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Living environment, service quality satisfaction and depression among Chinese older adults in elderly caring social organizations

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ABSTRACT

Background: Older adults living in elderly caring social organizations (SOs) are prone to suffer from depression. Many studies have found correlations between environmental and quality-of-life factors and depression; however, evidence from elderly caring SOs is rare, particularly in China.

Methods: A cross-sectional study was conducted among service recipients in elderly caring SOs in Anhui and Chongqing, China. Data on demographic and health-related characteristics, living environment factors, and service quality satisfaction factors in 2171 older adults were used for analysis. The binary logistic regression model was conducted to estimate the association between living environment and service quality satisfaction factors and depression.

Results: Our results indicated that living environment factors in terms of exposure to suitable temperature and humidity (OR = 0.655; 95 % CI: 0.446, 0.963), green coverage >30 % (OR = 0.432; 95 % CI: 0.337, 0.553) were associated with lower odds of developing depression. Also, an opposite relationship was found in the noise factor (OR = 1.985; 95 % CI: 1.395, 2.823). Higher satisfaction with admission and discharge services, dietary services, entertainment services, and psychological support services were also found to be associated with a lower risk of depression.

Limitations: A cross-sectional design precluded determining whether living environment, service quality satisfaction, and depression are causally related. Measurement of living environment factors and service quality satisfaction factors needs to be further clarified comprehensively.

Conclusions: Enhancing the living environment and the quality of the services provided to seniors in the elderly caring SOs is conducive to the reduction of the likelihood of depression.

1. Introduction

Depression, as a severe psychological disorder, symbolizes a burden on individual health, families, and society. In 2008, the World Health Organization (WHO) ranked depression as the third most significant contributor to the worldwide burden of disease and projected its ascension to the foremost cause by 2030 (Malhi and Mann, 2018). Effectively controlling or reducing the incidence of depression has been recognized in many high-income countries (Davies et al., 2019). As individuals aging, the physiological functions of the elderly tend to become increasingly fragile and impaired, which is accompanied by varying degrees of cognitive and emotional alterations such as depression (Hahn et al., 2017; Keefe et al., 2013). Meanwhile, due to the extension of survival times, the absolute number of individuals with depression has risen with population aging. A growing body of research has investigated depression in later life while, with differing results. For instance, a comprehensive longitudinal study conducted in Portugal over five years, encompassing a sample size of 7584 older adults,

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revealed that approximately 31.2 % exhibited indications of depression (Senra et al., 2022). There was also evidence that about 33.09 % of elderly adults suffered from depression disorders in the China Health and Retirement Longitudinal Study (CHARLS) (Jing et al., 2020). It is thus of utmost importance to research how to prevent and reduce depression among older people.

The elderly caring social organizations (SOs), as a type of non-governmental organization offering services to the aged population, have emerged as pivotal actors in compensating for the inadequacies of both the government and the market (Ding et al., 2023; Tang et al., 2022). The rising population of elderly individuals residing independently has prompted a surge in the demand for socialized elderly care due to the limited availability of family resources for caregiving. According to official statistics from China, by the end of 2022, the country has 387,000 institutions and facilities dedicated to elderly care, providing an aggregate of 8,294,000 beds. Of these, 115,000 beds are in urban communities, while 232,000 are in rural areas. Approximately 2.14 million seniors reside in elderly caring SOs, such as nursing homes, senior apartments, and social welfare homes (China, 2024b). In general, individuals living in elderly caring SOs must meet specific criteria, including age (typically 60 years or older), health status (e.g., absence of mental illness and infectious diseases), and the principle of voluntariness. The costs associated with residing in elderly caring SOs encompass various components such as accommodation, meals, nursing care, and medical services. Older people with diminished self-care abilities often opt for nursing homes that offer specialized care, attributable to their compromised health and extended life expectancy (Ji et al., 2021). Elderly caring SOs frequently emerge as the optimal choice for isolated older adults, driven by their need for social engagement (Clune et al., 2023; Gangnus et al., 2023). Consequently, the demographic of older adults residing in elderly caring SOs represents a significant and noteworthy population.

Noteworthy, the older adults served by elderly caring SOs are prone to health problems, especially psychological and emotional challenges. Numerous studies have consistently demonstrated that older individuals residing in elderly caring SOs have a higher likelihood of being depressive compared to their counterparts residing within community settings (Guo et al., 2019; Hoben et al., 2019). Depression is challenging to detect and pay attention to during the typical care and nursing process, which will seriously impact the physical and psychological well-being of older people served by SOs (Wray et al., 2018). Therefore, identifying the associated risk factors is crucial to preventing depression in older people.

Several individual level risk factors for depression, including genetic (Zheng et al., 2016), socio-demographic (Nikoloski et al., 2019; Rajan et al., 2020), and behavioral factors (McCall-Hosenfeld et al., 2016) have been well-documented. In the last decades, the living environment, which refers to a range of natural and social factors that are intricately connected to the life of the population (e.g., air, noise, green area) (Chung et al., 2009; Dzhambov et al., 2018; Saucy et al., 2023), has attracted the attention of researchers in the field of public health. An increasing volume of studies validated the correlation between living environmental factors and depression. Certain environmental factors, such as access to fresh air and parks, are believed to be linked to a decreased prevalence of depression among older individuals (Gascon et al., 2018; Hou et al., 2022). Conversely, environmental factors characterized by traffic noise and a dearth of recreational amenities exhibit a positive correlation with depression (Dai et al., 2019). Mechanisms linking these life-environmental factors to depression may be increased physical stress response, improved lifestyle, and increased social engagement (Besser et al., 2017). Specifically, older adults in elderly caring SOs, as a group highly vulnerable to experiencing health burdens, are often faced with long-term and stable living environments (e.g., indoor temperature and humidity, light, etc.) that are frequently created and maintained by nursing facilities. Enhancements in the institutional living environment potentially yield favorable outcomes for the well-being of older adults. Nevertheless, prior investigations concerning the correlation between living environment and depression in older adults have predominantly focused on community scenarios (Gascon et al., 2018; Hou et al., 2022; Moore et al., 2016), with relatively limited exploration in elderly caring SOs. Given the elevated prevalence of depression among older adults residing in elderly caring SOs, exploring the association between living environment and depression in this specific context assumes significant importance.

The increasing research attention is being directed towards the level of satisfaction among older individuals with the quality of services as a result of the advancements in elderly care services (Chang, 2019; Ding et al., 2023; Duffy et al., 2001; Yuwei et al., 2024). Service quality satisfaction can be defined as the subjective evaluation of older people's level of satisfaction with the quality of services (e.g., nursing care, food, cleaning, baggage counseling, etc.) provided by elderly caring SOs in which they reside (Duffy et al., 2001). Satisfaction with service quality is posited to have a significant impact on the mental well-being of older individuals served by elderly caring SOs, as it is considered a stable and enduring attitude that serves as a crucial indicator of their quality of life. This hypothesis suggests that the regulation of psychological activities is influenced by this satisfaction, emphasizing its importance in understanding the overall mental health of older individuals. For example, diversified and high-quality elderly care service contents can maximize the satisfaction of older people's life needs, provide an environment for social participation, and increase satisfaction, which in turn inhibits the emergence of the sources of adverse emotions (Kwagala et al., 2016). At the same time, some health-related services (e.g., rehabilitation services, psychological counseling services) can promote the early screening and alleviation of depression, and further create a good health environment for older people (Molenaar et al., 2023; Nollett et al., 2019). Increasingly, the need to improve the quality of life of older people and to maintain the aging environment has led to an increased emphasis on improving the satisfaction of the quality of services for older people. Nevertheless, existing studies investigating the relationship between service quality satisfaction and depression in older populations evaluated service content with varied factors and yielded mixed results. For example, a study conducted in South Australia revealed that enhancing food service satisfaction among nursing home residents proves to be efficacious in mitigating the prevalence of malnutrition and depression within the aged population (Pankhurst et al., 2023). In a study on the factors affecting depression among older adults in nursing homes in Tehran, Nazemi L et al. pointed out that dissatisfaction with the living services provided by caregivers and dissatisfaction with the quality of food became significant risk factors for the occurrence of depression in older adults (Nazemi et al., 2013). Interestingly, a prior study found that the implementation of a caregiving program for older adults had a positive impact on their mental state, except for depression (Kim et al., 2020). Therefore, to better explore and study the link between service quality satisfaction and depression in older adults, there is a critical need for more comprehensive measures of service quality satisfaction and more reliable statistical validation of this relationship.

Together, this study aims to verify the correlation between the living environment and service quality satisfaction and the depression of older people in elderly caring SOs. Interestingly, gender differences are often considered to be present in the occurrence of psychological disorders in older adults. Specifically, the primary objective of this study was to explore the correlation between living environment (including temperature and humidity, light, noise and greening), service quality satisfaction (8 dimensions) and depression among older adults in elderly caring SOs. Additionally, we further validated whether this potential relationship differed by gender. Based on these results, we propose some improvement measures suitable for implementation in senior living organizations, with a view to mitigating the dangers of depression in older adults.

2. Methods

2.1. Study design and data collection

This study was part of a large-scale survey of SOs in the field of elderly care conducted in Anhui Province and Chongqing Municipality, China, which was conducted from November to December 2019 and July to August 2022. Throughout the procedure, all ethical standards of Anhui Medical University were followed (No. 20180181).

Based on population distribution and geographic location, a multi-stage stratified cluster random sampling method was used to recruit subjects for a representative sample. First, we selected six cities in Anhui Province (Suzhou, Fuyang, Huainan, Lu'an, Anqing, and Chizhou) and four districts in Chongqing municipality (Tongliang, Rongchang, Dazu, and Jiangbei). Second, 30–45 elderly care organizations were sampled from each city or district based on the registration lists of elderly care organizations in the civil affairs departments of the selected cities (districts). Third, adults aged 60 or older staying in the selected elderly caring SOs were invited to participate in this study. When the sample size of each organization reached 10, registration was stopped, thus reducing the impact of the difference in the number of original occupants of the organization. The locations of the study area were shown in Supplementary Fig.S1 and the map was created using ArcGIS 10.8 (ESRI, West Redlands, CA, USA). In brief, a total of 2227 participants were interviewed, while 2171 (response rate 97.49 %) were included for analysis. Additional details regarding the study's design and data collection can be obtained from previous investigations. (Ding et al., 2023; Ji et al., 2021; Zhao et al., 2023a).

2.2. Measure

2.2.1. Measurement of living environment, service quality satisfaction

In this study, the participants' living environment was measured in four parts. On the one hand, the participants were inquired whether they were exposed to suitable temperature and humidity, sufficient light, and noise (e.g., broadcasting noise) (Weizenbaum et al., 2020). On the other hand, among the surveyed elderly caring SOs, data on the area of the organization's green space was also collected. The measurements were made by consulting the floor plans of the organizations and by asking the heads of the organizations about the area of their infrastructure. Specifically, the scope of green space in this investigation encompasses lawns, gardens, and recreational grounds (Dzhambov et al., 2018). Of course, the authenticity and compliance of the data obtained were ensured through effective coordination with the higher authorities of the elderly caring SOs. We measure whether the green ratio of the elderly caring SOs is >30 %. The results of the four items were counted by "yes and no", as they are closely related to the lives of older people.

Based on the measurement tools of satisfaction from previous studies (Maruta et al., 2020; Shimada et al., 2020), combined with the developing elderly caring SOs in China (China, 2024b; Chow, 2021; Gao et al., 2023), we designed the service quality satisfaction scale of old adults in organizations. The eight items of service quality satisfaction encompassed discharge and admission services, life care services, dietary services, cleaning services, washing services, entertainment services, psychological support services and rehabilitation services. Participants were asked how satisfied they were with the appropriate services provided by the elderly caring SOs. The five-point Likert scale was employed in our questionnaire to assess respondents' satisfaction levels, ranging from 1 (totally dissatisfied) to 5 (totally satisfied). With a Cronbach's α rating of 0.872, our scale demonstrated excellent internal consistency. Due to the highly skewed distribution of service quality satisfaction data, we categorized the satisfaction situation of the eight service quality items into low (S1, scored 1–3), medium (S2, scored 4), and high (S3, scored 5) levels of satisfaction (Hong and Peltzer, 2017).

2.2.2. Measurement of depressive symptom

The Center for Epidemiological Studies Depression Scale (CES-D-10) (Andresen et al., 1994), a widely used monitoring tool examining the mental health of old adults (Jing et al., 2020; Linnenkamp et al., 2023; Shin et al., 2023), was adopted to assess the depression status in this study. Respondents were queried regarding the frequency of significant depressive symptoms observed within the fortnight preceding the survey, ranging from "< 1 day" (score of 0) to "5 ~ 7 days" (score of 3), where the scoring was reversed for items 5 and 8 due to positive responses. Based on the sum of the ten items, we tabulated a depression score ranging from 0 to 30, with higher scores indicating higher depression risk. In this study, the participants were categorized into "nondepressed" (0−10) and "depressed" (11−30) (Tareke et al., 2023). There was good internal reliability for all scores in the present sample: Cronbach's α of the scale was 0.810.

2.2.3. Assessment of covariates

Information was collected on participants' demographic and health-related characteristics. Basic demographic variables included age (60–69, 70–79, and ≥ 80 years), gender, household registration (urban, rural), level of education (primary school and below, junior high school, high school and above), marital status (married, single), length of stay at the organization (≤5, 6–10, and ≥ 11 years). Besides, information on the income main source of the respondents, and the frequency of meeting relatives was collected. Health status was ascertained by asking participants whether they had received a doctor's diagnosis of diabetes, high blood pressure, high blood lipids, chronic hepatitis, malignancy, heart disease, chronic pulmonary disease (COPD/tuberculosis). Accordingly, respondents were categorized into the chronic condition group if they had at least one of the abovementioned diseases.

2.3. Statistical analysis

Continuous variables were reported as the mean value accompanied by the standard deviation, whereas categorical variables were expressed as percentages (%). First, we used *t*-tests and ANOVA to test hypotheses and compare means of CES-D-10 scores between groups. Second, we used binary logistic regression models to assess the association between living environment, service quality satisfaction, and depression, with depressive status (categorized as "not depressive", code = 0 and "depressive", code = 1) as the dependent variable. There were many potential confounding variables, including sociodemographic factors, social relationship factors, and chronic disease status. Specifically, living environment factors (temperature and humidity, light, noise, and greening) and service quality satisfaction factors (admission and discharge services, life care services, dietary services, cleaning services, washing services, entertainment services, psychological support services and rehabilitation services) were introduced into the regression model one by one in order to test the relationship between such factors and depression. Given the substantial body of research indicating that gender may be related to the occurrence of depression (Jing et al., 2020; Ying et al., 2023) and environmental and service satisfaction factors (Ares-Blanco et al., 2023; Hou et al., 2022), the present study conducted a gender-stratified analysis with the use of binary logistic regression models to explore the possible role of gender as a moderator.

In order to assess the robustness of the findings obtained through regression analysis, a sample of 1429 individuals (with rural household registration) was chosen from the study population for the purpose of conducting sensitivity analyses. Furthermore, binary logistic regressions were once again employed in this process.

The statistical analyses were performed utilizing the SPSS statistical program (IBM SPSS Statistics 23), with a significance level of $P < 0.05$ indicating statistical significance.

3. Results

3.1. Results of descriptive analysis

The descriptive information of the participants is presented in Table 1. In detail, the percentage of males slightly exceeded that of females, with males accounting for 56.3 %. About two-thirds of older adults were from rural areas (65.8 %). In addition, A significant number of respondents had a primary level of education and below (59.0 %) and had no spouse (82.0 %). More than half of the subjects had resided in the elderly caring SOs for less than five years (72.1 %) and could meet with their relatives (75.0 %). The average CES-D10 score was 6.19 ± 5.13, with 23.8 % of the participants classified as exhibiting symptoms of depression.

In box plots, CES-D10 scores were compared among 4 categories of living environment factors studied (Fig. 1A). Temperature and humidity, light, noise and greening factors showed their differences ($P < 0.001$) in CES-D10 scores. The graph in Fig. 1B compared the distribution of CES-D10 scores among the factors of service quality satisfaction that were studied.

The distribution of variations in depressive status among participants, categorized by demographic and health status characteristics, was presented in Supplemental Table S1. Statistically significant differences were observed between the non-depressed and depressed groups across variables such as region, age, gender, marital status, and frequency of meeting relatives. Specifically, among the 516 subjects classified in depression in this study, 53.7 % (277/516) were residents of Chongqing Municipality, 52.5 % (271/516) were aged 80 years or older, 52.1 % (269/516) were male and 84.7 % (437/516) belonged to the non-spousal status. In addition, the majority of the 50.3 % (832/1655) of older adults living in elderly caring SOs who reported a non-depressed state were often able to meet their relatives. Furthermore, Supplemental Table S2 illustrated the distribution of living environment factors and service quality satisfaction factors by depression categories.

Table 1
Basic characteristics of the study population.

	Total ($N = 2171$)	Composition ratio (%)
Regions		
Anhui	1167	53.8
Chongqing	1004	46.2
Age (years)		
60–69	301	13.9
70–79	774	35.6
≥80	1096	50.5
Gender		
Male	1223	56.3
Female	948	43.7
Residence		
Urban	742	34.2
Rural	1429	65.8
Education level		
Primary school and below	1282	59.0
Junior school	527	24.3
High school and above	362	16.7
Marital status		
Married	391	18.0
Single	1780	82.0
Length of stay (years)		
≤5	1566	72.1
6–10	343	15.8
≥11	262	12.1
Source of income		
Pension	304	14.0
Subsidy	712	32.8
Family providing	774	35.7
Others	381	17.5
Frequency of meeting relatives		
Never	544	25.0
Seldom	614	28.3
Often	1013	46.7
Chronic disease		
No	1189	54.8
Yes	982	45.2
CES-D10 score (mean ± SD)	–	6.19 ± 5.13
Depression status		
No	1655	76.2
Yes	516	23.8

3.2. Results of binary logistic regression analysis

The associations between living environment, service quality satisfaction factors, and depression status were shown in Table 2. Specifically, the connection between the living environment factors and depression status was relatively strong, except for the light factor. Among both sexes, the respondents in elderly caring SOs exposed to a living environment with noise (OR = 1.985; 95 % CI: 1.395–2.823) had elevated odds of being depressive, and exposed to >30 % greening coverage (OR = 0.432; 95 % CI: 0.337–0.553) would be less likely to suffer from depression. Suitable temperature and humidity (OR = 0.655; 95 % CI: 0.446–0.963) demonstrated a negative relationship on seniors' risk of having depression symptoms. However, as a result of the sex-stratified analysis, this association did not exist among the female older people.

The association between the service quality satisfaction factors and depression status was present in several elements and was generally weak. Older adults in elderly caring SOs had a falling risk of depression with higher levels of satisfaction with admission and discharge services (OR = 0.395; 95 % CI: 0.245–0.637), and this association appeared to be stronger among female respondents (OR = 0.326; 95 % CI: 0.154–0.689).

A valid association between dietary service satisfaction and depression could be found among both male and female seniors, i.e., it was measured that the participants who were more satisfied with the dietary service (S3) had a lower risk of depression (OR = 0.496; 95 % CI: 0.339–0.727) than those feel dissatisfied with the dietary service (S1). Male elderly who were more satisfied with the entertainment services provided by elderly caring SOs had a decreased risk of depression (OR = 0.644; 95 % CI: 0.353–1.114). Moreover, the association between higher satisfaction with psychosocial support services and lower depression risk in older adults did not seem to be gender-specific.

3.3. Results of sensitivity analysis

According to the sensitivity analysis using binary logistic regression models, similar results were obtained as in the main analysis (Supplemental Table S3). The rural participants in elderly caring SOs living in reasonable temperature and humidity were less likely to be depressed, although such linkage was only found among male respondents (OR = 0.530; 95 % CI: 0.306–0.918). In parallel, the noise factors and risk of developing depression showed similar results. Rural elderly exposed to living environment in elderly caring SOs with >30 % greenery had a lower risk of depression (OR = 0.399; 95 % CI: 0.296–0.538). In terms of satisfaction with the quality of services. Rural participants' higher satisfaction with admission and discharge services and psychosocial support services provided by elderly caring SOs were associated with a declining risk of developing depression, although this association was only found among female adults. Male rural respondents in elderly caring SOs with high satisfaction with entertainment services had a lower depression risk (OR = 0.496; 95 % CI: 0.249–0.838). Also, higher dietary service satisfaction among rural older adults was associated with a lower likelihood of depression (OR = 0.395; 95 % CI: 0.244–0.639).

4. Discussion

The present study assessed the potential impact of the living environment and service quality satisfaction on depression among older people who reside in elderly caring SOs in Anhui Province and

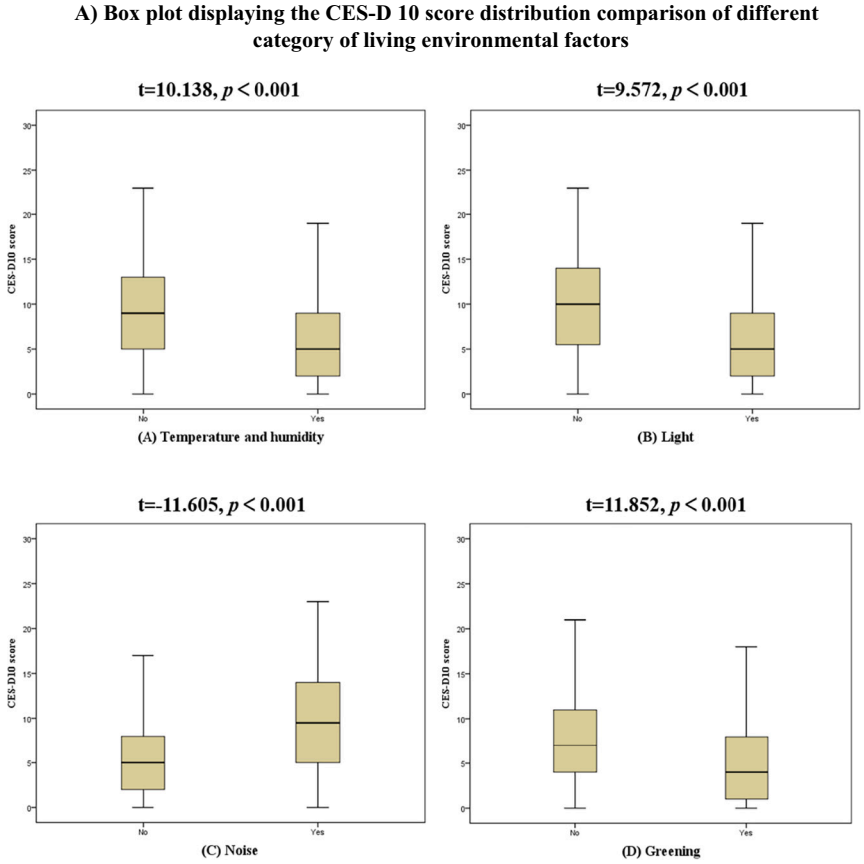

Fig. 1A. Box plot displaying the CES-D 10 score distribution comparison of different category of living environmental factors.

Chongqing Municipality, China. The findings of this research indicated that the living environment and service quality satisfaction may have an impact on the depression levels of older adults in elderly care SOs. However, it was noteworthy that these associations appeared to vary based on gender. For this, we formulated strategies to optimize the living environment and enhance the quality of care provided in elderly caring SOs to attenuate the risk factors noteworthy of depression among the elderly population.

A large body of evidence proposed that environmental exposure factors were associated with the development of various psychiatric disorders (e.g., depression, anxiety, panic). From a mechanistic point of view, environmental factors could act in conjunction with genetic factors to cause mitochondrial damage and oxidative stress, with the resultant undesirable consequences of mental disorders (Pousa et al., 2021). Examining the present study, we found that male participants residing in elderly caring SOs with appropriate temperature and humidity levels had a reduced risk of depression. Similar to our findings, Pousa et al. found that chronically exposed to non-optimal temperatures were at a significantly higher risk of developing depression among older people aged 65 years and over in China (Pousa et al., 2021). Older individuals may have difficulty regulating and adapting to temperature changes due to declining body functions, and may also experience medical conditions that can impact their mental state (Chung et al., 2009; Donaldson et al., 2003). A longitudinal survey in the United States based on 1.9 million individuals between 2008 and 2013 showed that, compared with the average temperature (10 °C–16 °C), higher than 21 °C decreases positive emotions and well-being, and increases negative emotions such as feelings of stress and anger (Cohen et al., 2024). Within elderly caring SOs, residents' perceptions of temperature and humidity are primarily influenced by indoor conditions. The use of air conditioning, heating, and cooling systems contributes to maintaining stable indoor temperature and humidity levels, thereby shaping residents' environmental perceptions. The results of this study further emphasize the responsibility of elderly caring SOs to regularly inspect and maintain temperature and humidity regulation facilities.

In addition, noise and greenness in the elderly caring SOs in this study were similarly found to be associated with the likelihood of older adults feeling depressed, which was consistent with previous findings. Noise in elderly caring SOs comes from various sources, including traffic noise, operational noise from facilities, and sounds generated by residents' activities and conversations. Extensive research has demonstrated that elderly individuals and those with chronic illnesses exhibit heightened sensitivity to environmental noise (Kim et al., 2021; Zhou et al., 2024). Results from the Heinz Nixdorf Recall Study also concluded that high noise exposure was a risk factor for depression (Orban et al., 2016). The presence of noise in life is often accompanied by restlessness in the daily activities of older people (Herranz-Pascual et al., 2019), and a decrease in the quality of sleep (Lin et al., 2022), which can precipitate depression. From a mechanistic perspective, noise can disrupt the equilibrium between excitation and inhibition within the cerebral cortex, resulting in abnormal conditioned reflexes and impairments in cerebrovascular tone. These disturbances may contribute to the development of psychological disorders, including depression and anxiety (Bjørndal et al., 2024). Some studies also suggested that a higher greenness index in the living environment could effectively relieve the impact of certain mental health issues, such as depression (Calamandrei et al., 2020; Gu et al., 2022). Green space implies not only ornamental value for older persons living in elderly caring SOs, but also provides residents with places for recreation and activities. Green space constitutes an important part of the living environment for older people. Previous studies have shown that the greening ratio in elderly caring SOs can only be adequate for non-disabled older people if it is >30 % (White et al., 2018). Hence, the aesthetically pleasing surroundings resulting from increased vegetation coverage and leisure facilities within the

B) Box plot displaying the CES-D 10 score distribution comparison of different category of service quality satisfaction factors

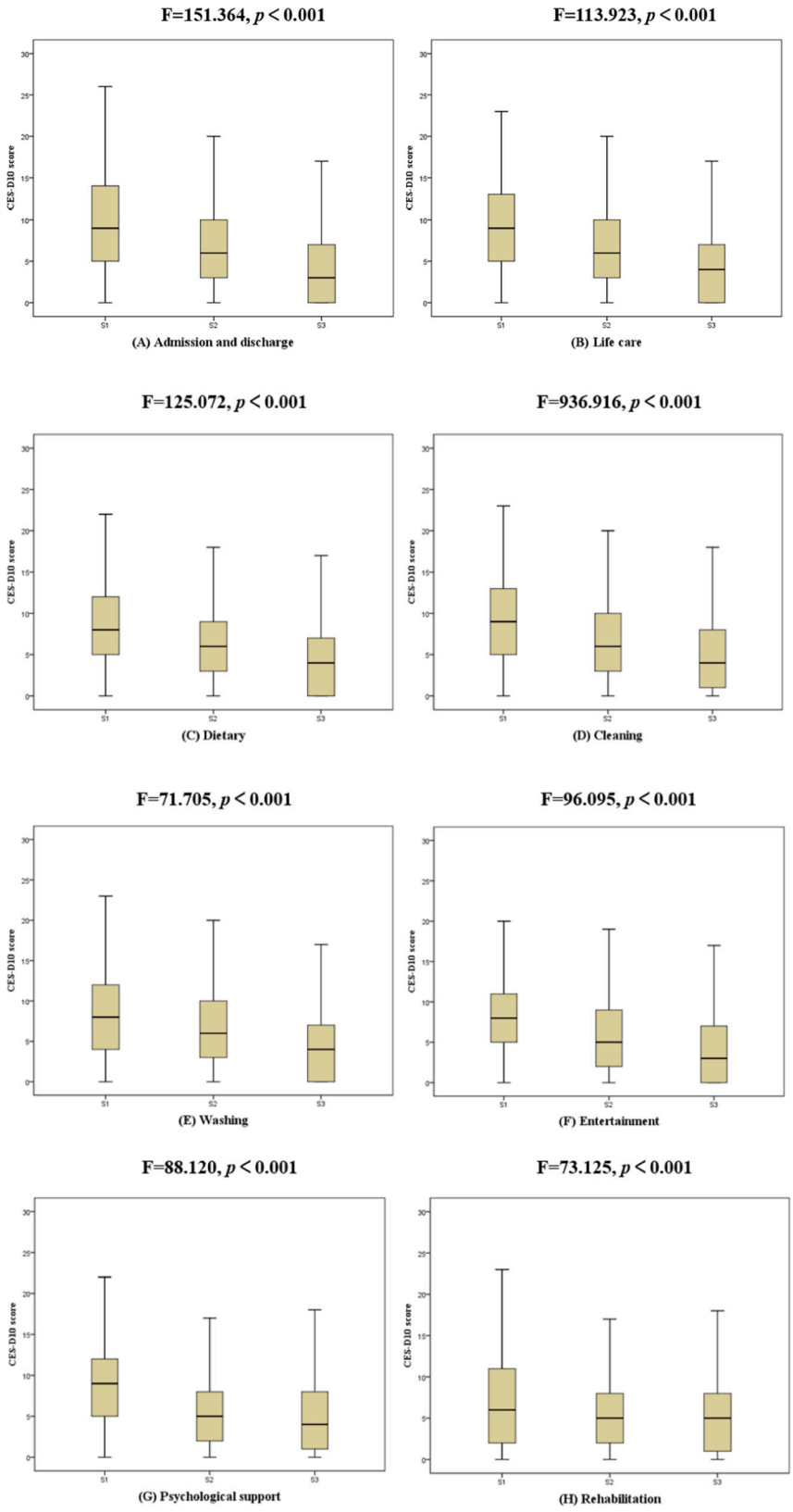

Fig. 1B. Box plot displaying the CES-D 10 score distribution comparison of different category of service quality satisfaction factors.

Table 2
Association between living environment, service quality satisfaction factors and depression, by gender.

	Total		Male		Female	
	OR $_{adjusted}$, 95 % CI	*P value*	OR $_{adjusted}$, 95 % CI	*P value*	OR $_{adjusted}$, 95 % CI	*P value*
Living environment						
Temperature and humidity (Yes) Ref: No	0.655 (0.446, 0.963)	0.031	0.530 (0.322, 0.872)	0.012	0.896 (0.477, 1.682)	0.732
Light (Yes) Ref: No	0.770 (0.495, 1.197)	0.245	0.779 (0.430, 1.411)	0.410	0.760 (0.387, 1.490)	0.424
Noise (Yes) Ref: No	1.985 (1.395, 2.823)	<0.001	2.101 (1.320, 3.344)	0.002	1.889 (1.075, 3.320)	0.027
Greening (Yes) Ref: No	0.432 (0.337, 0.553)	<0.001	0.497 (0.350, 0.705)	<0.001	0.399 (0.278, 0.571)	<0.001
Service quality satisfaction						
Admission and discharge Ref: S1						
S2	0.648 (0.450, 0.932)	0.019	0.788 (0.495, 1.252)	0.313	0.475 (0.257, 0.880)	0.018
S3	0.395 (0.245, 0.637)	<0.001	0.470 (0.247, 0.892)	0.021	0.326 (0.154, 0.689)	0.003
Life care Ref: S1						
S2	0.899 (0.617, 1.310)	0.580	0.759 (0.474, 1.216)	0.252	1.142 (0.586, 2.224)	0.697
S3	0.887 (0.554, 1.420)	0.617	0.790 (0.426, 1.464)	0.454	1.017 (0.469, 2.205)	0.966
Dietary Ref: S1						
S2	0.607 (0.455, 0.810)	0.001	0.551 (0.379, 0.803)	0.002	0.657 (0.409, 1.056)	0.083
S3	0.496 (0.339, 0.727)	<0.001	0.473 (0.278, 0.803)	0.006	0.480 (0.268, 0.858)	0.013
Cleaning Ref: S1						
S2	0.906 (0.621, 1.322)	0.604	0.906 (0.559, 1.468)	0.687	0.984 (0.551, 1.891)	0.960
S3	0.905 (0.577, 1.419)	0.664	0.910 (0.492, 1.681)	0.762	1.023 (0.496, 2.109)	0.951
Washing Ref: S1						
S2	0.961 (0.706, 1.307)	0.798	0.800 (0.536, 1.194)	0.275	1.152 (0.694, 1.912)	0.584
S3	0.870 (0.582, 1.302)	0.498	0.721 (0.412, 1.263)	0.253	0.996 (0.536, 1.853)	0.991
Entertainment Ref: S1						
S2	0.967 (0.736, 1.272)	0.812	1.037 (0.713, 1.508)	0.849	0.874 (0.574, 1.330)	0.530
S3	0.627 (0.437, 0.947)	0.112	0.644 (0.353, 1.114)	0.025	0.646 (0.375, 1.115)	0.117
Psychological support Ref: S1						
S2	0.462 (0.344, 0.620)	<0.001	0.605 (0.405, 0.905)	0.015	0.341 (0.218, 0.533)	<0.001
S3	0.484 (0.262, 0.924)	0.007	0.486 (0.275, 0.859)	0.013	0.674 (0.400, 1.135)	0.138
Rehabilitation Ref: S1						
S2	0.803 (0.599, 1.077)	0.143	0.796 (0.525, 1.208)	0.284	0.785 (0.513, 1.200)	0.263
S3	0.858 (0.583, 1.264)	0.439	1.103 (0.619, 1.964)	0.739	0.711 (0.415, 1.217)	0.214

The model adjusted regions, age, gender, residence, education level, marital status, length of stay, source of income, frequency of meeting relatives and chronic disease. Ref = reference group.

confined areas of elderly caring SOs not only facilitate the alleviation of daily stress experienced by older people, but also contribute to the regulation of outdoor temperature and mitigation of psychological discomfort among this demographic (Guo et al., 2023).

As semi-autonomous or full-care older people receive long-term services from elderly caring SOs, their perception and satisfaction with the services affect their mental health to a certain extent. Quality life services (including diet, rehabilitation, recreation, etc.) are conducive to maintaining a positive mindset among older people (Aalsma et al., 2015; Reyniers et al., 2014; Ward et al., 2008), which in turn reduces the risk of depression. In this study, respondents with had higher satisfaction with admission and discharge services were less likely to be depressed, although such linkage was only seen in the male elderly population. Assessing of an older person's competence is a crucial aspect of admission and discharge services. A quality admission and discharge service should enable early detection of depression in older people and reduce the number of hidden patients (China, 2024a). Gender differences in this association may be due to variations in institutionalization levels across regions. Interestingly, the current study discovered a negative correlation between participants' satisfaction with the dietary service and the likelihood of experiencing depression. In line with our findings, A longitudinal study conducted in Japan further substantiated a noteworthy reduction in the susceptibility to depression among elderly individuals who exhibit higher scores on the Healthy Eating Index. Consequently, it is imperative to allocate greater emphasis on the dietary patterns of older adults (Tani et al., 2015). In this study, an association had been observed in male participants between their level of satisfaction with entertainment services and their susceptibility to depression. In a general sense, fostering interpersonal interactions among older people through engagement in recreational activities not only promotes physical well-being but also serves as a preventive measure against low mood and depression (Lee et al., 2018; Zhu et al., 2013). However, different from our results, McCall-Hosenfeld et al. showed that the correlation between the frequency of engaging in recreational activities and the probability of experiencing depression was more pronounced among older adult females (McCall-Hosenfeld et al., 2016). One plausible explanation for this inconsistency could be the disparate living environments of the study participants. Hence, additional research is warranted to thoroughly investigate this conclusion in subsequent studies. Furthermore, the present study demonstrated that older adults residing in elderly caring SOs exhibited a reduced likelihood of experiencing depression when they received elevated levels of satisfaction with psychological support. In China, several SOs providing integrated eldercare services with medical care have been outfitted with skilled psychological counselors, thereby granting older individuals the opportunity to avail themselves of efficient daily psychological surveillance and therapy, ultimately diminishing the occurrence or endurance of depression (Shi et al., 2022; Tang et al., 2022).

Combining the results of our adjusted binary logistic regression analyses as well as sensitivity analyses, there was a non-significant association between higher satisfaction in life care services, cleaning services, washing services, and rehabilitation services and depression. In contrast to our results, a previous study showed that the frequency of care services received by older people in nursing homes was associated with the occurrence of depression (Tsai and Tsai, 2013). Meanwhile, other scholars had found that the provision of rehabilitation services could alleviate depressive symptoms in elderly patients with chronic illnesses (Buijck et al., 2012). There are two possible reasons for this incongruity. Firstly, the participants in this research were sourced from elderly caring SOs, where there exists a considerable disparity in the level of institutional services, thereby engendering inconsistency in the perception of service quality. Secondly, our adjusted model

incorporated various covariates, including demographic factors and health-related variables. These covariates may correlate with service quality satisfaction and depression, thereby diminishing or even nullifying the association between certain elements of service quality satisfaction and depression. Therefore, the development of a more sophisticated analytical framework becomes crucial for substantiating our findings in subsequent research endeavors.

This study focused on older adults residing in elderly caring SOs. Previous research indicated that, in contrast to their community-dwelling counterparts, institutionalized older adults exhibit comparatively better mental health outcomes (Arpacıoğlu et al., 2021; Zhao et al., 2023b). With the advancement of the global aging health service industry, elderly caring SOs have garnered significant scholarly attention due to their standardized and process-oriented services. Within these elderly caring SOs, older individuals are allowed to undergo mental health screenings, including assessments for depression, facilitating timely interventions (Ji et al., 2021). Furthermore, the provision of sports and recreational activities in elderly caring SOs enables older adults to participate in meaningful social interactions, which can alleviate stress and potentially mitigate the risk of developing depressive symptoms. In this study, depressive symptoms were identified in 23.8 % of the participants, a prevalence lower than that reported in a study conducted in Shandong Province, China, which found a 28.3 % prevalence among older adults residing in rural communities (Jiao et al., 2020). Consequently, the present study offers a valuable reference for investigating the mental health of older adults receiving different forms of care. In addition, in terms of the factors influencing depression among older people, the results of this study indicated the importance of building a conducive living environment and high-quality services in elderly caring SOs. Influenced by the organization's functional position and scope of business, elderly caring SOs tend to vary in their environment and service construction. Exploring different service contents and living environments will be beneficial to the analysis of the influencing factors of elderly psychological well-being in elderly caring SOs.

The prevention of depression, a prevalent and detrimental psychological disorder among older people, can be initiated through the enhancement of environmental and social elements (Hides et al., 2019). Drawing upon the primary outcomes of this study, some measures from the perspective of elderly caring SOs can be proposed, thereby reducing the impact of depression in the elderly population. First, we suggest elderly caring SOs should further improve the infrastructure and meet the construction standards required by government regulations, thus ensuring that the environment within the organization is satisfactory to older people. The environment of elderly caring SOs should be improved by purchasing supporting equipment, maintaining indoor temperature and humidity at the appropriate level, improving noise reduction equipment, expanding the scope of greenery and a series of other measures. Secondly, it is imperative for elderly caring SOs to effectively assess the individual needs of each resident under their care. Specifically, with regard to daily life assistance, these organizations should enhance their provision of tailored meal services and foster the development of caregivers' psychological counseling proficiency. By doing so, the overall quality of services for older people, encompassing psychological, spiritual, and medical rehabilitation, can be significantly enhanced. Thirdly, the participation of older people in daily activities should be valued. Elderly caring SOs should combine the different preferences of male and female older people, and carry out collective characteristic activities, such as chess, cooking, square dance and other competitions, to improve the social participation of older people. Finally, elderly caring SOs should not neglect the screening of depression, and pay great attention to the high-risk groups of depression, to give effective treatment to reduce the adverse consequences of severe depression.

This study possessed several notable strengths. Firstly, the representativeness of the sample was ensured through the implementation of a multistage sampling strategy and the inclusion of a substantial sample size. The sampling process took into account geographical characteristics and disparities between urban and rural areas. Additionally, the inclusion of a large sample size consisting of both male and female participants, coupled with a commendable response rate of 94.2 %, greatly contributed to the successful attainment of our study's objectives. Second, to ascertain the validity of our findings, we incorporated several covariates to examine the distinct impact of the living environment and service quality satisfaction, while controlling for other potential influencing variables. It is worth noting that our study is the inaugural attempt to evaluate the correlations between the living environment, service quality satisfaction factors, and depression among elderly individuals residing in elderly caring SOs in Anhui and Chongqing, China.

However, it is imperative to acknowledge the limitations of this study. Firstly, the adoption of a cross-sectional design weakened the ability to establish causal relationships. To address this limitation, future research should contemplate the implementation of a longitudinal design to explore the potential associations between the living environment, factors influencing satisfaction with service quality, and depression. Secondly, the measurement of satisfaction with the quality of services for older individuals was assessed using a single-question interview, which may introduce response bias. Therefore, it is recommended that a more comprehensive measurement tool be developed to ensure accurate and reliable data collection. Finally, while the CES-D10 has been recognized as a dependable tool for screening depression, it should be noted that relying solely on this scale may not be adequate for a precise diagnosis of depression. To mitigate potential misclassification bias, future studies should incorporate standard diagnostic procedures or employ more comprehensive instruments such as the Hamilton Depression Scale.

5. Conclusions

The present study found a significant association between the living environment and service quality satisfaction on depression among older adults living in elderly caring SOs, with the association appearing to be specific to gender. To effectively reduce the risk of depression in this population, it is crucial to address risk factors by improving the physical environment and amenities in elderly caring SOs, providing personalized services, and enhancing overall satisfaction. Future research should employ longitudinal designs and comprehensive assessments of environmental exposures and satisfaction to confirm these associations.

Ethics statement

All participants provided written informed consent, after fully comprehending the provided information. Furthermore, all participants possessed the necessary medical and ethical capacity to grant their consent. The procedure received approval and ethical clearance was obtained from the Biomedical Ethics Committee at Anhui Medical University (No. 20180801).

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CRediT authorship contribution statement

Xin Zheng: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Benjamin Otsen:** Writing – original draft, Formal analysis, Data curation. **Lanlan Zhao:** Writing – review & editing, Methodology, Investigation, Data curation. **Ziwen Xu:** Methodology, Data curation. **Shuo Ding:** Validation, Investigation. **Fuqin Xu:** Validation, Investigation. **Guoqing Liu:** Validation, Investigation. **Ying Guo:** Validation, Investigation. **Ling Tang:** Validation, Investigation. **Shufan Yang:** Project administration, Funding acquisition. **Zhongliang Bai:** Writing – review & editing, Project administration, Funding acquisition. **Ren Chen:** Writing – review & editing, Project administration, Funding acquisition.

Declaration of competing interest

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

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2024.08.132.

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