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Association between chronic diseases and depressive inclinations among rural middle-aged and older adults

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This study investigates the association between chronic diseases and depressive inclinations among middle-aged and older adults in rural Northwest China, emphasizing the moderating role of social relationships. Data collected via face-to-face surveys in a cross-sectional design conducted in March 2021, encompassing 395 participants aged 45 and above, were analyzed using Ordinary Least Squares (OLS) regression. The results indicate that, excluding metabolic diseases (such as dyslipidemia and diabetes), other chronic diseases significantly increase depressive inclinations, particularly eye diseases, chronic lung diseases, heart disease, rheumatoid arthritis, and gastrointestinal diseases. Additionally, a greater number of chronic diseases show a positive association with depressive inclinations. Among social relationships, spousal trust and intergenerational relationship satisfaction were associated with a mitigation of the association between chronic diseases and depressive inclinations, whereas skipped generational caregiving exacerbated this association. Other social relationships, including kinship and friendship network size, neighbor relationships, and villager relationships, exhibited no significant moderating associations. These findings underscore the critical role of positive family relationships and robust social support systems in improving the mental health of rural middle-aged and older adults. They provide practical insights for designing targeted policies and interventions to promote healthy aging and mental well-being in resource-limited rural settings.

Keywords Depressive inclinations, Chronic diseases, Rural areas, Social relationships, Middle-aged and older adults

Geriatric depression is a significant global public health issue due to its prevalence and impact. The World Health Organization estimates that approximately 350 million individuals globally suffer from depression, with prevalence rates reaching 7.5% among women and 5.5% among men aged 55 to 74 years[1]. By 2030, depression is projected to become the leading global health burden, particularly in low- and middle-income countries[2]. In China, rapid population aging has exacerbated this issue. A longitudinal analysis of the China Health and Retirement Longitudinal Study (CHARLS) revealed that the prevalence of depression among older adults increased from 36.8% in 2011 to 44.5% in 2018[3,4]. Depression incidence increases with age and elevates suicide risk in several cases, with suicidal ideation affecting up to 9.9% of them[5]. Consequently, depression is a major driver of morbidity and mortality among older adults. As the aging population grows, China faces dual challenges: addressing a mounting mental health crisis and managing the economic burden of geriatric depression[6].

Existing studies have extensively documented that the rising prevalence of chronic diseases among older adults is frequently accompanied by depression as a comorbidity. The biopsychosocial model underscores the complex integration of biological, psychological, and sociocultural dimensions in medicine. According to this model, the association between chronic diseases and depressive inclinations can be elucidated through the intricate interplay of biological, psychological, and social factors[7,8]. Understanding these interactions is crucial for clarifying disease mechanisms and improving clinical outcomes. The incidence of depression is higher in patients with chronic diseases compared to the general population, adversely affecting physical and mental health and reducing quality of life[9]. A systematic review highlights elevated depression rates among patients

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with cardiovascular disease, diabetes, cancer, arthritis, osteoporosis, chronic lung disease, and kidney disease[10]. Data from the 2013–2018 China Health and Retirement Longitudinal Study (CHRLS) indicate that older adults with 12 chronic diseases have higher depression prevalence than their healthy peers, with comorbidity being widespread[11]. Patients with diabetes, stroke, and arthritis are particularly vulnerable, facing an increased risk of severe depressive symptoms[12]. Depression in cardiovascular disease (CVD) patients often surpasses general population rates, with some cases progression to major depression[13]. Approximately 25% of individuals with diabetes exhibit significant depressive symptoms, with the combined incidence of depression doubling that either condition alone, creating challenges in clinical management[14]. Depression prevalence among Rheumatoid Arthritis (RA) patients reaches 66% and 44.7% in European and Chinese studies, respectively, far exceeding that of healthy individuals[15,16]. Similarly, studies on kidney disease and chronic lung disease confirm their direct contribution to depression risk[17,18]. Patients with multiple chronic conditions show markedly higher depression rates, with evidence linking risk to the number of chronic diseases[19,20]. In conclusion, the strong association between chronic diseases and depression exacerbates health burdens and intensifies demands on healthcare systems, underscoring the importance of integrated care approaches addressing both physical and mental health.

In the field of research on the relationship between social capital and health, many studies have been conducted. Social capital theory posits that the relational resources established between individuals or organizations contribute to the promotion of physical and mental health, with social relationships serving as the core foundation and manifestation of social capital[21,22]. Social capital is composed of structural capital, relational capital, and cognitive capital, which respectively represent the breadth and accessibility of social relationship networks, the quality of these relationships (such as trust and reciprocity), and the shared norms and values that facilitate collective action[23,24]. Social relationships not only constitute the foundation for the accumulation of social capital but also provide significant support for chronic disease patients by alleviating pain, reducing psychological burden, and improving overall health through emotional support and information sharing[25,26]. Furthermore, social relationships are established through interpersonal interactions, encompassing engagements with family members, friends, neighbors, colleagues, and others, which influence the construction of social capital and play a critical role in the interplay between chronic diseases and health outcomes in older adults[27]. On the one hand, the proliferation of digital technology is reshaping the social networks of older adults, leading to significant changes in their structure, quality of interactions, levels of participation, and social capital, which collectively have complex effects on health. The use of the Internet can enhance social capital by expanding social relationship networks, reducing symptoms of depression, and alleviating feelings of loneliness; however, its effects vary based on factors such as gender, age, education level, and usage patterns, and may even increase the risk of depression[28–33]. On the other hand, positive social relationships not only enhance the efficacy of social capital through trust and reciprocity but also improve cognitive function, alleviate stress, and reduce the risks of morbidity and mortality, thereby significantly enhancing the quality of life and life expectancy of older adults[34–36]. On the contrary, poor social relationships can undermine social capital, leading to negative emotions such as depression and anxiety, accelerating cognitive decline, and increasing the prevalence and mortality rates of chronic diseases[37–42]. Additionally, multi-layered social relationships, such as interactions within families and communities, serve as a crucial source of social capital and are key determinants influencing depressive symptoms in older adults[43]. Although existing studies have examined the multifaceted roles of social relationships in health, there is still a lack of in-depth research on the specific impacts of different types of social relationships on health outcomes. Therefore, this study categorizes social relationships into six types: spousal trust, intergenerational relationship satisfaction, skipped generational caregiving, kinship and friendship network size, neighbor relationships, and villager relationships. The aim is to investigate the specific effects of these social relationships on the physical and mental health of older adults.

Although existing studies have extensively investigated the impact of chronic diseases on depression, current research predominantly relies on national datasets or urban samples. While these data provide macro-level insights, they fail to capture the unique sociocultural and resource-related challenges faced by rural older adults. Previous research has demonstrated that prevalence rates of chronic diseases and depression are significantly higher in rural areas compared to urban settings, attributable to factors such as limited healthcare resources, slower economic development, and pronounced disparities in educational attainment[44–48]. Within the broader scope of chronic disease-depression relationships, factors including perceived social support, social participation, activities of daily living (ADLs), physical activity, self-perceptions of aging, sleep disturbances, and emotion regulation have been identified as influential mediators[49–55]. However, these findings largely derive from analyses of national-level data or general population studies, whereas research specifically targeting older adults in rural communities remains strikingly scarce. Rural regions are characterized by distinctive sociocultural norms, traditional familial cohabitation patterns, and tightly-knit neighborhood networks—factors that profoundly shape lifestyle choices and psychological well-being among rural older adults. Social relationships in these contexts are typically confined to kinship networks, neighbors, and fellow villagers, forming a unique social fabric that may significantly modulate the chronic disease-depression association. Nevertheless, current literature inadequately addresses these rural-specific sociocultural and social relationships, resulting in a critical gap in understanding the complex interplay between chronic diseases and depression within this vulnerable population. While prior studies have acknowledged the role of social relationships in health outcomes, they often conceptualize social support as a unidimensional construct or broadly categorize relationships as either positive or negative, neglecting to differentiate the distinct effects of specific relationship types.

To address these limitations, this study focuses on middle-aged and older adults in rural Northwest China, explicitly incorporating the region's unique sociocultural and resource-related contexts. Grounded in the biopsychosocial model and social capital theory, we classify social relationships into six distinct dimensions: spousal trust, intergenerational relationship satisfaction, skipped-generation caregiving, kinship and friendship network size, neighbor relationships, and villager relationships. This approach enables a systematic investigation

of their differential moderating effects on the chronic disease-depression association. To precisely capture the actual conditions of rural older adults, this study conducted in-depth primary data collection in rural areas, aiming to address the shortcomings of existing research regarding study populations, research content, and methodologies.

Based on the above research approach, this paper proposes the following research hypotheses:

Hypothesis 1 The presence of chronic diseases is positively associated with depressive inclinations among middle-aged and older adults.

Hypothesis 2 Different types of social relationships differentially moderate the relationship between chronic diseases and depressive inclinations.

This study aims to provide scientific evidence to support interventions targeted at older adults in rural areas, including optimizing resource allocation, strengthening social support networks, and developing health strategies tailored to rural characteristics. These efforts are crucial for enhancing the physical and mental well-being of older adults, reducing the prevalence of depression, and improving the rural healthcare system's capacity to effectively address health challenges.

Methods

Sampling

This study used cross-sectional data collected by Shaanxi Normal University in rural areas of Shaanxi Province in addition to a randomized controlled trial study on improving maternal and infant health. We targeted individuals aged 45 and above as the study population, and the survey was conducted in March 2021. The sample size was estimated using G power analysis. For an effect size of 0.3 in consideration of our pilot findings and a standard error of 0.025 with a 95% confidence interval, the desired sample size was 426 at the power of 0.8.

A multilevel cluster random sampling method was employed to identify potential participants, following a three-step protocol. First, ten economically underdeveloped counties were randomly selected from five prefecture-level cities within the province. Second, in each sample county, we excluded the township containing the county seat (as these areas tended to be wealthier and more urban). From the remaining townships, we randomly selected 10 townships for counties with more than 10 townships, while for counties with fewer than 10 townships, all townships were included. This process resulted in a total of 79 townships. Finally, several middle-aged and older adults from each township were randomly selected from a list provided by township officials, totaling 495 participants.

Ultimately, 395 valid surveys were included in this study, yielding a response rate of 79.8%. Non-responses were primarily due to two factors: (1) some participants could not be reached during the survey period, and (2) some surveys were deemed invalid due to incomplete responses, either in the outcome variable (PHQ-9 responses) or in the independent variables (chronic disease responses).

Sample characteristics

Table 1 presents the descriptive statistics for the study sample, categorizing individual, family, and medical-related characteristics. The majority of participants were female, comprising 81.2% of the sample. The mean age was 56.09 years (SD = 6.23), with ages ranging from 45 to 76 years. Among the participants, 56.05% were aged 45–56 years, indicating a skewed distribution toward younger ages within the study population. A high proportion of participants reported being married (93.3%). Regarding lifestyle factors, 9.4% of participants

Variables	Description	Mean ± standard deviation (range)/percentage
Panel A: Individual characteristics		
Gender	Female percentage, male = 0, female = 1	81.2%
Age	Continuous variable	56.09 ± 6.23 (45–76)
Marital status	Married percentage, 0 = No, 1 = Yes	93.3%
Alcohol consumption	Alcohol consumption, 0 = No, 1 = Yes	9.4%
Smoking	Smoking status, 0 = No, 1 = Yes	10.1%
Social activities	Social activities participation, 0 = No, 1 = Yes	45.4%
Panel B: Family characteristics		
Children	Number of children	2.75 ± 0.43 (0–6)
Cohabitation	Living with children, 0 = No, 1 = Yes	95.1%
Grandchildren	Number of grandchildren to care for	1.17 ± 1.2 (0–9)
Household income	Annual household income income (RMB 10,000)	2.29 ± 2.64 (0–25)
Panel C: Medical-related characteristics		
Pension insurance	With pension insurance, 0 = No, 1 = Yes	82.2%
Medical accessibility (km)	Distance to a formal medical facility	26.22 ± 20.57 (0–87)
Medical examination	Had medical examination last year, 0 = No, 1 = Yes	26.4%

Table 1. Descriptive statistics of individual, family, and medical-related characteristics.

consumed alcohol, 10.1% were smokers, and 3.7% engaged in both drinking and smoking. Participation in social activities was noted in 45.4% of the sample. On average, participants had 2.75 children (SD = 0.43, range: 0 to 6). A significant 95.1% of participants lived with their children. Additionally, participants cared for an average of 1.17 grandchildren (SD = 1.2, range: 0 to 9). The average annual household income was reported as 2.29 (in units of 10,000 RMB), with a standard deviation of 2.64 (range: 0 to 25). A substantial 82.2% of participants had pension insurance, reflecting a significant level of financial security among older adults in the study. The average distance to the nearest formal medical facility was 26.22 km (SD = 20.57 km, range: 0 to 87 km). Finally, 26.4% of participants reported having undergone a medical examination in the previous year.

Data collection

This study employed a questionnaire-based survey method, where trained enumerators conducted face-to-face interviews with each participant. Prior to the interviews, a consent form detailing the study's objectives, procedures, potential risks and benefits, and privacy protection measures was provided to all eligible participants. To ensure accuracy and consistency during data collection, enumerators underwent intensive training, followed by a pilot study with twenty participants conducted three days prior to the large-scale data collection. All interview questions were displayed on a tablet and asked sequentially by the enumerator, who simultaneously recorded the participants' responses. Each interview was conducted privately to prevent interruptions from family members or others.

Measures

Each participant provided information through an interview covering basic demographics, depression-related knowledge, attitudes toward depression, the Patient Health Questionnaire 9-item depression scale (PHQ-9), treatment for depression, interpersonal relationships, family dynamics, health and medical care, lifestyle behaviors, the Depression Anxiety and Stress Scale (DASS), work and social security, financial status, gender perceptions, and significant life events.

Dependent variable: depressive inclinations

Participants' depressive inclinations were measured using the Patient Health Questionnaire 9-item depression scale (PHQ-9), based on the nine score symptoms of depression[56]. The PHQ-9 scale was a self-assessment screening tool characterized by concise items and ease of use. It was widely employed in hospitals and primary health centers globally for depression diagnosis[57]. The PHQ-9 demonstrated good reliability and validity among older adults in the Chinese community, with a Cronbach's alpha coefficient of 0.832. The correlation coefficients between individual items and the overall scale ranged from 0.451 to 0.693, while inter-item correlation coefficients ranged from 0.233 to 0.523, indicating strong internal consistency and was suitable for depression diagnosis. It also exhibited high credibility, a robust detection rate, and was well-suited for evaluating depression in older adults in China[58].

The primary question posed to participants was "In the past two weeks, how often have the following symptoms been present in your life?" The items included: (1) loss of pleasure; (2) feelings of depression; (3) sleep disturbances; (4) low energy levels; (5) appetite disorders; (6) diminished self-esteem; (7) concentration difficulties; (8) slowed movements; and (9) negative thoughts. Each item was scored on a scale: "0" for none, "1" for a few days, "2" for more than half the time, and "3" for nearly every day. The total score ranged from 0 to 27, with 5 as the cutoff for distinguishing the presence or absence of depressive symptoms. Higher scores indicated greater severity of depressive inclinations.

Independent variable: chronic diseases

Chronic diseases were assessed based on whether participants had been diagnosed with any of 12 common chronic diseases, including hypertension, diabetes, heart disease, dyslipidemia, stroke or cerebrovascular disease, chronic lung disease, liver disease, eye disease, gastrointestinal disease, rheumatism arthritis, cholecystitis or cholelithiasis, and other conditions. Participants were asked: "Do you currently suffer from any of the following chronic diseases?" Each disease was scored as "1" if diagnosed with and "0" if not diagnosed or unknown. A total score of 0 indicates the absence of chronic diseases; a score of 1 represents the presence of one chronic disease; and a score of 2 or higher indicates comorbidity or multimorbidity.

Due to the potential high correlations among the 12 chronic disease variables, this study employed Principal Component Analysis (PCA) to transform these correlated variables into a smaller set of uncorrelated principal components. The Kaiser-Meyer-Olkin (KMO) measure yielded a coefficient of 0.693, which was above the acceptable lower threshold of 0.5. The results of Bartlett's test of sphericity indicated a statistically significant value of 0.000, which was less than the threshold of 0.005, demonstrating that the data were suitable for PCA ($KMO > 0.5$, $P < 0.005$)[59]. Five principal components (Cardiovascular and related diseases, Musculoskeletal and digestive related diseases, Metabolic diseases, Respiratory and liver diseases, and Other conditions) with eigenvalues greater than 1 were extracted through PCA, and these components, along with other covariates, were included in the model to assess multicollinearity. The test result revealed that the maximum variance inflation factor (VIF) was 1.47. This suggested that there was no significant multicollinearity among the variables, indicating a lack of serious linear relationships among the model variables, thereby providing a robust data foundation for subsequent statistical analyses.

Moderating variable: types of social relationships

This study categorized social relationships into six types: spousal trust, intergenerational relationship satisfaction, skipped generational caregiving, kinship and friendship network size, neighbor relationships, and villager relationships. The questions and the scoring criteria were as follows:

(1) Spousal trust: "Do you trust your loved ones?" Scored as "0" for no and "1" for yes.
(2) Intergenerational relationship satisfaction: "Overall, are you satisfied with your relationship with your children's generation (including daughter-in-law and son-in-law)?" Scored on a scale from "1" (very dissatisfied) to "5" (very satisfied), with higher scores indicating greater satisfaction.
(3) Skipped generational caregiving: "Are you caring for grandchildren?" Scored as "0" for no and "1" for yes.
(4) Kinship and friendship network size: "How many close relatives and friends do you have?" Higher scores indicate a larger number of close relatives and friends, representing a more extensive kinship and friendship network size.
(5) Neighbor relationships: "Overall, how is your relationship with your neighbors?" Scored from "1" (never care about each other, just nodding acquaintances) to "4" (most neighbors care a lot about you).
(6) Villager relationships: "Overall, how is your relationship with your fellow villagers?" Scored from "1" (never care about each other, just nodding acquaintances) to "4" (most villager care a lot about you).

Covariates

The following covariates were proposed in this study based on insights from the relevant literature: gender, age, marital status, alcohol consumption, smoking, social activity, cohabitation, household income, pension insurance, and grandchildren[12,19].

Statistical analyses

In this study, we employed Ordinary Least Squares (OLS) regression to examine the relationship between continuous independent variables and the dependent variable, given that all variables included in the regression model are continuous. This method was particularly suitable for effectively evaluating the significance of the regression coefficients. To initially analyze the relationship between chronic diseases and depressive inclinations, we established OLS as the baseline estimation model, as represented by the following equation:

$$\mathrm{Yi} = \alpha + \beta \mathrm{Xi} + \gamma \mathrm{Ci} + \varepsilon \tag{1}$$

In this equation, Yi denoted depressive inclinations, Xi represented chronic disease variables, Ci encompassed control variables, and ε was the random error term.

To further investigate whether social relationships exert a moderating effect, we established an interaction term and specified the following model:

$$\mathrm{Yi} = \alpha + \beta \mathrm{Xi} + \mathrm{bZi} + \mathrm{cXiZi} + \gamma \mathrm{Ci} + \varepsilon \tag{2}$$

In this model, Yi referred to depressive inclinations, Xi referred to chronic disease variables, Zi denoted social relationship variables, XiZi indicated the interaction term, Ci included control variables, and ε again represented the random error term. A significant interaction coefficient C would suggest that social relationships significantly moderated the relationship between chronic diseases and depressive inclinations.

All statistical analyses were conducted using Stata 15.0 software.

Results

Prevalence of chronic diseases and depressive inclinations characteristics

Table 2 presented the prevalence of various chronic diseases among the participants, along with their respective associations with depressive inclinations as indicated by the regression analysis. The findings suggested that the presence of specific chronic diseases is significantly associated with depressive inclinations among middle-aged and older adults in the study population. Specifically, the presence of eye disease, which was present in 16.8% of the population, showed a significant link to increased depressive inclinations ($P=0.001$). A diagnosis of chronic lung disease, with a prevalence of 8.9%, exhibited a significant positive association with depressive inclinations ($P=0.002$). The presence of heart disease, found in 13.6% of the cohort, was significantly associated with depressive inclinations ($P=0.004$). Having rheumatoid arthritis, observed at 27.2%, had a statistically significant positive association with depressive inclinations, indicated by $P=0.005$. Participants with gastrointestinal diseases, affecting 22.2% of the participants, demonstrated a significant association with depressive inclinations ($P=0.005$).

Several chronic disease diagnoses did not show significant associations with depressive inclinations. The presence of hypertension, reported by 25.4% of participants, did not exhibit a significant relationship with depressive inclinations ($P=0.087$). The presence of dyslipidemia, which affected 15.3%, similarly showed no significant effect ($P=0.645$). The presence of other conditions, present in 13.3% of participants, did not show a statistically significant relationship ($P=0.123$). Diagnoses of cholecystitis or cholelithiasis, reported by 14.6%, did not exhibit a significant relationship with depressive inclinations ($P=0.33$). Participants with diabetes were reported by 4% of participants and showed no significant association with depressive inclinations ($P=0.689$). Lastly, the presence of liver disease, with a prevalence of 3%, also did not present a significant relationship ($P=0.374$).

The associations between five principal components of chronic diseases and depressive inclinations

The subsequent analysis focused on verifying hypothesis 1, positing a positive correlation between the existence of chronic diseases and depressive inclinations in middle-aged and older adults. Table 3 summarized the regression analysis results for the associations between five principal components of chronic disease status and depressive inclinations among participants. The presence of cardiovascular diseases (the first principal component), which

Dependent variable	Prevalence (%)	Depressive inclinations			
		β	Std. Err.	95% CI	*P* value*
Eye disease	16.8%	0.155	0.047	0.063–0.25	**0.001**
Chronic lung disease	8.90%	0.154	0.048	0.058–0.249	**0.002**
Heart disease	13.60%	0.144	0.05	0.045–0.241	**0.004**
Rheumatoid Arthritis	27.20%	0.138	0.049	0.042–0.234	**0.005**
Gastrointestinal disease	22.20%	0.136	0.136	0.041–0.231	**0.005**
Hypertension	25.40%	0.085	0.049	− 0.012 to 0.181	0.087
Other conditions	13.30%	0.073	0.073	− 0.02 to 0.166	0.123
Stroke and cerebrovascular disease	8.40%	0.061	0.049	− 0.036 to 0.158	0.214
Cholecystitis or cholelithiasis	14.60%	0.047	0.048	− 0.047 to 0.14	0.330
Liver disease	3%	0.043	0.048	− 0.051 to 0.137	0.374
Dyslipidemia	15.30%	0.023	0.051	− 0.076 to 0.123	0.645
Diabetes	4%	0.02	0.05	− 0.079 to 0.119	0.689

Table 2. Associations between diagnoses of different chronic diseases and depressive inclinations. β is the regression coefficient, CI is for confidence interval. Std. Err. stands for Standard Error. Significant values are in bold.

Dependent variables	Type of chronic disease	Depressive inclinations			
		β	Std. Err.	95% CI	*P* value*
Cardiovascular and related diseases	Hypertension, Heart disease, Stroke and cerebrovascular disease	0.253	0.045	0.163, 0.341	**0.000**
Musculoskeletal and digestive related diseases	Arthritis or rheumatism, Gastrointestinal disease, Eye disease, Cholecystitis or cholelithiasis	0.337	0.045	0.248, 0.427	**0.000**
Respiratory and liver diseases	Chronic lung disease, Liver disease	0.245	0.045	0.155, 0.332	**0.000**
Other conditions	Other conditions	0.097	0.045	0.008, 0.186	**0.032**
Metabolic diseases	Dyslipidemia, Diabetes	0.055	0.046	− 0.034, 0.145	0.223

Table 3. The associations between different types of chronic diseases and depression inclinations. β is the regression coefficient, CI is for confidence interval. Std.Err. stands for Standard Error. Significant values are in bold.

included diagnoses of hypertension, heart disease, or stroke, showed a significant positive association with depressive inclinations ($P < 0.001$). This indicated that individuals diagnosed with cardiovascular conditions tended to exhibit higher levels of depressive inclinations. Participants with respiratory and liver diseases (the fourth principal component), including a diagnosis of chronic lung disease or liver disease, also demonstrated a significant association with depressive inclinations ($P < 0.001$), suggesting that those with these diagnoses were likely to experience higher levels of depression. The presence of musculoskeletal and digestive-related conditions (the second principal component), comprising reported diagnoses of arthritis/rheumatism, gastrointestinal disease, eye disease, or cholecystitis or cholelithiasis, exhibited a strong positive correlation with depressive inclinations as well ($P < 0.001$), indicating a significant impact among individuals with these conditions. Lastly, the presence of other conditions (the fifth principal component), categorized separately, demonstrated a significant relationship with depressive inclinations ($P = 0.032$). In contrast, the presence of metabolic diseases (the third principal component) such as diagnoses of dyslipidemia or diabetes did not show a statistically significant relationship with depression ($P = 0.223$), implying that these diagnoses might not have been as closely linked to depressive symptoms as others.

Regression analysis results

After controlling for variables including gender, age, marital status, alcohol consumption, smoking status, household income, social activities, cohabitation, pension insurance, and the presence of grandchildren, the analysis demonstrated that the number of diagnosed chronic diseases had a highly significant impact on depressive inclinations. The regression results indicated a β coefficient of 1.233 (Table 4). These findings suggested a positive association between the number of diagnosed chronic diseases and the likelihood of depressive inclinations. Specifically, the results indicated that each additional chronic disease diagnosis correlated with a higher probability of depressive inclinations, with significance at the 1% level.

The moderating effect of social relationships

The part focused on testing hypothesis 2, which proposed that the type of social relationships differentially moderated the relationship between chronic diseases and depressive inclinations. The analysis demonstrated a significant positive association between the presence of diagnosed chronic diseases and depressive inclinations

Variables	β coefficient	Std. err.	95% confidence interval	*P* value*
Chronic disease	1.233	0.137	0.963, 1.503	**0.000**
Gender	0.198	0.893	− 1.559, 1.954	0.825
Age	0.046	0.045	− 0.043, 0.135	0.310
Marital status	− 0.393	1.013	− 2.386, 1.600	0.698
Alcohol consumption	0.701	0.846	− 0.964, 2.366	0.408
Smoking	− 0.694	1.068	− 2.796, 1.407	0.516
Household income	− 0.000	0.000	− 0.000, 0.000	0.863
Social activities	− 0.101	0.337	− 0.764, 0.561	0.764
Cohabitation	0.528	1.164	− 1.761, 2.817	0.651
Pension insurance	0.005	0.801	− 1.571, 1.580	0.995
Grandchildren	0.216	0.198	− 0.173, 0.605	0.275
Constant	− 0.733	3.871	− 8.347, 6.881	0.850
Observations	349.000			
R-squared	0.236			

Table 4. Multiple variable regression analysis of factors associated with depressive inclinations. β is the multiple variable regression coefficient, CI is for confidence interval. Std. Err. stands for Standard Error. Significant values are in bold.

and further examined whether this relationship was moderated by social relationships. As shown in Table 5, the interaction between spousal trust and chronic diseases status exhibited a significant negative effect, with a β coefficient of -2.091 (95% Confidence Interval [CI]: -4.169 to -0.012, $P = 0.049$). This indicated that spousal trust significantly weakened the association between the presence of chronic diseases and depressive inclinations, serving as a negative moderator. Similarly, the interaction between intergenerational relationship satisfaction and diagnosed chronic diseases was also significantly negative, with a β coefficient of -0.358 (95% CI: -0.771 to -0.056, $P = 0.09$). At the 10% significance level, this suggested that intergenerational relationship satisfaction also played a significant inhibitory role in the association between participants' chronic diseases status and depressive inclinations, acting as a negative moderator. In contrast, the interaction between skipped generational caregiving and the presence of chronic diseases showed a significant positive effect, with a β coefficient of 0.869 (95% CI: 0.226 to 1.513, $P = 0.008$). This indicated that skipped generational caregiving significantly strengthened the association between diagnosed chronic diseases and depressive inclinations, serving as a positive moderator. For other social relationship variables, including kinship and friendship networks (β = -0.006, 95% CI: -0.034 to 0.021, $P = 0.648$), neighbor relationships (β = -0.009, 95% CI: -0.288 to 0.269, $P = 0.947$), and villager relationships (β = -0.013, 95% CI: -0.304 to 0.277, $P = 0.927$), no statistically significant interaction effects were observed. These findings suggested that kinship and friendship network size, neighbor relationships, and villager relationships did not moderate the relationship between chronic disease status and depressive inclinations. In summary, spousal trust and intergenerational relationship satisfaction significantly mitigated the effect of chronic diseases presence on depressive inclinations, while skipped generational caregiving amplified it. Other social relationship variables showed no moderating effects.

Discussion

This study initially examined the association between the presence of chronic diseases and depressive inclinations among middle-aged and older adults in rural Northwest China. The high prevalence of chronic diseases and depressive inclinations may be closely related to the rural economic underdevelopment, lack of medical resources, and low health awareness among residents. Furthermore, the research investigated the moderating effects of six types of social relationships on the association between the presence of chronic diseases and depressive inclinations, highlighting the significant role of social relationships in the physical and mental health of this group. The findings provide new evidence for family- and community-based policies and interventions, particularly in understanding the complex link between social relationships and health within the specific cultural context of rural areas.

Association between chronic disease and depressive inclinations

The proportion of rural middle-aged and older adults diagnosed with one or more chronic diseases is 76%, which closely aligns with the 76.3% reported in previous studies[60]. However, the detection rate of depressive inclinations was as high as 41.52%, substantially exceeding the reported detection rate of 15-20% in the national survey (CHILS, 2018)[61,62]. The region's underdeveloped economy, inadequate medical resources, and low health awareness of residents may be important factors leading to the above results.

The findings partially supported hypothesis 1, indicating that the presence of certain chronic disease diagnoses is associated with depressive inclinations. As shown in Table 2, diagnoses of eye disease, chronic lung disease, heart disease, rheumatoid arthritis, and gastrointestinal diseases exhibited statistically significant positive associations with depressive inclinations. In contrast, diagnoses of hypertension, diabetes, and dyslipidemia showed no significant associations. The results align with previous research, which highlights the differential effects of the presence of chronic diseases on depressive inclinations. Table 3 further corroborates these differential

Variable	β (Std. err.)	95% CI	β (Std. err.)	95% CI	β (Std. err.)	95% CII	β (Std. err.)	95% CI	β (Std. err.)	95% CI	β (Std. err.)	95% CI
Chronic disease	**3.243***** (1.049)	1.181, 5.306	**2.848***** (0.964)	0.952, 4.744	**0.508*** (0.3)	−0.082, 1.097	**1.299***** (0.175)	0.954, 1.643	**1.265**** (0.494)	0.294,2.236	**1.280**** (0.5)	0.297,2.262
Spousal trust	3.045 (2.584)	−2.039, 8.13										
Spousal trust × Chronic disease	−**2.091**** (1.056)	−4.169,−0.012										
Intergenerational relationship satisfaction			0.513 (0.607)	−0.68, 1.707								
Intergenerational relationship satisfaction × Chronic disease			−**0.358*** (0.21)	−0.771, 0.056								
Skipped generational caregiving					0.023 (0.884)	−1.716, 1.763						
Skipped generational caregiving × Chronic disease					**0.869***** (0.327)	0.226, 1.513						
kinship and friendship network size							0.004 (0.037)	−0.069,0.076				
kinship and friendship network size × Chronic disease							−0.006 (0.14)	−0.034, 0.021				
Neighbor relationships									−0.096 (0.395)	−0.873,0.581		
Neighbor relationships × Chronic disease									−0.009 (0.142)	−0.288,0.269		
Villager relationships											0.095 (0.396)	−0.684,0.874
Villager relationships × Chronic disease											−0.013 (0.148)	-0.304,0.277
Control variables	YES											
Constant	−4.538 (−4.683)	−13.751, 4.674	−2.618 (−4.661)	−11.787, 6.55	−1.077 (−3.825)	−8.601, 6.448	1.341 (3.967)	−6.462,9.145	−0.57 (4.126)	−8.686,7.546	−1.396 (4.146)	−9.551,6.759
Observations	338		349		349		342		348		348	
R−squared	0.233		0.243		0.269		0.243		0.238		0.238	

Table 5. The moderating effect of different types of social relationships on the association between chronic diseases and depressive inclinations. β is the regression coefficient, CI is for confidence interval. Std. Err. stands for Standard Error, which is presented in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Significant values are in bold.

effects: cardiovascular diseases, musculoskeletal/digestive diseases, and respiratory/liver diseases showed strong associations, whereas metabolic diseases did not. These results suggest that the relationship between chronic disease diagnoses and depressive inclinations is condition-specific rather than universal.

The coexistence of chronic diseases and depressive inclinations not only reflects the dual burden of physical and mental health challenges but also further deteriorates the quality of life among rural older populations. The results align with previous research, which highlights the differential effects of chronic diseases on depressive inclinations. This finding can be interpreted through the biopsychosocial model, wherein the clinically significant chronic disease diagnoses often lead to biological disruptions (e.g., inflammation, hormonal imbalances), psychological stressors (e.g., pain, functional limitations), and social factors (e.g., reduced social participation, strained social relationships), collectively exacerbating depressive inclinations.

The presence of distinct chronic diseases has varying effects on depressive inclinations, and comorbidity with depression is relatively common. Except for diagnosed metabolic diseases (such as diabetes and dyslipidemia), other chronic disease diagnoses are significantly associated with depression, a finding consistent with existing literature. Patients diagnosed with rheumatoid arthritis (RA), a chronic systemic inflammatory disease, are frequently linked to pain and disability, which can lead to mental health issues. The comorbidity of RA and depression is common, potentially arising from immune system dysfunction mediated by inflammatory factors and other contributing mechanisms[63,64]. Individuals with cardiovascular disease diagnoses, including hypertension, heart disease, and stroke, are closely associated with depressive inclinations, with those having these conditions being more prone to depression than the general population. Moreover, older adult patients with concurrent cardiovascular diagnoses and depression tend to have poorer prognoses compared to those without depression[65,66]. The presence of gastrointestinal diseases, with a prevalence of 25.4% in this sample, is bidirectionally associated with depressive inclinations, a relationship that has been repeatedly validated through the use of inflammatory biomarkers, potentially mediated by the activation of the brain-gut axis[67]. Additionally, vision impairment resulting from diagnosed eye diseases impacts emotional well-being and quality of life, contributing to the development of depression. The prevalence of depression is higher among individuals with documented vision-related diagnoses[68,69]. Patients diagnosed with chronic lung disease are at a heightened risk of depression. Pulmonary infections can worsen depression by increasing cortisol and inflammatory markers while reducing serotonin levels[70,71]. In the context of liver disease diagnoses, particularly among hepatitis B virus carriers, individuals are more likely to experience mental health issues (30.2% vs. 11.6%), with depression closely linked to the severity of diagnosed liver cirrhosis[72]. Furthermore, a cross-sectional study involving older adult populations in Spain and China found that patients having cholecystitis or gallstone diagnoses had poorer mental health, with a higher prevalence of biliary and gastrointestinal diseases diagnoses among individuals over 60 years of age who had depression[73].

No significant correlation was found between the presence of diagnosed metabolic diseases (such as diagnosed diabetes and dyslipidemia) and depressive inclinations. The prevalence of diagnosed diabetes in the sample was 4%, which is lower than the average rate in rural areas of China (8.2%)[74]. This discrepancy may be attributed to limited patient awareness and underdiagnosis, as approximately two-thirds of individuals with diabetes in China remain undiagnosed[75]. Previous studies have demonstrated substantial regional variation in the prevalence of diabetes diagnosis rates, both internationally and domestically[76,77]. These factors may help clarify the findings of the presence of diabetes and depressive inclinations in this study. Furthermore, no significant correlation was observed between the presence of dyslipidemia diagnoses and depressive inclinations, which contrasts with findings from previous studies suggesting that older adults with documented dyslipidemia in China may be more prone to developing depressive symptoms[78]. Firstly, the prevalence of diagnosed dyslipidemia in this study was 15.3%, significantly lower than the 47% prevalence reported for the older adult population in China[79]. This discrepancy may be attributed to the relatively underdeveloped living environment, economic conditions, and healthcare services in rural areas of Northwest China, where older adults may not receive adequate diagnostic screening or treatment for dyslipidemia, potentially weakening the relationship between detectable dyslipidemia status and depression. Additionally, the result may be influenced by various factors. Some studies have indicated that this relationship is not linear and can be modulated by individual differences such as age, gender, and lifestyle. For instance, some research suggests that lower HDL-C (high-density lipoprotein cholesterol) levels are associated with a reduced risk of depression, while others have proposed a potential positive correlation between HDL-C levels and depression. These conflicting findings may stem from differences in population-level disease ascertainment methods and their respective living environments[80,81].

The research findings reflect not only individual heterogeneity and regional characteristics but also significant influences from socioeconomic, environmental, and ecological factors. In rural areas, township governments and health clinics should provide regular health check-ups and mental health screening services, with particular attention to high-risk populations identified with multiple chronic disease diagnoses. Health education programs should aim to enhance rural residents' awareness of chronic disease diagnosis status and their mental health implications to reduce diagnostic inaccuracies and treatment delays. Healthcare professionals should develop personalized management plans tailored to the specific needs of patients presenting distinct chronic disease profiles.

Moderating role of social relationships

In explicit reference to hypothesis 2, the results provided differential support for its propositions. First, the hypothesis that high-quality social ties (e.g., spousal trust and intergenerational relationship satisfaction) would mitigate the association between the presence of chronic disease diagnoses and depressive inclinations was fully supported, as evidenced by statistically significant negative moderating effects. Second, the hypothesis regarding the exacerbating role of stressful social ties (e.g., skipped generational caregiving) was also supported, with a significant positive moderating effect. Third, the prediction that weak social ties (kinship/friendship networks,

neighbor relationships, villager relationships) would lack moderating effects was fully corroborated, as none of these interactions reached statistical significance. Thus, hypothesis 2 received mixed but interpretable support: while the directional predictions for strong and stressful ties were validated, the null effects of weak ties aligned with expectations. These findings collectively affirm the multidimensional nature of social relationships in shaping health outcomes.

These differences underscore the multidimensional nature of social capital, where diverse social relationships exhibit distinct characteristics in terms of network structure, relationship quality, and functional roles. High-quality or strong ties, such as spousal trust and intergenerational relationship satisfaction, mitigate the impact of participants' chronic disease status on depressive inclinations through emotional support and mutual trust. In contrast, skipped generational caregiving (e.g., caregiving for grandchildren) may act as a source of stress, exacerbating this effect. Weak ties, such as kinship and friendship network size, neighbor relationships, and villager relationships, showed limited moderating effects on the association between documented chronic disease diagnoses and depressive inclinations. These findings emphasize the critical role of different social relationships in shaping the mental and physical health of older adults and highlight the need to consider the type and specific function of social relationships when designing health interventions for populations with clinically confirmed chronic disease status.

The findings indicate that spousal trust significantly mitigates the impact of the presence of chronic disease diagnoses on depressive inclinations. As an intimate and high-quality social relationship, spousal relationships represent a core component of social capital. High levels of trust, reciprocity, and emotional support within spousal relationships effectively alleviate the psychological burden of chronic disease status, reducing depressive inclinations. This underscores the protective role of high-quality social relationships in influencing health outcomes. Such findings are consistent with research conducted in Korea, demonstrating that marital relationships weaken the association between chronic disease diagnoses and depressive inclinations through relationship quality and caregiving behaviors[82]. Based on 2018 CHARLS data (China Health and Retirement Longitudinal Study), a study employing the Actor-Partner Codependency Effect Model and the Difference Model Theory found that high spousal satisfaction can alleviate depressive symptoms for both oneself and one's spouse[83]. Additionally, the nationwide research results of the Chinese General Social Survey (CGSS) highlight that the marital status has a significant impact on the mental health of older adults compared with physical health[84].

The study found that positive intergenerational relationship satisfaction plays a protective role in mitigating the impact of participants' chronic disease diagnoses on depressive inclinations. As a key component of social capital, intergenerational relationship satisfaction provides essential emotional support, caregiving services, and financial assistance from children to their parents, which enhances the accumulation of social capital and psychological resilience among individuals with documented chronic conditions, thereby effectively alleviating depressive symptoms[85]. A literature review indicates that emotional and financial support are critical factors in significantly reducing depressive symptoms in older adults, with strong intergenerational support being linked to lessening depressive symptoms[87,88]. Compared to urban elderly individuals, rural middle-aged and older adults typically face greater challenges in accessing formal medical resources, community services, and social welfare[89]. Therefore, informal intergenerational support may play a more significant role in meeting the physical and mental health needs of older adults. Specifically, support from adult children can not only improve access to treatment for diagnosed chronic diseases for rural middle-aged and older adults with poorer health but also effectively alleviate psychological stress arising from economic hardships or diagnosis-related burdens. This support may be particularly vital for rural elderly individuals compared to their urban counterparts.

In contrast, skipped generational caregiving was found in this study to exacerbate the impact of the presence of chronic disease diagnoses on depressive inclinations. This may be related to the increased psychological and physiological burdens that grandparents face when taking on caregiving responsibilities for their grandchildren. The theory of social capital reflects its double-edged sword effect in this context, as certain social relationships can become sources of stress rather than support in specific situations. In this study, 73.95% of participants reported caregiving for grandchildren, exceeding the national average (66.47%). This finding underscores the prevalence of skipped-generation caregiving as a common familial activity in rural China. Rural households, adhering to an ethics-driven and economy-centered logic, often place grandparents in roles of child-rearing and familial caregiving. While contributing to household productivity, this caregiving responsibility increases physical health risks, emotional distress, and depressive inclinations among older adults. Insufficient family social capital, exacerbated by unequal resource distribution, further intensifies this burden[90]. Grandparents who provide extended caregiving hours, especially in rural areas (3.09 h/day compared to 2.58 h/day in urban areas), experience higher levels of depression, posing significant risks to their physical and mental health[91].

China's 2021 three-child policy has increased the caregiving burden on older adults, further straining already limited family resources[92]. On the one hand, older adults have more time to take care of their grandchildren, and the burden of caregiving has increased. On the other hand, the re-supply and distribution of support resources for older adults and the newly added care resources for the young have put pressure on the limited family resources. Caring for two or more young grandchildren can exacerbate depressive inclinations in older adults[93,94]. The average number of grandchildren cared for by participants was higher than one child, which may also be one reason why skipped generational parenting exacerbates the effects of chronic disease diagnoses on depressive inclinations in this study. The double burden of supporting older adults and raising the children that the family faces needs to arouse the attention of society. In promoting the older adults to play the role of human resources in skipped generational caregiving, we should advocate appropriate birth spacing and improve the social service support system for 0-3-year-olds as soon as possible. Efforts should aim to prevent the need for family care at a young age from translating into caregiving stress for older adults.

Finally, in rural areas, kinship and friendship network size, neighbor relationships, and villager relationships did not exhibit significant moderating effects on the association between the presence of chronic disease diagnoses and depressive inclinations. In the rural regions of Northwest China, this relatively weak social capital may be insufficient to provide adequate support, particularly regarding physical and mental health issues. This could be attributed to the fact that familial and friendship ties often manifest more in emotional interactions rather than practical support, resulting in inadequate protective effects on well-being. Neighbor relationships typically consist of weaker ties, with the support provided being limited to informal daily interactions, lacking in-depth emotional backing, and thus having a limited impact on alleviating depression related to clinically confirmed chronic conditions. In the sociocultural context of rural areas, villager relationships represent a broad but loose form of social network that primarily offers structural social capital (such as network breadth) but falls short in terms of relationship quality and emotional support, making it challenging to significantly enhance mental health outcomes.

In summary, the binary structure of Chinese society results in significant disparities between rural and urban areas in terms of infrastructure development, medical resources, and social welfare benefits. Deeply rooted traditional cultural values in rural Northwest China emphasize marriage, family, and local social networks, which exert a dual influence on residents' social relationships and mental health. On one hand, strong familial and community ties provide essential social support that can mitigate the impact of documented chronic disease status on depressive inclinations. On the other hand, the heavy family responsibilities and social pressures in rural settings may exacerbate psychological burdens. Furthermore, the aging population in this region holds strong traditional values, such as relying on children for elder care and intergenerational support, which further heightens the risk of physical and mental health issues[95]. Therefore, health interventions must be tailored to the unique cultural characteristics of the region, strengthening community-based services and addressing disparities in social capital allocation to prevent the onset and progression of chronic disease diagnoses and depressive symptoms while alleviating the pressures faced by informal caregivers and preserving the positive aspects of traditional support systems. These findings provide important theoretical insights and empirical evidence for future research and targeted intervention strategies.

Limitations

This study was conducted in 2021 during the COVID-19 pandemic. Although the pandemic was relatively stable in China during the data collection period and the sample regions were less affected compared to other areas, the pandemic may still have influenced participants' behaviors and responses, for example, by increasing their levels of stress and anxiety or altering their healthcare-seeking behavior[96]. This represents a limitation of our study, as the results might have differed if the study had been conducted in a non-pandemic context.

This study is a survey of cross-sectional data, and the cumulative effect and dynamic change trajectory of chronic diseases and depressive inclinations are not included in the study. The sample comes from middle-aged and older adults in rural maternity families, and women account for 80%. The proportion of skipped generational rearing was 73.95%, which could not explain the situation of the rural older adults as a whole. The chronic diseases information used in this study is mainly the information that interviewees have been informed that they have chronic diseases. Some interviewees may have been ill but did not go to the hospital for screening, so the accuracy may be biased, and the actual incidence of chronic diseases may be higher than the results of this study. The last item in the 12 categories of chronic diseases is "other conditions", and the questionnaire does not specifically note the name of chronic diseases, which cannot be further analyzed. Moreover, the measurement of social relationships was restricted to basic indicators. Many researchers have analyzed the relationship between gender differences and chronic diseases, depression, and social relationships. Gender differences were not analyzed in this study due to the high proportion of female participants in the sample. Future studies should explore this limitation and investigate these differences in greater depth. Finally, it is acknowledged that the use of self-report screening questionnaires such as the PHQ-9 may overestimate depressive inclinations due to factors such as social desirability bias or pre-exposure to questions about depression knowledge and attitudes.

This study primarily focused on rural areas in Northwest China, which may limit the generalizability of its findings to other rural regions in China or to countries with similar cultural backgrounds. The unique characteristics of this region, including economic development, sociocultural context, and healthcare disparities, warrant careful consideration when extrapolating these results. Future research could validate the universality of these findings by expanding the sample size or comparing data from different regions. We acknowledge the complexity of social relationships in rural areas, particularly the duality of cultural values. While traditional values emphasize familial and community ties that can provide robust support networks, they may also impose additional obligations and responsibilities that exacerbate psychological stress. Therefore, future studies should empirically investigate the dual influence of these cultural values on social relationships and mental health and explore how these dynamics evolve amidst urbanization and demographic changes. Increasing the sample size and comparing results across regions with varying cultural and economic characteristics will further enhance the generalizability of the findings.

Conclusions

Positive family relationships and a robust social support system, along with effective management of chronic diseases, are critical for enhancing both the physical and mental health of middle-aged and older adults in rural areas of China. This study sheds light on chronic disease status constitutes a major risk factor for depressive inclinations, strong social ties can modify this association. Therefore, when formulating policies for the allocation of social resources and family support for the elderly and their families, it is essential to consider their chronic disease burden alongside overall well-being comprehensively. By strengthening intergenerational

cooperation to address disease-related stressors and establishing collaborative multigenerational family models, and integrating chronic disease management strategies, resource sharing and mutual benefits can be achieved, thereby promoting healthy aging even among those managing chronic conditions. The findings of this study may provide significant practical guidance for developing chronic disease-aware policies and interventions aimed at improving the mental health of older adults in rural areas.

Data availability

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

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Author contributions

Conceptualization, X.L., Y.J.; Data curation, X.L., Y.J.; Funding acquisition, Y.S.; Methodology, X.L., Y.J; Project administration, Y.J.; Resources, Y.J.; Software, X.L.; Supervision, Y.J., M.Y., Y.S., N.H. Validation, X.L.; Visualization, X.L., Y.J; Writing-original draft, X.L.; Writing-review & editing, X.L., Y.J., M.Y., Y.S., N.H.

Declarations

Ethics approval and consent to participate

We followed the principals of the Declaration of Helsinki and received ethical approval from the Medical

Ethics Committee of Shaanxi Normal University (Xi'an, China) and Xi'an Jiaotong University (Xi'an, China, No.2020 – 1240). Each eligible participant received a consent form with information regarding program objectives, procedures, potential risks, and benefits, as well as an explanation of privacy protection. All participants signed a written informed consent form to be a part of this study.

Competing interests

The authors declare no competing interests.

Additional information

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