs such as filial piety exert a pivotal influence on the interpersonal interactions of Chinese older adults. Older adults who strongly adhere to these beliefs typically hold higher expectations for interaction with family members. Studies show that such expectations often result in receiving more family support, thus increasing life satisfaction while reducing loneliness and depression (Li et al., 2024). Therefore, the following hypothesis is proposed:

Hypothesis 3. In different subgroups, there is heterogeneity in the alleviating effects of interpersonal interactions on perceived depressive emotions among the elderly.

1.2. Chinese background

The historical and cultural backgrounds of China have shaped unique interpersonal networks, distinct from those in Western societies. For over two millennia, China's ancient society is predominantly agrarian, with smallholder economies at its core. This self-contained economic system fosters family-centered production activities and social connections based on acquaintances rather than broader networks. Within this framework, blood relations (e.g., parents and children, siblings, and other kinship relations) naturally become the fundamental basis for classifying affinities. Moreover, Confucianism, a cornerstone of traditional Chinese culture, emphasizes the concept of "love with distinctions," suggesting that the degree of love is determined by the order of affinities rather than equality. This means that traditionally, Chinese people prioritize relationships with parents and children, followed by siblings, relatives, and then friends, neighbors, and colleagues. This historical and cultural context has led to what is known as the "*Chaxugeju*" ("*Chinese Differential Mode of Association*") in Chinese interpersonal relationships. The term "*Cha*" represents horizontal relationships, indicating varying degrees of social distance within concentric social networks. "*Xu*" signifies the vertical dimension, reflecting the ordering and prioritization within these relationships. "*Geju*" means the pattern of social relations. Together, "*Chaxugeju*" refers to the social relation patterns that vary in both social distances and orders (Harrell, 2015; Herrmann-Pillath, 2016; Sinha & Lakhanpal, 2022). The analogy of a ripple is often used to illustrate the "*Chinese Differential Mode of Association*". Imagine throwing a stone into a pond and observing the ripples spreading outward. This ripple effect mirrors social relationships, with the self at the center. The closest and most intimate relationships are with core family members, such as parents and children. Moving outwards, there are extended family members like siblings and relatives. Beyond that, the relationships extend to friends, colleagues, and others, becoming progressively less intimate (Hamilton, 2015). While family relationships are also important in Western societies, they are not the center of social interaction as they are in China. In Western cultures, there is a greater focus on treating various relationships, including family, friends, and neighbors, more equally. Western culture places more emphasis on the individual's free choice and ordering of relationships rather than following rigid hierarchical structures or concentric circles (Fuhse, 2009; Hamilton, 2015).

Cultural background significantly influences the impact of relationships on mental health (Campos & Kim, 2017). Based on the *Chinese Differential Mode of Association,* we can speculate that interpersonal interactions in different types of relationships may have varied effects on the mental health of Chinese older adults. First, children have the closest relationship and Chinese Confucianism emphasizes "*Xiao*" (or filial piety). As the Chinese folk saying goes, "filial piety is the first of all virtues". Adult children in Chinese families have obligations to provide material and emotional support to their older parents (Lu et al., 2022). Moreover, closer child-parent relationships are linked to fewer depressive symptoms and better cognitive functioning in Chinese older adults, whereas this association is not significant for the elderly in the United States (Lu et al., 2023). Additionally, research in Colombia and Brazil demonstrates that social interactions with family members and children decrease the likelihood of depression among older adults and improve their overall quality of life (Bélanger et al., 2016). This phenomenon may be attributed to cultural differences in valuing family relationships. among older individuals For instance, in the United States, friends serve as the primary source of emotional support for the elderly, whereas in China, family members fulfill this role (Li & Cheng, 2015; Pethtel & Chen, 2010). Thus, interactions with children are crucial for promoting mental health among Chinese older adults. Second, siblings and relatives are extended family members in Chinese culture, and their relationship with "self" is second only to that of core family members. In Chinese culture, "*Ti*" (harmony among siblings) is a key moral standard, and relatives are expected to support each other. There is also a Chinese folk saying that "everything will prosper with family harmony", which implies that harmony and care within the family lead to positive outcomes. Given the importance Chinese people place on extended family, interactions with siblings and relatives may also benefit older adults' mental health. It is found that siblings' visits to older adults can make them aware that they have companions, thus reducing depressive symptoms and increasing their life satisfaction (Homan & Kong, 2024). Interactions with relatives play a similar role (Zhang et al., 2021). Third, friends, neighbors, and colleagues are on the outer edge of the ripple model, less close to the "self", and less intimate than family members. Thus, their interactions may have a smaller effect on the mental health of Chinese older adults. A study shows that interactions with friends and neighbors are related to positive aspects of mental health, but not to reducing mental disorders. Interactions with colleagues and strangers are not significantly correlated with either positive or negative emotions among older adults (Zhang et al., 2021). However, in the United States, older adults who frequently interact with friends, neighbors, and congregants experience less loneliness and more happiness, whereas interactions with family members do not yield the same effects (Litwin & Shiovitz-Ezra, 2011). Similarly, research on Canadian older adults finds that social interaction with friends contributes positively to their physical and mental well-being (Bélanger et al., 2016). Thus, based on the existing literature, the following hypothesis can be proposed:

Hypothesis 4. There is heterogeneity in the effects of interpersonal

interactions in different relationships on perceived depressive emotions among Chinese older adults.

2. Methods

2.1. Sample

Data used in this paper are from the Chinese General Social Survey (CGSS), which is a member of the world General Social Survey (GSS) family. CGSS is a comprehensive and large-scale academic survey in China, aiming to collect systematic and comprehensive information on Chinese people's behavior, attitudes and life. The questionnaire of CGSS consists of three modules: core module, topic module (rotation module), and additional module. CGSS sample covers 28 provinces/municipalities/autonomous regions in China and uses a multi-stage stratified Probability Proportionate to Size (PPS) sampling method, making it highly representative. It selects county-level units as Primary Sampling Units (PSUs), community-level units as Secondary Sampling Units (SSUs), and households as Tertiary Sampling Units (TSUs). CGSS has the following advantages for this study: First, it investigates participants' interpersonal interactions in different relationships, conducive to the construction of explanatory variables in this paper. Second, it surveys perceived depressive emotions of older people and comprehensive influencing factors, which facilitates constructing the dependent and control variables. CGSS spans 13 waves from 2003 to 2021. However, since the core explanatory variables in this paper are sourced from the additional module, which investigates different hot issues in each wave, there is an absence of information regarding interpersonal interactions in other waves. Therefore, data from 2017 is employed in this paper. In addition, since the current legal retirement age in China is 60 years old and people over 60 are commonly considered the elderly in China (Chen et al., 2018; Liu et al., 2022; Luo et al., 2020), the sample consists of older adults aged 60 or above.

2.2. Measures

2.2.1. Perceived depressive emotions

Dependent variable in this paper is the degree of perceived depression, measuring the self-rated depressive emotions of older adults. This variable is derived from the question in the CGSS core module "How depressed do you feel" and is denoted as *Perceived depression*. Based on the 5-Point Likert Scale, the answers are scored from 1 to 5, representing not depressed, mildly depressed, moderately depressed, very depressed and severely depressed, respectively. This indicator has also been widely used in existing studies (e.g., He et al., 2023; Hu et al., 2017). Besides, a dummy variable, *Whe_Depression*, is constructed for robustness check.

2.2.2. Interpersonal interactions

The explanatory variables are the frequencies of interpersonal interactions in different relationships. According to the question in the CGSS extension module: "How often do you interact with your adult children, siblings, relatives (excluding parents, siblings and adult children), friends, and other fellows that you interact with most?" Interaction modes include meeting in person, calling, chatting online, etc. Responses are classified from 1 to 8 as never, very seldom, several times a year, once a month, 2–3 times a month, once a week, several times a week and every day.

2.2.3. Loneliness

The mediating variable is the degree of loneliness, which is generated from the question in the CGSS extension module: "How often do you feel a lack of companionship", denoted as *Loneliness*. Responses are rated on a 5-point Likert scale from 1 to 5 as never, seldom, sometimes, often and frequently. Larger scores represent higher levels of loneliness. This indicator has also been commonly used in many studies to measure loneliness (Wang, 2023; Xiang et al., 2022).

2.2.4. Control variables

Referring to the literature on depressive emotions among older adults (e.g., Aylaz et al., 2012; Cheng et al., 2021; Li et al., 2022; Pham et al., 2024), the following variables are controlled to avoid omitted variable bias: Age, squared terms of age, gender, educational status, whether being migrant, whether Hukou is in urban, whether being ethnic minorities, whether having religious beliefs, whether being the Communist Party of China (CPC) member, personal income, whether having pension and medical insurance, marital status, number of children and regional dummies. Table 1 presents the meanings and descriptive statistics of these variables.

3. Results

3.1. Correlation analysis

This paper first conducts a correlation analysis to examine the relationship between interactions in different relationships, sense of loneliness, and depressive emotions among older adults. As depicted in Fig. 2, results are displayed in a heat map based on Spearman's rank correlation coefficients, illustrating four main characteristics. First, the correlation coefficients in red squares indicate that interpersonal interactions in different relationships are negatively correlated with depressive emotions (indicators including *Perceived depression* and *Whe_Depression*), as well as loneliness. This suggests that such interactions may alleviate depressive symptoms and loneliness among older individuals, thereby offering preliminary support for Hypothesis 1. Second, correlation coefficients presented in blue squares at the bottom left indicate a strong positive correlation between depressive symptoms and loneliness. Combined with the initial finding, it suggests that interpersonal interactions might potentially reduce perceived depressive emotions by alleviating loneliness, thus preliminary supporting Hypothesis 2. Third, the varying shades of red squares indicate notable discrepancies in the strength of the correlation between interpersonal interactions and depressive emotions across different relationships. This suggests that the effects of interpersonal interactions in different relationships on depressive emotions may be heterogeneous, providing initial support for Hypothesis 4. Fourth, the blue squares in the upper right reveal a high positive correlation between interactions in different types of relationships. Next, we will use more statistically rigorous methods to systematically investigate relationships between these factors.

3.2. Benchmark regression results

On the basis of the correlation analysis, and considering that the dependent variable *Perceived depression* is ordinal, the following Ordered Probit model is constructed to investigate the effects of interpersonal interactions in different relationships on perceived depressive emotions. Specifically, based on $Perceived\_depression_i$, the sample is divided into 5 groups. Groups $g = 1$ to 5 represent those who are not, mildly, moderately, very and severely depressed respectively. The probability p_{gi} of a given observation i in group g is

$$p_{gi} = Pr(Perceived\_depression_i = g) = Pr\left(\chi_{g-1} < \beta_0 + \beta_1 Interactions_i + \boldsymbol{x}_i'\boldsymbol{\psi}^2 + d_p + \epsilon_i \leq \chi_g\right) \quad (1)$$

$$Pr(\cdot) = \Phi\left(\chi_g - \beta_0 - \beta_1 Interactions_i - \boldsymbol{x}_i'\boldsymbol{\psi}^2 - d_p\right) - \Phi\left(\chi_{g-1} - \beta_0 - \beta_1 Interactions_i - \boldsymbol{x}_i'\boldsymbol{\psi}^2 - d_p\right) \quad (2)$$

or

$$Pr(\cdot) = 1 / \left\{1 + exp\left(\beta_0 + \beta_1 Interactions_i + \boldsymbol{x_i'}\boldsymbol{\psi^2} + d_p - \chi_g\right)\right\} - 1 / \left\{1 + exp\left(\beta_0 + \beta_1 Interactions_i + \boldsymbol{x_i'}\boldsymbol{\psi^2} + d_p - \chi_{g-1}\right)\right\} \quad (3)$$

In expression (1), the explained variable $Perceived\_depression_i$ denotes the degree of perceived depression of older adults. $Interactions_i$ are explanatory variables representing interpersonal interactions in different relationships, which are interactions with children, siblings, relatives, friends and fellows. $\boldsymbol{x_i'}$ and d_p are a vector of the control variable and province dummy variables, respectively. χ_0 is $-\infty$, χ_5 is $+\infty$. $Pr(\cdot)$ can be taken in the form of either equation (2) or (3). Equation (2) is used to estimate the Ordered Probit model, where $\Phi(\bullet)$ is the standard normal cumulative distribution function. Equation (3) applies the Ordered Logit model. Accordingly, the log likelihood of the maximum likelihood estimation (MLE) is

$$lnL = \sum_{i=1}^{N}\sum_{g=1}^{5} I_g(Perceived\_depression_i) ln\, p_{gi} \quad (4)$$

where $I_g(Perceived\_depression_i) = \begin{cases} 1, if\ Perceived\_depression_i = g \\ 0, if\ Perceived\_depression_i \neq g \end{cases}$ and N is the sample size. Based on this, β_1 and $\boldsymbol{\psi^2}$ are estimated by $\max_{\beta_1, \boldsymbol{\psi^2}} lnL$.

Table 2 presents the estimated results of the benchmark regressions using Ordered Probit model. Additionally, the results employing the OLS and Ordered Logit regression models are included in Tables A1 and A2 in the Appendix. Column (1) of Table 2 shows that the estimated coefficient of *Interactions with children* is −0.054, significantly negative at the 1% level, indicating that interactions with children reduce perceived depression among older adults. Columns (2)–(3) demonstrate that interactions with siblings and relatives also significantly decrease depressive emotions among the elderly. Thus, Hypothesis 1 is confirmed: Interpersonal interactions can lower depressive emotions among older adults.

Moreover, the absolute values of the estimated coefficients for *Interactions with siblings* (0.028) and *relatives* (0.030) are significantly smaller than that for *Interactions with children* (0.054). However, in columns (4)–(5), the estimated coefficients of *Interactions with friends* and *fellows* are not significant. This suggests that interactions with children have the greatest and most significant effect on alleviating depressive emotions among older adults, and interactions with siblings and relatives are also beneficial but have a smaller effect. Interactions with friends and fellows do not significantly relieve depressive emotions of the elderly, supporting Hypothesis 4: There is heterogeneity in the effects of interpersonal interactions in different relationships on depressive emotions among older adults. In addition, the estimates of control variables are generally consistent with theoretical expectations and existing literature. For example, higher income and being married are associated with lower levels of depressive emotions among older adults (Fang et al., 2019; Park & Seo, 2020; Piboon et al., 2012; Stokes & Moorman, 2017).

3.3. Robustness and endogeneity checks

3.3.1. Using another perceived depression measure

To address potential variations in respondents' interpretations of perceived depression levels, a dummy variable, *Whe_Depression*, is constructed. It indicates whether the degree of perceived depression is above mildly or not. Specifically, *Whe_Depression* is coded as 1 if the respondent is moderately, very or severely depressed, and 0 otherwise. Since respondents have no significant bias in judging whether perceived depression is *Whe_Depression* = 0 or 1, this dummy variable can help reduce measurement errors from varying interpretations of the question options. As *Whe_Depression* takes the value of 0 or 1, the fitted value of OLS may fall outside [0, 1]. Therefore, the Probit and Logit models are employed, which are based on the maximum likelihood estimate. The

Table 1
Descriptive statistics.

Variable	Description	Obs.	Mean	Std. Dev.	Min.	Max.
Dependent Variables						
Perceived depression	Degree of perceived depression, 1–5 levels	1408	2.253	1.033	1	5
Whe_Depression	Whether having higher degrees of perceived depressive emotions, Yes = 1, No = 0	1408	0.386	0.487	0	1
Explanatory Variables						
Interactions with children	Frequency of interactions with children, 1–8 levels	1408	6.713	1.544	1	8
Interactions with siblings	Frequency of interactions with siblings, 1–8 levels	1253	4.322	1.960	1	8
Interactions with relatives	Frequency of interactions with relatives, 1–8 levels	1249	4.508	2.250	1	8
Interactions with friends	Frequency of interactions with friends, 1–8 levels	1161	4.839	2.313	1	8
Interactions with fellows	Frequency of interactions with fellows, 1–8 levels	1110	3.699	2.510	1	8
Mediating Variable						
Loneliness	Degree of loneliness, 1–5 levels	1405	1.981	1.024	1	5
Control Variables						
Age	Age	1408	69.515	7.451	60	103
Age_squared	Squared term of age	1408	4887.8	1082.476	3600	10609
Whether female	Yes = 1, No = 0	1408	0.521	0.500	0	1
Whether higher educated	Yes = 1, No = 0	1408	0.067	0.251	0	1
Whether migrant	Yes = 1, No = 0	1405	0.079	0.270	0	1
Whether Hukou in urban	Yes = 1, No = 0	1401	0.400	0.490	0	1
Whether ethnic minorities	Yes = 1, No = 0	1408	0.063	0.243	0	1
Whether religious believer	Yes = 1, No = 0	1408	0.113	0.317	0	1
Whether CPC member	Yes = 1, No = 0	1406	0.160	0.367	0	1
ln_Income	Logarithm of personal income	1356	8.169	3.506	0	15.303
Whether having pension	Yes = 1, No = 0	1406	0.800	0.400	0	1
Whether having medical insurance	Yes = 1, No = 0	1406	0.926	0.262	0	1
Whether married	Yes = 1, No = 0	1408	0.748	0.434	0	1
Number of children	Number of children	1408	2.492	1.409	0	12
Province dummies						

Notes: Whether higher educated denotes whether having a college or higher degree. Hukou is a system of household registration used in China, mainly identifying a person as a rural or urban resident. CPC represents Communist Party of China and CPC member is the most important political identity in China.

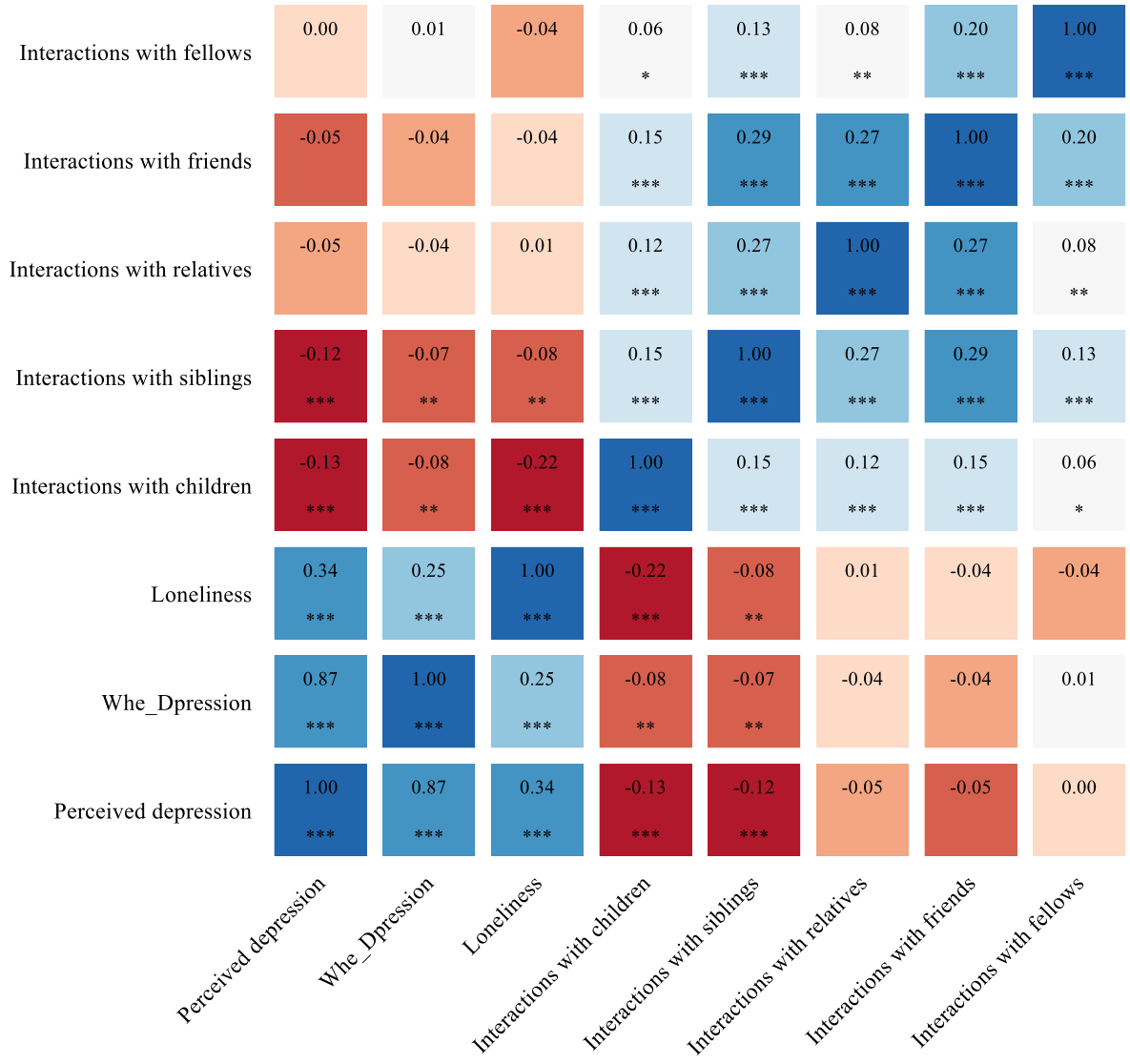

Fig. 2. Spearman's rank correlation matrix.
Notes: ***, **, and * indicate significance at the levels of 1%, 5%, and 10%, respectively.

log-likelihood function is of the form:

$$ln\,L = \sum_{i \in S} ln\left[F\left(\gamma_0 + \gamma_1 Interactions_i + \boldsymbol{x}_i' \boldsymbol{\psi}^3 + d_p\right)\right] + \sum_{i \notin S} ln\left[1 - F\left(\gamma_0 + \gamma_1 Interactions_i + \boldsymbol{x}_i' \boldsymbol{\psi}^3 + d_p\right)\right] \quad (5)$$

$$F(\cdot) = \Phi\left(\gamma_0 + \gamma_1 Interactions_i + \boldsymbol{x}_i' \boldsymbol{\psi}^3 + d_p\right) \quad (6)$$

or

$$F(\cdot) = exp\left(\gamma_0 + \gamma_1 Interactions_i + \boldsymbol{x}_i' \boldsymbol{\psi}^3 + d_p\right) \Big/ \left\{1 + exp\left(\gamma_0 + \gamma_1 Interactions_i + \boldsymbol{x}_i' \boldsymbol{\psi}^3 + d_p\right)\right\} \quad (7)$$

In equation (5), S is the set of all observations i, such that $Whe\_Depression_i = 1$. $F(\cdot)$ can take either the form of (6) or (7). Expression (6) corresponds to the Probit model, where $\Phi(\bullet)$ is the standard normal cumulative density function. Expression (7) corresponds to the Logit model. Based on this, γ_1 and $\boldsymbol{\psi}^3$ are estimated by $\max_{\gamma_1, \boldsymbol{\psi}^3} lnL$.

The estimated results using the Probit and Logit models are displayed in Tables 3 and A3 (in Appendix A), respectively. In all regressions, the estimated coefficients of *Interactions with children* remain significantly negative, with the largest absolute value. This indicates that interactions with children benefit older adults' mental health the most and this effect is very robust. Additionally, interactions with relatives also play a role. However, interactions with friends and fellows remain not significant, implying that they do not significantly alleviate depressive emotions among older adults. These results are consistent with the benchmark regressions, demonstrating the robustness of the analysis.

3.3.2. Double Debiased Machine Learning approach

To address potential model misspecification errors, Double Debiased Machine Learning (DDML) approach is employed. This approach provides unbiased estimates by addressing endogeneity issues (Chernozhukov et al., 2018). Consider the following partial linear models.

$$Perceived\_depression_i = \delta_0 + \delta_1 Interactions_i + f(\boldsymbol{x}_i) + \mu_i \quad (8)$$

$$Interactions_i = g(\boldsymbol{x}_i) + \upsilon_i \quad (9)$$

In models (8) and (9), $f(\boldsymbol{x}_i)$ and $g(\boldsymbol{x}_i)$ are functions of control variables that do not depend on any particular assumption about their form.

Table 2
Benchmark regression results.

Model	(1) Ordered Probit	(2) Ordered Probit	(3) Ordered Probit	(4) Ordered Probit	(5) Ordered Probit
Variable	Perceived depression	Perceived depression	Perceived depression	Perceived depression	Perceived depression
Interactions with children	−0.054*** (0.020)				
Interactions with siblings		−0.028* (0.017)			
Interactions with relatives			−0.030** (0.014)		
Interactions with friends				0.007 (0.015)	
Interactions with fellows					0.008 (0.014)
Age	0.006 (0.062)	0.031 (0.065)	−0.003 (0.062)	−0.027 (0.065)	0.048 (0.067)
Age_squared	−0.000 (0.000)	−0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	−0.000 (0.000)
Whether female	0.128** (0.065)	0.099 (0.068)	0.114* (0.067)	0.094 (0.071)	0.064 (0.071)
Whether higher educated	−0.116 (0.150)	−0.072 (0.152)	−0.127 (0.151)	−0.102 (0.151)	−0.048 (0.161)
Whether migrant	−0.169 (0.131)	−0.211 (0.135)	−0.217 (0.141)	−0.232* (0.141)	−0.286** (0.139)
Whether Hukou in urban	−0.186** (0.082)	−0.199** (0.086)	−0.198** (0.086)	−0.167* (0.088)	−0.142 (0.091)
Whether ethnic minorities	−0.375*** (0.139)	−0.479*** (0.142)	−0.464*** (0.140)	−0.341** (0.155)	−0.405*** (0.156)
Whether religious believer	−0.001 (0.098)	−0.014 (0.100)	−0.033 (0.099)	0.001 (0.105)	−0.054 (0.111)
Whether CPC member	−0.199** (0.099)	−0.215** (0.104)	−0.218** (0.103)	−0.245** (0.102)	−0.151 (0.112)
ln_Income	−0.044*** (0.010)	−0.040*** (0.011)	−0.045*** (0.011)	−0.037*** (0.012)	−0.042*** (0.011)
Whether having pension	−0.118 (0.080)	−0.149* (0.083)	−0.117 (0.085)	−0.120 (0.085)	−0.179** (0.085)
Whether having medical insurance	0.044 (0.121)	0.085 (0.120)	0.222* (0.122)	0.037 (0.135)	0.095 (0.134)
Whether married	−0.230*** (0.072)	−0.203*** (0.077)	−0.226*** (0.077)	−0.200** (0.080)	−0.242*** (0.079)
Number of children	−0.018 (0.024)	−0.017 (0.027)	−0.007 (0.026)	−0.011 (0.028)	0.003 (0.025)
Province dummies	Yes	Yes	Yes	Yes	Yes
Observations	1344	1198	1192	1108	1061
Pseudo R^2	0.058	0.056	0.058	0.053	0.053

Notes: ***, **, and * indicate significance at the levels of 1%, 5%, and 10%, respectively. The values in parentheses are standard errors robust to heteroskedasticity. Yes means the corresponding variables are controlled in the regression, while No means not controlled. Pseudo R^2 is reported for nonlinear models and Adjusted R^2 is reported for linear models. The same for other tables below.

Table 3
Robustness and endogeneity checks: Using another perceived depression measure (Probit).

Model	(1) Probit	(2) Probit	(3) Probit	(4) Probit	(5) Probit
Variable	Whe_Depression	Whe_Depression	Whe_Depression	Whe_Depression	Whe_Depression
Interactions with children	−0.057** (0.024)				
Interactions with siblings		−0.022 (0.021)			
Interactions with relatives			−0.038** (0.017)		
Interactions with friends				0.004 (0.018)	
Interactions with fellows					0.012 (0.017)
Controls	Yes	Yes	Yes	Yes	Yes
Constant	0.081 (2.963)	−1.352 (3.140)	0.692 (3.022)	0.156 (3.059)	−1.179 (3.289)
Observations	1341	1195	1189	1106	1059
Pseudo R^2	0.082	0.083	0.087	0.074	0.082

Machine learning algorithms are used to estimate $h(\boldsymbol{x_i}) = E[Perceived\_depression_i|\boldsymbol{x_i}]$ and $g(\boldsymbol{x_i}) = E[Interactions_i|\boldsymbol{x_i}]$. DDML utilizes cross-fitting to ensure independence between μ_i and v_i and achieve unbiased estimates (Chang, 2020; Colangelo & Lee, 2022). According to the Frisch-Waugh-Lovell Theorem, we can obtain the unbiased estimator $\widehat{\delta_1}$:

$$\widehat{\delta_1} = \frac{\frac{1}{N}\sum_{i=1}^{N}(Perceived\_depression_i - \widehat{h}(\boldsymbol{x_i}))(Interactions_i - \widehat{g}(\boldsymbol{x_i}))}{\frac{1}{N}\sum_{i=1}^{N}(Interactions_i - \widehat{g}(\boldsymbol{x_i}))^2} \quad (10)$$

where N is the sample size. $\widehat{g}(\boldsymbol{x_i})$ and $\widehat{h}(\boldsymbol{x_i})$ are the predicted values with cross-fitting. Moreover, to obtain robust estimator $\widehat{\delta_1}$, seven major machine learning algorithms, including Linear, Lasso, Ridge, Elastic Net, Support Vector Machine, Gradient Boosting, Random Forest are applied to estimate $g(\boldsymbol{x_i})$ and $h(\boldsymbol{x_i})$. The effects of interpersonal interactions in different relationships and their 90% confidence intervals are plotted in Fig. 3, with regression tables and details presented in Tables S1–S5 in the Supplementary Materials. It is clearly illustrated that the absolute values of the estimated coefficients of *Interactions with children* are the largest across all DDML approaches, with all endpoints of the confidence intervals to the left of 0. This suggests that interactions with children are the most helpful for addressing older adults' depressive emotions and this effect is very robust. Similarly, the effects of interactions with siblings and relatives on alleviating depressive emotions are also robust. Whereas, the estimated coefficients of *Interactions with friends* and *fellows* are close to 0, and the confidence intervals cross 0. This indicates that interactions with friends and fellows have no significant effect on decreasing depressive emotions among the elderly. These results confirm that the findings of benchmark regressions remain robust after dealing with endogeneity problems.

3.4. Mechanism analysis

Based on previous literature (Erzen & Çikrikci, 2018; Hsueh et al., 2019; Iecovich et al., 2004; Li & Tang, 2021; Shrira et al., 2020; Yu et al., 2020), it can be inferred that loneliness may mediate the effect of interpersonal interactions on reducing depressive emotions among older adults. Therefore, the following mechanism test framework is constructed to examine the mediating role of loneliness:

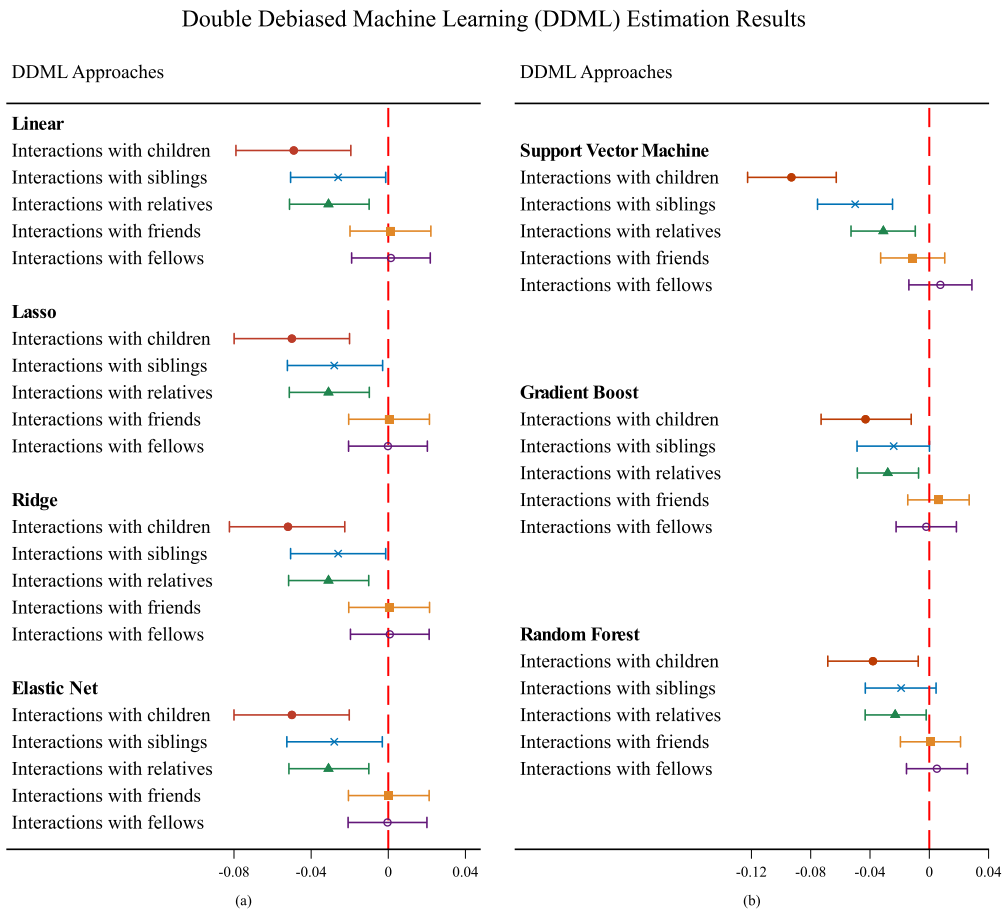

Fig. 3. Robustness and endogeneity checks: Double Debiased Machine Learning approach.

$$Loneliness_i = \theta_0 + \theta_1 Interactions_i + \boldsymbol{x}_i' \boldsymbol{\psi}^4 + d_p + \nu_i \quad (11)$$

$$Perceived\_depression_i = \lambda_0 + \lambda_1 Interactions_i + \lambda_2 Loneliness_i + \boldsymbol{x}_i' \boldsymbol{\psi}^5 + d_p + \tau_i \quad (12)$$

In equations (11) and (12), $Loneliness_i$ is the mediator to be tested, representing the degree of loneliness. If θ_1 in model (11) and λ_2 in model (12) are both significant, then $Loneliness_i$ is the mediator through which interpersonal interactions reduce depressive emotions among older adults.

Tables 4 and 5, as well as Tables A4-A6 (in Appendix A), exhibit the mechanism analysis results of five different interpersonal interactions. Columns (1) of the five tables are consistent with the benchmark regression results, demonstrating that interactions with children, siblings and relatives decrease depressive emotions among older adults, whereas interactions with friends and fellows show no such significant effect. The estimated results from equation (11) and equation (12) are shown in columns (2)–(3) in the following five tables. They indicate that only interactions with children and siblings (as shown in Tables 4 and 5) can significantly decrease loneliness and, in turn, significantly alleviate depressive emotions among older people. This suggests that loneliness mediates the influences of interactions with children and siblings on depressive emotions among older adults, while it does not have a mediating effect in interactions with others. To further test the robustness of this mechanism, the Ordered Logit model is applied. Results in columns (4)–(6) of the five tables show that using the Ordered Logit model can reach the same conclusions as the Ordered Probit, meaning that interactions with children and siblings can reduce depressive emotions among older adults by decreasing their loneliness.

Moreover, a Sobel test is conducted, with results presented in Table 6. Results show that for interactions with children and siblings, the Z-values of the Sobel test are −5.989 and −2.029, respectively, both statistically significant. However, for other interpersonal relationships,

Table 4
Mechanism analysis of interactions with children.

Model	(1) Ordered Probit	(2) Ordered Probit	(3) Ordered Probit	(4) Ordered Logit	(5) Ordered Logit	(6) Ordered Logit
Variable	Perceived depression	Loneliness	Perceived depression	Perceived depression	Loneliness	Perceived depression
Interactions with children	−0.054*** (0.020)	−0.143*** (0.021)	−0.014 (0.020)	−0.099*** (0.036)	−0.244*** (0.036)	−0.036 (0.036)
Loneliness			0.324*** (0.035)			0.583*** (0.063)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1344	1341	1341	1344	1341	1341
Pseudo R^2	0.058	0.075	0.086	0.061	0.078	0.089

Table 5
Mechanism analysis of interactions with siblings.

Model	(1) Ordered Probit	(2) Ordered Probit	(3) Ordered Probit	(4) Ordered Logit	(5) Ordered Logit	(6) Ordered Logit
Variable	Perceived depression	Loneliness	Perceived depression	Perceived depression	Loneliness	Perceived depression
Interactions with siblings	−0.028* (0.017)	−0.037** (0.018)	−0.018 (0.017)	−0.050* (0.030)	−0.063** (0.031)	−0.032 (0.030)
Loneliness			0.307*** (0.037)			0.551*** (0.069)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1198	1195	1195	1198	1195	1195
Pseudo R^2	0.056	0.066	0.082	0.059	0.068	0.085

Table 6
Sobel and Bootstrap test of interactions with children and siblings.

Sample	(1) Interactions with children	(2) Interactions with siblings
Effect	Z	Z
Sobel-Goodman mediation test		
Sobel	−5.989***	−2.029**
Aroian	−5.971***	−2.018**
Goodman	−6.008***	−2.041**
Proportion of mediating effect in total effect	0.747	0.339
Bootstrap test		
Mediating effect	−5.340***	−2.030**
Proportion of mediating effect in total effect	0.747	0.339

the Z-values do not reach the threshold for statistical significance. Additionally, the Z-values from the Aroian and Goodman tests are consistent with those in the Sobel test. Furthermore, when examining the influence of interactions with children on the depressive emotions among the elderly, loneliness acts as a mediating variable, with its mediating effect accounting for 74.7% of the total effect. This indicates that loneliness is a crucial mediator. Similarly, for interactions with siblings, loneliness accounts for 33.9% of the total effect, demonstrating its significance as a mediator. To further validate the robustness of these conclusions, the Bootstrap test is employed, with the results shown in Table 6. The results align with those obtained from the Sobel test. These analyses collectively indicate that interactions with children and siblings can alleviate depressive emotions in the elderly by reducing their loneliness. Thus, Hypothesis 2 is supported.

3.5. Heterogeneity analysis

To further investigate whether the impact of interpersonal interactions on depressive emotions varies among older adults with different characteristics, this paper initially examines the influence of basic demographic attributes, including gender, age, and health status. The estimated 90% confidence intervals are displayed in Fig. 4. Regarding gender, interactions with children, siblings, and relatives significantly mitigate depressive emotions primarily in female older adults. Concerning age, the effect on depressive emotions appears more pronounced in individuals aged over 75. In terms of health status, interactions with children, siblings and relatives are particularly impactful in reducing depressive emotions among older adults with poorer health.

Additionally, this paper explores the varying effects of interpersonal interactions on depressive emotions across different backgrounds, including exercise frequency, social status, and traditional beliefs. Results reveal that for older adults who exercise less frequently, interactions with children and relatives are particularly effective in lowering depressive emotions. For those with higher self-rated social status, interactions with children and relatives have a more pronounced effect on alleviating their depressive emotions. Hence, such interactions may bring them more emotional satisfaction and thus a greater reduction in perceived depression. Finally, regarding traditional belief, respondents are categorized based on their agreement with the CGSS question, "Do you think children should be primarily responsible for caring for their elderly parents?" It reflects the degree to which older adults agree with the Chinese culture of filial piety. The results reveal that interactions with children, siblings, and relatives are more effective in decreasing depressive emotions among older adults who agree more with filial piety.

3.6. Further analysis: different types of interactions with adult children

Previous sections have highlighted that interactions with children are most helpful in reducing depressive emotions among older adults. Now, we further examine the role of different types of interactions with adult children, specifically focusing on intergenerational transfers. Six explanatory variables are created for this purpose, detailed in the Supplementary Materials. Results of the effect of different types of interactions with adult children on older people's depressive emotions are displayed in Table 7. Columns (1)–(3) show that among the three types of backward intergenerational transfers, receiving emotional support (i.e., children listening more frequently to their older parents' thoughts) significantly reduces the elderly's perceived depression. In contrast, receiving money or help with household chores does not significantly decrease older adults' depressive emotions. Similarly, columns (4)–(6) of Table 7 demonstrate that providing emotional support to their children is also beneficial to address depressive emotions among older adults, while the other two types of forward intergenerational transfers do not have significant effects. This suggests that older adults prioritize emotional needs and thus more communication with their children can alleviate depressive emotions, whereas the role of monetary support and non-material assistance is less prominent in terms of mitigating depressive symptoms.

4. Discussion

In the context of the "*Chinese Differential Mode of Association*" in traditional Chinese culture, this paper examines how different interpersonal interactions affect depressive emotions among older adults from a cultural-psychological perspective. Results show that interactions with children, siblings, and relatives contribute to alleviating perceived depression in the elderly, while interactions with friends and fellows do not. Loneliness mediates the impact of interactions with children and siblings on depressive emotions among older adults. It is further demonstrated that emotional support significantly reduces depressive emotions, while monetary support and non-material assistance have weaker effects. Additionally, interpersonal interactions have a greater impact on those who are female, older than 75, have poorer health, exercise less frequently, have higher social status, and hold more traditional beliefs.

First, findings of this paper are consistent with existing literature. Prior research has shown that interpersonal interactions help to reduce depressive emotions among older adults (e.g., Bernier et al., 2019; Schwarzbach et al., 2013; Skałacka & Pajestka, 2021; Solomonov et al., 2019; Tanaka, 2018). This paper's results, indicating that interactions with children, siblings, and relatives are beneficial for older adults' mental health, align with these conclusions. Furthermore, existing literature suggests that interpersonal interactions provide emotional

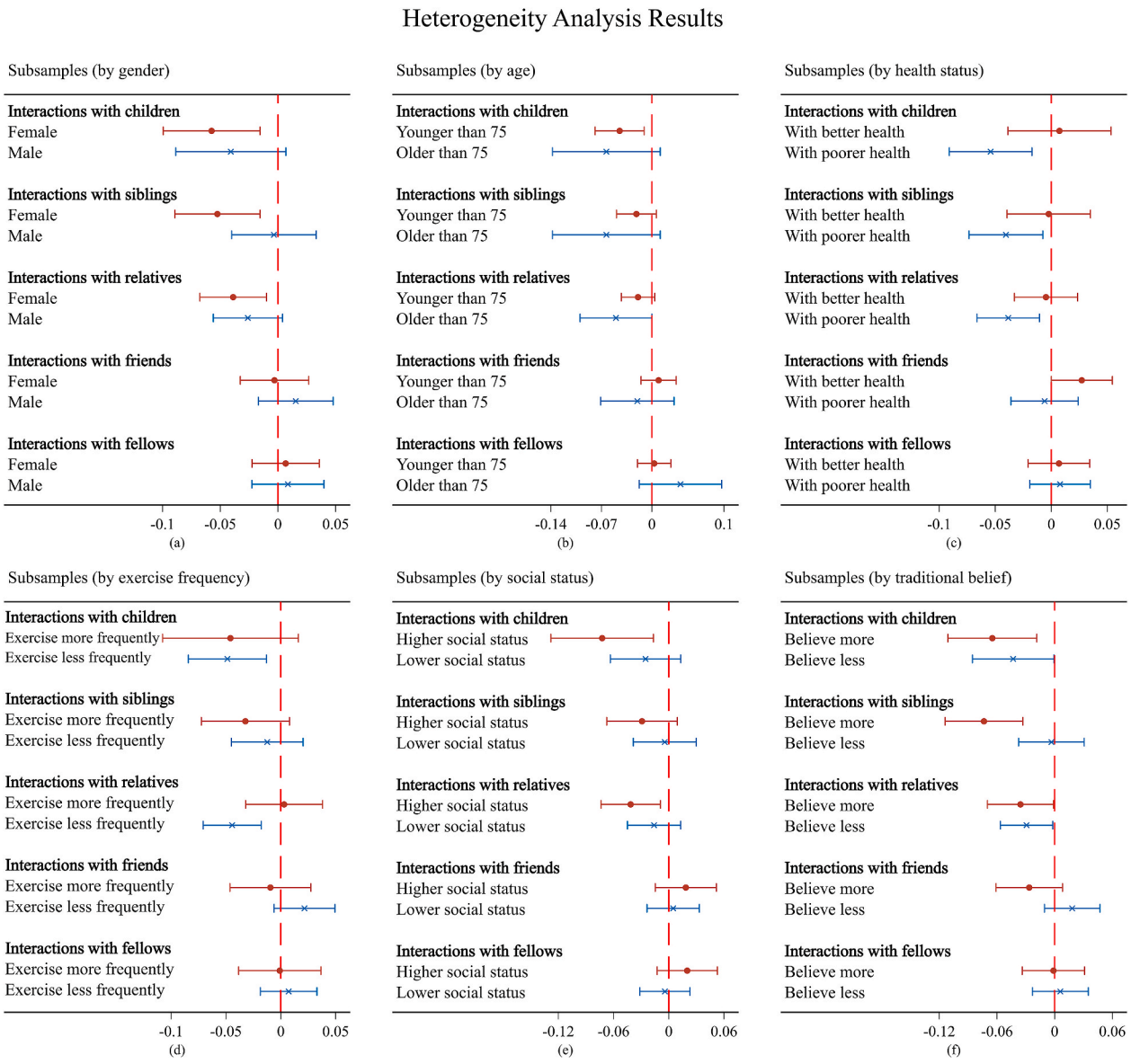

Fig. 4. Heterogeneity analysis results.

support to older adults, thereby reducing their sense of loneliness (Iecovich et al., 2004; Li & Tang, 2021; Yu et al., 2020). On the other hand, research emphasizes the close association between loneliness and depression, identifying loneliness as a significant predictor of depression (Garabrant & Liu, 2021; Hsueh et al., 2019; Shrira et al., 2020; Zhang et al., 2023) in the elderly. The mechanism analysis in this paper indicates that interactions with children and siblings can reduce loneliness and thus depression in older adults, confirming the above literature. Besides, this echoes the findings of Santini et al. (2016) that loneliness mediates the protective role of social support from children in mitigating depressive symptoms.

Second, this paper offers unique contributions compared to existing literature. From a novel cultural-psychological perspective, it examines the heterogeneous effects of interpersonal interactions in different relationships on depressive emotions among Chinese older adults. Although some studies have discussed the effects of interpersonal interactions on depressive emotions among older adults, an in-depth systematic examination of the heterogeneous roles of interpersonal interactions in different relationships is still lacking. While this paper confirms the positive psychological effects of interactions with children, siblings, and relatives, we also find that interactions with friends and fellows are not effective in alleviating depression among Chinese older people. This is inconsistent with some previous studies. For example, a study based on Australian older adults finds that those who interact with friends less than once a month are twice as likely to experience depression, while the frequency of interactions with family members shows no association with depression (Werner-Seidler et al., 2017). Additionally, this paper reveals that other types of interpersonal interactions do not significantly impact loneliness, contrary to findings from related literature based on older adults in Russia and Ukraine (Iecovich et al., 2004). This discrepancy may be due to different cultural contexts. Specifically, China's unique cultural background shapes a "*Chinese Differential Mode of Association*" that differs from Western norms. In China, core family relationships, especially with children, are highly valued and considered the closest bonds, followed by relationships with siblings and relatives, while connections with friends and peers are relatively less intimate. In contrast, in Western culture, people tend to treat relationships with family, friends, and others more equally. Therefore, research from these countries has found that interactions with friends have a positive impact on the mental well-being of older adults (Bélanger et al., 2016). These differences in interpersonal relationship patterns across cultures lead to the aforementioned disparities.

This further highlights the important role of cultural contexts in analyzing interpersonal interactions' effects on older adults' depressive emotions. Besides, this paper provides theoretical innovation in explaining the unique phenomenon of eldercare in China. Most elderly individuals in China prefer to receive care within their families rather than in nursing homes. Despite the generally superior quality of care and material resources provided by nursing homes, home-based care remains the predominant choice for elderly individuals in China. Furthermore, research indicates that older adults residing in nursing homes are often more susceptible to mental health issues compared to those living with family members. Although the Chinese government makes proactive efforts to improve the facilities and service standards of nursing homes, the incidence of depression among elderly residents in these institutions continues to escalate (Tang et al., 2022). This paper effectively elucidates this phenomenon. Results of this paper indicate that interpersonal interactions, particularly with children, contribute to reducing negative emotions among the elderly. Hence, Chinese older adults exhibit a strong preference for home-based care, where they can engage in more frequent and intimate communication with family members, leading to better mental well-being compared to those living in nursing homes. Therefore, this paper's findings underscore the importance of family interactions in shaping the psychological health of Chinese seniors, providing a new theoretical explanation for analyzing their inclination towards home-based care.

Finally, the heterogeneity analysis and further analysis in this paper deepen the discussion in existing literature regarding the relationship between interpersonal interaction and depression among the elderly. Previous studies have found a significant association between social support and depression, particularly among women (Wang & Blazer, 2015). The findings of this paper are consistent with this, indicating that interactions with children, siblings, and relatives have a more significant impact on alleviating depression among elderly women. This may be because women are generally more emotionally sensitive (Li et al., 2022; Xue et al., 2021), thereby highlighting the more prominent role of interpersonal interactions in alleviating their loneliness. Regarding health status, results of this paper suggest that interpersonal interactions have a more significant effect on reducing depression among elderly individuals with poorer health conditions. This finding aligns with previous research results (Bernier et al., 2019). This may be because older adults with poorer health status have a greater need for emotional support to relieve psychological pain. Therefore, interactions with loved ones, especially children, can more effectively mitigate their depressive emotions. In addition to gender and health status, this paper also finds that interpersonal interactions have more pronounced positive psychological effects for elderly individuals aged over 75, those with lower exercise frequency, higher social status, and a stronger adherence to traditional beliefs. Besides, further analysis in this paper reveals that providing emotional support to the elderly exacerbates their depressive symptoms. This is consistent with existing literature, which suggests that emotional connection plays a crucial role in the recovery process of elderly depression patients (Tanaka, 2018). However, some studies find a completely opposite conclusion, indicating that emotional support does not reduce negative emotions among the elderly (Bernier et al., 2019). Therefore, this paper expands the existing literature on the impact of interpersonal interaction on depressive emotions among older adults, providing reference for proposing corresponding policy implications for vulnerable groups.

As a high-risk group for mental health problems, older adults' depressive emotions need to be taken seriously and alleviated effectively. Therefore, findings of this paper also have important practical implications. First, cultural background is crucial when exploring ways to mitigate depressive emotions among older adults. From the perspective of the "*Chinese Differential Mode of Association*" of Chinese interpersonal relationships, this paper finds that interactions with blood-related family members, such as children, siblings, and relatives, can reduce depressive emotions among Chinese older adults. In contrast, interactions with blood-unrelated friends and fellows are less effective. Therefore, when addressing psychological problems, especially depressive symptoms, the cultural, historical, and customary backgrounds of older people should be considered to formulate effective treatment plans. Second, the mitigating effects of interpersonal interactions, especially intergenerational emotional interactions, on depressive emotions among older adults should be noted. It is particularly beneficial for the elderly to interact with children, as this can reduce their depressive emotions to a greater extent. In all types of intergenerational transfers, receiving and providing emotional support can significantly alleviate their perceived depression. Therefore, when treating depression in older adults, communication, companionship, and comfort provided by their children can supplement traditional medicine and psychotherapy. Third, older adults with higher levels of loneliness should be a high priority for attention. This study shows a strong positive correlation between loneliness and depressive emotions. Moreover, the mechanism analysis reveals that loneliness mediates the effect of interactions on depressive emotions. Thus, older adults with higher levels of loneliness may be more prone to depression and need more attention from their families. Forth, it is more important to fully realize the role of interpersonal interactions in alleviating the depressive emotions for the elderly who are female, older than 75 and with poorer health, as well as those who exercise less frequently, have higher social status, and hold more traditional beliefs. Therefore, children, siblings, and relatives should provide them with more care and emotional support to maximize the benefits of interpersonal interactions.

Table 7
Further discussion: Different types of interactions with adult children.

Model	(1) Ordered Probit	(2) Ordered Probit	(3) Ordered Probit	(4) Ordered Probit	(5) Ordered Probit	(6) Ordered Probit
Variable	Perceived depression	Perceived depression	Perceived depression	Perceived depression	Perceived depression	Perceived depression
Receiving emotional support	−0.076** (0.033)					
Receiving monetary support		−0.038 (0.028)				
Receiving non-material assistance			−0.011 (0.028)			
Providing emotional support				−0.065* (0.034)		
Providing monetary support					−0.017 (0.030)	
Providing non-material assistance						−0.018 (0.026)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1326	1325	1321	1325	1322	1320
Pseudo R^2	0.062	0.061	0.061	0.061	0.061	0.060

However, there are two limitations to this paper. First, although the CGSS dataset offers the advantages of a large sample size and national representativeness, it is a cross-sectional dataset. Panel data, by contrast, could provide more robust control over individual fixed effects and facilitate the exploration of the dynamic characteristics of interpersonal interactions and perceived depressive emotions among older adults over time. As such, future research could employ longitudinal data to delve deeper into these relationships. Second, limited by data availability, this paper can only investigate the overall impact of different interaction modes, including meeting in person, calling, chatting online and other ways, on the depressive emotions of older adults, failing to separately analyze each mode's effects. However, in the digital age, online interaction is increasingly significant, underscoring the need for further investigation into its influence on the psychological well-being of older individuals. Thus, future research could endeavor to address this gap by conducting detailed analyses of the differential impacts of various interaction modes on the depressive emotions of older adults.

5. Conclusion

This paper examines the heterogeneous effects of interpersonal interactions in different relationships on older adults' depressive emotions from a cultural-psychological perspective. Results demonstrate that: First, there is heterogeneity in the effects of interpersonal interactions in different types of relationships on depressive emotions among the elderly. Specifically, interactions with children are the most helpful in reducing depressive emotions for older people, followed by that with siblings and relatives. However, interactions with friends and fellows do not significantly alleviate depressive symptoms. This is well explained by the "*Chinese Differential Mode of Association*" in Chinese interpersonal relationships. Second, this paper performs robustness and endogeneity tests from multiple aspects. Findings are robust when using different perceived depression measures, and DDML approach. Third, loneliness is proven to mediate the effects of interactions with children and siblings on depressive emotions among older adults. Specifically, interactions with children and siblings help to alleviate depressive emotions by reducing feelings of loneliness. Fourth, this paper analyzes variations in the effects of interpersonal interactions in different subgroups, considering age, gender, health status, exercise frequency, social status, and traditional belief. Results indicate that these effects are more prominent for elderly individuals who are female, older than 75 and with poorer health, as well as those who exercise less frequently, have higher social status, and hold more traditional beliefs. Fifth, this paper further discusses the effects of different types of interactions with adult children on older people's depressive emotions. It finds that among all the backward and forward intergenerational transfers, both receiving and providing emotional support significantly decrease perceived depression in the elderly. This suggests that more communication with children is beneficial for addressing older adults' depressive emotions, whereas monetary support and non-material assistance are less effective in mitigating depressive symptoms.

Funding

This work was supported by the Project of National Social Science Fund of China [grant number 23CJL007].

Ethics statement

Ethical statement and approval were waived for this study, due to the data used in this article coming from the public database, Chinese General Social Survey (CGSS, http://cgss.ruc.edu.cn/English/Home.htm). This study does not involve human participants or animal subjects. This manuscript also does not contain personal information about any individual or a case history.

CRediT authorship contribution statement

Chao Li: Writing – original draft, Supervision, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Xiang Li:** Writing – review & editing, Writing – original draft, Visualization, Validation, Formal analysis. **Yuhan Zhang:** Writing – review & editing, Writing – original draft, Validation, Formal analysis, Data curation. **Wenyu Lao:** Writing – review & editing, Visualization, Validation, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that support the findings of this study are available from Chinese General Social Survey (CGSS, http://cgss.ruc.edu.cn/English/Home.htm).

Appendix ASupplementary tables

Table A1
Using ordered response models (OLS).

Model	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS
Variable	Perceived depression	Perceived depression	Perceived depression	Perceived depression	Perceived depression
Interactions with children	−0.050*** (0.019)				
Interactions with siblings		−0.025* (0.015)			
Interactions with relatives			−0.029** (0.013)		
Interactions with friends				0.005 (0.013)	
Interactions with fellows					0.006 (0.013)
Controls	Yes	Yes	Yes	Yes	Yes
Constant	2.741 (2.018)	1.673 (2.095)	2.679 (2.013)	3.396 (2.091)	1.213 (2.190)
Observations	1344	1198	1192	1108	1061
Adjusted R^2	0.117	0.109	0.113	0.094	0.098

Table A2
Using ordered response models (Ordered Logit).

Model	(1) Ordered Logit	(2) Ordered Logit	(3) Ordered Logit	(4) Ordered Logit	(5) Ordered Logit
Variable	Perceived depression	Perceived depression	Perceived depression	Perceived depression	Perceived depression
Interactions with children	−0.099*** (0.036)				
Interactions with siblings		−0.050* (0.030)			
Interactions with relatives			−0.051** (0.025)		
Interactions with friends				0.005 (0.026)	
Interactions with fellows					0.013 (0.025)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	1344	1198	1192	1108	1061
Pseudo R^2	0.061	0.059	0.060	0.056	0.056

Table A3
Robustness and endogeneity checks: Using another perceived depression measure (Logit).

Model	(1) Logit	(2) Logit	(3) Logit	(4) Logit	(5) Logit
Variable	Whe_Depression	Whe_Depression	Whe_Depression	Whe_Depression	Whe_Depression
Interactions with children	−0.093** (0.040)				
Interactions with siblings		−0.036 (0.034)			
Interactions with relatives			−0.064** (0.028)		
Interactions with friends				0.004 (0.030)	
Interactions with fellows					0.018 (0.028)
Controls	Yes	Yes	Yes	Yes	Yes
Constant	0.289 (5.010)	−2.181 (5.362)	1.238 (5.020)	0.583 (4.960)	−1.634 (5.612)
Observations	1341	1195	1189	1106	1059
Pseudo R^2	0.083	0.084	0.087	0.074	0.082

Table A4
Mechanism analysis of interactions with relatives.

Model	(1) Ordered Probit	(2) Ordered Probit	(3) Ordered Probit	(4) Ordered Logit	(5) Ordered Logit	(6) Ordered Logit
Variable	Perceived depression	Loneliness	Perceived depression	Perceived depression	Loneliness	Perceived depression
Interactions with relatives	−0.030** (0.014)	−0.005 (0.015)	−0.029** (0.014)	−0.051** (0.025)	−0.006 (0.025)	−0.051** (0.025)
Loneliness			0.326*** (0.038)			0.598*** (0.069)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1192	1191	1191	1192	1191	1191
Pseudo R^2	0.058	0.066	0.085	0.060	0.069	0.089

Table A5
Mechanism analysis of interactions with friends.

Model	(1) Ordered Probit	(2) Ordered Probit	(3) Ordered Probit	(4) Ordered Logit	(5) Ordered Logit	(6) Ordered Logit
Variable	Perceived depression	Loneliness	Perceived depression	Perceived depression	Loneliness	Perceived depression
Interactions with friends	0.007 (0.015)	−0.015 (0.016)	0.013 (0.015)	0.005 (0.026)	−0.029 (0.027)	0.018 (0.026)
Loneliness			0.358*** (0.041)			0.646*** (0.076)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1108	1106	1106	1108	1106	1106
Pseudo R^2	0.053	0.067	0.087	0.056	0.069	0.090

Table A6
Mechanism analysis of interactions with other fellows.

Model	(1) Ordered Probit	(2) Ordered Probit	(3) Ordered Probit	(4) Ordered Logit	(5) Ordered Logit	(6) Ordered Logit
Variable	Perceived depression	Loneliness	Perceived depression	Perceived depression	Loneliness	Perceived depression
Interactions with fellows	−0.008 (0.014)	−0.005 (0.015)	−0.006 (0.014)	−0.013 (0.025)	−0.003 (0.026)	−0.010 (0.025)
Loneliness			0.344*** (0.041)			0.625*** (0.075)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1061	1059	1059	1061	1059	1059
Pseudo R^2	0.053	0.062	0.085	0.056	0.065	0.089

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2024.101703.

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