



OPEN The prevalence of anxiety, depression and the mediating role in leprosy patients: a nationally representative cross-sectional study

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Leprosy is a chronic disease that severely affects the skin and nerves, sometimes leading to disability. The deformities deepen stigma and discrimination, even among patients who have been cured. Consequently, leprosy patients are more likely to suffer from mental illnesses than other diseases. A cross-sectional study was conducted in four Chinese provinces (Fujian, Yunnan, Shandong, and Guizhou), including patients who had completed the full course of multidrug therapy (MDT). We assessed anxiety and depression using the SAS and SDS scales, and functional ability using the ADLs. Influencing factors were analyzed with multiple linear regression, and structural equation modeling (SEM) was used to examine the relationships between anxiety, depression. A total of 382 valid questionnaires were received, with a participation rate of 95.5%. Among the participants, 24.08% reported anxiety, 22.51% reported depression, 45.81% experienced impairments in ADLs, and 65.18% had at least one of these conditions. Notably, 3.66% of patients experienced anxiety, depression, and ADL impairments concurrently. Multiple linear regression results showed that the No. of other chronic diseases ($P = 0.004$), income ($P = 0.016$), live with patients ($P = 0.005$), and other ethnic ($P < 0.001$) have a significant correlation with anxiety ($R^2 = 0.546$). Duration of disease ($P = 0.014$), No. of other chronic diseases ($P = 0.000$), live with patients ($P = 0.015$), and live with family ($P = 0.040$) were associated with depression ($R^2 = 0.155$). SEM results indicated that the paths SDS-SAS, SDS-No. of other chronic diseases, and ADLs-SAS had the highest direct effects of 0.75(95%CI:0.656 ~ 0.834), 0.56(95%CI:0.103 ~ 1.016) and $-0.33(95\%CI:-0.490\sim-0.165)$. The association between SAS and the (No. of other chronic diseases) was also indirectly influenced by SDS (0.420), exceeding the direct effect (0.040). Similarly, the indirect effect (-0.240) of SAS between SDS and ADLs was higher than the direct effect (-0.100). This study demonstrates that Chinese leprosy patients exhibit high levels of anxiety and depression, which are associated with impaired daily functioning. Mental health is influenced by multiple factors, including comorbid chronic diseases, living arrangements, disease duration, ADLs, income, and ethnicity. SEM revealed that anxiety mediates the impact of depression on functional limitations, highlighting the complex interplay between psychological factors and physical functioning. These findings underscore the need for comprehensive care strategies and psychosocial interventions to improve mental health and overall well-being in leprosy patients.

Keywords Leprosy, Anxiety, Depression, ADLs, Structural equation modelling

Leprosy is a chronic disease that severely affects the skin and peripheral nerves, sometimes leading to disability. Although the disease has been largely eliminated in many regions, approximately 210,000 new cases are reported worldwide annually¹. The burden of leprosy extends beyond physical impairments to encompass the

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mental health of affected individuals, as patients are more prone to mental disorders than those suffering from other chronic conditions. In recognition of this, the World Health Organization (WHO) has highlighted the importance of mental health issues and its impact on patients².

The current state of mental health among leprosy patients is concerning. Physical deformities exacerbate stigma and discrimination, even in individuals who have been cured, which contributes to psychological disorders such as anxiety and depression³. For instance, a cross-sectional study in India reported that over 70% of patients experienced at least one mental disorder. Specifically, 13–15% of the patients experienced moderate to severe depression, and nearly 20% had attempted suicide^{4,5}. Mental health issues in leprosy patients not only adversely affect the individuals themselves but also place a considerable burden on the government. In addition to exacerbating clinical symptoms, these psychiatric disorders may reduce the patients' ability to perform activities of daily living (ADLs), impair recovery, and ultimately lead to social isolation and low self-esteem⁶. Thus, assessing ADLs is necessary to reduce the burden of mental health issues on patients. Moreover, the coexistence of leprosy with other chronic diseases had a severe impact on the health status and quality of life of persons affected by leprosy, further increasing their demand for health care resources⁷.

The incidence of leprosy has shown a declining trend from 2000 to 2020, with a national detection rate of 0.032 per 100,000 in 2020⁸. However, limited knowledge hampers the development of effective strategies to address the psychological burden of the disease. Despite governmental efforts to reduce incidence and expand access to treatment, psychological and social rehabilitation remains inadequate, leaving many patients who had complete treatment still affected by depression and anxiety. Previous studies have underscored the urgent need for improved mental healthcare services for this population^{9,10}. By focusing on patients who had completed the full course of MDT, the study provides insight into long-term mental health outcomes and leprosy-related functional impairments, without confounding from active infection or treatment. Accordingly, we investigated all leprosy patients who had completed the entire course of MDT in four provinces of China (Fujian, Yunnan, Shandong and Guizhou), with the aim to elucidate the current prevalence of anxiety and depression among patients. Moreover, we explored the associations between these psychiatric disorders, ADLs, and their influencing factors by structural equation modeling (SEM), with the aim of contributing to the development of strategies for alleviating anxiety and depression in leprosy patients.

Materials and methods

Study population

The cross-sectional study was conducted in four provinces of China (Fujian, Yunnan, Shandong, and Guizhou) from January 2020 to December 2021. These provinces are endemic areas, with prevalence rate of 0.20, 0.62, 0.10 and 0.24 per 100,000 population during the study period^{11,12}. Most of the patients who had completed full course of MDT in these provinces were recruited. We checked the China Leprosy Management Information System (LEPMIS) to ensure that no patients were missed⁸. In addition, patients who were confused or unwilling to cooperate with the investigation were excluded from the study.

Recruitment process

This study was reviewed by the Ethical Review Committee of the Jiangsu Provincial Centre for Disease Control and Prevention, which granted an exemption from formal ethical approval because it constituted routine public health practice and did not involve the collection or use of human tissues or biological specimens. In addition, the study was conducted in accordance with the Declaration of Helsinki, and written informed consent was obtained from all leprosy patients and their legal guardians to protect participants' rights and privacy.

Inclusion criteria included:

- 1) Ability to understand the study procedures and complete the questionnaire or interview independently
- 2) Voluntary participation with signed informed consent
- 3) Confirmed diagnosis of leprosy and registration in the LEPMIS system
- 4) Availability for contact and follow-up during the study period

Exclusion criteria included:

- 1) Cognitive impairment, confusion, or severe psychiatric conditions preventing Understanding of the study
- 2) Refusal to cooperate or to sign the informed consent form
- 3) Incomplete patient information
- 4) Concurrent participation in other clinical trials or interventions that could affect the study outcomes
- 5) Individuals whose participation was judged by the investigators to pose a potential health risk or significantly interfere with study results;

Data collection

Data were collected using a structured questionnaire written in Chinese and administered in a question-and-answer format by trained local medical personnel and public health staff from the Centers for Disease Control and Prevention.

Demographic information (including gender, age, ethnicity, income, education level, and residence type) and clinical information (including body mass index [BMI], date of diagnosis, disease duration, delayed diagnostic time, disability status, age at onset, and number of other) were extracted from clinical records in the LEPMIS system and verified by the medical personnel during the interview. Notably, due to delayed diagnosis, some patients already presented with disabilities at the time of diagnosis. During interviews, particular attention was given to patients with recently developed disabilities. The second component assessed patients' self-care

ability using the Barthel Activities of Daily Living (ADLs) Index. The final component included the Self-Rating Anxiety Scale (SAS) and the Self-Rating Depression Scale (SDS), which were used to evaluate patients' anxiety and depressive symptoms.

Some indicators should be explained to avoid misunderstanding: (1) Duration of disease: This indicator measures the length of time leprosy-related symptoms were present before a formal diagnosis was obtained; (2) No. of other chronic diseases: It is used to quantify whether a patient has a co-existing chronic disease other than leprosy (e.g., diabetes or hypertension); (3) Residence forms: (1) Live with patients: Patients choose to live with those also receiving treatment in leprosy villages funded by the local government. In fact, leprosy villages were initially established in the early years of the People's Republic of China as part of an isolated treatment policy. With the the incidence of leprosy has significantly declined. Most leprosy villages have gradually phased out compulsory isolation and transitioned into rehabilitation and care facilities. Existing villages now provide for residents' basic needs through infrastructure upgrades and regular medical visits, while some uninhabited villages have become abandoned. Nationwide, the number of leprosy villages continues to decrease, and their historical functions have largely been taken over by community-based prevention programs and designated medical institutions. (2) Patients who choose to return home and receive treatment while living with immediate family members. (3) Live alone: Patients living independently without any cohabitants. 4. BMI Classification: Patients were categorized as underweight ($< 18.5 \text{ kg/m}^2$), normal ($18.5\text{--}23.9 \text{ kg/m}^2$), or overweight ($> 24 \text{ kg/m}^2$) based on Chinese adult BMI standards.

Measurement of anxiety, depression, and activities of daily living(ADLs)

- 1) **Activities of Daily Living:** The Barthel Index (BI) has been proposed as a standard tool for assessing ADLs in patients because of its reliability, sensitivity, and utility^{13–15}. It evaluates the patient's status in terms of 10 representative aspects of self-care competence. It has been widely used in clinical practice: eating (0–10), bathing (0–5), grooming (0–5), toileting (0–10), transferring (0–15), climbing stairs (0–10), dressing (0–10), bowel control (0–10), urinary control (0–10), and mobility (0–15). The scale ranges from 0 to 100, with 100 indicating full independence and scores below 100 indicating partial or complete dependence.
- 2) **Anxiety:** SAS was developed by Zung in 1971 as a self-report psychometric scale^{16,17}. It comprises 20 items, with 5 of them being reverse-scored. Respondents rate each item on a scale from 1 to 4 based on the following options: 1 (none or minimal time), 2 (a little time spent), 3 (a significant amount of time), and 4 (mostly or all of the time). The total score for these items is an integer calculated by multiplying the raw scores of all things by 1.25. The total score can be categorized as follows: Not anxiety (≤ 50 points), mild anxiety (51–59 points), moderate anxiety (60–69 points), severe anxiety (≥ 70 points). Notably, the SAS has been extensively utilized in Chinese samples and has demonstrated item-total solid correlations and retest reliability. Higher scores on the scale correspond to higher levels of anxiety.
- 3) **Depression** The Self-Rating Depression Scale (SDS), developed by Zung in 1965, contains 20 items, with ten items reverse-scored^{18–20}. The total score of all things is multiplied by 1.25 and rounded to give a final score. It is also a scale developed by Zung in 1965 to assess depression. In the Chinese population, the SDS is categorized as severely depressed (≥ 73 points), moderately depressed (63–72 points), mildly depressed (53–62 points), and not depressed (< 53 points).

Statistical analysis

Data were analyzed using IBM Statistical Products and Services Solutions (SPSS, version 24.0, Armonk, NY, USA), with a significance level set at $\alpha = 0.05$. Continuous variables were expressed as mean \pm standard deviation (SD), and categorical variables as frequencies. The normality of continuous data was assessed using the Kolmogorov-Smirnov test. Comparisons of depression and anxiety scores between groups were performed using independent samples t-tests or one-way analysis of variance (ANOVA). Welch's correction was applied when variances were unequal, and Spearman's correlation analysis was used to explore potential relationships. Categorical variables such as gender, ethnicity, and residence type were converted into dummy variables. Multiple linear regression (MLR) analyses were conducted to identify associations between depression/anxiety scores and these categorical variables. The selection of variables for the final MLR models was based on a combination of theoretical relevance, evidence from previous literature, and statistical significance in univariate analyses. This ensured that retained variables were meaningful predictors while avoiding overfitting, and provided a transparent rationale for including some sociodemographic factors while excluding others.

Given the complex interrelationships among anxiety, depression, and influencing factors such as activities of daily living (ADL), Structural Equation Modeling (SEM) was employed to estimate direct, indirect, and total effects. SEM is a powerful tool for uncovering causal pathways and complex relationships that simple regression cannot fully capture. The fit of the SEM models was evaluated using R^2 values, which indicate the proportion of variance in the outcome explained by the model (e.g., $R^2 = 0.546$ for anxiety indicates that approximately 54.6% of the variability in anxiety scores is explained by the included predictors). Bootstrapping was used to estimate confidence intervals (CI) for indirect effects. If the CI did not include zero, the indirect effect was considered significant. Some indirect effects were found to be larger than the corresponding direct effects, indicating that certain factors may influence outcomes primarily through intermediate variables rather than exerting a direct impact. Clinically, this suggests that interventions targeting these mediating factors could be more effective than focusing solely on direct predictors. Statistical significance was set at $^*P < 0.05$, $^{**}P < 0.01$, and $^{***}P < 0.001$. SEM analyses were conducted using Stata (StataCorp, 2013, Version 15, College Station, TX, USA).

Factors	Classification	SAS	SDS
Age	< 70, 71–80, > 81	NS	**
Gender	Male, Female	*	NS
Income	< 400, 400–800, > 800	***#	*#
BMI	Underweight, Normal, Overweight	NS	*#
Ethnic	Han, Others	**	*
Education	Illiterate, Elementary, Junior or above	**	***
Residence type	Live with family, Live with patients, Live alone	**	**
Age at onset	< 15 years, ≥ 15 years	NS	**
Delayed diagnosis	< 1 year or none, 1–7 years, > 7 years	*#	NS
Duration of disease	< 10 years, 10–20 years, ≥ 20 years	*	***#
Disability	No disability, G1D, G2D	NS	NS
ADLs	Not fully independent, Completely independent	**	**
NO. of chronic diseases	0, 1–3, ≥ 3	**	**

Table 1. Demographic characteristics and univariate analysis of SAS, SDS and ADLs among leprosy patients. #: Welch test when variance is not homogeneous; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; NS: Not Significant.

Scale[N (%)]	1	2	3	4
SAS	290(75.92%)	58(15.18%)	31(8.12%)	3(0.78%)
SDS	296(77.49%)	43(11.26%)	37(9.69%)	6(1.57%)
SAS ONLY	92(24.08%)			
SDS ONLY	86(22.51%)			
SAS + SDS ^{&}	32(8.38%)			
SAS + ADL ^{&}	22(5.76%)			
SDS + ADL ^{&}	22(5.76%)			
SAS + SDS + ADL ^{&}	14(3.66%)			
Any one type	249(65.18%)			
None	133(34.82%)			
Total	382(100%)			

Table 2. The degree of SAS, SDS and ADLs in leprosy patients. [&]: Indicates patients with the listed conditions. SAS, SDS: 1 = None, 2 = mild, 3 = Moderate, 4 = Severe).

Results

Demographic characterization

A total of 400 questionnaires were collected, of which 382 were valid, yielding a participation rate of 95.5%. The Cronbach's α coefficients for the SAS, SDS, and ADLs (BI) scales were 0.91, 0.88, and 0.93, indicating sufficient internal consistency for all scales. The demographic characteristics are shown in Table 1. The results suggested that SAS was significantly higher in patients who were female, income (< 400), ethnic (other), illiterate, live alone, delayed diagnostic time (> 7 years), not fully independent, and suffered from 3 or more other chronic diseases. In addition, patients with age > 81 years, income (< 400), underweight (< 18.5), ethnic (Han), illiterate, live alone, duration of disease (> 20 years), not fully independent, and suffering from 3 or more other chronic diseases had higher levels of depression. In addition, no patients with recently developed disabilities were identified at the time of the interview. Details are provided in the supplementary materials S Table 1.

Prevalence of anxiety, depression and ADL

The levels of depression, anxiety, and ADLs are shown in Table 2. It can be seen that 24.08% of the patients showed varying degrees of anxiety, with mild levels of anxiety (15.18%) being the most commonly reported. Depression (22.51%) was slightly less prevalent than anxiety. Similarly, mildly depressed (11.26%) patients were the most commonly reported. As for ADLs, 175 patients (45.81%) faced challenges in full independence. More seriously, 3.66% of these patients were accompanied by anxiety, depression and impairment in ADLs. Overall, 65.18% of patients had any one of the above conditions.

Univariate correlation analysis

To explore the correlation between depression, anxiety, ADLs and their influencing factors, spearman correlation analysis was conducted (Fig. 1). The results clearly showed that gender, income, ethnic, education, residence forms, duration of disease, ADLs, and the No. of other chronic disease were significantly associated with anxiety ($P < 0.05$). Meanwhile, age, ethnic, education, residence forms, duration of disease, No. of other chronic diseases

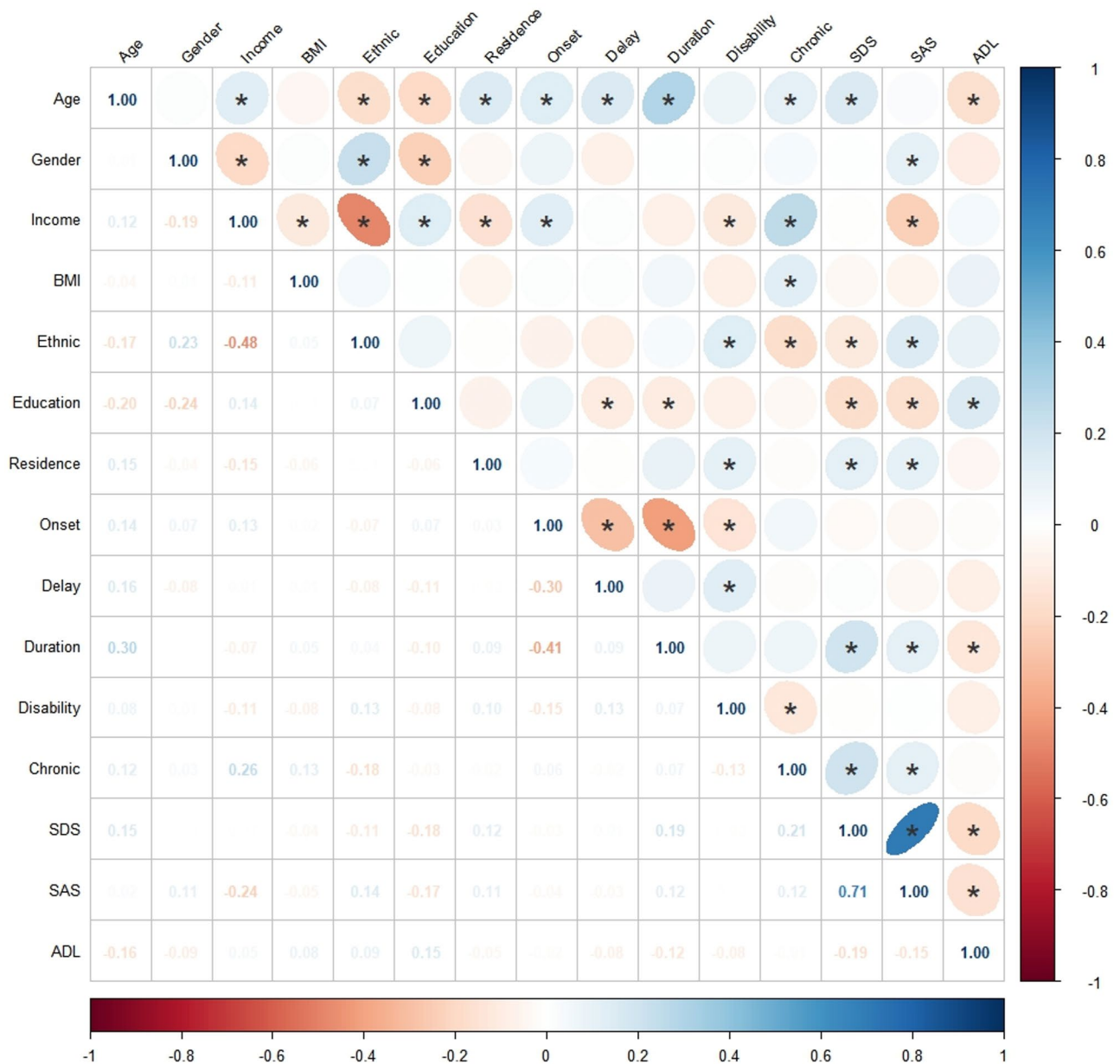


Fig. 1. Correlation Analysis of Demographic Characteristics, disease Status, and Scales in Leprosy Patients. * $P < 0.05$. Abbreviations: Residence, type of residence; Onset, age at disease onset; Delay, delayed diagnosis; Duration, disease duration; Chronic, number of other chronic diseases.

and ADLs were significantly correlated with depression ($P < 0.05$). In addition, SAS and SDS scores also showed significant correlations ($P < 0.05$).

Multivariate linear regression analysis

Statistically significant factors in univariate analyses were used as independent variables, and anxiety or depression index scores were used as dependent variables in multivariate analyses (Table 3). The results showed that the No. of other chronic disease ($P = 0.004$), income ($P = 0.016$), living with patients ($P = 0.005$), and other ethnic ($P < 0.001$) had a significant correlation with the risk of anxiety ($R^2 = 0.546$). Furthermore, the duration of disease ($P = 0.014$), No. of other chronic diseases ($P = 0.000$), live with patients ($P = 0.015$), and live with family ($P = 0.040$) were associated with increased risk of depression ($R^2 = 0.155$).

Results of structural modeling studies (SEM)

The results of the SEM analyses are shown in Table 4; Fig. 2. Table 4 provides the effect coefficients, standard errors, and summary information for the SEM paths. It can be seen that SDS-SAS SDS-No. of other chronic disease and ADLs-SAS has the highest direct effects of 0.75 (95% CI: 0.656 ~ 0.834), 0.56 (95% CI: 0.103 ~ 1.016) and -0.33

Independent variables	B	SE	95%CI		P	VIF
			Lower	Upper		
SAS(R² = 0.546)						
ADL	-0.008	0.019	-0.046	0.030	0.671	1.091
SDS	0.552	0.033	0.487	0.617	0.000***	1.240
Duration of disease	-0.081	0.054	-0.188	0.026	0.136	1.079
No. of other chronic disease	0.563	0.196	0.177	0.949	0.004**	1.131
Income	-0.002	0.001	-0.003	0.000	0.016*	1.391
Education	-0.317	0.637	-1.570	0.936	0.619	1.104
Gender						
Male	REF	REF	REF	REF	REF	REF
Female	0.685	0.932	-1.148	2.518	0.463	1.164
Form of residence						
live alone	REF	REF	REF	REF	REF	REF
Live with patients	-2.723	0.973	-4.637	-0.809	0.005**	1.527
Live with family	-0.967	1.132	-3.194	1.260	0.394	1.548
Ethnic						
Han	REF	REF	REF	REF	REF	REF
Others	4.788	0.944	2.931	6.645	0.000***	1.356
SDS(R² = 0.155)						
Age	0.049	0.066	-0.081	0.178	0.458	1.271
Duration of disease	0.221	0.089	0.045	0.396	0.014	1.141
No. of other chronic diseases	1.411	0.302	0.817	2.005	0.000***	1.046
ADL	-0.107	0.030	-0.166	-0.048	0.000***	1.045
Education	-1.768	0.989	-3.712	0.177	0.075	1.037
Form of residence						
live alone	REF	REF	REF	REF	REF	REF
Live with patients	-3.786	1.548	-6.830	-0.743	0.015*	1.507
Live with family	-3.703	1.796	-7.233	-0.172	0.040*	1.519
Ethnic						
Han	REF	REF	REF	REF	REF	REF
Other	-0.856	1.359	-3.528	1.816	0.529	1.096

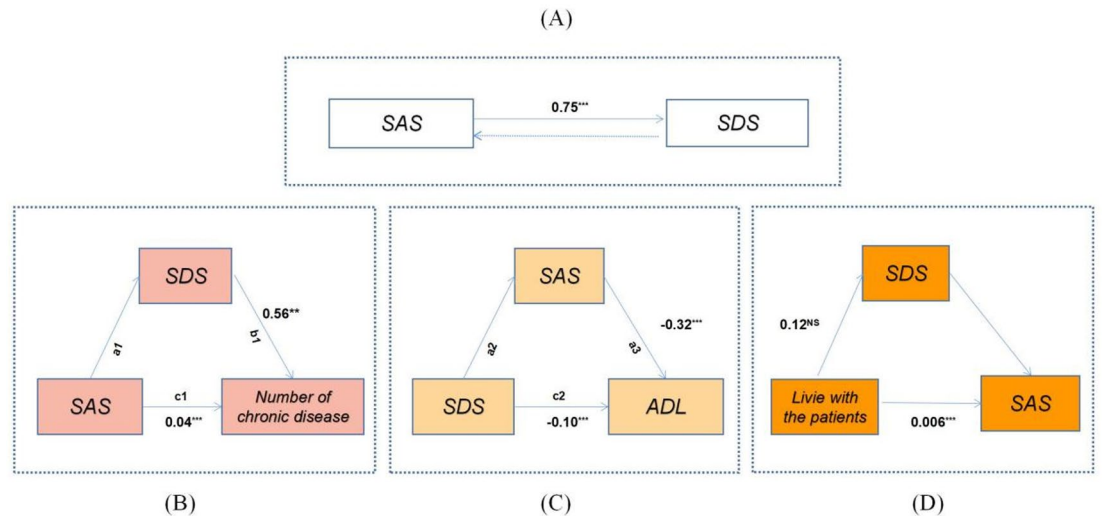
Table 3. Multiple linear regression analysis of factors associated with SAS and SDS scores among leprosy patients. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. REF: Reference category, used as the baseline for comparison. B: Unstandardized regression coefficient. SE: Standard error of the regression coefficient. VIF: Variance Inflation Factor, measures the degree of multicollinearity among independent variables

Simulation path		B	SE	Z	95%CI		P> Z
					Lower	Upper	
SDS	Live with patients	0.123	0.985	0.12	-1.807	2.052	0.901
	No. of other chronic diseases	0.560	0.233	2.4	0.103	1.016	0.016*
	ADL	-0.096	0.027	-3.62	-0.149	-0.044	0.000***
SAS	SAS	0.745	0.045	16.4	0.656	0.834	0.000***
	Live with patients	0.006	0.002	2.63	0.001	0.01	0.008**
	No. of other chronic diseases	0.043	0.001	4.54	0.024	0.061	0.000***
ADLs	SAS	-0.327	0.083	-3.95	-0.49	-0.165	0.000***

Table 4. Analysis of direct and indirect effects of SAS and SDS with influencing factors. SE: Standard error. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. B: Unstandardized regression coefficient. SE: Standard error of the regression coefficient. Z statistic for testing significance.

(95% CI: -0.49~-0.165), respectively ($P < 0.001$). The effects of living with patients (95% CI: 0.001 ~ 0.01), No. of other chronic disease (95% CI: 0.024 ~ 0.061), and ADLs (95% CI: -0.49~-0.165) were also statistically related to SAS ($P < 0.01$).

The relationship between SAS SDS can also be seen in Fig. 2A. As shown in Fig. 2B, the association between SAS and the No. of other chronic diseases was indirectly influenced by SDS. The indirect effect (SDS) between



Figs. 2. SEM model for anxiety (SAS) and depression (SDS) involvement. **A** Direct effects between SAS and SDS; **B** The direct effect between SAS and the No. of other chronic diseases, with SAS acting as a mediating variable in the model. **C** Direct effect between SDS and ADL, with SAS as a model mediating variable; **D** Direct effect between live with patients and SAS, with SDS as a model mediating variable. NS: Not significant. $a_{1-3}/b_{1-3}/c_{1-3}$: direct effects in the model.

anxiety and the No. of other chronic disease ($a_1b_1 = 0.42$) was much higher than the direct effect ($c_1 = 0.04$). We conclude that the indirect effect of depression accounts for more than 90% of the total effect between anxiety and more chronic disease. Figure 2C shows the mediating role of SAS in the relationship between SDS and ADLs. Similarly, the indirect effect of anxiety ($a_2b_2 = -0.24$) accounts for more than 70% of the total effect. Meanwhile, the direct effect between SDS and ADLs should not be ignored ($c_2 = -0.10$). Furthermore, Fig. 2D shows that there was no mediating effect of live with patients on the relationship between anxiety and depression.

Discussion

Anxiety and depressive symptoms are common complications of leprosy, yet their predictors remain poorly understood²¹. To address this gap, we investigated the prevalence of these symptoms and identified key determinants among patients who had completed MDT. Newly diagnosed cases were excluded due to the low prevalence of leprosy in China, the need to assess long-term psychological outcomes without confounding from active infection, and the persistence of mental health issues even after successful treatment. Studying this population provides valuable insights for improving follow-up care and psychosocial support.

Among the cases included in this study, 24.08% experienced anxiety, 22.51% experienced depression, 45.81% faced challenges in ADLs, and 65.18% had at least one of these conditions. The levels of depression and anxiety were higher than those in the general population globally (4.4%/3.6%) and in China (3.58%/5.0%)^{22–24}. The findings suggest that there is an association between mental disease and a history of leprosy. International comparisons showed variability: an Indian study reported rates of 33% for depression and 19% for anxiety, whereas in Nepal the prevalence was lower (10%/13%)⁵. Such discrepancies likely reflect variations in study design, patient populations, assessment tools, and cultural contexts. For example, the Indian study included both newly diagnosed and long-term cases, while our study focused exclusively on patients who had completed MDT, capturing long-term psychological outcomes without the confounding effects of active disease. The Nepalese survey used different screening instruments, which may have contributed to lower estimates compared with the SAS and SDS applied here. Cultural perceptions of psychological distress, as well as differences in healthcare access and social support, may further shape cross-country differences. In China, the relatively high prevalence of mental health symptoms may be related to persistent stigma, physical impairments, limited social support, and socioeconomic or healthcare barriers, which may reinforce isolation, dependence, and chronic psychological stress. These findings highlight the importance of culturally informed psychosocial support and comprehensive mental health strategies that may help address the needs of leprosy patients.

Multiple linear regression analyses were conducted to identify factors associated with anxiety (SAS) and depression (SDS) among patients. A significant positive correlation was observed between anxiety and depression, indicating that patients with higher anxiety scores often also had higher depression scores. This suggests that these psychological conditions tend to co-occur and interact. Such co-occurrence may arise from shared psychological stressors, the burden of chronic disease, functional impairments, and social stigma. Previous studies have similarly reported frequent co-occurrence of depression and anxiety^{25,26}. In our study, lower income was associated with SAS scores, which may be related to financial stress and limited access to healthcare resources. Financial constraints may impede engagement in activities promoting physical and mental benefits, affecting emotional regulation and stress relief²⁷. Ethnicity was also associated with SAS, with patients from minority groups exhibiting higher anxiety scores. This association may reflect differences in cultural

beliefs, lifestyles, education, and socioeconomic status, and increased exposure to prejudice or discrimination, which could contribute to elevated psychological burden^{28–30}. Finally, cohabitation with other leprosy patients was inversely associated with anxiety. It is possible that anxiety is more prominent during the early stages of the disease, and living with peers who have undergone similar experiences may provide emotional reassurance and opportunities for discussion of health-related challenges, thereby reducing feelings of social isolation and loneliness. This form of social interaction may preferentially attenuate acute anxiety arising from uncertainty, treatment burden, and social stigma. In contrast, depression often reflects more chronic psychological burden, including feelings of helplessness and cumulative disability-related stress, which may be less responsive to peer presence alone. Therefore, while peer-based social support may help buffer acute stress and anxiety, its association with long-standing depressive symptoms appears more limited, highlighting the importance of considering comprehensive psychosocial support strategies for depression among leprosy patients.

The SDS results revealed a positive correlation between the duration of disease and live with family. Longer disease duration may lead to treatment fatigue and increase risk of depression^{31–33}. This prolonged treatment and care process can lead to feelings of frustration, helplessness, and despair, which could be related to depressive symptoms. Regarding living arrangements, both “living with patients” and “living with family” were negatively correlated with SDS scores compared to living alone. This observation may reflect enhanced social support and emotional connection provided by cohabitants, which could help buffer stress and improve overall mental well-being. Individuals living alone may lack immediate emotional support, making them more vulnerable to depressive symptoms during the chronic course of leprosy^{34,35}. Additionally, the No. of other chronic diseases and ADLs may also associated with both SAS and SDS. It is well known that leprosy is a chronic disease that requires long-term treatment and nursing care, and the treatment regime may become even more damaging when the patients have comorbid conditions such as hypertension or diabetes. This complexity likely contributes to the observation of higher anxiety and depression scores in patients with three or more chronic diseases. ADL impairments were also related to elevated SAS/SDS scores. Although the exact mechanisms are unclear, it is plausible that functional limitations themselves, even in the absence of social stigmatization, may contribute to anxiety or depression due to reduced independence and self-efficacy. Experts suggested that patients with ADL impairments may be more prone to psychological distress, although the relationship could sometimes be bidirectional, with anxiety or depression further limiting daily functioning. However, due to the limited sample size, no statistically significant association was found between disability and mental health outcomes.

As previously described, we conducted SEM analyses to elucidate the mediating effects of SAS and SDS among the relevant factors (No. of other chronic diseases and residence forms). Our findings suggest that the direct impact of anxiety on the count of diverse chronic disorders among leprosy patients may be limited. Put differently, this means that the association between anxiety and the escalation of other chronic ailments may be influenced by depression. This aligns with accumulating evidence suggesting shared biological mechanisms linking anxiety, depression, and the emergence of chronic disorders later in life. We found a significant mediating effect of anxiety between depression and reduced ADLs. The relationship highlights the intricate interplay between psychological factors in leprosy patients and their impact on functional autonomy. This concurs with the findings of Peng et al.’s study, where they indicated that depression is a pivotal predictive factor for impairments in activities of daily living³⁶. It was worth noting that they did not identify a mediating relationship between depression and ADL in the research. In contrast, a study conducted by Atsuro et al. in Bangladesh reported no significant differences in ADLs between leprosy patients and healthy individuals, and the relationship between anxiety and depression in patients was not examined³⁷. These discrepancies indicate the need for further, large-scale surveys to verify and refine our understanding of the psychological determinants of functional outcomes in patients.

This study represents the first systematic assessment in China of anxiety and depression among leprosy patients who have completed MDT, providing insights into long-term psychological outcomes. It integrates functional ability and mental health by linking ADL impairments with psychiatric symptoms, highlighting their potential combined impact on daily life. Using SEM, we explored complex relationships and mediating effects, including the previously unreported potential role of anxiety between depression and ADL limitations. The analysis is based on multi-province dataset covering four provinces in China, which may enhance representativeness and generalizability. By comparing findings with studies from India and Nepal, the study situates the psychological burden of leprosy within an international context. Additionally, it identifies specific sociodemographic and clinical influencing factors, such as chronic diseases, residence, income, and ethnicity, to inform targeted interventions. We found that anxiety and depression often co-exist among leprosy patients, placing a heavy burden on them, which may underscores the urgency of comprehensive care strategies and strengthened overall patient management. Self-help health groups have been established in some leprosy-endemic countries, where patients meet regularly and are taught how to care for ulcers and other disabilities to promote physical and psychological recovery. In our view, general hospitals could consider improving diagnosis and treatment, promoting early detection, and shorten disease duration, thereby reducing anxiety and depression. Furthermore, local measures could be implemented to reduce stigma, such as producing video and audio programs and training medical staff.

Limitations

Several limitations of this study should be acknowledged. The small sample size and predominance of elderly participants, reflecting the low prevalence of leprosy, may limit generalizability. Recall and other survey-related biases could have influenced the findings. The cross-sectional design precludes causal inference, restricting conclusions regarding the directionality of associations between ADLs and mental health. Permanent sequelae and participants’ psychiatric histories were not assessed, which may contribute to psychological distress even after treatment. Moreover, leprosy may continue to affect mental health through persistent stigma, subtle

functional impairments, reduced self-esteem, or socioeconomic and healthcare-related challenges. Future research **could consider** employ longitudinal designs to clarify causal relationships, incorporate assessments of sequelae and pre-existing psychiatric conditions, explore interactions among sociodemographic and clinical factors, and evaluate interventions aimed at alleviating anxiety and depression. Such studies would provide a more comprehensive understanding of mental health outcomes in leprosy patients and guide evidence-based psychosocial care.

Conclusion

This study indicates a high prevalence of anxiety and depression among Chinese leprosy patients, which may be associated with their daily functioning. Anxiety and depression often co-occur, with factors such as chronic diseases, residence forms, disease duration, ADL impairments, income, and ethnicity influencing mental health. Anxiety appeared to mediate the relationship between depression and functional limitations, highlighting the complex interplay of psychological factors. These findings underscore the need for comprehensive care, timely treatment, psychosocial support, and stigma reduction could help to improve the mental health and overall well-being of leprosy patients.

Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to the Chinese government's requirement for confidentiality of information on leprosy patients but are available from the corresponding author upon reasonable request.

Received: 8 March 2024; Accepted: 31 October 2025

Published online: 07 November 2025

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Acknowledgements

We sincerely thank all the staffs in Shandong, Fujian, Hunan and Yunnan who participated in this survey.

Author contributions

XL: writing, methodology, software and formal analysis. JZ: methodology, software and formal analysis. LX: data curation, software and writing. GL: conceptualization and formal analysis. YL: methodology. LZ/PW: conceptualization, supervision, and writing.

Funding

This research was funded by the Research Project of China Disabled Persons' Federation on assistive technology, grant number 2021CDPFAT-46.

Declarations

Ethics approval

The study was reviewed by the Ethical Review Committee of the Jiangsu Provincial Centre for Disease Control and Prevention, which granted an exemption from formal ethical approval as it constituted routine public health practice.

Informed consent

Informed consent was obtained from all individual participants (or their legal representative) prior to inclusion in the study.

Competing interests

The authors declare no competing interests.

Additional information

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1038/s41598-025-27084-9>.

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