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Association between living arrangement and psychological well-being among patients with major depressive disorder: the moderating role of body mass index

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Abstract

Background Major depressive disorder (MDD) is highly prevalent globally, significantly impacting psychological well-being (PWB). Herein, we aim to evaluate the impact of different living arrangements on PWB in individuals with MDD and explore the potential moderating role of BMI in this relationship.

Methods Participants with MDD were recruited from a specialist mental health hospital between December 2019 and April 2023. The diagnosis of MDD was assessed by trained psychiatrists using the Mini-International Neuropsychiatric Interview (M.I.N.I.). Psychological well-being was evaluated using the World Health Organization-Five Well-Being Index. Univariable and multivariable logistic regression models were used to examine the association between different living arrangements and PWB at the 12-month follow-up. The Participants were categorized into underweight, normal weight, and overweight groups based on BMI, followed by conducting stratified analysis.

Results After adjusting for covariates, living with family (AOR = 1.80, 95%CI = 1.14–2.87, $P = 0.026$) was associated with a higher PWB. There was significant moderating effect of BMI on the association of living arrangements with PWB ($P = 0.049$). The stratification analyses revealed significant associations between living arrangements and PWB in the normal weight group, while no significant associations were found in the underweight and overweight groups.

Conclusions Living with family was significantly associated with higher levels of PWB in individuals with MDD, especially among those with a normal BMI. These findings highlight the synergistic effect of living with family and maintaining a healthy BMI on improving PWB in depressed individuals.

Keyword Major depressive disorder, Psychological well-being, Living arrangements, Body mass index, Cohort study

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Background

Major depressive disorder (MDD) is highly prevalent globally, contributing significantly to disability-adjusted life years due to its substantial impact on quality of life and productivity [1]. A growing body of research has explored the diverse factors that contribute to the onset and persistence of MDD, including biological, social, and environmental factors [2, 3]. Major depressive disorder is associated with reduced psychological well-being (PWB), as well as impaired emotional, social, and physical functioning [4].

Psychological well-being is broadly defined as"the combination of feeling good and functioning effectively,"encompassing both emotional satisfaction and daily functioning [5]. In the context of MDD, PWB is not only an indicator of recovery but also a critical factor in preventing relapse. According to the positive clinical psychology framework, enhancing protective factors—those elements that contribute to resilience and psychological strength—is as important as mitigating risk factors for depression when seeking to prevent the recurrence and maintenance of depression [6]. It is posited that strengthening PWB could serve as a buffer against future depressive episodes, providing the impetus to target PWB as a central element in maintaining long-term mental health [7]. Therefore, understanding the factors that influence PWB is vital for developing comprehensive therapeutic strategies to support recovery and sustained well-being in individuals with MDD.

In recent years, emerging evidence has shown that living arrangements can significantly influence. Certain arrangements have been associated with improved PWB, particularly by offering emotional and practical support for individuals with depression [8]. The foregoing relationship has been extensively studied across various populations, particularly among older adults and adolescents [9–15]. For example, older adults living with family members often report better PWB than those living alone, largely due to the support received within family settings [11]. Similarly, the family structure and living arrangements during adolescence have been closely linked to the PWB, influencing their social development and mental health outcomes [12]. However, these findings may not generalize to individuals with MDD who may be differentially affected by impaired psychosocial functioning when compared to the general population. In addition, limited research has specifically examined the association between living arrangements and PWB among individuals with MDD.

Body Mass Index (BMI), a common indicator of weight relative to height, has been linked to various health outcomes [16], including PWB and depression. A separate multicenter study indicated that pregnant women with a BMI greater than 25 kg/m^2 are associated with lower PWB compared to those with a BMI below this threshold [17]. Similarly, analyses from a Finnish twin cohort support an association between BMI and PWB. One study using a co-twin control design found that heavier monozygotic twins had poorer PWB than their leaner co-twins [18]. Another analysis from the same cohort reported an inverse U-shaped relationship, suggesting that both low and high BMI are associated with reduced PWB [19]. However, findings across studies remain inconsistent. For example, a study in China found higher BMI to be linked with greater PWB [20], while other research has reported no significant association after adjusting for confounders [21]. Overall, the relationship between BMI and PWB remains inconclusive and warrants further investigation.

According to a study conducted in Singapore, loneliness may act as a potential mediator in the relationship between living arrangements and PWB [22], and growing evidence indicates that individuals with obesity experience significantly higher levels of social isolation and loneliness compared to those without obesity [23–27]. Considering that the role of BMI in the association between living arrangements and PWB in patients with MDD is unclear, and the effect of the interactions between BMI and living arrangement contribute to PWB is unknown, this cohort study hypothesizes that having a normal BMI and living with family may synergistically enhance the PWB of individuals with MDD. This study aimed to investigate the relationships between various living arrangements and PWB in patients with MDD, and to assess whether BMI moderates the association between living arrangement and PWB.

Methods

Study design and participants

Data were sourced from a patient subgroup within the Depression Cohort in China (DCC) study (ChiCTR registry number: 1900022145), an extensive and ongoing cohort study focused on individuals with a diagnosis of MDD or at high risk of developing depression. The design and methodology of the DCC study have been comprehensively described in earlier publications [28]. The Toronto-based Building Bridges to Integrate Care (BRIDGES) model is used in DCC to connect primary care, specialist hospitals, and community services, standardizing the screening, diagnosis, and treatment of subthreshold depressive symptoms and MDD [29].

Participants who met the criteria for MDD between December 2019 and April 2023 were recruited based on the specialist mental health hospital for the study. The inclusion criteria were as follows: (1) 18–65 years; (2) diagnosed with MDD by trained psychiatrists using the Mini-International Neuropsychiatric Interview based on the Diagnostic and Statistical Manual of Mental

Disorders 5th edition; (3) inpatients or outpatients; (4) with or without medication; and (5) having the ability to comprehend research questionnaires and independently provide informed consent. Exclusion criteria were as follows: (1) current or historical diagnosis of other psychiatric disorders (e.g., bipolar disorder, schizophrenia, paranoid mental disorder, mental disorders caused by epilepsy, or mental retardation); (2) alcohol or drug dependence disorders; and (3) pregnant or perinatal females. After participating in the baseline survey, patients were followed up for 12 months. The DCC study was approved by the Institutional Review Board of the School of Public Health, Sun Yat-sen University (L2017044), and written informed consent was acquired from all individuals before participating in the study.

A total of 1424 patients with MDD were enrolled. After excluding patients with baseline World Health Organization-Five Well-Being Index (WHO-5) ≥ 50, and those with missing WHO-5 data at follow-up (n = 60), the study included 1364 participants at baseline. After excluding patients who were lost (n = 606), this study ultimately included 758 patients with MDD. Figure 1 shows the inclusion and exclusion process of participants.

Independent variables

The independent variables included living arrangements and BMI. Living arrangements were classified as follows: living alone, living with family and living with non-relatives. BMI, a continuous measure of body weight relative to height, was calculated as body weight in kilograms divided by squared height in meters (kg/m^2). We also categorized BMI into three distinct groups: underweight (BMI < 18.5), normal weight (BMI < 24), and overweight (BMI ≥ 24) following the recommendations of China Obesity Task Force [30] and the Working Group on Obesity in China [31].

Dependent variables

PWB was assessed at baseline and 12 months using the WHO-5 [32]. The scale is a unidimensional psychological measurement tool designed to assess the respondent's positive emotions and mental state over the past two weeks. It consists of five positively worded items, such as"feeling cheerful and in good spirits,""feeling calm and relaxed,"and"feeling active and vigorous,"aiming to reflect the overall PWB of the respondent. Each item on the scale is scored from 0 to 5, representing the range from the worst to the best PWB. The total score is then converted to a 0 to 100 scale, and stratified: scores ≥ 50 indicate good PWB, while scores < 50 suggest poor PWB [33]. This scale is commonly used to evaluate mental health conditions and is known for its simplicity and ease of use [34], and had high reliability in this study (Cronbach's alpha at baseline and 12 months were 0.804 and 0.959, respectively).

Covariates

Potential covariates were assessed via self-report questionnaires at baseline, including sociodemographic characteristics, lifestyle and health characteristics, psychological characteristics, and clinical characteristics.

Sociodemographic characteristics included: age, gender (male and female), marital status (married and unmarried), education level (junior high school or below; senior high school; and college or above), and household income (< 10 000 yuan/month; 10 000–49 999 yuan/month; and $\geq$ 50 000 yuan/month).

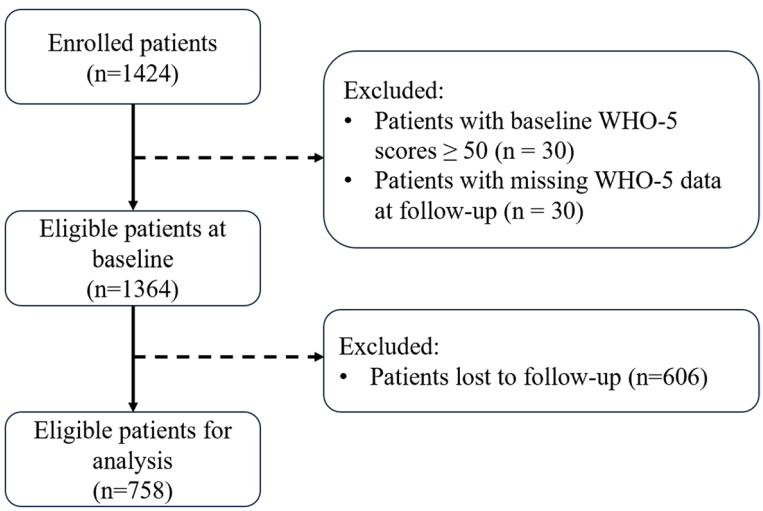

Fig. 1 The inclusion and exclusion process of patients with MDD

Lifestyle and health characteristics included: current cigarette smoking (yes and no), current alcohol drinking (yes and no), exercise habits per week (yes and no), sleep quality (good; average; poor; very poor), childhood trauma history and chronic diseases history. Current smokers/drinkers were defined as smoking cigarettes/drinking alcohol for one or more days during the past 30 days. Exercise habits were defined as exercising once a week for at least 30 min each time. Childhood trauma history was assessed using the Short Form of the Childhood Trauma Questionnaire (CTQ-SF, Cronbach's $\alpha = 0.89$ in this study), which has demonstrated good psychometric properties and cultural equivalence in the Chinese population [35]. Chronic diseases history was defined as the prevalence of any of the following: (1) hypertension; (2) diabetes; (3) heart disease; (4) apoplexy; (5) thyroid disease; (6) tumors; and (7) others.

Psychological characteristics included: the severity of depressive symptoms, the severity of anxiety symptoms and resilience. The severity of depressive symptoms was assessed using the Patient Health Questionnaire-9 (PHQ-9, Cronbach's $\alpha = 0.82$ in this study) [36], which has been validated in the general Chinese population [37]. The severity of anxiety symptoms was assessed using the Generalized Anxiety Disorder Scale-7 (GAD-7, Cronbach's $\alpha = 0.89$ in this study) [38]. Resilience was assessed using the Connor-Davidson Resilience Scale (CD-RISC, Cronbach's $\alpha = 0.91$ in this study) [39].

Clinical characteristics included: the severity of insomnia symptoms, previous episodes (yes and no), recent medication use (yes and no), and age of onset. The severity of insomnia symptoms was assessed using the Insomnia Severity Index (ISI, Cronbach's $\alpha = 0.91$ in this study) [40]. Previous episodes refers to whether the patient has experienced prior depressive episodes that were separated from the current episode by a period of at least two months of remission, during which the patient experienced significant mood improvement. Recent medication use refers to whether the patient has taken any depression-related medication in the past six months, regardless of whether the medication was prescribed by a healthcare provider or self-purchased. Age of onset refers to the age at which the patient first experienced depressive symptoms.

Statistical analysis

First, participants were stratified into two groups based on their WHO-5 scores, using a cutoff value of 50 points. Descriptive statistics were performed for each variable within these two groups to characterize their profiles. For continuous variables, data were summarized using median and interquartile range (IQR). Categorical variables were presented as frequencies and percentages. To compare continuous variables between the two groups, Wilcoxon rank-sum tests were utilized, while comparisons for categorical variables were conducted using chi-square tests.

Second, univariable and multivariable logistic regression models were used to examine the association between different living arrangements and PWB at the 12-month follow-up. The living arrangement 'Living Alone' was set as the reference group. Model 1 was unadjusted, assessing the relationship between living arrangements and PWB without controlling for other factors. Model 2 was adjusted for covariates identified from the descriptive analysis, specifically those variables with P value less than 0.10 or widely reported in the literature (i.e., sex and age), to control for confounding effects and provide a more accurate estimation of the relationship between living arrangements and PWB. Missing data for any covariates in Model 2 were handled using direct deletion, as the glm function in R excludes observations with incomplete data by default.

Third, to assess multiplicative interactions between living arrangements and BMI on PWB, we introduced a product interaction term (living arrangements × BMI) into the multivariable logistic regression models. The AOR (95% CI) and P value of the product term were used to measure interaction on the multiplicative scale. Subsequently, stratified analyses were conducted to assess whether the association between living arrangements and PWB varied by different BMI groups.

Last, we conducted a sensitivity analysis. To adequately address missing data, we repeated all analyses using imputed data sets with the multiple imputation method by chained equations.

All analyses were conducted using R statistical software version 4.4.1. Statistical significance was defined as a two-tailed P value < 0.05.

Results

Participant characteristics

In the initial cohort of 1424 participants, 758 (53.2%) remained after 12 months of follow-up, with the reduction attributable to loss to follow-up and missing data. There were no statistically significant differences in baseline characteristics between the 758 participants who completed the follow-up and the original cohort of 1424 participants (Supplementary Table S1).

The baseline characteristics of the study participants are presented in Table 1. In the final analysis, we included participants with a median (IQR) age of 27.0 (9.0) years, among whom 228 (30.1%) were males and 530 (69.9%) were females. Individuals with higher PWB at the 12-month follow-up tended to be older, more often married, and reported more favorable childhood experiences,

Table 1 Baseline characteristics of 758 participants with MDD

	Total $N=758$	Poor PWB $N=464$	Good PWB $N=294$	P^a
Gender, n (%)				0.816
Male	228(30.1)	141(30.4)	87(29.6)	
Female	530(69.9)	323(69.6)	207(70.4)	
Age, median (IQR)	27.0(9.0)	26.0(8.0)	27.0(8.8)	0.014
Education level, n (%)				0.515
Junior high school or below	36(4.7)	19(4.1)	17(5.8)	
Senior high school	83(10.9)	53(11.4)	30(10.2)	
College or above	639(84.3)	392(84.5)	247(84.0)	
Marital status, n (%)				0.005
Unmarried	505(70.1)	328(73.9)	177(64.1)	
Married	215(29.9)	116(26.1)	99(35.9)	
Missing data	38(5.0)	20(4.3)	18(6.1)	
Household income, n (%)				0.226
< 10 000 yuan/month	266(37.4)	171(39.7)	95(33.8)	
10 000–49 999 yuan/month	387(54.4)	228(52.9)	159(56.6)	
≥ 50 000 yuan/month	59(8.3)	32(7.4)	27(9.6)	
Missing data	46(6.1)	33(7.1)	13(4.4)	
Current cigarette smoking, n (%)	179(24.0)	120(26.3)	59(20.3)	0.063
Missing data	12(1.6)	8(1.7)	4(1.4)	
Current alcohol drinking, n (%)	370(49.2)	235(51.1)	135(46.2)	0.194
Missing data	6(0.8)	4(0.9)	2(0.7)	
Exercise habit per week (at least 1 time and ≥ 30 min), n (%)	190(25.2)	105(22.8)	85(28.9)	0.058
Missing data	3(0.4)	3(0.6)	0(0)	
Sleep quality, n (%)				0.164
Good	71(9.5)	38(8.3)	33(11.3)	
Average	223(29.7)	130(28.4)	93(31.7)	
Poor	291(38.7)	191(41.7)	100(34.1)	
Very poor	166(22.1)	99(21.6)	67(22.9)	
Missing data	7(0.9)	6(1.3)	1(0.3)	
CTQ-SF baseline, median (IQR)	46.0(18.0)	48.0(17.5)	44.0(19.0)	< 0.001
Missing data	34(4.5)	21(4.5)	13(4.4)	
Chronic diseases history, n (%)	68(9.2)	41(9.1)	27(9.3)	0.915
Missing data	19(2.5)	14(3.0)	5(1.7)	
PHQ-9 baseline, median (IQR)	19.0(8.0)	20.0(7.0)	18.0(7.0)	< 0.001
Missing data	14(1.8)	12(2.6)	2(0.7)	
GAD-7 baseline, median (IQR)	14.0(8.0)	14.0(7.0)	13.0(7.0)	0.024
Missing data	21(2.8)	16(3.4)	5(1.7)	
CD-RISC baseline, median (IQR)	37.0(18.0)	36.0(19.0)	40.0(17.0)	< 0.001
Missing data	25(3.3)	13(2.8)	12(4.1)	
ISI baseline, median (IQR)	15.0(10.0)	16.0(9.0)	14.0(10.0)	0.002
Missing data	8(1.1)	6(1.3)	2(0.7)	
Previous episodes, n (%)	260(34.3)	154(33.2)	106(36.2)	0.399
Missing data	1(0.1)	0(0)	1(0.3)	
Age of onset, median (IQR)	24.0(10.0)	23.0(10.0)	25.0(9.0)	< 0.001
Missing data	6(0.8)	4(0.9)	2(0.7)	
Recent medication use, n (%)	258(34.0)	169(36.4)	89(30.3)	0.082
Living arrangement, n (%)				0.028
Living alone	212(28.0)	145(31.3)	67(22.8)	
Living with family	448(59.1)	258(55.6)	190(64.6)	
Living with non-relatives	98(12.9)	61(13.1)	37(12.6)	
BMI, median (IQR)	20.9(4.8)	20.8(4.9)	21.0(5.2)	0.158

[a] *P* value was based on the Pearson chi-square test for categorical data and the Wilcoxon test for continuous data

Abbreviations: IQR interquartile ranges, *CTQ-SF* the Short Form of the Childhood Trauma Questionnaire, *PHQ-9* the Patient Health Questionnaire-9, *GAD-7* the Generalized Anxiety Disorder-7, *CD-RISC* the Connor-Davidson Resilience Scale, *ISI* the Insomnia Severity Index

Table 2 Associations of living arrangements and BMI with PWB

Variable	Model 1[a]		Model 2[a]	
	OR (95% CI)	*P*	AOR (95% CI)	*P*
Living arrangement				
Live alone	1(ref)		1(ref)	
Live with family	1.59(1.13,2.26)	**0.008**	1.80(1.14,2.87)	**0.012**
Live with non-relatives	1.31(0.79,2.16)	0.287	1.69(0.95,3.00)	0.073
BMI	1.03(0.99,1.06)	0.164	1.02(0.97,1.07)	0.365

Model 1: unadjusted for any potential covariates

Model 2: adjusted for age, gender, marital status, current cigarette smoking, exercise habit per week, CTQ-SF baseline, PHQ-9 baseline, GAD-7 baseline, CD-RISC baseline, ISI baseline, previous episodes, age of onset, recent medication use

Abbreviations: OR odds ratio, *AOR* adjusted odds ratio, *95% CI* 95% confidence interval

[a] The logistic regression models were used

Table 3 Associations of interaction items with PWB

Interaction Item	AOR (95% CI)	*P* for interaction
Live with family *BMI	0.90(0.81,1.00)	**0.049**
Live with non-relatives *BMI	0.93(0.79,1.09)	0.380

Model was adjusted for age, gender, marital status, current cigarette smoking, exercise habit per week, CTQ-SF baseline, PHQ-9 baseline, GAD-7 baseline, CD-RISC baseline, ISI baseline, previous episodes, age of onset, recent medication use

Abbreviations: *OR* odds ratio, *AOR* adjusted odds ratio, *95% CI* 95% confidence interval

lower depression and anxiety, greater resilience, and milder insomnia. Furthermore, this good PWB group experienced a later onset of depression and were more likely to live with family members or non-relatives.

Associations between living arrangements and PWB at 12 months: the moderating role of BMI

The results of the logistic regression models for PWB are presented in the Table 2. Model 1, a univariate logistic regression, shows a significantly positive association between living with family and PWB compared to living alone (OR = 1.59, 95% CI = 1.13–2.26, P = 0.008). However, living with non-relatives is not significantly associated with PWB. In Model 2, which adjusts for additional covariates, living with family continues to show a significantly positive association with PWB (AOR = 1.80, 95% CI = 1.14–2.87, P = 0.026). Table 3 introduces interaction terms between living arrangements and BMI. The interaction terms showed that the interacting effects of BMI play a significant role in the relationship between living arrangements and PWB (P for interaction = 0.049).

Stratified analysis of living arrangements and PWB across BMI categories

As shown in Fig. 2, stratified logistic regression analysis by BMI categories revealed that the positive association between living arrangements and PWB was evident only in the normal BMI group. Specifically, among individuals with a normal BMI, both living with family (AOR = 2.87, 95% CI: 1.52–5.58, P = 0.001) and living with non-relatives (AOR = 2.69, 95% CI: 1.24–5.92, P = 0.013). In contrast, no significant associations were observed in the underweight or overweight groups. Notably, the effect sizes in the normal BMI group were larger than those observed in the main analysis (Table 2). When setting'Live with family'as the reference group in the normal weight group, there is no significant difference between'Live with family'and'Live with non-relatives'in relation to PWB (Supplementary Table S2).

Sensitivity analyses

Given the possibility of missing data affecting the results, we performed additional sensitivity analyses using multiple imputation to account for missing values. The sensitivity analyses yielded results consistent with the study's main findings (Supplementary Tables S3–S5).

Discussion

To the best of our knowledge, this is one of the first longitudinal studies to examine whether BMI moderates the relationship between living arrangements and PWB in individuals with MDD. Our study identified that living with family, as opposed to living alone, was significantly associated with higher PWB in individuals with MDD. Moreover, our findings suggest that living with family and maintaining a healthy BMI, specifically in the range of 18.5 to 24 kg/m^2, have a synergistic effect on enhancing PWB. In particular, a normal BMI appeared to strengthen the association between living with family and higher levels of PWB, indicating that individuals with a healthy BMI may benefit more from the positive impact of cohabiting with family members on PWB. These insights offer valuable guidance for developing targeted public health strategies to improve the PWB of individuals with MDD, particularly those living alone or with an unhealthy BMI.

Our findings align with previous research in this area [9–12, 22, 41]. A prior study demonstrated that living alone was associated with lower levels of subjective well-being [41]. In rural China, a cross-sectional study among elderly adults, though using a different assessment tool, reported that those living with their children and grandchildren reported significantly higher PWB compared to those who did not [9]. Similarly, a large-scale cohort study using data from the Chinese Longitudinal Healthy

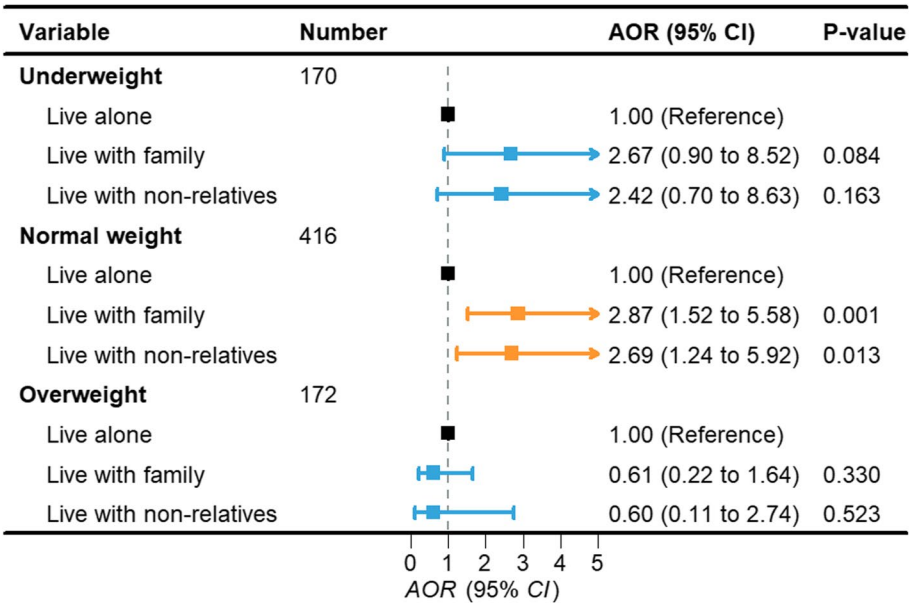

Fig. 2 Stratified Analysis of Living Arrangements and PWB by BMI. The black square means reference. The yellow lines mean *P*-value < 0.05, and the blue lines mean *P*-value > 0.05. All models were adjusted for age, gender, marital status, current cigarette smoking, exercise habit per week, CTQ-SF baseline, PHQ-9 baseline, GAD-7 baseline, CD-RISC baseline, ISI baseline, previous episodes, age of onset, recent medication use. Abbreviations: AOR, adjusted odds ratio; 95% CI, 95% confidence interval

Longevity Survey, which included a sample of 16,020 participants and used six brief questions to measure PWB, reported that living with family was associated with higher PWB scores compared to living alone [10]. Although these studies employed different methods to assess PWB and may have been influenced by various confounders and biases in their analyses, their results generally accord with our findings. Our findings herein contradict the results of select studies, which have suggested that women living independently exhibit lower risk of decline in mental health, as measured by SF-36, compared to those living with a spouse [42]. This discrepancy may be attributed to cultural and societal differences, particularly between the United States and China, as well as variations in study populations.

A possible explanation for the strong association observed between living with family members and higher PWB among individuals with MDD is that living with family members often provides robust social support, which is widely recognized as a critical protective factor in the field of mental health [43–45]. It is reported that family support helps foster healthier stress responses and regulate stress hormones, reducing harmful behaviors linked to chronic stress [46, 47]. For individuals with MDD, the emotional support and daily care provided by family members may enhance emotional regulation [48], alleviate feelings of loneliness [49], and improve coping mechanisms [50], all of which contribute positively to PWB [51]. An additional factor that may contribute to the foregoing observation is that persons with MDD often report experience a decline in behavioral motivation. It is hypothesized that family members, through cohabitation, may effectively monitor the affected individual's daily activities, encouraging adherence to medication regimens, regular sleep patterns, and healthy dietary interventions [52]. The foregoing hypothesis posits that behavioral oversight of cohabiting family members may aid in the development of behaviors that reduce the risk of illness progression and consequently improve the patient's quality of life and PWB. Additionally, such supervision may foster a sense of responsibility, making it easier for patients to maintain structured daily routines, which is crucial for the recovery of individuals with MDD.

Our prospective cohort study also revealed that BMI moderated the relationship between living arrangements and PWB in persons with MDD. Specifically, stratified analyses showed that participants with a normal BMI experienced higher levels of PWB when living with family or living with non-relatives, while both underweight and overweight BMI weakened this connection. Our results are in accordance with previous reports wherein a normal BMI is often associated with higher self-esteem and better social integration, both of which are factors

of PWB [19, 53–55]. Individuals with higher self-esteem may be more inclined to seek and accept familial support, forming a positive feedback loop that enhances their PWB [54]. Moreover, those with a normal BMI tend to experience less social stigma and maintain a more positive self-image compared to underweight or overweight individuals [56], which may increase their receptiveness to family support and further promote well-being. Biological factors may also contribute to BMI's moderating role. Individuals with abnormal BMI are more likely to develop physical comorbidities such as osteoporosis, type 2 diabetes, and cardiovascular disease [57]. These burdens may diminish the emotional and practical benefits of family support, as individuals with poor health may focus more on managing symptoms than on engaging in supportive relationships. As such, their capacity to benefit from familial support may be limited compared to those with a normal BMI.

In the first place, we recommend that families actively support their relatives with MDD by providing emotional and practical assistance, fostering a nurturing environment that enhances PWB. Additionally, it is crucial for healthcare providers to recognize the importance of social support in promoting positive PWB among MDD individuals. We advocate for the implementation of structured interventions, such as family therapy and support groups, to strengthen familial relationships and reduce feelings of isolation [58]. The foregoing findings emphasize the synergistic effect of maintaining a normal BMI and living with family in enhancing PWB, particularly in individuals with MDD. The aforementioned observation suggests that the combination of a healthy physical condition and a supportive family environment may have synergistic effects to promote greater measures of happiness, highlighting the complex interactions between physical health, social context, and PWB in the context of mental health challenges.

At the policy level, these findings suggest the necessity of incorporating family-centered strategies into national mental health service frameworks. Policymakers should consider expanding community-based mental health programs that facilitate family involvement, improve access to psychosocial support, and provide resources for long-term care coordination. In addition, health insurance policies could be adjusted to cover family-oriented mental health interventions, thereby lowering access barriers and encouraging early engagement. Given the moderating role of BMI, policy efforts should also promote interdisciplinary collaboration between mental health services and general healthcare providers, supporting integrated models that include physical health assessments and nutritional counseling as part of routine psychiatric care.

There are several limitations in this study that warrant consideration. First, the representativeness of the sample may be limited. Although this study is based on a prospective cohort, the participants may not fully represent the broader population. If the sample is drawn from specific regions or healthcare facilities, the findings may not be generalizable to other populations or regions, particularly in different cultural contexts. In China, norms surrounding family living and social support are shaped by collectivist traditions, where intergenerational co-residence and strong familial bonds are common and socially reinforced. This cultural context may amplify the influence of family support on psychological well-being. By contrast, in more individualistic societies that emphasize independence and self-reliance, the role and impact of familial support may differ significantly. These cultural differences suggest that the observed associations may not be directly generalizable across societies. Future cross-cultural research is needed to determine whether the moderating role of BMI and the effects of family support on well-being hold in diverse sociocultural settings. Second, many of the measures used in this study rely on self-reported data, which may introduce reporting bias. Participants'assessments of their living arrangements, BMI, and PWB may be influenced by social desirability, recall bias, or their current emotional state, which could affect the accuracy of the data. Third, the use of BMI as the sole measure of physical health has limitations. BMI is a relatively simplistic indicator of weight relative to height and does not account for other important aspects of health, such as body composition (muscle vs. fat) or overall fitness. Fourth, BMI was treated as a static variable in this study. However, BMI may change over time, and such changes could influence PWB. Future studies should consider incorporating longitudinal measurements of BMI to better capture its dynamic effects. Fifth, due to the 12-month follow-up period, while it provides useful insights, it may not fully capture the long-term effects of living arrangements and BMI on PWB, nor can it eliminate concerns about causality. Extending the follow-up period could offer a more comprehensive understanding of how these factors influence PWB over time. Furthermore, the absence of randomized controlled trials limits the ability to definitively establish causal relationships.

Conclusions

In this prospective cohort study, living with family was significantly associated with higher levels of PWB in individuals with MDD, especially among those with a normal BMI. These findings highlight the synergistic effect

of living with family and maintaining a healthy BMI on improving PWB in depressed individuals. Further randomized clinical trials are needed to confirm whether interventions targeting living arrangements and BMI can enhance PWB in individuals with MDD, particularly those living alone or with an unhealthy BMI.

Supplementary Information

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Supplementary Material 1.

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Authors' contributions
All authors were involved in the study's conception, design and implementation. C.Y.L. and X.H. had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. C.X.W. and Y.F.L. drafted the first version of the manuscript. Y.Z.L., R.Y.C., W.X.W., L.G., X.J.Z., H.Z., K.M.T and R.S.M critically revised the manuscript. X.X.Z., J.J.H., Y.H.L., Y.C. and H.M.Z analyzed the data. All authors participated in approving the final version of the manuscript, and share responsibilities for all aspects of the work.

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Data availability
The data supporting the findings of this study can be obtained from the corresponding author (Ciyong Lu) upon reasonable request.

Declarations

Ethics approval and consent to participate
The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration. All procedures involving human patients were approved by the Institutional Review Board of Sun Yat-sen University School of Public Health (Ethical code: L2017044). All participants signed informed consent after detailed understanding of the study protocol.

Consent for publication
Not applicable.

Competing interests
Roger S. McIntyre has received research grant support from CIHR/GACD/National Natural Science Foundation of China (NSFC) and the Milken Institute; speaker/consultation fees from Lundbeck, Janssen, Alkermes, Neumora Therapeutics, Boehringer Ingelheim, Sage, Biogen, Mitsubishi Tanabe, Purdue, Pfizer, Otsuka, Takeda, Neurocrine, Sunovion, Bausch Health, Axsome, Novo Nordisk, Kris, Sanofi, Eisai, Intra-Cellular, NewBridge Pharmaceuticals, Viatris, Abbvie, Atai Life Sciences. Dr. Roger McIntyre is a CEO of Braxia Scientific Corp. Kayla M. Teopiz has received fees from Braxia Scientific Corp. Other authors declare that they have no competing interests.

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