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New insights into social isolation and loneliness

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New insights into social isolation and loneliness

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Editorial: New insights into social isolation and loneliness

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social support, loneliness, pandemic, social isolation, stigma, mental health

Editorial on the Research Topic
New insights into social isolation and loneliness

This Research Topic provides new insights into social isolation and loneliness. Social isolation represents a significant public health problem, with well-documented detrimental consequences for people's health, including reduced mental well-being, an increased risk of diseases such as hypertension, cardiovascular disease, cancer, mortality, and cognitive decline. Ample evidence supports that social isolation is a major contributor to mortality. With the recent impact of COVID-19 and other changes in social conditions, public health leaders have underscored how social isolation and loneliness have become increasingly concerning. Social isolation can affect individuals regardless of gender or age, and further investigation will provide understanding about the occurrence process and related factors. This Research Topic aims to enhance our understanding of social isolation and loneliness.

Ten out of the 17 manuscripts submitted to the journal by international researchers were deemed suitable for publication after undergoing a thorough peer review process. The following is a summary of the main results for each manuscript.

In the first article in this special Research Topic, Babalola et al. explored the determinants of social support among Nigerians living with HIV. In a cross-sectional study in Lagos State, Nigeria in 2021, 400 persons living with HIV from six health facilities responded to surveys about perceived social support and HIV stigma. The sample reported substantive social support in general, but stigma was negatively associated with social support. However, being female, higher income, and disclosing seropositive status positively associated with social support. HIV-related stigma negatively affects social support, but support from family and friends reduced this effect. The implications call for more social support in this vulnerable population.

In the next article, Fan et al. examined the mediating effect of stigma between self-perceived burden and loneliness in stroke patients. This study found a positive correlation between loneliness in stroke patients and their self-perceived burden and stigma. Mediation analysis indicated that stigma played a complete mediating role in the relationship between self-perceived burden and loneliness. Overall, the results emphasize the significance of stigma as a crucial modifiable psychological factor influencing the loneliness of stroke patients.

In the third article of this Research Topic, Holm-Hadulla et al. described the depression and social isolation during the COVID-19 pandemic in a student population. The survey, involving 27,162 participants, utilized the Patient Health Questionnaire (PHQ) and the Well-Being Index WHO-5. Findings revealed that after 1.5 years of restrictions, 40.16% reported "major" depressive syndromes, and 72.52% experienced severely reduced well-being. Nine months post-restrictions, "major" depressive syndromes decreased to 28.50%, and well-being improved

(53.96% with a Well-Being Index below 50). The study indicated a link between depressive syndromes and reduced well-being with social isolation and loneliness. Concerns about "loneliness and social isolation" decreased from 24.2% during restrictions to 7.7% after 9 months of eased restrictions. Qualitative analysis suggested a shift towards actively addressing loneliness, potentially contributing to the later reduction in depressive syndromes.

Yuan et al. examined the relationship between fall and loneliness among older people in China. A survey involving 4,289 older individuals identified significant differences in loneliness based on age, marital status, education, residence, solitariness, and falls. The study revealed that falls, especially occurring once, contributed to increased loneliness in older individuals. Notably, agreeableness, conscientiousness, and neuroticism played significant mediating roles between falls and loneliness. The findings suggest that considering the big five personality traits is crucial for understanding and addressing loneliness in older individuals.

Andrade et al. examined impact of social isolation caused by the COVID-19 pandemic on the mood profile of active and sedentary older adults. This observational study during the COVID-19 pandemic in southern Brazil focused on older adults over 60. Using an online questionnaire in May 2020 and June 2021, 150 participants were surveyed about sociodemographics, physical activity (PA), confinement, and mood states. Of these, 53.3% reported engaging in PA. Active older adults showed fewer mood changes, experiencing lower levels of confusion, depression, and fatigue compared to inactive peers. Prolonged confinement (over 50 days) correlated with a higher risk of depression. Mood states were influenced by the fear of contracting COVID-19, with greater fear associated with more mental confusion, depression, fatigue, tension, and lower vigor. Additionally, the study highlighted a positive correlation between the hours dedicated to PA and improved mood states, indicating potential benefits for older adults.

Wenig et al. examined the associations of loneliness with mental health and with social and physical activity among university students in Germany. The COVID-19 German Student Well-Being Study (C19 GSWS) conducted between October 27th and November 14th, 2021, gathered data from 7,203 respondents across five German universities. Loneliness, reported by 20.6% of students, was analyzed in relation to depressive symptoms, anxiety, physical and social activity, and sociodemographic characteristics. Students with depressive or anxiety symptoms had significantly higher odds of reporting loneliness. Less physical activity was associated with increased loneliness, while no association was found with social activity. Loneliness was linked to being single, living alone, and having temporary residency status in Germany.

Yong conducted a secondary data analysis from a 2012 internet addiction survey to understand nuanced factors associated with "hikikomori" or extreme social withdrawal. In particular, the study focused on outgoing behaviors from hikikomori and their association with loneliness. Factor analyses on a sample of 623 Japanese internet users found mental health factors like stress, distress, dissatisfaction with personal life were strongly associated with loneliness. These results contrast with usual classifications of hikikomori and suggest a need for a reevaluation of hikikomori among individuals working or pursuing education.

Sipowicz et al. aimed to evaluate the occurrence and severity of reactive depressive episodes, loneliness, and the sense of meaning in life in individuals who had a pulmonary SARS-CoV-2 infection about a year earlier. The participants included 63 hospitalized, 67 non-hospitalized patients, and 60 healthy controls. Hospitalized patients exhibited the highest frequency and severity of depression, followed by non-hospitalized individuals, and both groups showed significant differences compared to healthy controls. Feelings of loneliness were most pronounced in the hospitalized group, and loneliness severity was higher in outpatients compared to the control group. The sense of meaning in life was lowest among hospitalized patients, moderately reduced in outpatients, and typical of the general Polish population in the control group.

Finally, Jin and Hwang examined the neuro-cognitive deficits associated with loneliness in young adults. Two groups, high-lonely and low-lonely, were identified based on the UCLA Loneliness Scale v.3. The high-lonely group exhibited significantly poorer executive function and attention, even after accounting for depression and anxiety. The study suggests that loneliness may initially affect executive function and attention in early adulthood, later extending to other cognitive domains, similar to findings in the elderly. The results also indicate that depression and anxiety do not mediate the relationship between loneliness and neuro-cognitive functioning.

In conclusion, the editors wish to thank all the authors, the reviewers, and the editorial board members for contributing to this Research Topic. Loneliness represents a complex social problem transcending demographics, health, geography, and cultures. We hope this Research Topic might inspire future and novel research approaches in the field of social isolation and loneliness.

Author contributions

YK: Writing – original draft, Writing – review & editing. LL-S: Writing – original draft, Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Determinants of social support among people living with HIV in Nigeria–a multicenter cross-sectional study

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Background: More than 38.4 million people were living with HIV worldwide in 2021. Sub-Saharan Africa bears two-thirds of the burden, with Nigeria having nearly two million people living with HIV (PLWH). Social support from social networks such as family and friends improve the quality of life, and reduces enacted and perceived stigma, but social support for PLWH remains suboptimal in Nigeria. This study aimed to assess the prevalence of social support and associated factors among PLWH in Nigeria and to test whether stigma reduces types of social support.

Methods: This cross-sectional study was conducted in Lagos State, Nigeria, between the months of June and July 2021. A total of 400 PLWH were surveyed across six health facilities providing antiretroviral therapy. Social support (family, friends, and significant others) and stigma were measured with the Multidimensional Scale of Perceived Social Support and Berger's HIV Stigma Scale, respectively. Binary logistic regression was used to identify determinants of social support.

Results: More than half (50.3%) of the respondents had adequate social support overall. The prevalence of family, friends, and significant others support was 54.3, 50.5, and 54.8%, respectively. Stigma (Adjusted Odds Ratio [AOR]: 0.945; 95% Confidence Interval [CI]: 0.905–0.987) was negatively associated with adequate friend support. Female gender (AOR: 6.411; 95% CI: 1.089–37.742), higher income (AOR: 42.461; 95% CI: 1.452–1241.448), and seropositive disclosure (AOR: 0.028; 95% CI: 0.001–0.719) were associated with adequate significant others support. Stigma (AOR:0.932; 95% CI: 0.883–0.983) was negatively associated with adequate support overall. Our findings corroborate the social support theory, as stigma reduces the chance of receiving social support.

Conclusion: PLWH that enjoy support from families or friends were less likely to be affected by HIV-related stigma. More support is needed by PLWH from family, friends, and significant others to improve the quality of life and reduce stigma among PLWH in Lagos State.

KEYWORDS

HIV, ART, social support, family support, friend support, Nigeria

Introduction

More than 38.4 million people were living with HIV worldwide in 2021 (1). One of the most affected regions is sub-Saharan Africa (SSA), with about two-thirds of the global burden of HIV (2). The countries with the highest burden of HIV in SSA are South Africa, Ethiopia, and Nigeria (3). Nigeria, the most populous country in Africa, has about 1.9 million people living with HIV (PLWH) in 2021 (1).

Current estimates suggest an increase in HIV disclosure in SSA (4, 5). HIV disclosure has been linked to increased social support for PLWH (6). Social support involves relationships and interactions within the relationships that could enhance health and well-being (7). The impact of adequate social support on PLWH includes improved quality of life and overall physical and mental well-being (8). PLWH sometimes, after disclosing their seropositive status, receive support from their social networks, such as family, friends, and colleagues, which positively impacts their quality of life and psychosocial well-being (3, 9). The prevalence of overall support for PLWH is suboptimal and varies in the literature. For instance, in India, the prevalence of strong overall social support was 43.1% (9), 38.6% in Ethiopia (10), and 9.6% in Nigeria (11). The variation in prevalence may be due to geographical and cultural differences (12).

Several factors have been associated with social support among PLWH in the literature, including sociodemographic characteristics such as age, gender, ethnicity, religion, marital status, education, employment, income, medical history such as adherence to antiretroviral therapy (ART), duration of diagnosis, duration on ART, the status of spouse or partner, and partner use of ART (3, 9, 11, 13–15).

There is little knowledge of various types of social support (such as family, friends, and significant others) among PLWH in Nigeria, particularly support from significant others. In the context of this study, significant others (e.g., religious leader and a respected colleague) are those a person feels close to beyond their family and friends (16, 17). Although other studies in SSA have attempted to include other types of support, they often do not treat these support types separately but rather combine them (3, 13, 18, 19). Many of the studies in Nigeria have focused on the overall support of PLWH. For instance, Sule et al. (11) assessed factors associated with overall support, while Folasire et al. (17) assessed overall support and friend support only. Our argument here is that factors associated with support from friends may differ from overall support or even support from family, as shown by Folasire et al. (17). Here, we went one step further by considering social support subtypes separately. We aimed to: (1) assess the prevalence of and factors associated with family support, friend support, support from significant others, and overall support; (2) assess whether increased social support will reduce stigma among PLWH.

Theoretical framework

The social support theory by Cullen (20) was adopted and tested in this study. It posits that the likelihood of crime and delinquency is more likely to reduce with adequate support (20). Recently, the social support theory was used to test the impact of HIV status disclosure on social support and stigma among PLWH in Uganda (21). Social support has several dimensions, including emotional, perceived, instrumental, and informational support, and can be classified based on the source of support, such as support from significant others, friends, family, and the community (22). There is an associated relief when PLWH disclose their seropositive status, but it can predispose them to stigma (21). Therefore, we tested the impact of stigma on social support as the secondary objective and primarily assessed the determinants of social support.

Methods

Study area, study design, setting, and sampling technique

The study was conducted in Lagos State, Nigeria, which has a projected population of 19 million, 37 Local Council Development Areas and 20 local government areas (LGA), including Etio-Osa LGA [Population (23)]. The state has 26 General Hospitals and 256 Public Healthcare Centres, some of which offer ART services [Lagos (24)].

The descriptive cross-sectional study design was adopted in this study. The methodology adopted has been published elsewhere (16). In brief, the Finite formula with a 54.35% prevalence of low support in an earlier study conducted in Dublin (14), 5% margin of error, 95% confidence interval, and sampling frame of 4,212 (active PLWH as of April 2021 across all six facilities). The initial sample size was 350, and 10% was added to cater for non-response and increase study power, which gave a sample of 385 (increased to 400).

Data collection techniques

Multistage sampling was used to select the respondents between June and July 2021. First, one LGA (Eti-Osa LGA) was selected randomly. Second, six health facilities (Ikate Primary Health Centre [PHC], Ajah PHC, Badore PHC, Iru PHC, St. Kizito hospital, and Police hospital Falomo) were selected with simple random sampling, and the sample size was proportionately allocated to the facilities. Finally, PLWH were recruited from the health facilities using systematic random sampling. Two research assistants administered the questionnaire in each facility because the literacy of the participants could not be ascertained.

Measures

Dependent variable

Social support

Social support was assessed with the Multidimensional Scale of Perceived Social Support tool (MSPSS) with 12 items. The tool has three subscales - family, friends, and significant others. Each subscale has four items measured on a 7-point Likert scale (1 = Very Strongly Disagree, 2 = Strongly Disagree, 3 = Mildly Disagree, 4 = Neutral, 5 = Mildly Agree, 6 = Strongly Agree, 7 = Very Strongly Agree) (14). Some of the questions in the MSPSS tool include: "*My family really tries to help me*," "*I can count on my friends when things go wrong*," and "*There is a special person who is around when I am in need*." The subscales - family, friends, and significant others - were treated separately and in tandem to assess the impact of social support on PLWH (25). The score ranged from 12 to 84. As previously done in earlier studies, the mean of the score was used to dichotomize each

support type and the overall support. A score above the mean was classified as adequate support (coded as 1), and scores below the mean were considered inadequate support (coded as 0) (13, 26). In the present study, the Cronbach α for family, friend, and significant others, and overall support was 0.957, 0.914, 0.908, and 0.910, respectively. These Cronbach α scores vary from strong to excellent (27).

Independent variables

Stigma

Stigma was assessed with Berger's HIV Stigma Scale. The scale is a 40-item scale measured on a 4-point Likert scale (strongly disagree, disagree, agree, and strongly agree). Some of the questions include: "*Telling someone I have HIV is risky*" and "*People with HIV are treated like outcasts*." The scale is further categorized into four domains: personalized stigma, disclosure concern, negative self-image, and concerns with public attitudes (28). The overall score ranged from 40 to 160 (items 8 and 21 were reversed). A score between 40 and 80 was categorized as "Low stigma", a score between 81 and 120 was categorized as "Moderate stigma", while a score between 121 and 160 was categorized as "High stigma" (28). The scale has a Cronbach α of 0.910 (29). The Cronbach α was 0.920 in the present study, which suggests a strong reliability score (27).

Adherence to ART

Adherence to ART was measured with self-report. Participants on first-line treatment that reported missing more than one dose of ART within the last 30 days were considered non-adherent to ART; participants on second-line treatment that missed more than four (4) doses of ART within the last 30 days were considered non-adherent to ART. Put differently, participants who missed >5% of ART within a month were considered non-adherent to ART (30, 31).

Medical history and covariates

The medical history included duration of diagnosis and duration on ART (1–5, 6–10, >10 years) and disclosure of status (Yes, No). Also, spouse HIV status and use of ARV, if positive, were considered. The covariates include eight sociodemographic characteristics: age (18–27, 28–37, >37 years), gender (Male or Female), marital status (Single, Married, Cohabiting, Separated, Divorced, or Widow/er), ethnicity (Yoruba, Igbo, Hausa, or Others), religion (Christianity, Islam, or Others), the highest level of education (None, Primary, Secondary, or Tertiary), occupation (Self-employed, Civil Servant, Unemployed, Student, Others, or Pensioner), and monthly income (<**N** 30000, **N**30001- **N**50000, **N**50001- **N**100000, or > **N**100000).

Data analysis

The SPSS version 26 was used to analyze all data, and the level of statistical significance was set at 5%. Frequency was used to describe categorical variables, while the mean or median was used to describe normal and skewed data, respectively. Where appropriate, Pearson's Chi-Square or Fisher's exact test was used to test for the association between the independent variables and social supports. All the variables were considered for the regression analysis. Before regression analysis, multicollinearity was assessed with Variance Inflation Factor (VIF), and VIF <10 was accepted as a non-correlation between the

TABLE 1 Sociodemographic characteristics (*n*=396).

Variables	Frequency	Percentage
Age (years)		
18–27	104	26.3
28–37	165	41.7
> 37	127	32.0
Median Age (IQR)	32	18–68
Gender		
Female	237	59.8
Male	159	40.2
Ethnicity		
Yoruba	142	35.9
Igbo	124	31.3
Hausa	37	9,3
Others	93	23.5
Religion (N = 372)		
Christianity	269	72.3
Islam	100	26.9
Others	3	0.8
Marital status		
Single	175	44.2
Married	152	38.4
Cohabiting	19	4.8
Widow/er	28	7.0
Separated	13	3.3
Divorced	9	2.3
Level of education		
None	10	2.6
Primary	52	13.1
Secondary	187	47.2
Tertiary	147	37.1
Employment status		
Self-Employed	208	52.5
Civil Servant	64	16.2
Unemployed	50	12.6
Student	45	11.4
Others	23	5.8
Pensioner	6	1.5
Monthly Income (N) (N = 345)		
< N30,000	117	33.9
30,001 – 50,000	76	22.0
50,001 – 100,000	103	29.9
> 100,000	49	14.2

N, Naira; IQR, Interquartile range (25th –75th).

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TABLE 2 Personal and interpersonal medical history (n=396).

Variables	Frequency	Percentage
Duration of HIV Diagnosis		
1–5 years	328	82.8
6–10 years	39	9.8
>10 years	29	7.4
Median Duration of HIV Diagnosis (IQR)	3	1–20
Duration on ART		
1–5 years	328	82.8
6–10 years	41	10.4
>10 years	27	6.8
Median Duration on ART (IQR)	3	1–20
Adherent to ART		
Yes	247	65.5
No	136	35.5
Disclosure of Status (N = 390)		
Yes	280	71.8
No	110	28.2
Stigma		
Low	33	8.3
Moderate	281	71.0
High	82	20.7
Status of partner (N = 170)		
Positive	70	41.2
Negative	96	56.5
Do not know	4	2.3
Use of ART by partner (N = 114)		
Yes	58	50.9
No	56	49.1

HIV, Human Immunodeficiency Virus; ART, Antiretroviral therapy; IQR, Interquartile range.

explanatory variables (3). We found evidence of multicollinearity between the duration of diagnosis and the duration on ART. Duration on ART was dropped as it is less common in the literature than diagnosis duration. Also, we found a high correlation and collinearity between the domains of Berger's HIV Stigma scale and the overall stigma score; therefore, we used the overall stigma score rather than scores from the individual domains. Binary logistic regression analysis was performed to identify factors that predict each of the social support. All analyses were conducted at 95% confidence interval (CI).

Ethical considerations

Ethical clearance for the study was obtained from the Health Research and Ethics Committee of Lagos University Teaching Hospital (ADM/DSCST/HREC/APP/4400). Also, approval was sought from the Medical Director of the health facilities in Eti-Osa LGA. The interviewer explained in detail the study's purpose, the benefit of the study, and the risks involved. Written informed consent was obtained from the participants before the interview. Participants were allowed to withdraw from the study at any time without penalty, and the privacy of the participants was ensured during and after the interview. No incentive was given for participation.

TABLE 3 Prevalence of social support (n=396).

Variables	Frequency	Percentage
Family support		
Inadequate	181	45.7
Adequate	215	54.3
Mean family support (SD)	18.3	7.7
Friend support		
Inadequate	196	49.5
Adequate	200	50.5
Mean friend support (SD)	14.3	6.1
Significant others support		
Inadequate	179	45.2
Adequate	217	54.8
Mean significant others support (SD)	19.4	6.4
Overall social support		
Inadequate	197	49.7
Adequate	199	50.3
Mean overall support (SD)	52	15.8

SD, Standard deviation.

Results

Sociodemographic, medical history, and social support

Of the 400 questionnaires, 396 were fit for analysis, giving a response rate of 99%. The median age of the respondents was 32 (18–68) years, while the majority were females (59.8%). About 7 in 10 (72.3%) were Christians, and many were single (44.2%). Less than half (47.2%) had secondary school education, while about one-third had tertiary-level education. More than half were self-employed (52.5%), and 16.2% were civil servants (Table 1). Regarding medical history, 8 in 10 were diagnosed with HIV and commenced ART within the last 5 years; however, only 65.5% adhered to ART medications. Seven in 10 respondents had disclosed their seropositive status, and only 20.7% had experienced a high level of enacted stigma. Among those who were married/cohabiting, 4 in 10 (41.2%) of the spouses were living with HIV, and half (50.9%) of these spouses were on ART (Table 2). More than half (50.3%) of the respondents had adequate support overall. Specifically, 54.3, 50.5, and 54.8% of the respondents had adequate family support, friend support, and support from significant others, respectively (Table 3).

Factors associated with adequate support

In the bivariate analysis, age was significantly associated with family, friends, and overall social support only - PLWH above 37 years

TABLE 4 Association between sociodemographic, medical history and strong social supports.

Variables	Adequate family support			Adequate friend support			Adequate others support			Adequate overall support		
	No (%)	Yes (%)	*p*-value	No (%)	Yes (%)	*p*-value	No (%)	Yes (%)	*p*-value	No (%)	Yes (%)	*p*-value
Age (years)												
18–27	60 (57.7)	44 (42.3)		58 (55.8)	46 (44.2)		47 (45.2)	57 (54.8)		63 (60.6)	41 (39.4)	**0.003**
28–37	79 (47.9)	86 (52.1)	**0.001**	87 (52.7)	78 (47.3)	**0.034**	79 (47.9)	86 (52.1)	0.579	85 (51.5)	80 (48.5)	
> 37	42 (33.1)	85 (66.9)		51 (40.2)	76 (59.8)		53 (41.7)	74 (58.3)		49 (38.6)	78 (61.4)	
Gender												
Female	114 (48.1)	123 (51.9)	0.243	114 (48.1)	123 (51.9)	0.498	101 (42.6)	136 (57.4)	0.207	118 (49.8)	119 (50.2)	0.984
Male	67 (42.1)	92 (57.9)		82 (51.6)	77 (48.4)		78 (49.1)	81 (50.9)		79 (49.7)	80 (50.3)	
Ethnicity												
Yoruba	65 (45.8)	77 (54.2)		71 (50.0)	71 (50.0)		61 (43.0)	81 (57.0)		67 (47.2)	75 (52.8)	0.150
Igbo	63 (50.8)	61 (49.2)	**0.007**	59 (47.6)	65 (52.4)	0.606	53 (42.7)	71 (57.3)	0.300	61 (49.2)	63 (50.8)	
Hausa	23 (62.2)	14 (37.8)		22 (59.5)	15 (40.5)		22 (59.5)	15 (40.5)		25 (67.6)	12 (32.4)	
Others	30 (32.3)	63 (67.7)		44 (47.3)	49 (52.7)		43 (46.2)	50 (53.8)		44 (47.3)	49 (52.7)	
Religion												
Christianity	116 (43.1)	153 (56.9)	0.313	130 (48.3)	139 (51.7)	0.648	113 (42.0)	156 (58.0)	0.169	127 (47.2)	142 (52.8)	0.246
Islam	49 (49.0)	51 (51.0)		51 (51.0)	49 (49.0)		50 (50.0)	50 (50.0)		54 (54.0)	46 (46.0)	
Marital status												
Single	93 (53.1)	82 (46.9)		104 (59.4)	71 (40.6)		88 (50.3)	87 (49.7)		109 (62.3)	66 (37.7)	**<0.001**
Married	63 (36.8)	108 (63.2)	**<0.001**	67 (39.2)	104 (60.8)	**0.001**	62 (36.3)	109 (63.7)	**0.014**	61 (35.7)	110 (64.3)	
Separated/Divorced	16 (72.7)	6 (27.3)		14 (63.6)	8 (36.4)		13 (59.1)	9 (40.9)		17 (77.3)	5 (22.7)	
Widow/er	9 (32.1)	19 (67.9)		11 (39.3)	17 (60.7)		16 (57.1)	12 (42.9)		10 (35.7)	18 (64.3)	
Level of Education												
None	4 (40.0)	6 (60.0)		6 (60.0)	4 (40.0)		6 (60.0)	4 (40.0)		7 (70.0)	3 (30.0)	**<0.001F**
Primary	35 (67.3)	17 (32.7)	**0.023F**	33 (63.5)	19 (36.5)	0.104F	30 (57.7)	22 (42.3)	0.177F	40 (76.9)	12 (23.1)	
Secondary	82 (43.9)	105 (56.1)		92 (49.2)	95 (50.8)		79 (42.2)	108 (57.8)		86 (46.0)	101 (54.0)	
Tertiary	60 (40.8)	87 (59.2)		65 (44.2)	82 (55.8)		64 (43.5)	83 (56.5)		64 (43.5)	83 (56.5)	
Employment												
Unemployed	38 (48.1)	41 (51.9)		32 (40.5)	47 (59.5)		35 (44.3)	44 (55.7)		41 (51.9)	38 (48.1)	0.081
Civil servant	30 (46.9)	34 (53.1)	0.068	28 (43.8)	36 (56.3)	**0.001**	31 (48.4)	33 (51.6)	0.712	31 (48.4)	33 (51.6)	
Self employed	85 (40.9)	123 (59.1)		102 (49.0)	106 (51.0)		96 (46.2)	112 (53.8)		95 (45.7)	113 (54.3)	
Students	28 (62.2)	17 (37.8)		34 (75.6)	11 (24.4)		17 (37.8)	28 (62.2)		30 (66.7)	15 (33.3)	

(Continued)

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TABLE 4 (Continued)

Variables	Adequate family support			Adequate friend support			Adequate others support			Adequate overall support		
	No (%)	Yes (%)	*p*-value	No (%)	Yes (%)	*p*-value	No (%)	Yes (%)	*p*-value	No (%)	Yes (%)	*p*-value
Monthly Income (N)												
< N30,000	60 (51.3)	57 (48.7)		70 (59.8)	47 (40.2)		58 (49.6)	59 (50.4)		68 (58.1)	49 (41.9)	**<0.001**
30,001 – 50,000	44 (57.9)	32 (42.1)	**<0.001**	38 (50.0)	38 (50.0)	**0.003**	46 (60.5)	30 (39.5)	**0.006**	48 (63.2)	28 (36.8)	
50,001 – 100,000	30 (29.1)	73 (70.9)		48 (46.6)	55 (53.4)		39 (37.9)	64 (62.1)		36 (35.0)	67 (65.0)	
> 100,000	14 (28.6)	35 (71.4)		14 (28.6)	35 (71.4)		17 (34.7)	32 (65.3)		12 (24.5)	37 (75.5)	
Duration of HIV diagnosis												
1–5 years	163 (49.7)	165 (50.3)	**0.002**	165 (50.3)	163 (49.7)	0.307	154 (47.0)	174 (53.0)	0.247	172 (52.4)	156 (47.6)	**0.033**
6–10 years	11 (28.2)	28 (71.8)		15 (38.5)	24 (61.5)		13 (33.3)	26 (66.7)		12 (30.8)	27 (69.2)	
>10 years	7 (24.1)	22 (75.9)		16 (55.2)	13 (44.8)		12 (41.4)	17 (54.8)		13 (44.8)	16 (55.2)	
Duration on ART												
1–5 years	163 (49.7)	165 (50.3)	**0.002**	165 (50.3)	163 (49.7)	0.320	154 (47.0)	174 (53.0)	0.180	172 (52.4)	156 (47.6)	**0.020**
6–10 years	11 (26.8)	30 (73.2)		16 (39.0)	25 (61.0)		13 (31.7)	28 (68.3)		12 (29.3)	29 (70.7)	
>10 years	7 (25.9)	20 (74.1)		15 (55.6)	12 (44.4)		12 (44.4)	15 (55.6)		13 (48.1)	14 (51.9)	
Adherent to ART												
Yes	123 (49.8)	124 (50.2)	**0.030**	120 (48.6)	127 (51.4)	0.992	116 (47.0)	131 (53.0)	0.276	134 (54.3)	113 (45.7)	**0.014**
No	52 (38.2)	84 (61.8)		66 (48.5)	70 (51.5)		56 (41.2)	80 (58.8)		56 (41.2)	80 (58.8)	
Disclosure of Status												
Yes	78 (70.9)	32 (29.1)	**<0.001**	75 (68.2)	35 (31.8)	**<0.001**	62 (56.4)	48 (43.6)	**0.005**	84 (76.4)	26 (23.6)	**<0.001**
No	99 (35.4)	181 (64.6)		117 (41.8)	163 (58.2)		114 (40.7)	166 (59.3)		109 (38.9)	171 (61.1)	
Stigma												
Low	12 (36.4)	21 (63.6)	0.076	14 (42.4)	19 (57.6)	0.157	11 (33.3)	22 (66.7)	**0.046**	13 (39.4)	20 (60.6)	**0.002**
Moderate	123 (43.8)	158 (56.2)		134 (47.7)	147 (52.3)		122 (43.4)	159 (56.6)		129 (45.9)	152 (54.1)	
High	46 (56.1)	36 (43.9)		48 (58.5)	34 (41.5)		46 (56.1)	36 (43.9)		55 (67.1)	27 (32.9)	
Status of partner												
Positive	20 (28.6)	50 (71.4)	**0.046**	24 (34.3)	46 (65.7)	0.104	29 (41.4)	41 (58.6)	0.100	22 (31.4)	48 (68.6)	0.178
Negative/Do not know	42 (43.8)	54 (56.3)		45 (46.9)	51 (53.1)		28 (29.2)	68 (70.8)		40 (41.7)	56 (58.3)	
Use of ART by spouse												
Yes	16 (27.6)	42 (72.4)	**0.019**	16 (27.6)	42 (72.4)	**0.001**	21 (36.2)	37 (63.8)	0.521	16 (27.6)	42 (72.4)	**0.030**
No	30 (48.4)	32 (51.6)		35 (56.5)	27 (43.5)		26 (41.9)	36 (58.1)		29 (46.8)	33 (53.2)	

F: Fisher's *p*-value; Bolded value of ps are significant at *p*: <0.05

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TABLE 5 Binary logistic regression analysis for family and friend support.

Variable	Adequate family support					Adequate friend support				
	Coefficient	AOR	95%	CI	*p*-value	Coefficient	AOR	95%	CI	*p*-value
Age (years)	0.019	1.019	0.959	1.083	0.539	−0.010	0.990	0.935	1.048	0.731
Gender										
Male (Reference)										
Female	0.534	1.706	0.416	6.985	0.458	1.111	3.037	0.760	12.136	0.116
Ethnicity										
Hausa (Reference)										
Igbo	−0.532	0.587	0.042	8.254	0.693	−1.661	0.190	0.013	2.883	0.231
Yoruba	0.566	1.760	0.190	16.282	0.618	−1.663	0.190	0.021	1.701	0.137
Others	1.199	3.317	0.217	50.684	0.389	−2.186	0.112	0.008	1.627	0.109
Religion										
Islam (Reference)										
Christianity	0.126	1.135	0.248	5.196	0.871	−1.166	0.847	0.185	3.881	0.831
Level of education										
None/Primary (Reference)										
Secondary	1.509	4.524	0.496	41.277	0.181	1.538	4.655	0.512	42.302	0.172
Tertiary	−0.310	0.734	0.051	10.522	0.820	1.121	3.069	0.194	48.502	0.426
Employment										
Unemployed (Reference)										
Employed	0.088	1.092	0.148	8.056	0.931	−2.042	0.130	0.013	1.341	0.087
Monthly Income (N)										
< N30,000 (Reference)										
30,001 – 50,000	−0.745	0.475	0.069	3.261	0.448	1.037	2.822	0.388	20.523	0.306
50,001 – 100,000	1.095	2.988	0.289	30.894	0.358	1.851	6.368	0.557	72.749	0.136
> 100,000	0.993	2.700	0.157	46.344	0.493	1.949	7.018	0.398	123.852	0.183
Duration of HIV Diagnosis	0.238	1.268	0.980	1.641	0.071	−0.072	0.931	0.723	1.199	0.579
Adherent to ART										
No (Reference)										
Yes	−1.164	0.312	0.073	1.334	0.116	0.387	1.472	0.355	6.102	0.594

(Continued)

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TABLE 5 (Continued)

Variable	Adequate family support					Adequate friend support				
	Coefficient	AOR	95%	CI	*p*-value	Coefficient	AOR	95%	CI	*p*-value
Disclosure of Status										
No (Reference)										
Yes	−1.718	0.179	0.017	1.911	0.155	3.493	32.899	0.643	1682.052	0.082
Stigma	−0.021	0.980	0.944	1.017	0.285	−0.056	0.945	0.905	0.987	**0.012**
Status of partner										
Negative/Do not know (Reference)										
Positive	−0.615	0.541	0.030	9.677	0.676	−0.734	0.480	0.013	17.954	0.691
Use of ART by spouse										
No (Reference)										
Yes	2.506	12.259	0.589	255.309	0.106	1.433	4.190	0.121	144.681	0.428
Nagelkerke R^2:			0.461					0.500		
Hosmer and Lemeshow χ^2 (*p*-value)			5.114 (0.745)					3.513 (0.898)		

AOR, Adjusted Odds Ratio; HIV, Human Immunodeficiency Virus; ART, Antiretroviral therapy; N, Naira; Bolded value of ps are significant at *p*-value: 0.05.

had more of this support (see Table 4). Specifically, 66.9, 59.8, and 61.4% of participants older than 37 years had adequate support from family, friends, and overall social support, respectively. Ethnicity was only associated with family support. More than two-thirds (67.7%) of other tribes had adequate family support, half (54.2%) of the Yoruba tribe had adequate support, less than half (49.2%) of the Igbos had adequate family support, and more than a third (37.8%) of the Hausa group had adequate family support.

Marital status was significantly associated with all support types. For family support, more than two-thirds (67.9%) had adequate support, which is similar to the 63.2% for married PLWH. A similar pattern was observed for family support and overall social support. Level of education was associated with family and overall support only, where more than half of those with secondary level education (56.1%) and tertiary education (59.2%) got adequate family support, while only a third (32.7%) of those with primary education had adequate family support. A similar pattern was observed with the overall social support. Employment status was significantly associated with only friend support. More than half of the unemployed (59.5%), civil servants (56.3%), and self-employed (51.0%) PLWH had adequate friend support, and nearly a quarter (24.4%) of students living with HIV had adequate support from friends.

Monthly income was significantly associated with all the subtypes and overall social support, and about 7 in 10 PLWH that earned more than N100,000 ($443 to a Naira = $226) had adequate support. We found an association between the duration of HIV diagnosis and family support and overall social support, as increased duration of diagnosis increased family and overall support. PLWH that were adherent to medications had significantly more family and overall support only. Six in 10 (61.8%) PLWH not adherent to ART, and half (50.2%) of those adherent to ART had adequate family support. Similarly, more than half (58.8%) of those not adherent had adequate overall social support, while only 45.7% of those adherent to ART had adequate overall social support.

Interestingly, only 29.1% of those who had disclosed their HIV status and 61.8% of those yet to disclose their seropositive status had adequate family support. This was also true for other social support subtypes and overall social support. Seven in 10 (71.4%) PLWH whose spouses were also living with HIV received adequate family support, while other types of support were not associated with spousal use of ART. Similarly, seven in ten PLWH whose spouses were on ART had adequate support from family and friends. Regarding stigma, support from significant others and overall support were associated with stigma. Specifically, six in 10 PLWH with low support had reported adequate support from significant others and overall support (Table 4).

In the multivariate analysis, all the variables were fitted in a regression model for each support subtype and the overall social support. The independent variables explained 54.8% of the variance in significant others support. None of the variables predicted family support (Table 5). For friend support, stigma reduces the chance of receiving adequate friend support (Adjusted Odds Ratio [AOR]: 0.945; 95% CI: 0.905–0.987). The model for significant others support shows that females were 6.41 times (95% CI: 1.089–37.742) more likely to have adequate support from significant others than males. PLWH earning between N50,001–100,000 were 42.46 (95% CI: 1.452–1241.448) times more likely to get support from significant others than those earning <N30,000 (Table 6). The independent variables

TABLE 6 Binary logistic regression analysis for significant others and overall support.

Variable	Adequate others support					Adequate overall support				
	Coefficient	AOR	95%	CI	*p*-value	Coefficient	AOR	95%	CI	*p*-value
Age (years)	−0.029	0.972	0.907	1.042	0.419	0.001	1.001	0.936	1.070	0.987
Gender										
Male (Reference)										
Female	1.858	6.411	1.089	37.742	**0.040**	1.087	2.965	0.638	13.774	0.165
Ethnicity										
Hausa (Reference)										
Igbo	−0.224	0.799	0.040	15.983	0.883	−0.834	0.434	0.020	9.404	0.595
Yoruba	−0.671	0.511	0.047	5.515	0.580	−1.676	0.187	0.012	2.870	0.229
Others	−1.486	0.226	0.014	3.704	0.297	−2.373	0.093	0.005	1.901	0.123
Religion										
Islam (Reference)										
Christianity	−0.389	0.678	0.123	3.729	0.655	0.142	1.153	0.211	6.314	0.870
Level of Education										
None/Primary (Reference)										
Secondary	0.378	1.459	0.114	18.658	0.772	1.370	3.934	0.370	41.800	0.256
Tertiary	−0.592	0.553	0.024	13.026	0.714	−0.115	0.892	0.048	16.587	0.939
Employment										
Unemployed (Reference)										
Employed	0.036	1.037	0.108	9.950	0.975	−1.542	0.214	0.021	2.198	0.194
Monthly Income (N)										
< N30,000 (Reference)										
30,001 – 50,000	−1.737	0.176	0.021	1.452	0.107	0.137	1.146	0.131	10.042	0.902
50,001 – 100,000	3.749	42.461	1.452	1241.448	**0.030**	3.417	30.463	1.388	668.627	**0.030**
> 100,000	3.196	24.424	0.612	973.959	0.089	3.371	29.106	0.926	915.007	0.055
Duration of HIV Diagnosis	0.266	1.305	0.969	1.757	0.080	0.269	1.309	0.932	1.839	0.121
Adherent to ART										
No (Reference)										
Yes	−0.244	0.783	0.166	3.693	0.758	−0.995	0.370	0.073	1.860	0.227

(Continued)

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TABLE 6 (Continued)

Variable	Adequate others support				Adequate overall support			
	Coefficient	AOR	95% CI	*p*-value	Coefficient	AOR	95% CI	*p*-value
Disclosure of Status								
No (Reference)								
Yes	−3.588	0.028	0.001 0.719	**0.031**	0.220	1.246	0.107 14.476	0.860
Stigma	−0.003	0.997	0.957 1.039	0.875	−0.070	0.932	0.883 0.983	**0.010**
Status of partner								
Negative/Do not know (Reference)								
Positive	−4.437	0.012	0.001 0.542	**0.023**	−2.532	0.080	0.001 5.121	0.234
Use of ART by spouse								
No (Reference)								
Yes	3.065	21.444	0.738 623.451	0.075	3.225	25.161	0.425 1490.426	0.121
Nagelkerke R^2:			0.548				0.554	
			9.030 (0.340)				6.285 (0.615)	

AOR, Adjusted Odds Ratio; HIV, Human Immunodeficiency Virus; ART, Antiretroviral therapy; N, Naira; Bolded value of ps are significant at *p*-value: 0.05.

explained 50% of the variance in friend support. PLWH that disclosed their seropositive status were less likely to get adequate support from significant others than those that had not disclosed their status (AOR: 0.028; 95% CI: 0.001–0.719). Also, PLWH whose partners are living with HIV were less likely to have adequate support from significant others than those whose partners were not living with HIV (AOR: 0.012; 95% CI: 0.001–0.542).

Only monthly income and stigma predicted adequate overall social support in the overall social support model. The independent variables explained 55.4% of the variance in overall social support. PLWH earning between N50,001–100,000 were 30.5 times (95% CI: 1.388–688.627) more likely to get support from significant others than those earning <N30,000. Those that experienced stigma were less likely to get adequate overall social support (AOR: 0.932; 95% CI: 0.883–0.983).

Discussion

This study explored the level of family support, friend support, and support from significant others and the associated factors among PLWH in Nigeria. The prevalence of adequate overall social support was 54.3%, corroborating the finding of an earlier study conducted in Jos, Nigeria, where moderate/high support prevalence was 59.6% (11). However, it is higher than the 38.6% strong support reported in Ethiopia (10) and the 48.6% moderate/high social support reported in India (9). Our finding is lower than the 82.4% reported in an earlier study conducted in Ethiopia (32). The plausible explanation for the variation could be different assessment tools, as some of these studies used Oslo Social Support Scale against the MSPSS used in our study. We found that 5 in 10 PLWH have adequate family support and support from significant others, which is not similar to an earlier study conducted in India where they found that 8 in 10 PLWH had sufficient support from family, friends, and others (9). The difference may reflect geographical and cultural variations in support for PLWH (12). Also, the discrepancy may be due to differences in the support classification in both studies.

We found that females had a higher level of support from significant others, which is in contrast to earlier studies conducted in Nigeria (14), and Ethiopia (3); however, two studies are in agreement with our finding (7, 33). The possible explanation given by Li et al. (7) was that females share unpleasant experiences with special persons to reduce psychological pressure, unlike men who choose to adjust without sharing experiences. Also, when women confirm their seropositive status, they are quicker to disclose it to a significant or trustworthy person, which can earn them social support and access to healthcare services (29). This may partly explain our finding that those whose partners were living with HIV were more likely to get significant support, including financial support and emotional resilience (34, 35). In addition, receiving counselling by seroconcordant couples may stimulate improved communication and relationship, and facilitate better coping strategies, according to the World Health Organization (36).

We found that PLWH with higher income experience higher overall social support. This finding comports with earlier studies (7, 11, 13). The explanation for our finding could be that those with higher incomes get more support from family and friends as they may be the family's breadwinner (7).

PLWH with a lower level of stigma had a higher level of support from friends and overall social support, a finding that echoes the conclusion of studies from sub-Saharan Africa (28, 37) and outside Africa (38). Based on our second objective, our finding supports the social support theory, which posits that higher support reduces stigma among PLWH (21). The plausible explanation could be that a higher level of social support boosts self-esteem, which improves self-worth and social behavior (39), which can buffer the effect of enacted stigma among PLWH (40). Additionally, the fact that most PLWH in our study had disclosed their status may explain why the stigma level was low. According to Oke et al. (28), HIV disclosure is a proxy measurement of stigma and a low level of status disclosure increases stigma.

The major strength of our study was the recruitment of participants from multiple health facilities in Lagos State, which is known as the commercial hub of Nigeria with diverse people and cultures, allowing for a diverse set of participants. Also, this present study examined the prevalence of support from different social networks and the factors that predict adequate support from each social network. However, the limitation of this study is that the findings need to be interpreted with caution because a cross-sectional study cannot establish causality. Longitudinal studies are warranted to understand social support among PLWH in Lagos State and Nigeria at large.

Conclusion

Our data shows that more than half of PLWH in our study receive adequate support from family, friends, and significant others. Despite not identifying any predictor of family support, adequate support from friends reduces stigma. Further, females, those that earn a higher income, those who have disclosed their status, and those whose spouse was living with HIV get more support from significant others. PLWH needs more support from family, friends, and significant others to improve quality of life and reduce stigma.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the Health Research and Ethics Committee of Lagos University Teaching Hospital. The patients/participants provided their written informed consent to participate in this study.

Author contributions

OEB and OAB conceived the concept and designed the methodology, and wrote the manuscript. OEB led data collection. OAB analyzed the data. LB and OA verified data analysis and supervised the entire process. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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The mediating effect of stigma between self-perceived burden and loneliness in stroke patients

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Introduction: Stroke patients may experience reduced socialization and feelings of isolation due to post-stroke sequelae such as impaired motor function and cognitive deficits. Factors associated with loneliness need to be explored to develop targeted interventions. However, little is known about the impact of self-perceived burden and illness stigma on loneliness in this population.The aim of this study was to explore the mediating effect of stigma on self-perceived burden and loneliness in stroke patients.

Methods: The cluster random sampling method was adopted to select 1028 stroke patients from the neurology department of third-grade A hospitals and second-grade A hospitals in 5 cities of Henan Province from May 2022 to August 2022. A general data questionnaire, self-perceived burden scale, stroke stigma scale, and loneliness scale were used to investigate. The structural equation model was used to analyze the mediating effect of stigma between self-perceived burden and stigma.

Results: The loneliness of stroke patients was positively correlated with self-perceived burden and stigma. The results of the mediation analysis showed that stigma played a complete mediating role between self-perceived burden and loneliness.

Discussion: The results of the study revealed the relationship between self-perceived burden, stigma, and loneliness in stroke patients. Stigma mediated the relationship between self-perceived burden and loneliness in this population.Stigma should be emphasized as an important modifiable psychological factor that affects loneliness of stroke patients.

KEYWORDS

stroke, self-perceived burden, stigma, loneliness, mediation

Introduction

Stroke is an acute cerebrovascular disease characterized by symptoms and signs of ischemic or hemorrhagic damage to brain tissue (1). Stroke has a prevalence of 1,115 cases per 100,000 people in China and a mortality rate of 115 cases per 100,000 people, with more than 2 million new cases each year. Nearly 50% of stroke patients exhibit motor dysfunction after a stroke (2), while cognitive deficits are present in 30 to 40% of patients (3). These include hemiparesis, aphasia, dementia, etc., which severely affect the quality of life and social participation of patients. Long-term post-stroke rehabilitation places a significant burden on families and society in terms of medical costs. Furthermore, patients are dependent on family members for care due to their reduced ability to care for themselves (4, 5). In addition, patients are prone to depression, stigma, loneliness, and other psychological disorders. As one of the most serious psychological problems, loneliness after stroke has attracted growing attention in recent years. Loneliness not

only increases the risk of stroke by 32%, but is also associated with an elevated risk of stroke recurrence (6, 7). On the other hand, a national study has shown that loneliness is present in 44% of stroke patients (8). Moreover, loneliness reduces the quality of life of stroke patients (9). Therefore, it is necessary to explore the factors affecting post-stroke loneliness in the Chinese sociocultural context in order to develop targeted interventions.

Loneliness is defined as the subjective, unpleasant experience of lack or loss of companionship (10). The effects of loneliness on individuals are multifaceted. First, loneliness can increase adrenaline secretion, strengthen vasoconstriction, increase vascular resistance, and can lead to hypertension (11), which is a risk factor for stroke (6). Hence, loneliness increases the risk of stroke. Loneliness also increases the risk of depression, anxiety, and cognitive decline (12–14), and has a negative impact on one's physical and mental health. Finally, loneliness can lead to social withdrawal, aggressive behavior, and suicidal thoughts (11, 14), and severely impacts social interpersonal relationships. Therefore, identifying the factors that influence loneliness is essential to improve the emotional health needs of stroke patients.

Exploring the factors associated with loneliness can help develop targeted interventions. Many factors are associated with loneliness, including demographic, illness, and psychological factors. Previous research has revealed higher loneliness in divorced patients, female gender, older, with smaller families, and economically disadvantaged patients (8). These factors are primarily comprise demographics and disease-related factors, but cannot be easily modified by interventions. Previous studies have shown that self-perceived burden is an important factor influencing loneliness (15). Moreover, stigma is positively associated with loneliness (16). Although many studies have been conducted to explore the link between loneliness and self-perceived burden and stigma, the mechanisms underlying these three variables are unclear and require further research.

Self-perceived burden is defined as an empathic concern due to the impact of one's illness and care needs on others, resulting in guilt, distress, responsibility, and a diminished sense of self (17). Self-perceived burden is a common psychological condition among individuals with chronic illnesses. Over the past years, the overall burden of stroke (including health, economic, and social costs) on individuals, families, and national healthcare systems has increased (18, 19). Compared to Western countries, China's health care system is still inadequate and formal community care services remain underdeveloped (20). Most stroke patients return home after stabilization for financial reasons, and failure to receive professional stroke rehabilitation after discharge may lead to poor physical function. Stroke survivors receiving care from others, especially those with functional impairment, demonstrate self-perceived burden (21). Influenced by Confucianism and the core values of collectivism, Chinese people regard caring for family members as an obligation. One of the core elements of Confucianism is filial piety, which includes the values of respect, love, and support for parents (20). Influenced by this traditional culture, family members of stroke patients in China take on the primary care of the patient. The collectivist sense of value emphasizes group interests over individual interests and suggests individual sacrifice for the sake of the family (20, 22, 23). As a result, stroke patients experience psychological stress when receiving care from family members because they do not want to become a burden or a liability to the family. Thus, Chinese familial values are both a source of social support and a possible source of stress for patients. Previous studies have reported that 99% of stroke patients experienced mild to moderate self-perceived burden (24), which was associated with physical conditions (e.g., pain and somatic weakness) and negative psychological conditions (e.g., depression and suicidal ideation) (25). In a study of older stroke patients, self-perceived burden was found to be negatively associated with patients' self-management behaviors, negatively impacting their recovery and quality of life (26). In addition, a study reported a positive association between self-perceived burden and stigma in adults with epilepsy (27). Goffman was the first to suggest that stigma, which can "largely tarnish a person's reputation," induces psychological and emotional stress (5). Stigma is "an attribute that is deeply discrediting" and mainly involves psychological and emotional stress. Stigma hinders treatment and negatively impacts the quality of life of patients with chronic diseases (5). Influenced by Chinese family values, patients have a strong sense of dependence on their families (20), and studies have shown that high dependence leads to elevated levels of stigma (5). Stroke patients face varying degrees of physical, psychosocial, and cognitive impairment, such as hemiplegia, aphasia, and depression, which can further lead to feelings of shame (28), and can lead to a sense of stigma. Stigma and loneliness are positively correlated, which has been observed across countries and diseases. Self-perceived burden is an important factor influencing loneliness, and stigma may mediate this psychological process. The psychological stress theory (29) states that individuals who are exposed to negative life events (stressors) experience physiological, psychological, and behavioral stress responses mediated by a variety of internal and external factors. In this study, the self-perceived burden, stigma, and loneliness of stroke patients were analyzed in relation to the psychological stress theory. Stroke patients were hypothesized to have varying degrees of self-perceived burden after the onset of stroke, which might be mediated by the patient's own psychological adjustment to developing stigma and result in increased loneliness. Therefore, structural equations were used to test this hypothesis, evaluating the mediating role of stigma in the relationship between self-perceived burden and loneliness.

In summary, self-perceived burden was hypothesized to be related to stigma and loneliness, and that stigma may be a potential mediator between self-perceived burden and loneliness. This study aimed to quantify the levels of self-perceived burden, stigma, and loneliness in stroke patients and to explore the potential relationship between self-perceived burden and stigma, and loneliness. The results would provide a theoretical basis for developing interventions to improve loneliness in such patients. This study hypothesized that (a) self-perceived burden is positively associated with loneliness (b), stigma is positively associated with loneliness, and (c) stigma mediates the relationship between self-perceived burden and loneliness.

Methods

Design

A descriptive cross-sectional design was utilized in this study, which followed the guidelines of the Strengthening Reports of Observational Studies in Epidemiology (STROBE) for cross-sectional studies.

Participants

Using a convenience sampling method, the participants were recruited from 10 communities and 20 hospitals in 5 cities across eastern (Zhoukou City), western (Luoyang City), southern (Xinyang City) northern (Anyang City), and central (Zhengzhou City) Henan Province, China. Inclusion criteria: (1) age ≥ 18 years; (2) meeting the stroke diagnostic criteria; (3) being conscious and able to communicate effectively verbally or in writing; and (4) informed consent and voluntary participation in this study. Exclusion criteria: (1) those with a history of psychiatric disorders; (2) comorbidities including serious physical diseases, malignant tumors, or serious central nervous system diseases; and (3) autism diagnosed before the onset of stroke.

The sample size was taken to be 5–10 times the number of variables (30). A total of 25 variables were included in this study and a minimum sample size of 125 was calculated. Considering a 20% no-response rate, the minimum sample size for this study was 157.

Data collection

Data were collected between May and August 2022 using self-report questionnaires, including demographic and clinical information, self-perceived burden, stigma, and loneliness. Stroke patients from the hospital completed the questionnaire on the day before discharge, and participants from the community provided data during the high-risk stroke population screening process. Surveyors were trained to use uniform instructional language to introduce the requirements for completing the questionnaire, informing participants of the purpose of the study and the right not to participate or to withdraw from the survey at any time. Paper or online questionnaires were distributed on-site, and the participants were asked to complete the questionnaires according to their actual situations. The average time to complete the questionnaire was approximately 25 min. The questionnaires were verified and collected on the spot after completion. A total of 1,040 questionnaires were distributed, with 1,028 valid questionnaires, achieving a valid recovery rate of 97.2%.

Tools

Demographic and clinical information

The demographic and clinical information included gender, age, education level, place of residence, economic status, marital status, number of children, etc.

Self-perceived burden scale

The Self-Perceived Burden Scale (17) (SPBS) was used to assess patients' self-perceived burden. The scale consisted of 10 items, evaluating 3 dimensions: physical burden, emotional burden, and financial burden. A 5-point Likert scale was used, with a total score range of 10–50. Higher scores indicated a higher self-perceived burden. The total score was classified into four levels: none (10–19), mild (20–29), moderate (30–39), and severe (40–50). Previous studies have indicated a Cronbach's alpha coefficient of 0.86 for this scale, while a Cronbach's alpha coefficient of 0.926 was achieved in the current study.

Stroke stigma scale

Stigma was assessed by the Stroke Stigma Scale (SSS) (31). The scale includes self-perception (5 entries), somatic impairment (4 entries), experience of discrimination (4 entries), and social interaction (3 entries), for a total of 16 entries across 4 dimensions. All were scored on a 5-point Likert scale (1 = never, 5 = always). The total score ranged from 16 to 80, with higher scores indicating higher levels of stigma among the subjects. The total score was divided into five levels: very low (<18.75), low (18.75–31.25), moderate (31.25–48.44), high (48.44–68.75), and very high (>68.75). The Cronbach's alpha coefficient for each dimension ranged between 0.771–0.864.The Cronbach's alpha coefficient of this scale in this study was 0.852.

Loneliness scale

The UCLA (University of California, Los Angeles) Loneliness Scale (32) was used to assess loneliness, which consisted of 20 items. Each of the items was rated on a 4-point Likert scale (1–4 representing never to always, respectively). The total score was 20–80, with higher scores indicating more severe loneliness. The scale was divided into four levels: low (20–34), moderate (35–49), moderate to high (50–64), and high (65–80). Previous studies have indicated a Cronbach's alpha coefficient of 0.89 for this scale, while a Cronbach's alpha coefficient of 0.825 was achieved in the current study.

Ethical considerations

The study protocol was approved by the Ethics Committee of the First Affiliated Hospital of Zhengzhou University (2020-KY-459). The study followed the principles of anonymity and confidentiality, and informed consent was obtained from the participants.

Data analysis

The SPSSAU online data analysis platform[1] was used for data analysis. Count data were described by frequency and composition ratio, whereas measurement data were described by $\bar{x} \pm SD$ and compared between groups using independent samples *t*-test and one-way ANOVA. The measurement data that did not conform to a normal distribution were described by median and quartiles, and the Mann–Whitney *U* test and Kruskal–Wallis *H* test were used for comparison between groups. Pearson correlation analysis was used to explore the correlation between self-perceived burden, stigma, and loneliness in stroke patients. The pathways of action among self-perceived burden, stigma, and loneliness were analyzed using SPSSAU, and indirect effects were estimated by the bootstrap resampling method with 5,000 replicate samples, and 95% confidence intervals (CI) were calculated. A mediating effect was considered significant if the 95% CI did not include zero. $p < 0.05$ (two-sided test) was considered statistically significant.

1 https://spssau.com/index.html

Results

Participant characteristics

A total of 1,028 stroke patients were included in this study, and the mean age of the patients was (62.09 ± 13.72) years. There were 578 (56.2%) males and 450 (43.8%) females, 85.6% of the patients were married (880), 656 (63.8%) patients lived in rural areas, 73.3% of the participants had a low level of education (secondary school or less), and 83.9% had more than 2 children. The baseline characteristics are displayed in Table 1.

Correlation analysis between variables

The results of this study showed that all three variables, self-perceived burden, stigma, and loneliness, were positively correlated with each other. The mean loneliness score in stroke patients in this study was (22.86 ± 6.57), while the mean score of self-perceived burden was (20.46 ± 6.16), and the mean score of stigma was (29.16 ± 8.13), as displayed in Table 2. 70% of the responses indicated low levels of loneliness, and 1.3% suggested moderate levels of loneliness. In contrast, high and higher levels of loneliness were not detected. The percentages of insignificant, mild, and moderate self-perceived burden were 40.3, 53.6, and 6.1%, respectively. Furthermore, the percentages of patients with very low, low, moderate, and high levels of stigma were 8.2, 53.5, 36.7, and 1.7%, respectively. The correlation analysis is shown in Table 2, where loneliness was positively correlated with both self-perceived burden ($r = 0.254$, $p < 0.01$) and stigma ($r = 0.604$, $p < 0.01$).

Intermediary analysis

The results of this study show that stigma fully mediates the relationship between self-perceived burden and loneliness. In other words, self-perceived burden may exacerbate patients' stigma and result in increased loneliness. A structural equation model was constructed using the SPSSAU data analysis platform; variables with differences ($p < 0.05$) in scores on the loneliness scale in education, family monthly income, smoking status, type of stroke, duration of illness, and heart disease were used as control variables. Self-perceived burden was set as the independent variable, with stigma as the mediating variable and loneliness as the dependent variable, and path analysis was used to fit the hypothetical model. The model fitting results revealed that the chi-squared degrees of freedom ratio showed a good model fit, with the chi-square freedom ratio (χ^2/df) = 0.000, the fitness index (GFI) = 1.000, the benchmarked fitness index (NFI) = 1.000, the comparative fitness index (CFI) = 1.001, and the asymptotic residual mean square and root square (RMSEA) = 0.000, as detailed in Table 3 and Figure 1. The results showed that self-perceived burden significantly predicted stigma ($\beta = 0.621$, $t = 16.898$, $p < 0.001$), and stigma significantly predicted loneliness ($\beta = 0.469$, $t = 20.331$, $p < 0.001$). In contrast, the direct effect of self-perceived burden on loneliness was not significant ($\beta = -0.014$, $t = -0.452$, $p > 0.05$), ab = 0.291, Boot SE = 0.023, 95% confidence interval (0.229–0.320), indicating that stigma fully mediates the effect between self-perceived burden and loneliness, as displayed in Table 4.

Discussion

Understanding the psychological mediators of the relationship between self-perceived burdens and loneliness is crucial for developing strategies to improve loneliness in stroke patients. Previous studies have only explored the relationship between loneliness, self-perception, and stigma separately, but stigma has been neglected as a mediator. To our knowledge, this is the first study investigating the relationship between self-perceived burden, stigma, and loneliness in stroke patients, using a large hospital and community-based sample. This study confirmed our hypothesis, revealing a positive association between self-perceived burden and stigma and loneliness. More importantly, stigma fully mediated the relationship between self-perceived burden and loneliness. Our findings provide directions for the development of interventions to improve loneliness in such patients.

The mean loneliness scores indicated low levels of loneliness in stroke patients, which were even lower than stroke patients in the United States (33). This finding could be attributed to cultural differences. Individual independence is a dominant ideology in the United States, whereas collectivism plays a central role in China. The typical American family is a "mobile family," as they enjoy moving from place to place very often. Chinese people with collectivist values tend to live in a fixed place and maintain close ties with their neighbors and help each other (34), which may influence loneliness. In this study, the self-perceived burden score of stroke patients was (20.46 ± 6.16), similar to the findings of Ren et al. (35), which were lower than epilepsy patients and cervical cancer patients undergoing radiotherapy (27, 36). Self-perceived burden was present in 59.7% of stroke patients in this study, and about 90.2% reported low to moderate stigma, emphasizing the high incidence of self-perceived burden and stigma. Many Chinese people believe in the concept of karma (37). The Taoist view of good and evil states that the world is essentially fair and that good is rewarded with good and evil with evil. Therefore, influenced by traditional culture, stroke patients may believe that the suffering caused by the disease is self-inflicted, which might increase the patient's self-perceived burden and stigma. The risk of recurrent stroke is high (5-year incidence 32.3%) (38), which can be disabling or fatal. Disease recurrence can cause significant psychological stress and loss of confidence in treatment, leading to negative emotions and avoidant coping mechanisms, which may trigger feelings of self-perceived burden, stigma, and loneliness. Loneliness increases the 5-year mortality rate of stroke patients by three times (39) and is associated with lower self-esteem (6), which is detrimental to the physical and mental health of patients. Therefore, exploring the factors influencing loneliness in stroke patients provides a reference for strategies to improve patients' loneliness and their prognosis.

Consistent with previous studies (36), the study found a positive association between self-perceived burden and loneliness. Stroke patients with higher self-perceived burden have higher levels of loneliness. In addition, people with high self-perceived burden are particularly sensitive to relying on others and exhibit decreased

TABLE 1 Participant characteristics ($N = 1,028$).

Characteristic	*N* (%)	UCLA score [score, M(P25,P75)]	*Z*/*H*	*p*
Age (years)			3.915(1)	0.271
≤54	271(26.4)	23(18,27)		
55~64	261(25.4)	22(18,27)		
65~71	239(23.2)	23(19,29)		
≥72	257(25)	23(19,28)		
Sex			−0.267(2)	0.789
Male	578(56.2)	23(18,28)		
Female	450(43.8)	23(18,28)		
Educational level			13.637(1)	0.003
≤Primary school	421(41.0)	24(20,28)		
Middle school	332(32.3)	23(17,27)		
High school	142(13.8)	22(17.5,27)		
College or university	133(12.9)	21(15.5,26)		
Employment			4.338(1)	0.114
Unemployed	626(60.9)	23(19,28)		
Retire	229(22.3)	23(17,29)		
On the job	173(16.8)	23(17,26.75)		
Resident			−1.653(2)	0.098
Countryside	656(63.8)	23(19,28)		
City	372(36.2)	22(17,28)		
Live alone			−0.209(2)	0.835
Yes	120(11.7)	23(18,28)		
No	908(88.3)	23(18.75,28)		
Marry status			1.821(1)	0.610
Unmarried	42(4.1)	23(17,30)		
Married	880(85.6)	23(18,28)		
Divorce	14(1.4)	25(20.75,29.25)		
Widowhood	92(8.9)	22(18.25,27.75)		
Income (CNY/monthly)			10.612(1)	0.014
< 3,000	530(51.6)	23(19,29)		
3,000 ≤ income < 5,000	425(41.3)	22(18,27)		
5,000 ≤ income < 10,000	62(6.0)	23(14.75,26)		
≥10,000	11(1.1)	21(11,25)		
Smoke			−2.502(2)	0.012
Yes	296(28.8)	22(18,26)		
No	732(71.2)	23(19,28)		
Drink			−1.797(2)	0.072
Yes	251(24.4)	22(18,27)		
No	777(75.6)	23(19,28)		
Child-number			4.653(1)	0.098
0	39(3.8)	26(20,31)		
1~3	838(81.5)	23(18,28)		
≥4	151(14.7)	23(20,27)		

(Continued)

TABLE 1 (Continued)

Characteristic	*N* (%)	UCLA score [score, M(P25,P75)]	*Z*/*H*	*p*
Stroke type			−2.436(2)	0.015
Ischemic	843(82.0)	23(18,27)		
Hemorrhagic	185(18)	23.5(20,30)		
Family history of stroke			−0.873(2)	0.383
Yes	156(15.2)	23(20,27)		
No	872(84.8)	23(18,28)		
Recur-times			6.700(1)	0.082
0	296(28.8)	22(17,28)		
1	508(49.4)	23(19,27)		
2	166(16.2)	24(18,29)		
≥3	58(5.6)	24(18.75,28)		
Disease duration (months)			12.515(1)	0.014
0 < months≤3	749(72.9)	23(18,28)		
3 < months≤6	114(11.1)	25(20.75,29)		
6 < months ≤9	29(2.8)	24(21,29.5)		
9 < months ≤12	26(2.5)	19.5(16.75,26.25)		
>12	110(10.7)	22.5(18,26)		
Thrombolysis			−0.787(2)	0.431
Yes	136(13.2)	22(16,28)		
No	892(86.8)	23(19,28)		
Hypertension			−1.050(2)	0.294
Yes	323(31.4)	22(18,28)		
No	705(68.6)	23(19,28)		
Diabetes			−1.224(2)	0.221
Yes	759(73.8)	23(19,28)		
No	269(26.2)	23(18,27)		
Hyperlipidemia			−1.710(2)	0.087
Yes	837(81.4)	23(18,27)		
No	191(18.6)	24(18,29)		
Heart disease			−1.997(2)	0.046
Yes	854(83.1)	23(18,27)		
No	174(16.9)	24(19,29)		
NHISS score			1.519(1)	0.218
<5	628(61.1)	22(18,27)		
5 ~ 15	303(29.5)	23(19,28)		
16 ~ 20	62(6.0)	26(21,29)		
>20	35(3.4)	27(21,31)		
mRS grade			9.121(1)	0.104
0	228(22.2)	23(19,28)		
1	275(26.8)	22(17,28)		
2	188(18.3)	23(19.25,29)		
3	178(17.3)	23(18,28)		
4	102(9.9)	23.5(21,28.25)		
5	57(5.5)	22(15,28)		
Total	1,028			

(1) *H*-value; (2) *Z*-value.

TABLE 2 Correlation analysis of self-perceived burden, stigma, and loneliness.

	$\bar{X} \pm SD$	Loneliness	Stigma	Self-perceived burden
Loneliness	22.86 ± 6.568	1		
Stigma	29.16 ± 8.125	0.582**	1	
Self-perceived burden	20.46 ± 6.161	0.275**	0.472**	1

**$p < 0.01$.

TABLE 3 Fitting indicators and evaluation criteria.

Fit index	χ^2/df	GFI	RMSEA	NFI	IFI	CFI
Evaluation criteria	<3	>0.90	<0.10	<0.90	>0.90	>0.90
Index value	0.000	1.000	0.000	1.000	1.001	1.001

χ^2/df, Chi-square/degree of freedom; GFI, goodness-of-fit index; RMSEA, root mean square error of approximation; NFI, normed fit index; IFI, incremental fit index; CFI, comparative fit index.

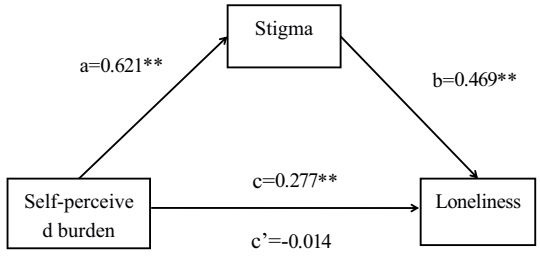

FIGURE 1
Mediating effect of stigma between self-perceived burden and loneliness a, effect of self-perceived burden on stigma; b, effect of stigma on loneliness; c, total effect of self-perceived burden on loneliness; c', direct effect of self-perceived burden on loneliness; **$p < 0.01$.

contact, leading to increased loneliness (15). In addition, most stroke patients have physical dysfunctions and require assistance with daily living activities, which may lead to feelings of guilt and burden, and thus increase their self-perceived burden (21, 35). In traditional Chinese culture, loss of self-care ability and dependence on others in daily life may cause patients to develop thoughts of uselessness, a reduced sense of self-worth, and worry about becoming a burden to the entire family (28). The interaction between self-perceived burden and physical activity limitations affects loneliness (40). Moreover, self-perceived burden is associated with negative psychological conditions, such as anxiety and depression (25). This may lead to higher levels of loneliness (11). Our findings suggest that self-perceived burden should be considered an important factor in improving loneliness in stroke patients.

This study suggests a positive correlation between stigma and loneliness in patients with stroke, that is, stroke patients with higher levels of stigma have higher levels of loneliness. Patients with chronic diseases often feel guilt and self-blame for current or previous unhealthy lifestyles, which, in addition to stigmatizing attitudes in social settings, may lead them to distance themselves from others and result in loneliness (41). Stroke patients with higher levels of stigma tend to choose to live in isolation at home (42), which may exacerbate the patient's loneliness. Furthermore, physical dysfunctions are a common complication of stroke, including hemiplegia, aphasia, and salivation, and can lead to self-image disorders and stigma. Patients may be afraid of making a fool of themselves in front of others and reduce social interaction, resulting in loneliness. Chinese culture focuses mainly on interpersonal relationships. Chinese people are very sensitive to matters of reputation and will do their best to maintain it (22). Another characteristic of Chinese culture in terms of important social relationships is the close ties between neighbors. As the old Chinese proverb says, a close neighbor is better than a distant cousin, emphasizing the responsibility of neighbors to accompany and care for each other. However, this also means that news can spread very quickly, and stroke patients with a disturbed self-image may reduce interactions with those around them in order to maintain their reputation, leading to loneliness.

Expectedly, stigma mediates the relationship between self-perceived burden and loneliness in stroke patients. In other words, self-perceived burden may exacerbate patients' stigma and, in turn, their loneliness. Additionally, a positive correlation between self-perceived burden and stigma has been shown (27). Self-perceived burden is a barrier to help-seeking (40). Therefore, stroke patients may adopt avoidant coping behaviors, aggravated by a low motivation to seek medical care, increased physical disability, and increased stigma (5). These aspects further increase their loneliness. However, the psychological factor of stigma can be modified by intervention, and our findings suggest that stigma is an actionable target for loneliness intervention programs for stroke patients.

Limitations

Nevertheless, the limitations of the study should be acknowledged. First, owing to the cross-sectional design of this study and the application of mediation analysis, only correlations between the variables were demonstrated, while the causal relationships between self-perceived burden, stigma and loneliness could not be determined. A longitudinal study is needed to determine the causal relationship between the variables in the future. In addition, this study used a self-administered questionnaire to collect data, which may result in recall and reporting bias.

TABLE 4 Mediating effect of stigma between self-perceived burden and loneliness.

	Loneliness			Stigma			Loneliness		
	β	SE	*t*	*β*	SE	*t*	*β*	SE	*t*
intercept	15.288**	1.359	11.246	15.732**	1.557	10.103	7.910**	1.203	6.574
Education	−0.364	0.214	−1.702	0.152	0.245	0.62	−0.436*	0.181	−2.411
Income	−0.505	0.335	−1.508	−0.184	0.384	−0.479	−0.419	0.283	−1.482
Smoke	1.025*	0.434	2.363	−0.073	0.497	−0.147	1.059**	0.366	2.894
Stroke type	1.328*	0.516	2.572	0.534	0.592	0.904	1.078*	0.436	2.472
Disease duration	−0.024	0.151	−0.161	0.049	0.173	0.284	−0.047	0.127	−0.372
Heart disease	0.795	0.532	1.494	0.747	0.61	1.225	0.445	0.449	0.99
SPB	0.277**	0.032	8.646	0.621**	0.037	16.898	−0.014	0.031	−0.452
Stigma	–	–	–	–	–	–	0.469**	0.023	20.331
R^2	0.096			0.225			0.357		
F	15.538**			42.323**			0.759**		

SPB, self-perceived burden; β, standardized regression coefficient; SE, standard error; *$p < 0.05$, **$p < 0.01$.

Conclusion

In conclusion, this study shows that self-perceived burden and stigma are key correlates of loneliness in stroke patients, and that after controlling for the effects of confounders, stigma fully mediates the relationship between self-perceived burden and loneliness. This suggests that healthcare professionals should pay attention to the assessment of patient stigma in their clinical work. Appropriate measures should be taken to reduce patients' stigma, such as educating stroke patients about the disease, relieving their psychological pressure, and encouraging patients to actively participate in social life and face the disease with a positive attitude to reduce negative emotions and loneliness.

Relevance to clinical practice

The present study further confirms the high prevalence of loneliness in stroke patients. As loneliness affects the prognosis of stroke patients and significantly impacts their recovery, elucidating the factors that contribute to loneliness and exploring measures to reduce loneliness is essential in stroke patients. The results of this study suggest that self-perceived burden can indirectly influence loneliness in stroke patients due to the mediating role of stigma. This relationship entails some clinical implications. First, the assessment of stroke patients' loneliness, self-perceived burden, and stigma should be emphasized. Patients' negative emotions should be identified and promptly relieved to promote their mental health. Educational activities should be introduced to change people's perceptions of the disease and reduce the public discrimination and the internalized stigma of patients. Second, the Chinese government should establish a robust social security system to provide comprehensive medical coverage and social welfare for stroke patients. For example, strengthening community stroke care systems and recruiting staff who match the cultural beliefs of the area in which they are located to provide culturally sensitive care. Finally, the development of the internet has facilitated communication and interaction, and tools such as social media can be used to connect stroke patients with others, promote social activity and participation, and assist their reintegration into society.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of the First Affiliated Hospital of Zhengzhou University (2020-KY-459). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

YG, KM, and CY: designed the study. WF, KM, CY, and YG: gathered data. KM, YG, and WF: analyzed data. WF and KM: drafted the manuscript. KM, YG, and CY: revised the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Depression and social isolation during the COVID-19 pandemic in a student population: the effects of establishing and relaxing social restrictions

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Introduction: In a quasi-naturalistic study design, we evaluate the change in psychopathological syndromes and general well-being after the alleviation of social restrictions. The aim of this study was to investigate the specific relationship between social isolation and depressive syndromes.

Methods: At two timepoints, the first during maximal social restrictions, the second after social restrictions had widely ended for 9 months, depressive and other syndromes were measured in an online survey addressing the total cohort of students registered at Heidelberg University, Germany via e-mail (n = 27,162). The complete Patient Health Questionnaire (PHQ) was used with nine items for depressive syndromes. In addition, well-being was measured by the Well-Being Index WHO-5. In the quantitative and qualitative part of the study psychopathological syndromes and well-being were related to social isolation and feelings of loneliness.

Results: After 1.5years of pandemic-related social restrictions, "major" depressive syndromes were reported by 40.16% of the respondents to the PHQ in a sample of 2,318 university students. 72.52% showed a severely reduced Well-Being-Index. Nine months after the end of social restrictions, "major" depressive syndromes were reported by 28.50% of the participants. Well-being improved after the alleviation of social restrictions, as well: 53.96% showed a Well-Being Index of below 50 vs. 72.52% in the first study. The quantitative and qualitative analysis of the free texts of the respondents suggest that a significant amount of depressive syndromes and reduced well-being are related to social isolation and loneliness. While in the times of the pandemic restrictions the participants mostly reported "loneliness and social isolation" (24.2%) as their main problem, only 7.7% described these as their main problem after social restrictions had been loosened for 9months. The qualitative analysis hints that at t2 participants were more likely to mention possible ways to actively deal with loneliness than at t1, which might be interpreted along the lines of the decrease in depressive syndromes.

Discussion: Keeping the self-selection bias in mind our study results suggest that one third of "major" depressive syndromes and one quarter of severely reduced well-being accompany social restrictions or are even caused by them, with loneliness being an important factor. These results should be taken into account by health policies when coping with future pandemics.

KEYWORDS

depression, anxiety, stress, well-being, social isolation, loneliness, COVID-19, students

Introduction

The COVID-19 pandemic has severely impacted physical and mental health. During the pandemic, a significant increase in somatic symptoms (such as fatigue) and mental health concerns such as dysfunctional coping strategies (i.e., COVID-19 anxiety syndrome) or allostatic overload were observed (1–3). Regarding the decline of mental health, depressive symptoms featured among the most prominent (4). According to the bio-psycho-social framework of depression there is a complex interaction of biological and psychological factors with social influences (1–3). Research on creativity and depression shows how dealing with loneliness accounts for human cultural productivity as well as its impasses. Depression is one of the mental and neurological manifestations of COVID-19.Here, we focus on the influence of social isolation on the prevalence of depressive syndromes. During the COVID-19 pandemic, an increase in mental disorders was registered worldwide (5–7). Studies from all over the globe reported increased levels of loneliness related symptoms, such as depression, anxiety, stress, and Covid-fear (8–12). Higher levels of psychopathology, namely depression but also anxiety and COVID-fear, may at least partially result from social isolation (8). During the pandemic-related social restrictions a study in China with 746,217 students showed prevalence rates of an acute stress reaction in 34,9%, of depressive syndromes in 21,1% and of anxiety syndromes in 11,0% (6). In a US study with 45,000 participants, 35% of undergraduate and 32% of graduate students were screened positive for "major depressive disorders" during pandemic-related social restrictions (7). A study in Bangladesh found that almost 69.3% of college and university students partaking experienced event-specific stress during the COVID-19 pandemic, with 46.9% being depressed and 33.3% suffering from anxiety (10). Overall, ample evidence suggests that social restrictions in the context of the pandemic lead to feelings of loneliness and dramatically impact mental health (13–17). During the COVID-19 pandemic, public measures related to lockdowns such as physical distancing, work disruptions, school closings, and mobility restrictions profoundly changed social life and daily routines (18–25). The reduction of social contacts, with a consequent increase in social isolation and feelings of loneliness, was associated with increased prevalence of depression, anxiety and suicidal behavior (14, 26).

Loneliness is generally seen as a risk factor for many mental disorders such as depression, anxiety, and stress (22, 27–29). A United States study found that 43% of respondents exhibited elevated levels of loneliness, which was associated with depression and suicidal ideation. Especially for women, younger and less educated persons, social isolation due to pandemic-related restrictions led to depression and feelings of loneliness (15, 30–32). Stress has been shown to predict depression directly, whereas COVID-fear connection to depression is mediated through anxiety (33, 34). Covid-fear is significant for other mental health issues as well, such as obsessive–compulsive disorder and substance use (35, 36).

Research hypothesis

In a quasi-naturalistic study design, we evaluate the change in psychopathological syndromes and general well-being after the alleviation of social restrictions. The aim of this study was to explicate the specific relationship between social isolation and depressive syndromes. This could be achieved by investigating whether and to what extent depressive and other psychopathological syndromes like anxiety, somatoform, alcohol and bulimic syndromes decreased after pandemic-related social restrictions had been loosened or reversed for 9 months. Our main hypothesis was that depressive syndromes decreased to a larger extent compared to other syndromes because results of a pre-study conducted while public, professional and social life were restricted showed that depression was more often attributed to loneliness due to social restrictions during the COVID-19 pandemic than other syndromes were (5).

Methods

After approval by the Ethics Committee of the University Hospital and the Data Protection Officer of Heidelberg University, the totality of all students of Heidelberg University ($n = 27{,}162$) were asked per e-mail to participate in an online survey. The survey was completely anonymous. The first survey took place between May 26th, 2021 and June 11th, 2021 via the Limesurvey" platform while the aforementioned social restrictions had been set up for one and a half years. Data of this survey have been published in 2021 (5). The second survey took place from May 25th, 2022 to June 10th, 2022 after the social restrictions had been relaxed for 9 months, and, thus, exactly 1 year after the 1st survey. In order to protect the security of the sensitive data, also to get reliable answers due to trust, the email addresses of the respondents were not stored, so all students at Heidelberg University were asked to complete the questionnaire in both years. In addition, a sub-sample was formed consisting of those respondents who indicated that they had participated in each year. The financial background of the students is stable; there is no university fee, also the students have an opportunity to get financial support during their studies, such as the education advancement grants (Ausbildungsförderung, BAföG). Demographic variables collected included age, gender, and field of academic study. These categories were the same in each year.

Investigative tools

Mental health symptoms were assessed with the German version of the Patient Health Questionnaire (PHQ-D) (37) containing nine items for depressive syndromes (PHQ-9) and seven items for anxiety syndromes (PHQ-7) (27). In international comparison, the PHQ is the most frequently used screening instrument to assess depression and anxiety as well as somatoform (13 items) and alcohol syndromes (six items, five of which were used). Therefore, it is not a diagnostic test, but rather an exploration of signs of the level of depression and anxiety syndromes. Especially the PHQ subtests for depressive and anxiety and somatoform syndromes show a high reliability: internal consistency is Cronbach s = 0.88 for the depression module and the anxiety module, and $\alpha = 0.79$ for the somatoform module (30). Test–retest reliabilities are $r = 0.83$ and $r = 0.84$, respectively, and the reliabilities for self- and external evaluation are also $r = 0.83$ and $r = 0.84$ (38).

To measure the change of well-being between the two -surveys we used the German version of the WHO-5 Well-Being Index (39). The WHO-5 is used as a screening instrument to measure subjective well-being (38) and allows international comparisons. It has a high internal consistency of Cronbach s = 0.88.

Differences in dichotomous variables between the two surveys were tested by Fisher's exact test (hybrid form according to Mehta and Patel (22)), differences of ordered categorical variables by Jonckheere-Terpstra tests and of categorical variables by χ^2-tests.

The entire quantitative data analysis was carried out using R Version 4.1.0. The R packages "psych," "clinfun" and "crosstable" were used for the calculation of descriptive parameters and statistical tests. For PHQ-D and WHO-5, comparisons were made of the descriptive data with corresponding norm values for students and other populations.

Other measures deployed in the study were Sense of Coherence Scale (SOC), Brief COPE, Social Support Inventory (ESSI-D), Interpersonal Reactivity Index (IRI), and General Self-Efficacy Scale (SGSE). This comprehensive set of tests took participants about 60 min in average to complete.

Qualitative analysis

Participants also were asked to freely comment on the main complaints concerning the pandemic and the related restrictions. In addition to make proposals on how to improve their situation. In a first survey, 2,103 persons responded, in the follow-up, 581 did. For qualitative analysis we conducted thematic analysis. Thematic analysis is a method of analyzing qualitative data in which a data set is searched to identify, analyze and report recurring patterns (40). The analyzing process is conducted through multiple steps: from getting to know the entire dataset, to creating a definition and narrative description of each theme and to the final analysis and description of the results (40, 41). The method lends itself to identifying, analyzing and presenting themes or patterns in a sample, based on the analysis of categories. Through its theoretical freedom, thematic analysis offers a flexible and explorative research tool that can potentially provide a rich and detailed, yet complex, account of the data. Thematic analysis was developed to look for common or shared meanings and not to understand single individuals' unique experiences, so it is an efficient method to use for large samples (41).

Results

In the first survey, 2.135 students completed the extensive questionnaire and were included in the analysis. The whole response rates of 8.8% were much higher than those of the regular surveys of the German Student Union (Deutsches Studierendenwerk), where response rates of between 2 and 3% are achieved (42). In the second survey, 682 students completed the demographic inquiry as well as the WHO-5, 599 also completed the PHQ. The difference in response rate will be discussed later; regarding the mere fact of eased restrictions in terms of social isolation as well as the hypothesis that more persons more severely strained might have a greater urge to have these strains recognized, this is not surprising.

There are no significant differences between the respondents of the first and second survey in respect to gender, age distribution, and field of academic studies (see Table 1). Given the large n, even small differences tend to show statistical significance which, due to their marginal importance, were disregarded in the present analysis.

The most prominent finding of the present study is that "major depressive syndromes" decreased significantly from 40.16 to 28.50%.

TABLE 1 Participants' age, gender and field of academic studies.

Variable		2021		2022		*p*
		N	%	*N*	%	
Age	Under 21	662	27.61	173	24.68	0.1790[1]
	21–23	941	39.24	274	39.09	
	24–25	392	16.35	143	20.40	
	26–27	161	6.71	45	6.42	
	Over 27	242	10.09	66	9.42	
Gender	Male	780	32.53	254	36.23	0.0210[2]
	Female	1,578	65.80	416	59.34	
Field of studies	Humanities	562	23.44	175	24.96	0.0423[3]
	Law	242	10.09	52	7.42	
	Medicine	372	15.51	89	12.70	
	Mathematics/ natural sciences	729	30.40	246	35.09	
	Psychology/social sciences	305	12.72	87	12.41	
	Others	188	7.84	52	7.42	

Tests of differences between surveys: [1] Jonckhhere-Terpsta test, [2]Fisher's Exact Test, [3]χ^2-Test.

Also "other depressive syndromes" decreased significantly from 16.92 to 11.33 (see Table 2). The average depression score of the PHQ improved from 11.61 (SD: 6.09) in the first survey, to 10.22 (SD: 6.25) in the second survey (Student's *t*-test: $p < 0.001$).

Somatoform syndromes differed slightly but not significantly between the two surveys (25.39% vs. 21.17%). Generalized anxiety and panic syndromes did not differ significantly either (19.98% vs. 17.53%). Also, general stress syndromes were nearly the same (17.16% vs. 16.36%) as were signs of abuse of alcohol or addiction (9.88% vs. 9.52%) and bulimia and binge eating syndromes (8.33% vs. 9.02; see Table 2).

Also, in the analysis of continuously divided depressive syndromes, there were significant and clinically relevant differences between the two surveys. A score of less than 5, indicating "no or minimal" impairment, showed 12.2% of the respondents in the first survey vs. 18.3% in the second one. A score of 5–10, indicating "mild depressive" impairment, reported 28.7% vs. 33.7% of the respondents. A score of 10–14, which is seen as an indication of "moderate depressive" impairment, was shown by 27.3% vs. 24.2%. A score of 15–19 indicating "moderately to severe" symptoms was found in 20.0% vs. 14.2%. and a score of 20–27 indicating "severe depressive" symptoms had 11.9% vs. 9.7% of the respondents. This means while 31.9% of the students in the first survey showed indications of "moderately to severe" or "severe depression" only 23.9% showed indications of "moderately severe" or "severe depression" in the second survey.

The high extent of depressive syndromes and their change after 9 months of relaxed social restrictions corresponds to the finding that well-being measured by the WHO-5 also improved in a statistically significant and clinically relevant amount from 37.56 (SD 21, 27) to 47.17 (SD 21.99) (26, 43). While 72.52% of the respondents showed a severely impaired well-being in the first survey, 53.96% showed a WHO-5 Well-Being of lower than 50 in the second survey (see Table 2).

TABLE 2 Frequencies of syndromes in survey 2021 and 2022 according to the PHQ.

Syndrome	Sex	2021		2022		p^1
		N	%	*N*	%	
Major depressive syndrome		2,139	40.16	600	28.50	<0.001
	f	1,421	41.87	360	27.78	<0.001
	m	682	35.78	217	29.03	0.071
Other depressive syndromes		2,139	16.92	600	11.33	<0.001
	f	1,421	15.97	360	10.00	0.004
	m	682	19.06	217	12.44	0.024
Panic and anxiety syndromes		2,137	19.98	599	17.53	0.199
	f	1,419	23.82	360	18.89	0.049
	m	682	12.02	217	13.82	0.480
Stress ≥10		2,133	17.16	599	16.36	0.667
	f	1,419	19.73	360	17.50	0.370
	m	678	11.95	217	14.29	0.409
Somatoform syndrome		2,139	25.39	600	21.17	0.036
	f	1,420	33.10	360	27.78	0.058
	m	683	9.37	217	9.22	1.000
Bulimia/binge syndrome		2,138	8.33	599	9.02	0.618
	f	1,420	8.59	360	10.56	0.256
	m	682	7.77	217	6.91	0.769
Alcohol syndromes		2,135	9.88	599	9.52	0.876
	f	1,418	8.25	360	8.61	0.831
	m	681	13.07	217	11.98	0.727
WHO-5; 100 < 50		2,358	72.52	682	53.96	<0.001
	f	1,552	73.78	407	52.09	<0.001
	m	767	69.62	247	53.85	<0.001

[1]Tests of differences between surveys: Fisher's Exact Test.

With regard to gender, it is noticeable that "major" depressive syndromes were present in 41.87% vs. 27.78 of women ($n = 1,419$) and in 35.78% vs. 29.03% of men ($n = 682$), when comparing the two surveys. Somatoform syndromes were found in 33,10% vs. 27.78% of women and 9.37% vs. 9.22% of men. Panic and anxiety syndromes were present in 23.82% vs. 18.89% of women and 12.0% vs. 13.8% of men (see Table 2).

Results of qualitative analyzes

In this mixed-designed study, there was a qualitative part in the questionnaire which was used to get a deeper understanding of the students and the situation they experienced. Using the PHQ-14 questionnaire's closing question: "*What are your main complaints?*" students showed remarkable differences between the timepoint after 1.5 years of severe social restrictions and a timepoint after 9 months of loosened or no social restrictions.

Nine categories could be discerned within the free-form answer texts and were connected to anchoring examples in the text as well as rules for further coding. Among these nine categories, "social isolation and loneliness" was the one with most single codings, with 24.2% of respondents claiming to suffer from it, while only 7.7% of the respondents in the 2022 post-survey did. Typical comments regarding the most urgent strains at the time were as follows: *"That you spend so much time alone. Usually, a friend or family member would notice when you are not well. Now you sit at home alone in such situations, you do not call anyone because you know that your friends have enough problems themselves at the moment and therefore you do not get the mental support that you would need in some moments."* Although many respondents commented on it, the category "study related stress" was less frequent than "social isolation and loneliness." Typical comments were: *"Studying; worrying about taking the exam; worrying about patients dropping out during treatment; worrying about whether you'll pass the course.."*

In contrast, the main complaints in 2022 were "study related stress" increasing to 26.9% of the participants from 15.7% in the pre-survey. Typical answers were as follows: *"Feeling like I'm not doing enough for my studies and that others are doing everything better than me." "Anxiety attacks before exams." "Stress about university and work.."* Notably the theme of "loneliness" with 7.7% was considerably less frequent in 2022 compared to 24.2% in 2021. Notably, in some students the former pandemic-related social restrictions continued to have an impact. Typical reports sounded like: *"I lack friendships at university because I started to take courses during the pandemic and since then I did not have the chance to find the contacts that I lacked at the beginning of my studies."*

In summary, in 2021 most students reported on suffering under "social isolation and loneliness," whereas in 2022 most suffered under "study related stress." In relation to the results from the quantitative part of the study, these findings appear to be most relevant. The details of the qualitative analysis will be published in a separate article.

Discussion

This significant lower response rate (2.5%) to the extensive questionnaire might be due to a self-selection bias (28). This response rate is similar to with comparable studies in populations of German students (39). However, one could argue that filling out an online survey on social isolation in the times of pandemic restrictions might itself be influenced by the study's subject matter. Therefore, the decrease in response rate might be due to less burden of disease and more social activities.

Focusing on the impact of social restrictions during the COVID-19 pandemic, this study compared the frequency of psychopathological syndromes and impairment in well-being in a large student population at a timepoint of high social restrictions versus a timepoint 1 year later when social restrictions had been widely relaxed for 9 months. Data shows that social restrictions are related to an increase of depressive syndromes and a decrease of well-being while relaxation of severe social restrictions is related to a reduction of depressive syndromes and improved well-being as Wasserman et al. (26) proposed. After 9 months in which interpersonal interactions were possible again on campus and in social life elsewhere "major" depressive syndromes among students decreased from 40.16 to 28.50%. This, however, still exceeds the rate of 22.7% of persons burdened by depressive syndromes in a comparable prepandemic study of students (29).

While the amount of other syndromes like those related to anxiety, somatoform, alcohol, bulimia and binge eating syndromes did not change significantly, our study shows that about one third of the

depressive syndromes improved after the relaxation of social restrictions. This underlines the supposition of Wasserman et al. (26) that depressive syndrome may be triggered or even caused by social restrictions leading to loneliness. This is also consistent with findings reporting an association between mental health and a variety of lockdown measures, such as school closings, workplace-disruptions or transport restrictions (44–47). To borrow the phrase of Killgore and colleagues (17), loneliness must be considered *a signature mental health concern in the era of COVID-19* (13, 17).

The impairment of well-being is statistically significant and clinically relevant in times of long-lasting social restrictions which, in case of the time in which the first survey was undertaken, had been lasted for approximately 14 months (28, 42). After relaxation of the restrictions well-being is improved. While during the social isolation nearly three quarters of the respondents showed low well-being, it was about two quarters after the relaxation of social restrictions. Notably, the average WHO-5 Well-Being Index score of 47.2 remains to be considerably lower than in the pre-pandemic studies in Germany, for example, 65.0 in 2016 (29, 30) and 57.0 in 2020 (31). This is not surprising since pandemic-related restrictions might have had an impact on some students´ long-term social life.

Even though an in-depth analysis of the qualitative data is beyond the scope of this paper (especially focusing on overarching themes across different self-reports of participants which might further show the relations between feeling burdened by social isolation, online-only university courses and dissatisfaction with institutional support), results of the qualitative analysis underline that social restrictions leading to loneliness is a relevant factor in the pathogenesis of depressive syndromes and reduced well-being. This result convenes with the study of Wassermann et al. (26) which showed that decreased opportunities to contact people outside home have a negative impact on mental health. While loneliness and suffering under the social restrictions were the main complaints in our pre-survey, everyday stress with academic studies was the main complaint in the post-survey. Consequently, participants in the first survey most frequently stated that a loosening of social restrictions would improve their situation. In the second survey the most frequent proposals of the students focused on the reduction of exam stress and problems to academic studies. These self-reports have to be interpreted in light of the findings suggesting that the duration of loneliness is more strongly correlated with mental health symptoms than its intensity (15). We suppose that testing this hypothesis is an interesting venue for further research.

Also, qualitative analysis hints that in 2021 more participants were likely to report *complaints* (regarding state and university decisions in handling the pandemic) while in 2022 they were more likely to state their *claims* and wishes. This can be interpreted as a shift from a "depressive" and passive stance in dealing with burdens in 2021 to a more active way of self-management in 2022. After all, while social restrictions took a huge part in an increase of depressive syndromes, the conclusion that easing restrictions will in turn lead to health and well-being is questionable. Qualitative data suggest, however, that in 2022 participants reported a "healthier" (in the sense of increased self-efficacy) way of managing problems. Easing restrictions, then, would probably not directly lead to well-being but to empowering participants to actively change conditions in which they do not feel well (e.g., seeking social contact) and thus no longer meet depressive syndrome criteria.

Compared to the 21.1% of depressive syndromes in the 2020 comprehensive study during high social restrictions in China by Ma et al. (6) which used similar measures as our study, our second survey presents with 28,50% of "major" depressive syndromes even higher scores at a timepoint after social restriction measures had stopped. However, in the study of Ma et al. "acute stress syndromes" were with 34.9% much more frequent than in our studies (17.16% in 2021 and 16.36% in 2022). The percentages of "major" depressive syndromes in our post-survey are distinctly lower than those of a comprehensive study from the United States with 30,725 undergraduate students and 15.346 graduate and professional students conducted in May–July 2020 at 9 public research universities by Chirikov et al. (48). This study shows that the prevalence of depressive syndromes among students was twice as high in 2020 as in 2019, with 35% of undergraduate and 32% of graduate students showing "evidence" of "major depressive disorders." In the year before the pandemic Chirikov et al. (48) showed, that only 15% of students presented with indications of "major depression." The main shortcoming of the study by Chirikov et al. (48) is, that it is based on the PHQ-2, which consists of only 2 items. Other obligatory symptoms for the diagnosis of major depression in the sense of the International Classification of Disease (ICD-10) and the International Diagnostic Statistical Manual (DSM-5-R), such as reduced activities and somatic syndrome, are thus not assessed. In this respect, the term "major depression" is not appropriate from a clinical-psychiatric perspective. The application of the PHQ-9 is more advanced because it takes into account the breadth of depressive symptoms with lack of activities, joylessness and somatic syndrome in addition to the mood disorder.

Conclusion

Keeping the self-selection bias in mind (49), our results strongly suggest that relaxing social restrictions and alleviating loneliness improves well-being and depression of many students in a significant and clinically relevant way. Future lockdown policies should take these results into account, e.g., by controlled facilitation of personal encounters in the form of face-to-face teaching and enabling of social contacts in seminars, refectories, libraries, sports facilities, cultural events, etc. This is also relevant for dealing with future pandemic outbreaks or other crises. The impact of social lockdowns is severe for many people. In sum, loneliness must be considered a "signature mental health concern in the era of COVID-19" (13). Thus, preventing loneliness and maintaining ways to actively manage crises amounts to a major public health concern in future lockdown policies. The current major focus is on providing the necessary treatment to the many young people who suffer from depressive syndromes related to social restrictions and loneliness. Our findings underscore the importance of improving social contact to reduce negative impact of the COVID-19 pandemic. Clinicians are thus encouraged to focus on interventions that strengthen and enable social interactions.

Under pandemic conditions, we should support not only students but also other populations and especially persons lacking social networks (45) since they are more vulnerable to mental illness in times of pandemic crises (31). Also, one should bear in mind the preventive role social interaction in quasi-institutional contexts such as universities, schools or sports clubs and others play. Those can serve as a "quasi-vaccination" against mental burdens stemming from loneliness. Special resources should be allocated to maintain a minimum of social life and self-management even in times of crises. Personal contacts are indispensable for well-being, mental health, and

social relatedness (48, 50). The vast majority of students long for opportunities to develop socially and want to contribute to professional, scientific, and humanistic progress in line with the guiding principle of the World Health Organization (WHO): more (socially) active people for a healthier world (44).

Limitations

The following limitations have to be considered: (1) The results presented here, though making a strong case for keeping in mind the impact of (restricted) social life on mental health, can only highlight influencing factors. There might be other factors contributing to feeling less burdened at the timepoint of our second survey, most notably having more knowledge about COVID-19 itself or access to vaccination (which might turn out to influence both relaxing social restriction by political institutions and a reduction of mental health problems in individuals). Surely, there has been a complex interplay of personal, societal, medical, and political development during the pandemic's first 2 years. (1) Notably, the response rate to the extensive questionnaire in our first survey which was much higher than in the regular surveys of the German Student Union could not be preserved in the second survey reported here. (2) We cannot exclude a self-selection bias, neither in the first nor in the second survey. Those students particularly affected by pandemic-related restrictions may have responded more frequently in the first and in the second study. Less concern among students at the time of the second survey, however, may reason less participation in the follow-up and, thus, may also be due to self-selection. This self-selection bias, which also applies to comparable studies from Germany, United States, and China does not detract from the central finding that severe social restrictions and resulting loneliness are related with an increase of depressive syndromes and a decrease of well-being. (3) Future studies on the sequelae of pandemics or other societal crises on mental health issues should include quantitative measurements of loneliness and isolation in addition to the qualitative method we applied in this study. Also, extended qualitative measures, e.g., retrospective interviews to address long-term negative effects of social restrictions on social life and well-being, are favorable. (4) The anonymous survey design allows only for group comparisons. Further limitations are that we used only self-reports and that the PHQ and other of the employed measures have not been validated specifically in the student population. The fact that no incentives were given to the students may have reduced the response rates, but at the same time makes it more probable that only serious and reliable answers were given.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Ethics Committee of the University Hospital. The patients/participants provided their written informed consent to participate in this study.

Author contributions

RH-H initiated and designed the study and wrote the 1st version of the paper. HW, GB, TS, AM, and SH participated in the data collection and analysis of the data. All authors discussed jointly the results and wrote together the final version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The relationship between fall and loneliness among older people in China: the mediating role of personality trait

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Aims: We aimed to explore the role of personality traits between fall and loneliness.

Methods: A questionnaire survey was used to investigate falls, the big five personality traits, and loneliness among older people (≥60years old) in China mainland.

Results: A total of 4,289 older people participated in the survey. There are significant differences in age, marital status, education level, residence, solitariness, and fall in relation to loneliness among older people. Falls, especially when they occurred only one time, would increase the loneliness of older people. Agreeableness, conscientiousness, and neuroticism were significant mediating effects between falls and loneliness.

Conclusion: This study implied that agreeableness, conscientiousness, and neuroticism were meditating factors between falls and loneliness. In the future, we should consider the big five personality traits more to understand loneliness and offer older people interventions for reducing their loneliness. The study design was cross-sectional, so the temporal precedence of mediators and causality could not be tested. Because the data were collected retrospectively, current loneliness is likely to have confounding effects on retrospective recall.

KEYWORDS

loneliness, social isolation, accidental fall, older people, big five personality, mediating effect

1. Introduction

In general, loneliness is the discrepancy between a person's preferred and actual level of social contact. Loneliness reflects a subjective feeling of the absence of desired affection and closeness from close family members, intimate friends, or someone significant (1). With the accelerating aging and increasing life expectancy in China, loneliness is growing among older people, especially older people with poor health (2). In China, for example, a national survey found that 29.6% of older people (≥ 60 years old) reported that they 'often felt lonely' (3). During the pandemic, especially, 34.2% of older people suffered from loneliness, of which 15.5% were severely lonely (4). Many studies showed that

loneliness is highly related to the health status of older people. In a large sample survey, loneliness strongly indicated the development of pain, fatigue, and depression as well as the cluster of all three symptoms several years later (5). For mental health, loneliness was longitudinally associated with posttraumatic stress symptoms, and there might be a bidirectional predictive relationship (6, 7).

In China, as the aging process accelerates, fall is still a serious problem. It was reported that the annual fall rate among Chinese older people ranged from 11 to 34% (8); 54.95 per 1,000 injuries would be fall-related injuries (9), and unintentional falls mortality rose from 7.65 to 8.03 per 100,000 people between 2006 and 2016 (10). According to a survey, older people who have experienced a fall would reduce social participation actively (11). After older people experienced a fall, they would make activity restrictions and gradually make subsequent social isolation (12). This could further increase feelings of loneliness. Fall was associated with loneliness among older people, which was common for those living alone (13, 14). A longitudinal study showed that both low social contact and living alone among older people were highly associated with self-reported falls even after controlling for sociodemographic, health, and lifestyle variables (15). According to the German Aging Survey, any fall in the past 12 months was associated with increased odds of loneliness among older adults. A higher level of loneliness showed in more times fall occurred (16). A systematic review implied the association between falls and loneliness among older people (17). Therefore, we need to explore the relationship between fall and loneliness further.

Since the 1990s, the Big Five personality has been a hot research topic, which consists of extraversion, agreeableness, conscientiousness, neuroticism, and openness (18, 19). While the Big Five personality may be regarded as an important model in personality studies, it is not an integrative model (19). Each personality trait has a unique impact on psychology and behavior. A systematic review showed that different personality traits had different attitudes to falls among older people (20). That was important for the successful implementation of fall-prevention programs. A study indicated that the relationship between loneliness and personality was largely explained by its relationship with neuroticism (21). Neuroticism was positively associated with indoor falls and recurrent outdoor falls (22). Moreover, it was proved that agreeableness among older people was negatively associated with loneliness (23, 24). Fallen older people feel so lonely that they reduce social contact. If they are unwilling to seek help due to their personality traits, they will experience more loneliness as a result (11, 12, 25). Therefore, it is important that the Big Five personality traits be studied to assist in understanding loneliness and offer the interventions for reducing loneliness among older people.

In summary, fallen older people are more likely to feel lonely. At present, although the relationships among the variables of fall, loneliness, and personality trait have been examined separately, there is a lack of studies to explore the relationship between the three. Hence, this study aims to explore the mediating role of personality traits between falls and loneliness among older people in China.

2. Methods

2.1. Participants and procedures

A multi-stage sampling method was selected from 20 June to 31 August in the "Psychology and Behavior Investigation of Chinese Residents in 2022, PBICR." In this cross-sectional survey study, the participants were from 23 provinces, 5 autonomous regions, and 4 municipalities directly under the central government in China. Training investigators distributed the questionnaires to participants face-to-face and one-on-one (26). This study has been officially registered in the China Clinical Trial Registry (Registration No. ChiCTR2200061046). A total of 31,480 questionnaires were distributed. The inclusion criteria:(1) The participants had the nationality of the People's Republic of China; (2) they voluntarily participated in the study and signed an informed consent form; and (3) they understood each item of the questionnaire and completed the questionnaire on their own or with the help of an investigator. The exclusion criteria: (1) The participants were confused, mentally abnormal, or have cognitive impairment; (2) they were currently participating in other similar studies. The excluding invalid questionnaires: (1) filling time $\leq$ 100 s; (2) conflicting answers between entries; and (3) incompletely filled. Finally, 30,505 valid questionnaires were collected, with an effective rate of 96.9%.

In our study, older people were selected. The age of participants must be equal to or more than 60 years old. Finally, 4,289 older people were enrolled in this study.

2.2. Measures

2.2.1. Sociodemographic characteristics

The questionnaire also contained questions related to participants' sociodemographic characteristics, including age, gender, marital status, education level, monthly family income, residence, and solitariness.

2.2.2. Fall

Falls are defined as sudden, uncontrollable changes in body posture that result in an individual falling to the ground or low flat surfaces, which can result in serious injuries, unconsciousness, or seizures (9). In this study, falls are divided into three categories: (1) No fall; (2) A single fall means that the fall frequency is once; and (3) Multiple falls mean that fall frequency is more than once. The survey explored the number of falls in the last 3 months.

2.2.3. Personality

The Ten-Item Big Five Personality Inventory (BFI-10) (27, 28) was selected to investigate personality. It is a very short measure of the Big Five personality traits (extraversion, agreeableness, conscientiousness, neuroticism, and openness). Each personality dimension is measured by two items. The scale is adopted on a 5-point Likert scale ranging from one (disagree strongly) to five (agree strongly). Items 1, 3, 4, 5, and 7 are reverse scoring, and items 2, 6, 8, 9, and 10 are forward scoring. Higher scores indicate higher levels of a given personality trait. The Cronbach's α of the BFI-10 in our study was 0.600.

2.2.4. Loneliness

Loneliness was measured using the Three-Item Loneliness Scale (T-ILS) (29). The items for the T-ILS were "How often do you feel left out?," "How often do you feel isolated from others?," and "How often do you feel that you lack companionship?" The scale is adopted on a 3-point Likert scale (1 = hardly ever, 2 = some of the time, and 3 = often). The score range of the T-ILS is thus three to nine. Loneliness becomes more apparent as the score rises. The T-ILS was originally derived from the UCLA Loneliness Scale, which was used for older people (30). In many studies, the T-ILS is increasingly being used for older people (31, 32). The Cronbach's α of the T-ILS in our study was 0.849.

2.3. Statistical analysis

SPSS 26.0 was used to make statistical analysis. Descriptive statistics of sociodemographic characteristics and variables of interest were reported. Frequency and percentage were used to describe categorical variables. Continuous variables were reported on the mean (M) and standard deviation (SD). One-way ANOVA test and independent t-test were used to examine the differences in loneliness. $p < 0.05$ was considered statistically significant. Further, we used the *post hoc* test for significant difference factors by the statistics method of LSD. Spearman analyses were performed to examine whether there is a correlation between the big five personality traits and falls. Pearson correlation analyses were performed to examine whether there is a correlation between the big five personality and loneliness. Multiple linear regression analysis was conducted to further explore the associated factors which had statistical significance in univariate analysis.

The macro-program PROCESS 3.4 was selected to examine the mediation of the big five personality traits between fall and loneliness (33, 34). Model 4 was used to test the direct, indirect, and total effects based on 5,000 bootstrapped samples. The mediating effect was significant if the 95% bias-corrected confidence interval did not include zero.

3. Results

3.1. Common method biases tests

For this study, subjectivity was excluded as much as possible in order to avoid common method bias. The samples were collected nationwide and anonymously. In the meantime, the exploratory factor analysis method was used to test the common method bias. The results revealed three factors with an eigenvalue greater than one, and the total variation explained by the first factor was 22.303%, which was far lower than the critical value of 40%. Thus, there was no significant common method bias.

3.2. Descriptive statistics

A total of 4,289 older people participated in the survey. The mean age was (68.82 ± 6.315) years old, of which 85.6% were younger than 75. The proportion of men (49.1%) and women (50.9%) is balanced. Overall, the incidence of falls among older people within 3 months was 9.47%. The incidence of falls under 75 years old was 9.23%, and the incidence of falls above 75 years old was 10.88%. Plus, the incidence of falls in older men was 9.03%, and in older women was 9.89%. Within 3 months, the rate of multiple falls was 2.80% among older people. Among those younger than 75 years old, the rate of multiple falls was 31.86, and 17.91% occurred among those older than 75 years old. Among men, the rate of multiple falls was 2.99%, accounting for 33.16% of total falls. For women, the rate of multiple falls was 2.61%, accounting for 26.39% of total falls. Moreover, the big five personality (extraversion, agreeableness, conscientiousness, neuroticism, and openness) scores were (6.48 ± 1.505), (7.00 ± 1.409), (7.13 ± 1.525), (5.90 ± 1.354), and (6.31 ± 1.426).

Table 1 shows participants' characteristics and the corresponding distributions of the loneliness scores. Overall, the total loneliness score was (4.45 ± 1.547). According to the results, there was a significant difference in age, marital status, education level, residence, solitariness, and fall. According to the *post hoc* test, the loneliness scores of the married were lower than the unmarried, the divorced, and the widowed ($p < 0.001$). The loneliness scores of older people with multiple falls were higher than those with a single fall ($p < 0.001$) and with no fall ($p < 0.001$).

3.3. Correlation analysis

Between the big five personality traits and fall, the correlation analysis presented that fall was negatively correlated with agreeableness ($r = -0.069$, $p < 0.001$) and conscientiousness ($r = -0.068$, $p < 0.001$); loneliness was positively correlated with neuroticism ($r = 0.085$, $p < 0.001$) and openness ($r = 0.039$, $p = 0.011$); fall was not correlated with extraversion ($r = -0.015$, $p = 0.313$).

Between the big five personality traits and loneliness scores, the correlation analysis presented that loneliness was negatively correlated with extraversion ($r = -0.130$, $p < 0.001$), agreeableness ($r = -0.192$, $p < 0.001$), and conscientiousness ($r = -0.181$, $p < 0.001$); loneliness was positively correlated with neuroticism ($r = 0.170$, $p < 0.001$); loneliness was not correlated with openness ($r = -0.029$, $p = 0.058$).

3.4. Multiple linear regression analysis

Multiple linear regression analysis was performed with loneliness as the dependent variable and agreeableness, conscientiousness, and neuroticism as mediating variables and fall as the independent variables. While age, marital status, education level, residence, and solitariness were controlling variables, as shown in Table 2, agreeableness, conscientiousness, neuroticism, and fall were important influence risks for loneliness. After agreeableness, conscientiousness, neuroticism, and fall entered the model, $\triangle R^2$ increased by 5.8%. They were statistically significant with agreeableness ($\beta = -0.124$, $p<0.001$), conscientiousness ($\beta = -0.113$, $p < 0.001$), and neuroticism ($\beta = 0.170$, $p < 0.001$). In the meantime, the regression coefficient for fall decreased from 0.772 to 0.661 ($p < 0.001$). There was a mediating effect with agreeableness, conscientiousness, and neuroticism.

TABLE 1 Loneliness scores among older people with different characteristics ($n = 4,289$).

	Number (%)	Loneliness	*t/F* value	Value of *p*
Age (years)			*−3.058*	*0.002*
≤75	3,673 (85.6)	4.42 ± 1.523		
> 75	616 (14.4)	4.63 ± 1.671		
Gender			*−1.514*	*0.130*
Men	2,105 (49.1)	4.42 ± 1.527		
Women	2,184 (50.9)	4.49 ± 1.565		
Marital status			*27.433*	*<0.001*
Unmarried	122 (2.8)	4.98 ± 1.674		
Married	3,576 (83.4)	4.36 ± 1.496		
Divorced	103 (2.4)	4.91 ± 1.652		
Widowed	488 (11.4)	4.92 ± 1.722		
Education level			*3.309*	*0.002*
Primary and below	2047 (47.7)	4.53 ± 1.529		
Above primary	2,242 (52.3)	4.38 ± 1.559		
Monthly family income (¥)			*0.543*	*0.653*
≤3,000	1881 (43.8)	4.44 ± 1.559		
3,001 ~ 6,000	1760 (41.1)	4.45 ± 1.520		
6,001 ~ 9,000	375 (8.7)	4.55 ± 1.498		
≥9,001	273 (6.4)	4.44 ± 1.695		
Residence			*4.646*	*<0.001*
Rural	1919 (44.7)	4.57 ± 1.549		
Urban	2,370 (55.3)	4.35 ± 1.538		
Solitary			*−9.712*	*<0.001*
No	3,658 (85.3)	4.36 ± 1.487		
Yes	631 (14.7)	5.00 ± 1.757		
Fall			*107.184*	*<0.001*
No	3,883 (90.53)	4.34 ± 1.488		
A single fall	286 (6.67)	5.37 ± 1.670		
Multiple falls	120 (2.80)	5.75 ± 1.788		

3.5. Mediation model analysis

In this study, fall was set as the independent variable (X). When no fall was the reference group, $X1$ represented a single fall, and $X2$ represented multiple falls. Agreeableness (M1), conscientiousness (M2), and neuroticism (M3) were set as the mediating roles. Loneliness was set as the dependent variable (Y). As shown in Table 3, the bootstrap's 95% CI of agreeableness, conscientiousness, and neuroticism did not overlap the zero; they had a significant mediating effect between fall and loneliness.

4. Discussion

In this study, for loneliness among older people, there are significant differences in age, marital status, education level, residence, solitariness, and fall. Many studies showed that age was significantly positively correlated with loneliness (35, 36). People with older subjective ages might not be able to benefit as much from close social relationships as those with younger subjective ages in relieving loneliness (36). Loneliness among the married was lower than among the unmarried, the divorced, and the widowed. When children grew up, they could spend less time caring for their parents. Older people will become more dependent on their spouses, who support each other. They could communicate and interact with each other to create a good family atmosphere. This can relieve loneliness to some extent (37–40). With regard to education level, this study implied that lower levels of loneliness showed up in those with a higher education level, which was consistent with other studies (41, 42). In general, older people with a higher level of education are better at attending affairs and benefitting from more social resources to enhance their lives, which tends to make them experience less loneliness (42). In our study, older people living in urban areas felt significantly less lonely than those living in rural areas. In China, rapid economic development led to a growing number of young people leaving villages to find employment elsewhere, leaving their parents to live alone as empty-nest older people (42).

TABLE 2 Multiple linear regression (n = 4,289).

	Model 1		Model 2		Model 3	
	β	p value	β	p value	β	p value
(Constant)	3.988	*<0.001*	3.979	*<0.001*	4.494	*<0.001*
Age	0.158	0.019	0.149	0.024	0.199	0.002
Marital status	0.121	0.001	0.113	0.002	0.143	*<0.001*
Education level	0.031	0.345	−0.011	0.738	0.014	0.650
Residence	−0.216	*<0.001*	−0.167	*<0.001*	−0.136	0.003
Solitary	0.552	*<0.001*	0.492	*<0.001*	0.386	*<0.001*
Fall			0.772	*<0.001*	0.661	*<0.001*
Agreeableness					−0.124	*<0.001*
Conscientiousness					−0.113	*<0.001*
Neuroticism					0.170	*<0.001*
F value	26.616	*<0.001*	53.934	*<0.001*	69.994	*<0.001*
R^2	0.030	*<0.001*	0.070	*<0.001*	0.128	*<0.001*
$\triangle R^2$	0.030	*<0.001*	0.040	*<0.001*	0.058	*<0.001*

TABLE 3 The mediating effect between fall and loneliness through personality traits (n = 4,289).

Effect	Estimate	Boot SE	Bootstrap 95%CI	
			Low	High
Total effect (X1 → Y)	1.026	0.093	0.845	1.208
Total effect (X2 → Y)	1.406	0.140	1.132	1.680
X1 → M1 → Y	0.035#	0.012	0.014	0.060
X2 → M1 → Y	0.055#	0.020	0.019	0.095
X1 → M2 → Y	0.022#	0.012	0.001	0.046
X2 → M2 → Y	0.071#	0.020	0.034	0.111
X1 → M3 → Y	0.057#	0.016	0.027	0.091
X2 → M3 → Y	0.113#	0.026	0.065	0.169

#The mediating effect was significant.

Compared to their rural counterparts, older people who live in urban areas have greater access to healthcare services, technology, and facilities. By taking advantage of these resources, they have more opportunities to network with others, participate in social activities, volunteer, and attend senior colleges (41). Solitariness is a significant risk factor for loneliness among older people all the time (42, 43). As the old saying goes, "The more children, the more happiness." Frequent contact and communication with family were critical in preventing and relieving loneliness (42). Older people who have few or poor interpersonal relationships could experience more loneliness. Spouses and adult children would provide older people with social and emotional support to relieve their loneliness (44).

We found that falls, only when they occurred one time, increased the loneliness of older people, which was consistent with other studies (13, 15). It was reported that the fallen older people had a significant decrease in activity as a result of the fear of falling, which led to increased loneliness (12). In the meantime, the higher level of loneliness will increase the fear of falls to a greater extent, which will increase the risk of falls (45). This could lead to a vicious cycle. Falls may also increase the burden of caregivers, especially when they take care of people with complex needs (11, 46). According to these reference studies, common conclusions included activity restrictions for managing the fear of falls and preventing falling (46–48). After a fall, older people would reduce social participation actively and caregivers would restrict activities, which increases dependence on caregivers further. In this situation, with fewer social interactions, loneliness will increase.

The current study showed agreeableness, conscientiousness, and neuroticism were meditating factors between falls and loneliness. There was a negative correlation between agreeableness and loneliness, which was consistent with another study (23). Older people with higher agreeableness often have a more positive attitude and trust others more (18). When they fall, they prefer to ask for social support and others' help. That could relieve the loneliness effectively. There was a negative correlation between conscientiousness and loneliness. Higher conscientiousness often represents the ability to be prudent, responsible, and self-controlled (18). A study indicated that higher conscientiousness was accompanied by higher adherence to adapting to healthy behaviors (49). Therefore, older people with higher conscientiousness would pay more attention to their health and actively prevent falls. Although they

fall, they often address it more actively rather than closing themselves off. There was a positive correlation between neuroticism and loneliness, which was consistent with other studies (23, 50). Older people with higher neuroticism are more sensitive to stressful events, which lead to emotional distress or even disorder. They are often unable to cope effectively with pressure and tend to close themselves off (18). When they fall, whether injured or not, they blame themselves and gradually lose contact and restrict activities. As a result, they will experience social isolation and increased loneliness (11, 12).

Although we have found that agreeableness, conscientiousness, and neuroticism were meditating factors between fall and loneliness, the mediating effect coefficient was a bit small. Therefore, we only explored the statistical significance. On the one hand, each big five personality trait was weekly correlated with falls and loneliness ($|r| < 0.30$, $p < 0.05$) in this study. This result only implies a correlation between the three. If we want to explore the relationship and interplay, we should consider the longer-term changes because the big five personality traits remain stable over relatively short periods of time (51). On the other hand, due to many demographic factors affecting loneliness (3) and the complex relationship between the big five personality traits and loneliness (23, 24), we need to exclude disruptions of relevant factors and make research to verify practical values in the future. In the meantime, it has been proven that interventions for social isolation made less effort to relieve loneliness (52). We also explore the complex multi-factor between fall and loneliness. According to recent studies, when we make interventions for older people who have higher fall risks or have experienced falls, it is critical to consider the influence of the Big Five personality traits (22, 24, 53).

5. Highlights and limitations

Older people who have experienced falls are more likely to feel lonely. At present, although the relationships among the variables of fall, loneliness, and personality trait have been examined separately, there was a lack of studies to explore the role of personality traits between falls and loneliness. This study indicated that agreeableness, conscientiousness, and neuroticism were significant mediating effects between falls and loneliness. Moreover, it was reported that interventions for social isolation made less effort to relieve loneliness. Therefore, for older people with different personality traits, in the future, interventions could make some adjustments according to distinctions between different personalities.

There were still some limitations that could be improved in future studies. First, self-report questionnaires were used in our study, and the ultra-short measure might be inadequate. Hence, the results of the questionnaire might be affected by participants' subjective experiences and limited by insufficient assessment. Second, our data were collected during the summer, when older people responded to the questionnaire by their memories, leading to recall bias. Most of the older people were younger than 75 years old, which had an impact on the results. Third, although this study indicated that agreeableness, conscientiousness, and neuroticism had significant mediating effects between falls and loneliness, the mediating effect coefficient was a bit small, partly due to the large sample size. Because the cross-sectional study did not allow for testing the temporal precedence of mediators and causality, in the future, research should explore practical applications. Finally, although our data were from the national level, the distribution of data on older people remained uneven in different regions. Therefore, the conclusions could only reflect certain issues from the side.

6. Conclusion

In this study, we found that there are significant differences in age, marital status, education level, residence, solitariness, and fall in relation to loneliness among older people. Falls, especially when they occurred one time increase the loneliness level of older people. This study implied that agreeableness, conscientiousness, and neuroticism were meditating factors between falls and loneliness. In the future, we should consider the big five personality traits more to understand loneliness and offer older people interventions to reduce their loneliness.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

LY, WY, and ZL: study design. LY, WY, DY, RH, and LJ: data collection. LY, DY, RH, and LJ: data analysis and article revision. LY: article writing. WY and ZL: article guide. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Impact of social isolation caused by the COVID-19 pandemic on the mood profile of active and sedentary older adults: physical activity as a protective factor

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Background: The COVID-19 pandemic has changed our habits and lifestyle due to social isolation and mobility restrictions. This new scenario, together with the fear of contracting the coronavirus, influenced mental health, especially among older adults, who presented reductions in social contact and physical activity (PA). Thus, the objective of the study was to analyze the impact caused by social isolation during the COVID-19 pandemic on the mood states of active and sedentary older adults.

Methods: This is an observational study conducted during the COVID-19 pandemic. Older adults aged over 60years, who were registered in the database of the Secretariat for the Promotion of Citizenship from a city in southern Brazil, participated in the research. An online questionnaire was applied with questions about sociodemographic characteristics, level of PA, confinement, and mood states in two periods: May 2020 and June 2021. The Mann–Whitney U test was used to compare the mood states of active and inactive individuals during the pandemic.

Results: One hundred and fifty participants answered the questionnaire, of which 80 (53.3%) reported practicing PA. More active older adults suffered fewer changes in mood when compared to inactive older adults, with lower levels of confusion ($p = 0.035$), depression ($p = 0.002$), and fatigue ($p = 0.000$). Older adults confined for more than 50 days were more likely to develop depression. In addition, the mood state correlated with the variable fear of contracting the coronavirus; the greater the fear, the greater the mental confusion, depression, fatigue, and tension, and the lower the vigor in the older adults. The practice of PA is also correlated with the mood state; the greater the number of hours dedicated to PA, the lower the confusion, depression, fatigue, and tension of the older adults.

Conclusion: The practice of PA positively influenced the mental health of older adults during periods of isolation and social restrictions. PA has a protective factor for the development of mental health problems and improves mood states, with greater time performing PA leading to more benefits.

KEYWORDS

physical exercise, mood states, mental health, public health, aged, SARS-CoV-2

Introduction

In March 2020, the World Health Organization (WHO) declared the COVID-19 pandemic a public health concern (1). Due to the high transmission rate of the disease, social isolation measures were used worldwide to reduce transmission of the virus and prevent associated diseases and deaths (2, 3).

The pandemic has presented new challenges for society. It has been shown that the COVID-19 pandemic is associated with higher levels of worry, fatigue, loneliness, avoidance, and covid-anxiety syndrome across different countries (4, 5). In Brazil, the first case of COVID-19 was in February 2020, but soon the cases began to grow, with Brazil being the second country with the most deaths from COVID-19 in the world (6). In this context, the older adult population was characterized as a risk group, with greater chances of developing more severe forms of the disease, requiring intensive care, due to a higher rate of hospitalizations and a higher incidence of deaths (7, 8). Thus, these factors directly implied the severity of the degree of isolation of this population (9), which negatively affected mental health and well-being (10), due to emotional stress factors, such as activity restrictions, mourning for family and friends, and conflicting information from social media (11).

As a result of these factors, significant increases in anxiety and depression rates were observed during this period (12). Deleterious effects were also observed in mood states, which are frequently temporary and can vary in intensity and duration (13). The ideal mood profile is known as the iceberg profile, characterized by a high level of vigor and low levels of tension, fatigue, anger, depression, and confusion (14, 15). Although researchers have reported that with advancing age, the mood profile tends to approach the iceberg profile, in the midst of confinement, negative changes were observed, which demonstrated that most mood variables suffered oscillations mediated by the restrictive measures of each moment (16).

The COVID-19 pandemic presented several challenges for the population due to lifestyle changes related to social isolation (17). Older adults, characterized as a risk group, presented significantly reduced practice of physical activity (PA) and social contact and were exposed to several psychological stress factors that negatively affected mental health (18, 19). Studies have revealed disturbances in the mood profile of the population, reporting increased levels of tension, depression, fatigue, anger, and confusion, as well as a reduction in vigor, compared to previously observed patterns (20).

In the context prior to the pandemic, physical inactivity was already considered a global health problem, being considered the fourth largest risk factor for mortality in the world and an economic burden for society (21, 22). In addition, the isolation related to COVID-19 negatively influenced health-related behaviors because, during this period, older adults presented a reduction in the quality of nutritional standards, increased alcohol consumption, and more expressively, significantly reduced practice of physical activity (11). This reduction was associated with an increase in sitting time, and reductions in the value of metabolic equivalents of task (METs), and the number of daily steps (23). While the practice of PA during the pandemic was associated with improved well-being, quality of life, and mood in general (24, 25), deprivation or reduced practice was associated with several negative effects on the physical and mental health of older adults, reinforcing the relevance of maintaining the practice of PA within the possibilities of low exposure to the virus in this context (26).

In this way, social isolation negatively influences mood states and the level of PA (27, 28), and lower levels of PA directly impact mood states (29), thus a vicious cycle is formed. However, the use of PA to interrupt this cycle has been shown to be efficient. In younger people (19–59 years), moderate PA during the isolation period improved mental health (30), being a strategy used in different populations even before periods of restriction. Considering the relevance of the topic and the lack of studies that relate mood in older adults and the practice of PA during social isolation due to the COVID-19 pandemic, the aim of the current study was to analyze the impact caused by social isolation during the COVID-19 pandemic on the mood states of active and sedentary older adults.

Methods

Study design and participants

This observational study was conducted using self-administered online questionnaires during two moments of the pandemic: May 2020 and June 2021, periods characterized by a higher and lower level of social isolation according to the restrictive measures of the Brazilian health authorities, respectively. The older adults were recruited from the databases of the Secretariat for the Promotion of Citizenship from a city in southern Brazil. A telephone contact was made to verify the interest in participating in the study. For those interested, a link was sent to access the questionnaire through Google Forms. People aged 60 or over of both sexes, residents of their own homes or family members, were included in the sample.

The study was approved by the Ethics Committee for Research Involving Human Beings of the State University of Santa Catarina, under number 40392220.2.0000.0118. The questionnaire was evaluated anonymously. The patients/participants provided their written informed consent to participate in this study. Sociodemographic data related to social isolation/confinement, level of PA, and mood states were collected.

Sociodemographic and clinical aspects

Self-administered questionnaires were used to collect data on sociodemographic and clinical characteristics, including sex, age, marital status, and occupation, as well as PA, level of apprehension/fear about contracting COVID-19, and period of social isolation. The levels of PA were collected from the participants according to the question: How many hours a week do you dedicate to physical exercises and sports during the quarantine period? Participants were classified as inactive (no exercise) or active (performed physical exercise for at least 30 min a week). Confinement levels were collected with the following question: Approximately how many days have you been confined for? For the classification of confinement levels, the criterion based on the analysis of the likelihood test was used, thus the best classification used was up to 50 days confined and more than 50 days confined.

Mood states

The Profile of Mood States (POMS) is one of the most used tools for assessing moods across various populations (31, 32). The Brunel

Mood Scale (BRUMS), derived from the POMS, was used to assess mood states (tension, depressed mood, anger, vigor, fatigue, and confusion) (33). The BRUMS consists of 24 questions, with response options for each one ranging from 0 (none) to 4 (extremely), depending on the mood state at the time of assessment. The total score for each mood ranges from 0 to 16. The BRUMS has proven to be a valid and reliable tool to assess the mood state of Brazilian and the older adult population (33, 34).

Statistical analysis

Data analysis was performed using the software Statistical Package for the social sciences (version 20.0), with descriptive statistics (mean, standard deviation, frequency, and percentage) and inferential statistics. The distribution of data normality was determined by the Kolmogorov–Smirnov test. The Mann–Whitney U test was used to compare the mood states of active and inactive individuals during the pandemic, in addition to comparing the mood of older adults at the beginning and end of social isolation. Spearman's correlation test was used to verify the correlation between mood and the degree of social isolation. Data were stratified by age (over 70 years old or under 70 years old). The Mann–Whitney U test was used to compare age ratings. Factors associated with depression in older adults during the pandemic were analyzed using logistic regression. Thus, it was possible to estimate the crude and adjusted odds ratios (OR), as well as their respective 95% confidence intervals (95% CI). The independent variables were inserted according to the following hierarchical model: sex, marital status, and educational level in the first level, days of confinement and fear of contracting coronavirus in the second level, and physical activity in the third level. The hierarchical model is used when the choice of factors to be included in the model is based on a conceptual structure, which describes the hierarchical relationships between risk factors. This model is used to study the determinants of childhood infectious diseases, illnesses, malnutrition, low birth weight, infant mortality, hypertension and obesity (35). While the following examples are derived from the field of child health, the general principles apply to many other health issues as well. The hierarchical model was applied in this article with the objective of estimating the factors associated with the presence of mood state depression in the older adult during the pandemic. Socioeconomic factors are the distal determinants (gender, marital status, and education) and can affect, directly or indirectly, all other groups of risk factors. Second-level variables include, in turn, days of confinement and fear of contracting the coronavirus and can affect third-level variables, in this case physical activity (36).

For the categorization of variables, a likelihood test was used, as proposed by Bu et al. (37), using a proportion of 0.5. Variables were included in the adjusted model regardless of the p-value of the crude analysis. The significance level used in this study was $p < 0.05$.

Results

A total of 255 older adults were invited to participate in the study, of which 150 answered the questionnaires, 83 in the first data collection and 67 in the second. Most of the older adults were women (88%) and were between 60 and 87 years old. Table 1 presents the sociodemographic characteristics of these individuals.

Older adults who remained active during the pandemic showed a more positive mood for mental health and had lower levels of confusion ($p = 0.035$), depression ($p = 0.002$), and fatigue ($p = 0.000$) compared to sedentary older adults (Table 2). When stratifying by age, there was a difference in depression ($p = 0.034$) and fatigue ($p = 0.030$) between active and sedentary older adults aged less than 70 years, in addition to a difference in depression between active and sedentary older adults aged over 70 years ($p = 0.038$).

In addition, older adults who remained confined for more than 50 days were more likely (23 times) to develop mood depression (OR 0.23; CI 1.10–0.61) (Table 3).

TABLE 1 Sociodemographic characteristics and physical activity of participants.

	Older adults ($n = 150$)
Age (mean ± SD)	68.60 ± 6.4
Sex	**N (%)**
Female	132 (88%)
Male	18 (12%)
Marital status	**N (%)**
Single	9 (6%)
Married	63 (42%)
Widower	52 (34.7%)
Separate	26 (17.3%)
Do you currently practice your profession?	**N (%)**
Yes	28 (18.7%)
No	43 (28.7%)
Retired	79 (52.7%)
Health insurance	**N (%)**
Yes	37 (45.1%)
No	45 (54.9%)
How do you rate your health currently?	**N (%)**
Terrible	1 (1.2%)
Bad	2 (2.4%)
Regular	27 (32.9%)
Good	44 (53.7%)
Excellent	8 (9.8%)
Days of confinement (Mean ± SD)	101.52 ± 80.0
Level of fear of contracting the coronavirus	**N (%)**
None	22 (14.7%)
Low	19 (12.7%)
Moderate	52 (34.7%)
Very high	40 (26.7%)
Extreme	17 (11.3%)
Practice physical activity	
Yes	80 (53.3%)
No	70 (46.6%)

SD = standard deviation; F = absolute frequency; % = relative frequency/percentage.

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TABLE 2 Mood states of active and sedentary older adults in the pandemic.

Mood states	Active older adults ($n = 80$) Mean ± SD	Sedentary older adults ($n = 70$) Mean ± SD	p-value
Tension	3.23 ± 2.5	4.21 ± 3.3	0.082
Depression	1.71 ± 2.2	3.37 ± 3.4	0.002*
Anger	1.36 ± 2.1	2.28 ± 3.2	0.179
Vigor	7.52 ± 3.5	6.91 ± 3.6	0.308
Fatigue	1.76 ± 2.1	3.94 ± 4.0	0.000*
Confusion	1.95 ± 2.2	1.95 ± 2.2	0.035*

SD = standard deviation; Mann–Whitney-U-test. *Statistical significance $p < 0.05$.

Older adults at the end of social isolation showed a reduction in confusion, depression, and fatigue when compared to the beginning of isolation (2020) (Table 4). In the stratification by age, there was a difference in fatigue ($p = 0.022$) in older adults under 70 years old, whereas in older adults over 70 years old, the differences were in the variables depression ($p = 0.005$) and fatigue ($p = 0.048$) between days of social isolation.

Figure 1 represents the iceberg profile identified in the older adults according to the practice of physical activity, the pandemic period, and age.

Correlations were observed between the degree of social isolation and mood in the older adults during the COVID-19 pandemic. The older adults who left home more frequently during the pandemic performed more hours of physical activity ($p = 0.000$; $r = 0.487$), and presented the following characteristics in terms of mood: less confusion ($p = 0.022$; $r = -0.250$), depression ($p = 0.001$; $r = -0.358$), fatigue ($p = 0.019$; $r = -0.256$), and tension ($p = 0.014$; $r = -0.268$) when compared to older adults with more days of social isolation.

Similar results were observed when stratifying by age. In older adults under 70 years of age, the variable number of times a week they left home correlated with depression ($p = 0.031$; $r = -0.305$) and vigor ($p = 0.046$; $r = 0.283$). In the older adults over 70 years of age, it was found that the greater the number of days they left home, the less the confusion ($p = 0.003$; $r = -0.509$), depression ($p = 0.016$; $r = -0.421$), and tension ($p = 0.009$; $r = -0.457$), suggesting that a greater the number of days in social isolation is associated with worsening mental health of the older adults.

The mood state also correlated with the variable fear that the older adults have of contracting the coronavirus; the greater the fear of contracting the coronavirus, the greater the confusion ($p = 0.020$; $r = 0.189$), depression ($p = 0.026$; $r = 0.181$), fatigue ($p = 0.022$; $r = 0.186$), and tension ($p = 0.002$; $r = 0.251$), and the lower the vigor ($p = 0.033$; $r = -0.173$) in older adults.

The practice of physical activity also correlated with mood states; the greater the number of hours dedicated to physical activity, the lower the mental confusion ($p = 0.022$; $r = -0.244$), depression ($p = 0.000$; $r = -0.308$), fatigue ($p = 0.000$; $r = -0.372$), and tension ($p = 0.015$; $r = -0.197$) of older adults (Table 5).

TABLE 3 Factors associated with the presence of mood state depression in the older adults during the pandemic.

Variables	Brute analysis OR (CI95%)	Adjusted analysis**
Sex[a]		
Male	1.00 (0.33–2.97)	1.32 (0.39-4.41)
Female	1	1
Marital status[a]		
Single	1.12 (0.22–5.66)	0.92 (00)
Married	0.79 (0.29–2.16)	1.10 (0.13–9.01)
Widower	0.67 (0.23–1.93)	0.79 (0.19–3.22)
Separate	1	1
Educational level[a]		
Unlettered	1	1
Complete primary education	0.66 (0.07–5.67)	0.47 (0.11–1.98)
Incomplete primary education	0.31 (0.04–2.20)	1.08 (0.27–4.33)
Complete high school	0.66 (0.09–4.52)	1.35 (0.34–5.36)
Complete higher education	0.84 (0.12–5.49)	0.00 (0.00–0.00)
Postgraduate	0.00 (0.00–0.00)	1.54 (0.17–13.57)
Days of confinement[b]		
Until 50 days	1	1
More than 50 days	0.25 (1.10–0.61)*	0.23 (0.09–0.59)*
Fear of contracting coronavirus[b]		
None	0.85 (0.22–3.26)	2.06 (0.38–11.01)
Low	0.48 (0.11–2.15)	0.57 (0.08–3.65)
Moderate	0.53 (0.16–1.75)	0.99 (0.23–4.16)
Very high	0.67 (0.20–2.25)	0.95 (0.23–3.93)
Extreme	1	1
Practice physical activity[c]		
Does not exercise	1.24 (0.60–2.55)	0.82 (0.31–2.14)
Practice exercise	1	1

**Analysis adjusted for all variables. *Hosmer-Lemeshow* = 0.758. *Significant association by confidence intervals (95% CI).
[a]Sex, marital status, and educational level.
[b]Days of confinement and fear of contracting coronavirus.
[c]Physical activity.

Discussion

During the COVID-19 pandemic, an increase in the prevalence of mood disorders was observed due to social isolation and fear of contracting the disease (10, 20, 38), allied with a reduction in the level of PA (26). However, the practice of PA has been shown to mitigate the deleterious effects of confinement on mental health (25).

In the present study, less confined older adults who left the house on more days performed more PA and presented a better mood profile, with lower levels of mental confusion, depression, fatigue, and tension, when compared to the more confined older adults, reinforcing the associations between confinement, PA, and mental health, already evidenced in other studies (39, 40).

Relationship between confinement and mental health

According to Santomauro et al. (41) the reduction in human mobility was considered one of the biggest factors associated with the emergence of mood disorders during the pandemic. In the study

conducted by Richardson et al. (16) with older adults in the United Kingdom, depressive mood increased until the beginning of the easing of restrictive measures, reinforcing the possible relationship between isolation and mental health. In our study, older adults who were confined for more than 50 days were 23 times more likely to develop a depressed mood. When analyzing the mood profile during different periods of the pandemic, it was observed that at the end of 2021, the older adults presented a better mood profile (less confusion, depression, and fatigue) than in 2020.

Factors such as fear, uncertainty, economic hardship, and changes in daily habits showed a negative correlation with the general population's mental health (42). Fear of COVID-19 has been shown to be significantly associated with worsening mental health status, negatively influencing factors such as anxiety, stress, depression, and sleep quality (43). In our study, the variable fear of contracting the coronavirus was positively correlated with confusion, depression, fatigue, and tension, and negatively correlated with vigor in the older adults, thus demonstrating that individual concern related to COVID-19 potentiated the deleterious effects of confinement in older adults. This result may be associated with the fact that due to the fear of contracting COVID-19, many older adults were isolated, which reduced the level of PA.

TABLE 4 Comparison of the mood state of the older adults in 2020 and 2021.

Mood	Social isolation 2020 ($n = 82$) Mean ± SD	Social isolation 2021 ($n = 68$) Mean ± SD	p-value
Tension	4.03 ± 2.9	3.25 ± 2.0	0.061
Depression	2.82 ± 2.9	2.11 ± 2.9	0.028*
Anger	2.03 ± 3.0	1.48 ± 2.4	0.161
Vigor	6.93 ± 3.4	7.64 ± 3.7	0.291
Fatigue	3.28 ± 3.4	2.17 ± 3.1	0.005*
Confusion	2.71 ± 2.6	2.02 ± 2.5	0.038*

SD, Standard derivation; *Statistical significance at $p < 0.05$.
Mann–Whitney U Test.

Mood profile and levels of physical activity

The practice of PA during the pandemic seems to be a factor that promotes mental health and protects against depression, fatigue, and confusion in mood in older adults.

PA was already recommended for the older adult population before the outbreak of COVID-19, as it helps to maintain physical and mental health, in addition to being considered a form of treatment for various diseases and health problems (44–49). Furthermore, PA can help improve the quality of life (50, 51) and psychological well-being associated with positive mood indices (52, 53). Therefore, during the pandemic, maintaining PA levels was essential to reduce the damage caused by isolation. However, a reduction in PA was observed in the general population, including among older adults (26).

PA proved to be fundamental during the pandemic, as active older adults had lower levels of confusion, depression, and fatigue. Analyzing other factors, the practice of PA continued to show positive results. When comparing older adults over and under 70 years of age, we found that the younger group presented more benefits with the practice of PA, since among those over 70 years old there were significant improvements only in depression. With increasing age, it is expected that older adults will have more difficulties in moving and performing exercises, which may explain the differences between the groups since the PA practice was not controlled. In the study carried out by Sojli et al. (54), emotional stress related to COVID-19 was similar in individuals aged 65–75 years

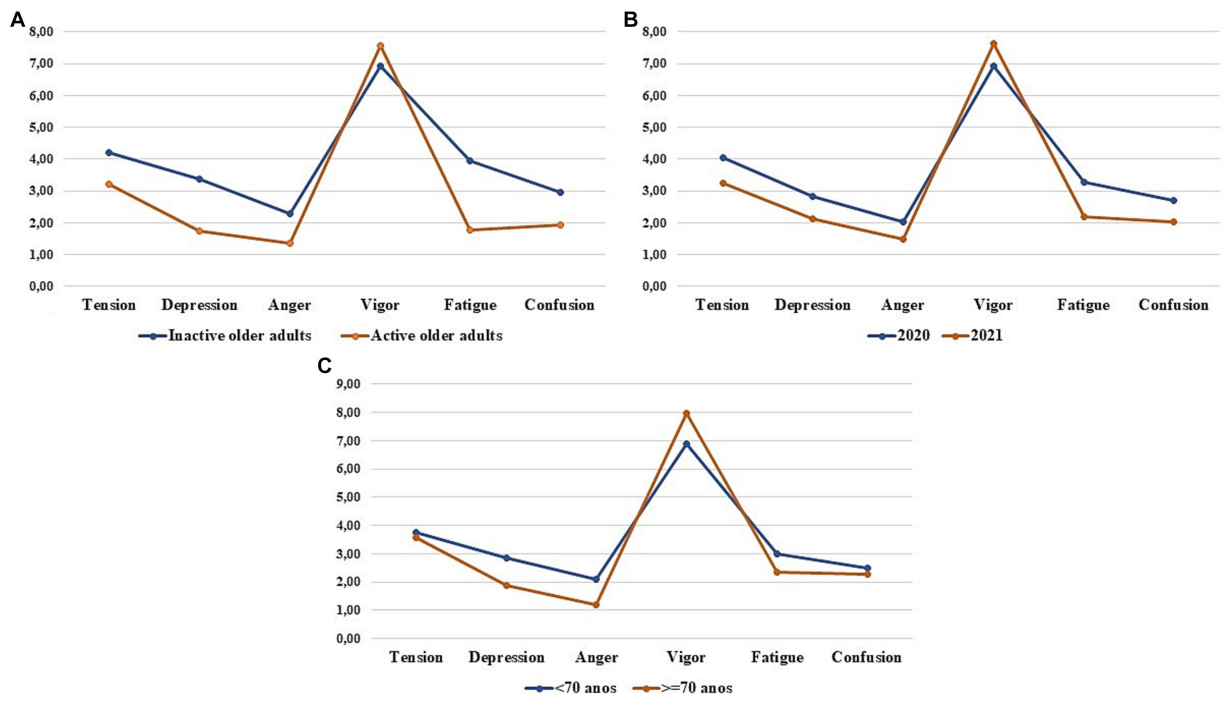

FIGURE 1
Mood profile of older adults according to physical activity **(A)**, pandemic period **(B)** and age **(C)**.

TABLE 5 Mood state correlations with days of social isolation, fear of contracting the coronavirus and practice of physical activity.

Mood states	Tension	Depression	Anger	Vigor	Fatigue	Confusion
Days of social isolation	$p = 0.014$*	$p = 0.001$*	$p = 0.457$	$p = 0.488$	$p = 0.019$*	$p = 0.022$*
	$r = -0.268$	$r = -0.358$	$r = 0.067$	$r = -0.063$	$r = -0.256$	$r = -0.250$
Fear of contracting the coronavirus	$p = 0.002$*	$p = 0.026$*	$p = 0.476$	$p = 0.033$*	$p = 0.022$*	$p = 0.020$*
	$r = 0.251$	$r = 0.181$	$r = 0.058$	$r = -0.173$	$r = 0.186$	$r = 0.189$
Practice of physical activity	$p = 0.015$*	$p = 0.000$*	$p = 0.180$	$p = 0.309$	$p = 0.000$*	$p = 0.022$*
	$r = -0.197$	$r = -0.308$	$r = -0.109$	$r = 0.083$	$r = -0.372$	$r = -0.244$

*Statistical significance at $p < 0.05$. Spearman correlation.

or older and relatively low when compared to other age groups, however, the practice of PA was not analyzed.

Corroborating the findings related to the protective effect of PA on the mental health of older adults, other studies observed a relationship between PA and depressive symptoms (55, 56). In addition, a review showed that higher levels of PA in volume, frequency, and regularity are associated with lower levels of symptoms of depression and anxiety in the general population (57). Important dose-response relationships that enhance the protective effect were also observed through the negative correlation between the number of hours dedicated to PA and the mood profile observed in the older adults in the variables confusion, depression, fatigue, and tension.

The WHO recommends the practice of at least 150 min of PA per week and reinforces that any level of PA greater than none can be beneficial to health when compared to physical inactivity (58). In the current study, it was observed that 30 min of PA or more were enough to improve the mental health of the older adults during the pandemic, reinforcing the relevance of protection and promotion that increased levels of PA provided. These results are in line with scientific evidence, since PA presents, through various functions such as psychological, physiological and immunological, a vital component for the health of different populations, one of them investigated in the present study as the older adults (59, 60). In this regard, home-based physical exercise programs for older adults seem to offer a safe, easily accessible, and low-cost PA alternative for this population (61).

Limitations and future studies

Despite the important results verified, this study has some limitations, such as the small sample size, the sample being from a single municipality, and the majority of participants being female. In addition, it was not verified whether the participants had mental health problems before the pandemic and the intensity of the practice of PA was not evaluated.

Future studies should be developed, including monitoring variables regarding the type of physical exercises, volume, intensity, duration, and weekly sessions, among others, in addition to expanding mental health variables during the post-pandemic process of COVID-19.

Future studies should try to measure the level of daily activity of the participants, considering that activities of daily living (for example, gardening, sweeping the house, among others), can also be considered physical activities, depending on the amount performed weekly, and may also impact the physical and mental health of participants.

Another point to be considered as a limitation is the level of distraction that the participants had, when they did not remain in isolation, since in our findings, the older adults who left home more presented a better mood profile, compared to the group with more days in social isolation. In new studies, it would be interesting to identify the level of distraction or interaction when the older adults do not remain in social isolation (outside their homes), in order to identify if there are any additional relationships, considering the greater chance of social contact and even levels of daily activities, affecting physical activity. In addition, future studies should consider the role of possible pharmacological or psychological treatments.

Studies with proposals and applications of different physical exercise protocols for older adults are recommended, both at the individual level and for future public policies.

Strengths, innovations, and applications of the study

Our study is one of the rare empirical investigations on this subject, being innovative as it presents a comprehensive view of changes in the mood of older adults during the pandemic associated with the practice of PA. One of the strengths of the study is the analysis of the time of social confinement to which many older adults were subjected during the pandemic, its effects on mood and mental health, and the role of PA in this context. Relevant aspects of the effects of social confinement and the possible protective effect of PA on the mental health of older adults in a pandemic context were demonstrated.

As applications of the findings, we can highlight the need for attention to the time of social isolation that older adults are subjected to, during pandemics or even in social isolation contexts, to reduce these periods as much as possible and provide options for PA remotely, face-to-face, or with the use of technologies, seeking to motivate and promote PA for older adults, knowing the benefits to physical and mental health. These findings can be used as a source of inspiration to guide public policies.

Conclusion

The practice of PA positively influences the mental health of older adults during periods of isolation and social restrictions. PA, for older adults in social isolation, seems to be a protective factor against the development of mental health problems, and may improve mood states, especially depression, fatigue, and confusion. Exposure to long periods of social confinement is a high-risk factor for mood and mental health problems, especially when associated with a sedentary lifestyle.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Ethics Committee for Research Involving Human Beings of the State University of Santa Catarina. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

AA contributed to the design and coordination in the production of the study. AA, AD'O, and GV contributed to data acquisition, data analysis and interpretation. AA, AD'O, GV, SC, and PD critically reviewed the article for intellectual content. KS contributed to data analysis and interpretation. AB, AD'O, and GV drafted the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Associations of loneliness with mental health and with social and physical activity among university students in Germany: results of the COVID-19 German student well-being study (C19 GSWS)

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Introduction: University students are at high risk for loneliness with a potential negative impact on health. The COVID-19 measures disrupted students' academic routine and social life, which might have affected their perception of loneliness. This study investigated the prevalence of perceived loneliness among university students in Germany during the COVID-19 pandemic and its associations with mental health, behavioral outcomes, and sociodemographic characteristics.

Methods: COVID-19 German student well-being study (C19 GSWS) collected data from five German universities from October 27th to November 14th, 2021, resulting in a sample of 7,203 respondents. Associations of loneliness with depressive symptoms, anxiety, social and physical activity, as well as sociodemographic characteristics, were analyzed using multivariable logistic regressions.

Results: A total of 20.6% of students reported loneliness. Students with depressive or anxiety symptoms had more than eight- or sixfold odds, respectively, for reporting loneliness (depressive symptoms: OR = 8.29; 95% CI: 7.21–9.52; anxiety: OR = 6.48; 95% CI: 5.65–7.43) compared with students who did not report any symptoms. Students who were less physically active were more likely to experience loneliness compared with students who were more physically active (no moderate physical activity: OR = 1.39; 95% CI: 1.21–1.59; no vigorous physical activity: OR = 1.19; 95% CI: 1.04–1.36). We found no association between loneliness and social activity. However, loneliness was associated with being single (OR = 2.93; 95% CI: 2.55–3.36), living alone (OR = 1.31; 95% CI: 1.13–1.52), or having a temporary residency status in Germany (OR = 2.24; 95% CI: 1.65–3.04).

Conclusion: Our findings highlight the importance of loneliness as a relevant factor associated with health. Further research is needed to determine potential protective factors to tackle loneliness and to investigate how study conditions at higher education institutions may affect students' perceived loneliness.

KEYWORDS

loneliness, mental health, university students, COVID-19 pandemic, depressive symtoms, anxiety, physical activity

1. Introduction

Feeling lonely is an unpleasant individual experience, which is not synonymous with social or objective isolation. Loneliness occurs when the network of social relations is quantitatively or qualitatively insufficient (1). Whether or not social networks are considered to be deficient depends on the individual relationship correlates (e.g., relationship aims, type of relationship) (2). Evidence suggests that a sense of belongingness or social connectedness might act as a buffer against loneliness (3). Conversely, the lack of social connectedness might result in feelings of loneliness (4).

Evidence further suggests that loneliness is associated with an increased all-cause mortality (5), being female (6–9), living alone (7–9), and being single (8, 9). Loneliness is also strongly linked to mental health: depression, generalized anxiety disorder, and suicidality have been shown to be strongly associated with loneliness (8, 10, 11). Moreover, loneliness is an important predictor of long-term health and is not only limited to older individuals (12). Adolescents and young adults are also widely affected by feelings of loneliness, and strong associations with depressive symptoms and anxiety have been demonstrated (12, 13). Generally, previous research indicated that loneliness, anxiety, and depression were distinct but interrelated phenomena (11, 14). Furthermore, loneliness in youth is a relevant predictor of the health status in adulthood (15) and correlates with future mental health problems. As the duration of loneliness in youth seems to be an important predictor for depression later in life, the prevention of loneliness among young people is a pressing issue (16, 17). It appears, therefore, important to identify and address loneliness at an early stage in childhood or in young adulthood in order to prevent its negative effects on mental health later on in life.

The prevalence of perceived loneliness and mental illness among young adults, in particular among university students, is generally at high levels (18–20). Former studies on loneliness among university students and young adults examined associations with age, gender, living situation, relationship status, immigration status, and mental health problems. In general, younger age groups were found to be more likely to experience loneliness (6, 7, 9, 21). Within this age group, younger and older students were reported to have higher feelings of loneliness compared with middle-aged students (19), indicating a U-shaped association between age and loneliness among university students. Similarly, being female (22, 23), living alone (18, 19, 24), being single (18, 19, 23, 25), and studying abroad (19) were associated with more feelings of loneliness. In contrast, some studies could not confirm these associations between loneliness and gender among higher education students (18, 25).

Loneliness is a mental health issue that has received particular attention during the COVID-19 pandemic (26). The pandemic caused governments to implement measures to contain the disease such as school and university closures and social distancing. In Germany, the first lockdown started in March 2020 with easing steps over the subsequent summer. When the incidence rates increased again in autumn 2020 (27), the second lockdown began and lasted until May 2021. Whereas elementary and secondary school students had already been able to return to their institutions earlier, higher education institutions remained closed and, thus, online teaching continued. From April 2022 onwards, universities were reopened throughout Germany and returned to face-to-face teaching.

Some studies found that during the pandemic, social isolation and its consequences led to increased prevalence rates of loneliness (28–30). Especially for children and adolescents, the disease containment measures had effects on their mental health and were associated with increased loneliness (16, 29, 30). Even before the pandemic, loneliness was shown to pose significant health risks in terms of anxiety and depressive symptoms for young adults and students (12, 16, 18). During the pandemic, an increase of mental health issues (31) and loneliness (31, 32) among university students was observed. The pre-existing predictors of loneliness observed prior to the pandemic appeared to remain unchanged throughout the course of the pandemic: Bu et al. (33) found that being female or of younger age, living alone, having lower education or income, and belonging to ethnic minorities were risk factors for loneliness.

To reduce or prevent loneliness, recent studies revealed the benefits of social networks regarding life satisfaction and well-being (34, 35). The social interactions during physical activity (e.g., with other participants or with an instructor) could influence individuals' perceptions of social support (36). In this sense, physical activity could offer various relationship opportunities and could create a sense of belonging (37). The evidence of the association between physical activity and loneliness is inconclusive. On the one hand, physical activity might reduce feelings of loneliness; on the other hand, loneliness may decrease the engagement in physical activity (38). In university students, physical activity seems to be a protective factor against loneliness (18, 39). A low level of physical activity (less than 1 hour per week) was associated with loneliness (18). However, Jennen et al. (40) found that just being physically active was insufficient to have an effect on loneliness. Another study found that young adults had to experience physical activity as enjoyable in order to experience decreased feelings of loneliness (41).

The literature regarding the impact of social contact on loneliness among university students is mixed. Generally, work by Diehl and Hilger (24) revealed that the transitional phase between school and university is often connected with a change of residency and, thus, the loss of existing social networks and close family connections. In a Finnish study, loneliness was associated with less social contact with friends in younger ages (21). However, especially for students, friendships and frequent social contact were beneficial to their mental health during the pandemic (42). Rumas et al. (43) found that a larger social network was accompanied by less loneliness, but frequent virtual contact did not help to reduce loneliness. Earlier studies found that the lack of quality of social contact, rather than quantity, was associated with loneliness (41).

Overall, we conclude from the present literature that university students are at risk of exposure to loneliness and its negative health outcomes. Beutel et al. (8) noted that loneliness should be regarded as a relevant health variable on its own. In order to address the research gaps regarding loneliness and mental health, and the role of social networks, and physical activity for loneliness among university students, the aims of this study were (1) to examine the prevalence of perceived loneliness among German university students in a later phase of the COVID-19-pandemic and (2) to identify factors associated with loneliness. Factors of interest included (2a) anxiety and depressive symptoms, (2b) social and physical activities as well as (2c) sociodemographic characteristics. First, we expected anxiety and depressive symptoms to be positively associated with loneliness. Second, we hypothesized that students who engaged in at least one social activity per week are less likely to feel lonely. In addition, our third hypothesis was that students who were physically active were also less likely to experience feelings of loneliness.

2. Materials and methods

2.1. Study design and procedures

The COVID-19 German student well-being study (C19 GSWS) is a cross-sectional study and followed the COVID-19 International Student Well-being Study (C19 ISWS) (44). The online questionnaire of the C19 GSWS was implemented at five German universities: Charité – Universitätsmedizin Berlin, University of Bremen, University of Siegen, Martin-Luther-University Halle/Wittenberg, and Heinrich-Heine-University Düsseldorf. Using LimeSurvey, data collection was conducted at the same time at all five participating universities between October 27th and November 14th, 2021, i.e., at the beginning of the winter semester. During this time, the learning and teaching situation at German universities varied widely due to different regional COVID-19 regulations. In general, face-to-face interaction was limited in favor of online teaching: only few seminars with smaller learning groups were offered in person, whereas most of the lectures were held remotely throughout the whole winter semester.

The questionnaire used was a modified version of the C19 ISWS questionnaire. The core questionnaire used can be found elsewhere (45). The participants invited were students aged 18 years and above who were enrolled at one of the five universities. University students were invited to participate in the online survey via e-mail, e-learning platforms (Martin-Luther-University Halle/Wittenberg and University of Bremen), or via Instagram (Heinrich-Heine-University Duesseldorf). Students had the option of answering the survey in German or English. More information about the design and recruitment of the C19 GSWS study is available elsewhere (46). Further, the dataset is openly accessible via 10.5281/zenodo.7659845 (47).

All participants gave their informed consent before participating in the survey. The ethics committees of the five participating universities have obtained ethical approval (University of Bremen 2021-28-EIL, University Halle-Wittenberg 2020–066, Heinrich-Heine-University Duesseldorf 2020-958_1, Charité – Universitätsmedizin Berlin and University of Siegen have accepted the ethic vote of the University of Bremen). We used the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline for reporting this cross-sectional study (48).

2.2. Measures

2.2.1. Loneliness

Loneliness was assessed with a single item from the Center for Epidemiologic Studies Depression Scale (CES-D) (49): 'Please indicate how much of the time during the past week you felt lonely'. Response options included: 'none or almost none of the time', 'some of the time', 'most of the time', and 'all or almost all of the time'. Responses were converted to binary coding to allow for a comparison of those who reported feeling lonely most, almost all and all of the time (in the following referred to as 'major loneliness') with those who reported feeling lonely 'none or almost none of the time' or 'some of the time' (in the following referred to as 'minor loneliness' (reference category)).

2.2.2. Anxiety and depressive symptoms

Anxiety symptoms were assessed with the 2-item Generalized Anxiety Disorder Scale (GAD-2), which is based on the GAD-7 (50). The GAD-2 is a valid and reliable instrument for assessing generalized anxiety symptoms in a university context (51). The GAD-2 was conducted with the following basic question: 'Over the last 2 weeks, how often have you been bothered by the following problems' and the two items were 'feeling nervous, anxious, or on edge' and 'not being able to stop or control worrying'. For each item, there were the following answer options: (0) 'not at all', (1) 'several days', (2) 'more than half the days', and (3) 'nearly every day'. The GAD-2 sum score can range from 0 to 6, and as suggested in the literature, we chose a cut-off point of 3 (50) to indicate whether the participants showed anxiety symptoms (0 to 3 'no anxiety symptoms' (reference category); 4 to 6 'anxiety symptoms'). The Cronbach's alpha in our sample was 0.85 for GAD-2.

Depressive symptoms were measured with the short-form version of the Patient Health Questionnaire (PHQ-2) (50, 52). The PHQ-2 includes the first two items ('feeling down, depressed, or hopeless' and 'little interest or pleasure in things') of the PHQ-9, and we used the same basic question, response options, and cut off as for GAD-2 (53). In addition, the PHQ-2 is also validated in the university context (54). The Cronbach's alpha in our sample was 0.79 for PHQ-2.

2.2.3. Social activity

A new variable was generated based on 10 items assessing social activity. Participants were asked to indicate whether, in the last week, they had engaged in any of the following activities: (1) a walk with another person; (2) a bike ride with another person; (3) drinks or a picnic with friends or family; (4) talked to friends or family on the street; (5) participated in a recreational class online (e.g., yoga, aerobics, fitness); (6) played a game or a quiz online with friends or family; (7) talked to friends or family through a video-call; (8) talked to friends or family over the phone; (9) chatted with friends or family online (excluding video-calls or phone calls); (10) none of the above. Multiple responses were possible. First, we summed all social activities per participant and second, chose a cutoff >0, similar to Nyqvist et al. (21). This resulted in a new variable with two categories: those who had participated in at least one social activity (reference category) and those who had not participated in any activity in the previous week.

2.2.4. Physical activity

In our study, physical activity was assessed using two items: 'On average, during the last week, how often did you perform vigorous physical activities like lifting heavy things, running, aerobics, or fast cycling for at least 30 min?' and 'On average, during the last week, how often did you perform moderate physical activities like easy cycling or walking for at least 30 min?'. For each item, there were the following answer options: (1) (almost) never; (2) less than once a week; (3) once a week, (4) more than once a week; (5) (almost) daily. For the analysis, we recoded the variables into a binary variable. As suggested by Shankar et al. (55), participants who reported moderate or vigorous physical activity only once a week or less (answers 1–3) were classified as not meeting the criteria for being physically active. Participants who reported levels of physical activity (answers 4–5) were classified as being physically active (reference category).

2.2.5. Sociodemographic characteristics

We included the following variables in our analyses: self-identification with gender ('female', 'male', 'diverse'), age (categorized into 'between 18 and 20 years old', 'between 21 and 25 years old', and 'aged 26 and older', as done by Hysing et al. (19)), relationship status ('single', 'in a relationship', 'it is complicated'), residence status in Germany ('permanent residency' and 'temporary residency'), and living situation ('living alone' and 'living with other persons in the household').

2.3. Data analyses

First, frequencies were calculated for sociodemographic characteristics, as well as prevalence of loneliness, by the different sociodemographic characteristics. Second, a multivariable logistic regression model was employed to examine the associations of social activity, physical activity, and sociodemographic variables as independent variables with loneliness as dependent variable. The co-variates included in the model were age, gender, relationship status, living situation, and residency status. Thus, the regression model was adjusted for all variables included simultaneously in a single block. Third, two multivariable logistic regression models for anxiety and depressive symptoms as independent variables were carried out to determine associations with loneliness as dependent variable, adjusting for sociodemographic characteristics (age, gender, relationship status, living situation, and residency status). Respondents with missing values in the variables of interest were excluded from the regression models. Before entering the independent variables into the models, we tested for multicollinearity. Correlations between the independent variables were low ($r < 0.70$), indicating that multicollinearity was not a confounding factor in the analysis. The results from the logistic regression analyses were presented as odds ratios (ORs) with 95 percent confidence intervals (CIs). All statistical analyses were performed with IBM SPSS, version 26, on a Windows 10 Education system.

TABLE 1 Characteristics of the sample ($n = 7,203$).

Variables	*n*	%
Gender ($n = 7,100$)		
Male	2,199	31.0
Female	4,824	67.9
Diverse	77	1.1
Age ($n = 7,181$)		
18–20	1,434	20.0
21–25	3,906	54.4
≥ 26	1,841	25.6
Relationship status* ($n = 7,062$)		
In a steady relationship	2,963	41.2
Single	3,797	52.8
It is complicated	302	4.2
Living situation ($n = 6,992$)		
Alone	1,482	21.2
With others	5,510	78.8
Residency status in Germany* ($n = 7,165$)		
Permanent residency	6,927	96.3
Temporary residency	238	3.4
Degree program ($n = 6,996$)		
Bachelor	3,305	47.2
Master	1,385	19.8
State exam	2,306	33.0
Study field ($n = 7,203$)		
Health-related	1,905	26.4
Other	5,298	73.6
University ($n = 7,203$)		
University of Bremen	1,819	25.3
Charité – Universitätsmedizin Berlin	1,131	15.7
Heinrich-Heine-University Düsseldorf	520	7.2
Martin-Luther-University Halle/ Wittenberg	2,168	30.1
University of Siegen	1,565	21.7
Social activity ($n = 6,975$)		
No social activities last week	626	9.0
1 or more social activities last week	6,349	91.0
Moderate physical activity ($n = 7,163$)		
Physically inactive	2,274	31.7
Physically active	4,889	68.3
Vigorous physical activity ($n = 7,127$)		
Physically inactive	4,141	58.1
Physically active	2,986	41.9

*Missing percentages are due to answer options 'no information' or 'I do not know'.

3. Results

The sociodemographic characteristics of the sample are presented in Table 1. Of the 7,203 students in the sample, most identified themselves as female (67.9%) and were between 21 and 25 years old (54.4%). A little more than half of the participants were not in a steady relationship and were either single (52.8%) or had a complicated

relationship status (4.2%). Further, most of the participants lived together with others (78.8%) and had a permanent residency in Germany (96.3%). Almost half of the students were currently enrolled in a bachelor's program (47.2%), one quarter was enrolled in a health-related field of study (26.4%), and the largest proportions were studying in Halle/Wittenberg (30.1%), Bremen (25.3%) and Siegen (21.7%). Most of the students (91.0%) participated in at least one social activity within the last week. Regarding moderate and vigorous physical activity in the last week, 31.7% or 58.1%, respectively, of the participants were physically inactive.

Table 2 presents self-reported major loneliness in the overall sample. In total, 20.6% of the students reported major loneliness in the past week. Feelings of major loneliness were more prevalent among participants being single (29.6%), living alone (26.2%), or having a temporary residency in Germany (38.1%). See prevalence of major loneliness by sociodemographic characteristics in Table 3.

Table 4 presents the results of the multivariable logistic regression analysis to determine the associations of social activity, physical activity, and sociodemographic characteristics with loneliness as dependent variable. There was no association between feelings of loneliness and participation in social activities. Being physically inactive was associated with major loneliness (no moderate physical activity: OR = 1.39; 95% CI: 1.21–1.59; no vigorous physical activity: OR = 1.19; 95% CI: 1.04–1.36). Furthermore, the analysis showed that the odds of experiencing major loneliness increased for students being single (OR = 2.93; 95% CI: 2.55–3.36), reporting a complicated relationship status (OR = 3.86; 95% CI: 2.94–5.08), living alone (OR = 1.31; 95% CI: 1.13–1.52), or having a temporary residency in Germany (OR = 2.24; 95% CI: 1.65–3.04).

Table 5 and Table 6 present the results of the regression models analyzing the associations between depressive symptoms and anxiety, respectively, as independent variables, and loneliness as dependent variable, while controlling for sociodemographic variables. We found a more than eightfold chance of suffering from loneliness among students who reported depressive symptoms (OR = 8.29; CI: 7.21–9.52), compared with students in the reference group. Reporting anxiety symptoms was also associated with a more than sixfold likelihood for reporting loneliness (OR = 6.48; CI: 5.65–7.43).

4. Discussion

This study investigated the prevalence of loneliness among university students and its association with mental health, social and physical activity, as well as sociodemographic characteristics, during the late phase of the COVID-19 pandemic at five German universities using the C19 GSWS dataset.

TABLE 2 Prevalence of loneliness in the sample (n = 6,928).

Loneliness during the past week in the sample	*n*	%
Minor loneliness (Defined as: none or almost none of the time, some of the time)	5,504	79.4
Major loneliness (Defined as: most, all or almost all of the time)	1,424	20.6

With respect to our first study objective, we found that one-fifth of the respondents reported feelings of loneliness most or almost all the time. Our findings are consistent with and add to previous work showing that the prevalence of loneliness among students is similarly high as before the pandemic in, e.g., Norway (19) and Iran (56). Some previous research showed a lower pre-pandemic prevalence of loneliness among students in Germany (18) and another study, investigating the prevalence of loneliness in the adult population, showed that it was only half that reported in our study (8). It is difficult, however, to make direct comparisons, because different studies used various ways to measure the prevalence of loneliness. In addition, it is important to consider, however, that the risk of infection with the potentially lethal coronavirus caused anxiety and self-isolation (57). Therefore, social isolation can be considered as a normal, non-pathological reaction to cope with the risk of infection during the pandemic (9). According to Shiovitz-Ezra and Ayalon (58), situational loneliness is a temporary experience due to a major change in social life but with the likelihood of fast remission. While situational loneliness might not be a severe problem, suffering from feelings of loneliness over a long period of time could lead to chronic loneliness. Finally, chronic loneliness increases the overall mortality risk (58) and is associated with future mental health problems (16). It remains unclear from our data whether the loneliness reported by our study participants reflects situational or chronic loneliness. As the studies of Zahedi et al. (56) and Hysing et al. (19) showed similar prevalence rates of loneliness among university students before the pandemic, we assume that both situational and chronic loneliness may have contributed to the prevalence rate observed.

Regarding our first hypothesis, our findings are in agreement with the hypothesis and with previous research showing that loneliness is associated with depressive symptoms and anxiety (12, 13). Previous research reported loneliness, anxiety, and depression to be interrelated (11, 14). However, similar to Lee et al. (29), our results also suggest that loneliness could be a crucial mechanism for the increase in depressive symptoms during the pandemic. An important consideration in interpreting the results is that depression is likely to make people rate their social support as insufficient, to let them withdraw from their social network, and to make them feel lonely (10). It is possible that students with stronger social networks experienced greater disruption in their social lives and, as a result, felt lonelier during the pandemic (29). In this context, previous research emphasized that especially COVID-19-specific worries, social and physical isolation, and the lack of interaction were associated with negative mental health outcomes for students (23).

A second aim (2b) of our study was to examine associations between loneliness and social and physical activity. In contrast to our second hypothesis, our analyses did not reveal an association between social activities and loneliness. However, we were only able to consider the number of weekly activities in our analyses. Previous research suggests that simply increasing the number of social contacts is unlikely to be sufficient to reduce loneliness, because loneliness can also be experienced in the company of other people (12). Further, previous research indicated that the quality of social contact, rather than the quantity, is a predictor of loneliness (41, 59). However, the results of Elmer et al. (23) suggested that students with smaller personal networks were more likely to become lonely during the pandemic. In addition, during the pandemic, students were forced to

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TABLE 3 Prevalence of major loneliness by sociodemographic characteristics.

Major loneliness by sociodemographic characteristics	*n*	%*
Gender (*n* = 1,400)		
Male	439	20.8
Female	940	20.2
Diverse	21	28.0
Age (*n* = 1,418)		
18–20	311	22.5
21–25	766	20.4
≥ 26	341	19.3
Relationship status (*n* = 1,396)		
In a steady relationship	447	12.2
Single	844	29.6
It is complicated	105	20.6
Living situation (*n* = 1,393)		
Alone	376	26.2
With others	1,017	19.2
Residency status in Germany (*n* = 1,410)		
Permanent residency	1,324	19.9
Temporary residency	86	38.1
Degree program (*n* = 1,390)		
Bachelor	725	22.9
Master	253	19.1
State exam	412	18.4

*Percentage within the variable gender, age, relationship status etc.

TABLE 4 Associations between social activity, moderate and vigorous physical activity and loneliness as dependent variable: a multivariable logistic regression model (*n* = 6,396).

Variables		Loneliness	
		OR*	95% CI
Social activity	1 or more social activities last week (ref.)	1.00	
	No social activities last week	1.07	(0.86–1.34)
Moderate physical activity	Physically active (ref.)	1.00	
	Physically inactive	1.39	(1.21–1.59)
Vigorous physical activity	Physically active (ref.)	1.00	
	Physically inactive	1.19	(1.04–1.36)
Age	18–20 (ref.)	1.00	
	21–25	1.01	(0.86–1.20)
	≥ 26	1.03	(0.85–1.25)
Gender	Male (ref.)	1.00	
	Female	1.10	(0.95–1.26)
	Diverse	1.42	(0.80–2.53)
Relationship status	In a steady relationship (ref.)	1.00	
	Single	2.93	(2.55–3.36)
	It is complicated	3.86	(2.94–5.08)
Living situation	With others (ref.)	1.00	
	Alone	1.31	(1.13–1.52)
Residency status in Germany	Permanent residency (ref.)	1.00	
	Temporary residency	2.24	(1.65–3.04)

OR, odds ratios; CI, confidence interval; ref., reference category; *ORs adjusted for all other variables in the table.

use digital communication with their social networks, and they may have experienced this shift in communication and social interaction as both negative and positive (60). Studies on older adults showed that sharing activities and experiences with peers created a sense of belonging and could decrease feelings of loneliness during the pandemic (61). In addition, Masi et al. (62) found in their meta-analyses, among others, that interventions increasing opportunities for social interaction could reduce loneliness for different age groups. However, the literature on loneliness interventions is inconsistent and mainly available for older age groups (63).

With respect to physical activity, however, we found support for our third hypothesis that loneliness and physical activity were inversely related. Our results are in line with previous research showing that students' physical activity seems to protect against loneliness (18, 39). Prior evidence showed that the way students experience physical activity is also very important to decrease feelings of loneliness (40). Students may compensate any lack of trustworthy friendships and meaningful social interactions with social bonds in team sports (39). Previous studies suggested that students' physical activity decreased during the pandemic (64). It is possible that team athletes, in particular, experienced greater social isolation and loneliness during the pandemic, because COVID-19 measures included social distancing and cancelation of team sport activities. More research is needed to disentangle the interplay between different types of physical activity and loneliness.

Regarding sociodemographic variables and their association with loneliness, our results are in line with previous research showing that students being single (18, 19, 23, 25), living alone (18, 19, 24), and studying abroad, i.e., having a temporary residence status (19), are more likely to suffer from loneliness. Moreover, we found no association between gender or age and loneliness, which is consistent with some previous studies (18, 25). Other studies, however, describe that students who are female or younger are more affected by loneliness (22, 23). Such associations with gender and age may be attributed to different sample compositions, a gender imbalance in the samples, and time of data collection. Labrague et al. (22) studied a sample of nursing school students with a high percentage of female students, and Elmer et al. (23) studied a sample of students, mainly from engineering and science programs with a low percentage of female students. Age and gender may be relevant determinants of

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TABLE 5 Associations between depressive symptoms and loneliness as dependent variable: a multivariable logistic regression model (n = 6,499).

Variables		Loneliness	
		OR**	95% CI
Depressive symptoms (PHQ-2*)	No depressive symptoms (ref.)	1.00	
	Depressive symptoms	8.29	(7.21–9.52)
Age	18–20 (ref.)	1.00	
	21–25	0.95	(0.80–1.14)
	≥ 26	0.97	(0.79–1.20)
Gender	Male (ref.)	1.00	
	Female	1.02	(0.88–1.19)
	Diverse	0.91	(0.49–1.70)
Relationship status	In a steady relationship (ref.)	1.00	
	Single	3.24	(2.80–3.76)
	It is complicated	3.49	(2.58–4.71)
Living situation	With others (ref.)	1.00	
	Alone	1.36	(1.16–1.59)
Residency status in Germany	Permanent residency (ref.)	1.00	
	Temporary residency	2.15	(1.54–3.01)

OR, odds ratios; CI, confidence interval; ref., reference category; *cut off point of 3; **ORs adjusted for all other variables in the table.

TABLE 6 Associations between anxiety and loneliness as dependent variable: a multivariable logistic regression model (n = 6,498).

Variables		Loneliness	
		OR**	95% CI
Anxiety (GAD-2*)	No anxiety (ref.)	1.00	
	Anxiety	6.48	(5.65–7.43)
Age	18–20 (ref.)	1.00	
	21–25	1.00	(0.85–1.19)
	≥ 26	1.00	(0.81–1.23)
Gender	Male (ref.)	1.00	
	Female	0.89	(0.77–1.04)
	Diverse	0.70	(0.39–1.26)
Relationship status	In a steady relationship (ref.)	1.00	
	Single	3.14	(2.71–3.63)
	It is complicated	3.64	(2.71–4.89)
Living situation	With others (ref.)	1.00	
	Alone	1.37	(1.18–1.61)
Residency status in Germany	Permanent residency (ref.)	1.00	
	Temporary residency	2.21	(1.60–3.01)

OR, odds ratios; CI, confidence interval; ref., reference category; *cut off point of 3; **ORs adjusted for all other variables in the table.

loneliness within different subject groups. Further, both studies were conducted during the first lockdown in April 2020 (22, 23). This was the students' first exposure to closed campuses and online teaching. Before the COVID-19 pandemic (18) and later during the first lockdown (23), gender and age were not associated with loneliness. At the time of our survey, it was the fourth semester under the COVID-19 restrictions, so younger and female students may have been able to develop better coping strategies to deal with social isolation.

Overall, our findings confirm that loneliness is a severe mental health outcome among university students, and early intervention is needed to prevent loneliness from persisting over an extended period of time. Our results suggest that close social relationships seem to be an important protective factor, while the number of social activities does not appear to play a significant role. During the pandemic, when students were forced to follow social distancing measures, it seemed to make a considerable difference whether they lived alone, were single, or were international students. Health promotion programs should focus on the role of friendship and promote social contact, especially during the transition phase from school to university and particularly target international students. Overall, physical and social activity may help to connect students in the setting of their university and can be addressed in student health programs. Interventions to reduce loneliness should focus on improving social skills and increasing social support and opportunities for social contact including group based physical activity (62).

5. Strengths and limitations

The multi-center COVID-19 German student well-being study (C19 GSWS) contributes to the existing knowledge on associations of loneliness with depressive symptoms, anxiety and physical activity among university students in Germany during the pandemic based on a large sample. Despite these strengths, the current results could not analyze any differences according to teaching situations across universities during the pandemic and should be interpreted with consideration of several limitations. First, we cannot make a causal claim due to the cross-sectional design. Longitudinal research is needed to distinguish between situational and chronic loneliness, as chronic loneliness has a major impact on health outcomes later on in life. Second, this study used a single-item measure of loneliness, a question from the CES-D (49), which might explain the strong associations of loneliness with mental health outcomes. However, using one single item measure for loneliness is common (8, 58), including the university context (19, 65). Future studies could validate or compare the single item measurement to other validated measures such as the University of California, Los Angeles Loneliness Scale (UCLA Loneliness Scale) (66). Third, the C19 GSWS was performed with a convenience sample and, thus, a selection bias cannot be ruled out. This might have affected the prevalence rates reported in this study. Students with severe loneliness could be less likely to participate which would have led to an under-reporting of loneliness. However, we assume that the effect of any selection bias on the reported associations is low. More than a quarter of the participants were university students of medicine or health-related subjects. Hence, the results are not representative of the general German student

population. Similarly, our sample had a higher proportion of female participants which resulted in a gender imbalance. Previous studies have shown the same gender distribution: women are more likely to participate in health-related research (67). However, the effects of this imbalance on the associations presented can be considered as low, since the analysis was adjusted for gender and no significant gender differences in loneliness were found. Furthermore, the present study used self-reported measures. The PHQ-2 and GAD-2 measured the symptoms of the last 2 weeks; the items assessing loneliness, physical activity and social activity only referred to the last week. Although the PHQ-2 and GAD-2 are well-validated scales, interview-based scales are the gold standard for mental health assessment.

6. Conclusion

The present study underlines the importance of loneliness as a relevant health variable among university students. About one in five students reported major feelings of loneliness during the pandemic. We found associations of loneliness with depressive symptoms, anxiety, and physical activity. Loneliness among university students was linked to being single or having a complicated relationship status, living alone, or having a temporary residency in Germany. Unlike other previous research, we did not find associations between loneliness and participation in social activities. Moreover, our results could not identify gender and age as correlates of loneliness among university students. Further research is needed to study potentially protective factors and to investigate how conditions at universities may affect loneliness among students. Students' health management programs should implement interventions to tackle loneliness and to build a health-promoting study environment.

Data availability statement

The dataset presented and analyzed in this study can be found in an online repository, namely Zenodo: https://zenodo.org/record/7659846.

Ethics statement

The studies involving humans were approved by University of Bremen 2021-28-EIL, University Halle-Wittenberg 2020-066, Heinrich-Heine-University Duesseldorf 2020-958_1, Charité – Universitätsmedizin Berlin and University of Siegen have accepted the ethic vote of the University of Bremen. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

VW: Conceptualization, Methodology, Visualization, Writing – original draft. EH: Conceptualization, Data curation, Writing – review & editing. CS: Conceptualization, Writing – review & editing. HB: Conceptualization, Writing – review & editing. SN: Conceptualization, Writing – review & editing. CP: Conceptualization, Writing – review & editing. KH: Conceptualization, Methodology, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The sense of loneliness and meaning in life in post-COVID convalescents—a preliminary study

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Introduction: The COVID-19 epidemic has provided opportunity to study the impact of a well-defined severe illness on the development of a depressive episode and the associated sense of loneliness and lack of meaning in life.

Materials and Methods: The aim of the study was to assess the occurrence of a reactive depressive episode, the severity of depression, a sense of loneliness and meaning in life in subjects who approximately a year earlier than the date of the study had suffered from a pulmonary form of SARS-CoV-2 infection with radiologically documented interstitial lesions of the lungs, requiring and not requiring hospitalization compared to people who did not develop the disease as a result of infection with that virus. The study included 63 subjects hospitalized for pulmonary lesions, 67 not hospitalized and 60 healthy controls. The severity of depressive symptoms was measured using a Polish-language standardized version of the Beck Depression Inventory, a sense of loneliness using the De Jong Gierveld Loneliness Scale, and a sense of meaning in life using the Life Attitude Profile-Revised.

Results: The frequency of depression and its severity were found to be the highest in hospitalized patients compared to those treated at home and healthy people. A significant difference in the frequency of depression and its severity between outpatients and healthy people was also observed. The feeling of loneliness turned out to be greatest in the group of hospitalized people. Also, the severity of loneliness was found to be higher in the outpatient compared to the control group. The sense of meaning in life reached its lowest level among hospitalized patients, was moderately reduced in the outpatient group, and typical of the Polish population in the control group.

Discussion: Both pulmonary SARS-CoV-2 infection and hospitalization have been shown to be a risk factor for depression, increased feeling of loneliness and a reduced sense of meaning in life. The effect of trauma and the presence of depression can be the explanation for the increased sense of loneliness after the illness and the partial breakdown of the lifeline manifested by a decrease in the sense of meaning in life.

KEYWORDS

depression, SARS-CoV-2 infection, feeling of loneliness, sense of meaning in life, DJGLS, LAP-R

1 Introduction

Surviving the SARS-CoV-2 pandemic was a completely new experience for humanity at the turn of the second and third decade of the twenty-first century (1). The last time humanity encountered a global epidemic of such intensity was 100 years ago during the Spanish flu epidemic, resulting in the death of more people than during the First World War (2, 3). The severe course of the disease in some patients with a fatal outcome, high incidence and lockdown were a strong stressor for many people (4, 5). Patients who required hospitalization due to pulmonary complications of the type of interstitial changes and due to the effects of thrombosis accompanying the infection were particularly vulnerable to severe stress (6). The need for hospitalization meant a severe course with a high degree of dyspnea, complete isolation from the family and exposure to the deaths of other hospitalized patients (7). This was probably accompanied by very strong fear for oneself and the loved ones, reactive depressed mood, and sometimes the development of full-blown type I PTSD (8). The mass nature of the pandemic, high fatality and mortality rates, as well as the low effectiveness of the implemented treatment could have reformulated the question about the meaning of life and the worldview in many people and could have disturbed their system of values and hierarchy of needs (9, 10). Those who recovered were exposed to severe psychological trauma caused by somatic suffering, isolation and loneliness, as well as significant psychological suffering (11, 12). Recovery should be treated as a success, but the effects of SARS-CoV-2 infection are still felt by these people (13). Convalescent patients complain of memory disorders, various respiratory problems and anxiety-depressive disorders (14, 15). It has been noted that during the COVID-19 pandemic, there has been an increase in feelings of fatigue, loneliness, anxiety and depression, dysfunctional coping strategies in different populations (including, among others, the general population and the population of health care workers) (16–20). The social isolation forced by the pandemic and the associated sense of loneliness is likely to have been the reason for the observed increase in the severity of anxiety, depression and the use of ineffective ways of coping with stress. However, this hypothesis, seemingly obvious, requires empirical verification.

It is interesting whether the effects of the SARS-CoV-2 experience differ in people who required hospitalization vs. those treated in home isolation and those who did not contract the infection during the pandemic.

The aim of the study is to compare the severity of loneliness, the severity of depressive symptoms and the value of dimensions of the sense of meaning in life between the hospitalized group, the group treated at home and people who did not develop SARS-CoV-2. In connection with the aim of the work, the following research questions were formulated:

1 Do convalescents hospitalized, non-hospitalized, and subjects who had no COVID infection differ in terms of:

a) Severity of depression;
b) Severity of the feeling of loneliness;
c) The obtained values of all LAP-R scale dimensions.

2 Do the results obtained with the LAP-R scale correlate with the severity of depression and feelings of loneliness?

3 Does the severity of depression correlate with a sense of loneliness and a sense of meaning in life?

4 Were there any differences between men and women observed?

5 Does the age of the respondents correlate with the studied variables?

2 Materials and methods

2.1 Subjects

The tests were carried out in the period 01.2022–06.2023 at the Outpatient Department of Allergology and Lung Diseases of the Norbert Barlicki Memorial University Teaching Hospital No. 1 of the Medical University of Łódź and at the primary care outpatient department in Aleksandrów Łódzki.

Originally, the study enrolled 105 people hospitalized due to SARS-CoV-2 infection, 110 people who had SARS-CoV-2 without hospitalization, and 92 people who had not been infected with SARS-CoV-2.

The criteria for exclusion from the study were as follows:

- no consent to participate in the study,
- the failure to complete all survey questionnaires,
- the occurrence of thromboembolism in a patient before contracting SARS-CoV-2,
- the presence of congenital thrombophilia and blood coagulation disorders confirmed by the patients' medical records,
- past myocardial infarction or stroke before contracting SARS-CoV-2,
- the presence of malignancy within up to 5 years before contracting SARS-CoV-2,
- the confirmed presence of autoimmune diseases and congenital immune disorders,
- intellectual disability,
- dementia or active psychosis.

The information concerning the exclusion criteria came both from medical histories and the data obtained from patients. The low median age of subjects enrolled in our study is due to the high co-morbidity of the elderly patients.

One hundred and sixty patients were included in the study, including 63 convalescents hospitalized due to SARS-CoV-2 infection, 67 convalescents who did not require hospitalization due to SARS-CoV-2 infection and 60 subjects who did not have SARS-CoV-2 infection. The median age for all patients was 48.00 (Q1–Q3: 39.00–61.00) and did not differ with statistical significance between the groups ($p = 0.754$). All patients in the hospitalized group of convalescents required treatment with oxygen therapy or a respirator while in the other two groups none of the patients required oxygen therapy. Patient demographics are presented in Table 1.

The place of residence of the patients was not analyzed, as both the family doctor's clinic in Aleksandrów Łódzki and the N. Barlicki Memorial hospital are located in the metropolitan districts of the Łódź agglomeration, which is inhabited by over one million people, and the borders between these two cities are invisible in the structure of the agglomeration.

TABLE 1 Demographic data of patients participating in the study.

Variable		Convalescents who were hospitalized due to SARS-CoV-2 infection (*N* = 63)	Convalescents who did not require hospitalization due to SARS-CoV-2 infection (*N* = 67)	Patients who have never had a SARS-CoV-2 infection (*N* = 60)
Sex	Female	35 (55.56%)	32 (47.76%)	31 (51.67%)
	Male	28 (44.44%)	35 (52.24%)	29 (48.33%)
Age (21)		48.00 (39.00–63.00); Min-Max: 30.00–75.00	47.00 (39.00–60.00); Min-Max: 30.00–76.00	49.50 (39.50–61.50); Min-Max: 30.00–75.00
Oxygen therapy/ respirator	Yes	63 (100%)	0.00 (0%)	0.00 (0%)
	No	0.00 (0%)	67 (100%)	60 (100%)

The consistency score for Cronbach's LAP-r Alpha scale was 0.73 (Supplementary Table S1). Strong intercorrelations were observed between all dimensions of the scale, excluding acceptance of death (DA) and the remaining dimensions of the LAP-r scale (Supplementary Table S2).

Each of the subjects underwent a psychometric examination using the following tools: Beck's Depression Inventory (BDI II) in the Polish standardized version developed by the Psychological Test Laboratory of the Polish Psychological Association (22), Life Attitude Profile – Revised (LAP-R) developed by Gary T. Reker in the version standardized and published by the Psychological Test Laboratory of the Polish Psychological Association (23), De Jong Gierveld Loneliness (DJGLS) in the Polish standardized version (24). Additionally, each of the respondents completed a sociodemographic questionnaire of the authors' construction, which included questions about age, sex, past diseases, hospitalization due to SARS-CoV-2 infection, oxygen therapy.

2.2 Statistical analysis

The non-parametric Mann–Whitney U test was used in the study for analyses of continuous variables with a non-normal distribution in two groups, while for more groups (>2) the non-parametric Kruskal Wallis (K-W) test was used. For significant results in the K-W test, a *post-hoc* Dunn test was performed. Statistically significant results were presented using a box-plot. The Spearman rank correlation test was used to assess the relationship between continuous or ordinal variables, and the level of correlation between the variables was assessed using Spearman's rank correlation coefficient R. In order to assess the internal consistency of the LAP-r scale in the study, Cronbach's alpha was the measure of intercorrelation between scale dimensions. The normality of distribution for continuous variables was analyzed using the Shapiro Wilk W test. The results for continuous and ordinal variables were presented using medians with quartiles of 25% and quartiles of 75%, while qualitative variables were presented using frequencies and percentages. The significance level for all analyses was $p < 0.05$. The analyses were performed using the STATISTICA version 13.3 statistical software (TIBCO 2022, Poland).

2.2.1 Scales

The Polish adaptation of De Jong Gierveld Loneliness Scale (DJGLS) by Grygiel et al. (24), developed with the consent of the author of the tool (Cronbach's alpha 0.89) was applied in the assessment of the feeling of loneliness (24–26). It consists of 11 items, with a five-point score scale for each of them. The higher total DJGLS score reflects a more severe feeling of loneliness (24). The demographic data such as the patients' age, gender, marital status, residence and education level were collected using a questionnaire. The Polish adaptation of the Life Attitude Profile – Revised (LAP-R) questionnaire (Cronbach's alpha between 0.70 and 0.80) was used to assess the sense of meaning in life (27, 28). The questionnaire, consisting of 8 scales, originally developed by Gary T. Reker, published by the Psychological Test Laboratory of the Polish Psychological Association. Six scales, including Purpose (life goals and a sense of direction), Coherence (understanding oneself and the environment), Choice/ Responsibleness (a view on the ability to make life choices), Death acceptance (no fear of death, accepting death as normal), Existential vacuum (absence of meaning in life, goals and direction), Goal seeking (desire for new experiences) are simple. Each item rating ranges from 1 (strongly disagree) to 7 (strongly agree) and each subscale has 8 items. Except for the Existential vacuum scale, which is scored negatively, all the other scales are scored positively. The two remaining complex scales,. including The Personal Meaning Index (life goals, sense of direction, understanding of oneself and the environment)—a sum of coherence and purpose, and Existential Transcendence (a general measure of life attitudes)—a sum of purpose, coherence, choice/responsibleness, death acceptance with existential vacuum and goal seeking subtraction, are calculated on the basis of the simple scales.

The aim of the use of the Beck Depression Inventory version II (BDI) was to assess the severity of depressive symptoms (or depressiveness). The scale, adapted to Polish, validated and published by the Psychological Test Laboratory of the Polish Psychological Association, consists of 21 items assessing the occurrence and intensity of depressive symptoms within the past 2 weeks. Each item is scored from 0 to 3, and a total score can range from 0 to 63 points. The higher scores indicate the greater the severity of depressiveness.

3 Results

In the assessment of differences between hospitalized convalescents, non-hospitalized convalescents and people without SARS-CoV-2 infection, it was shown that convalescent patients who had been hospitalized with SARS-CoV-2 had the highest depression severity score on the BDI-II scale [Median (Q1–Q3): 6.00 (5.00–7.00), $p < 0.001$], and subjects without SARS-CoV-2 infection had the lowest [Median (Q1–Q3): 6.00–5.00–6.00, $p < 0.001$]. Similarly, hospitalized patients scored higher in the severity of the sense of loneliness in the DJGLS scale [Median (Q1–Q3): 13.00 (12.00–43.00)] than the other groups [Median (Q1–Q3)—non-hospitalized convalescents: 12.00 (11.00–13.00), $p < 0.001$, Median (Q1–Q3), subjects without

SARS-CoV-2 infection: 11.00 (11.00–12.00), $p < 0.001$]. For LAP-r scale dimensions, convalescents who had been hospitalized for SARS-CoV-2 infection, showed statistically significantly lower results in the following dimensions: Purpose (PU) [Median (Q1–Q3): 34.00 (25.00–38.00)], Coherence (CO) [Median (Q1–Q3): 35.00 (30.00–39.00)], Goal Seeking (GS) [Median (Q1–Q3): 36.00 (29.00–38.00)], The Personal Meaning Index (TPMI) [Median (Q1–Q3): 69.00 (56.00–77.00)] and Existential Transcendence (ET) [Median (Q1–Q3): 70.00 (49.00–86.00)] than the other study groups, and a statistically significantly higher score in the Existential Vacuum (EV) dimension [Median (Q1–Q3): 29.00 (24.00–36.00)] than the other groups. In the case of the dimension of the LAP-r scale concerning the Death Acceptance (DA), there were no statistically significant differences between convalescents hospitalized and non-hospitalized due to SARS-CoV-2 infection, while statistically significant differences were found between convalescent patients who did not require hospitalization and patients who had never had a SARS-CoV-2 infection [Median (Q1–Q3): 29:00 (28:00–30:00) vs. 30:00 (29:00–31:00), $p = 0.014$]. The results are shown in Figures 1, 2.

In the assessment of the relationship between the severity of depression and the sense of loneliness, and in the dimensions of the LAP-r scale, convalescent patients who had been hospitalized due to SARS-CoV-2 infection obtained the strongest, statistically significant correlations (Figure 3). In patients in this group, a very strong, statistically significant, positive correlation was found between the feeling of existential vacuum and the severity of depression ($R = 0.917$, $p < 0.001$), as well as between EV and the sense of loneliness in the DJGLS scale ($R = 0.903$, $p < 0.001$). Very strong, negative, statistically significant correlations were also obtained between PU, TMPI and ET and the severity of depression on the BDI-II scale and the sense of loneliness on the DJGLS scale.

In the case of convalescents who did not require hospitalization due to SARS-CoV-2 infection (Figure 4), medium but statistically significant correlations were observed, excluding the dimension of death acceptance on the LAP-r scale and the severity of depression on the BDI-II scale ($R = 0.225$, $p = 0.067$). Strong, positive, statistically significant correlations were found between PE and BDI-II ($R = 0.748$, $p < 0.001$) and between PE and DJGLS ($R = 0.812$, $p < 0.001$).

Similar results as in the group of non-hospitalized patients were obtained for patients who did not have SARS-CoV-2 infection (Figure 5). In this case, too, there was no statistically significant relationship between the severity of depression and the dimension of acceptance of death in the LAP-r scale ($R = 0.033$, $p = 0.802$), and additionally no significant correlation was found between the severity of depression and coherence ($R = -0.194$, $p = 0.137$). The strongest, negative, statistically significant correlations were found between

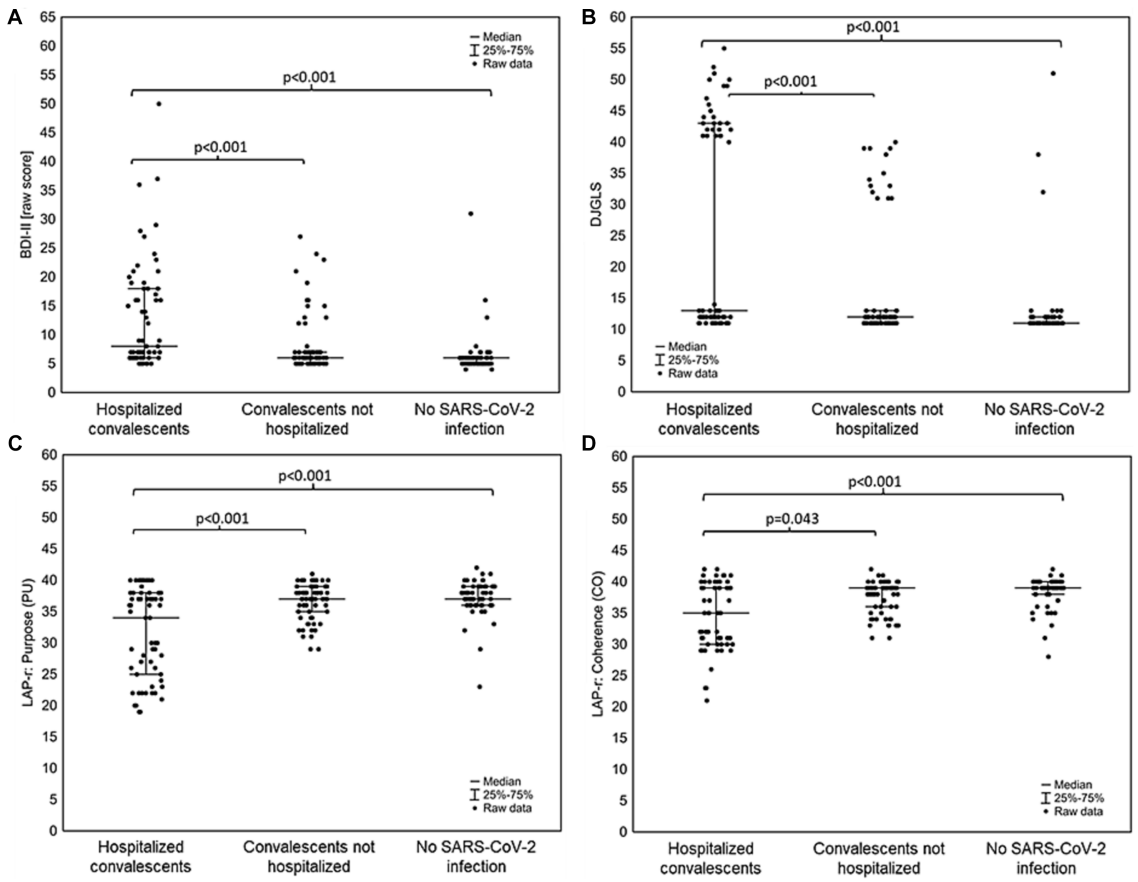

FIGURE 1
Differences between convalescents who were hospitalized for SARS-CoV-2 infection, convalescents who did not require hospitalization for SARS-CoV-2 infection and people who had never had SARS-CoV-2 infection in **(A)** severity depression according to the BDI-II scale; **(B)** feeling of loneliness on the DJGLS scale; **(C)** dimension of the LAP-r scale: Purpose (CU); **(D)** dimension of the LAP-r scale: Coherence (CO).

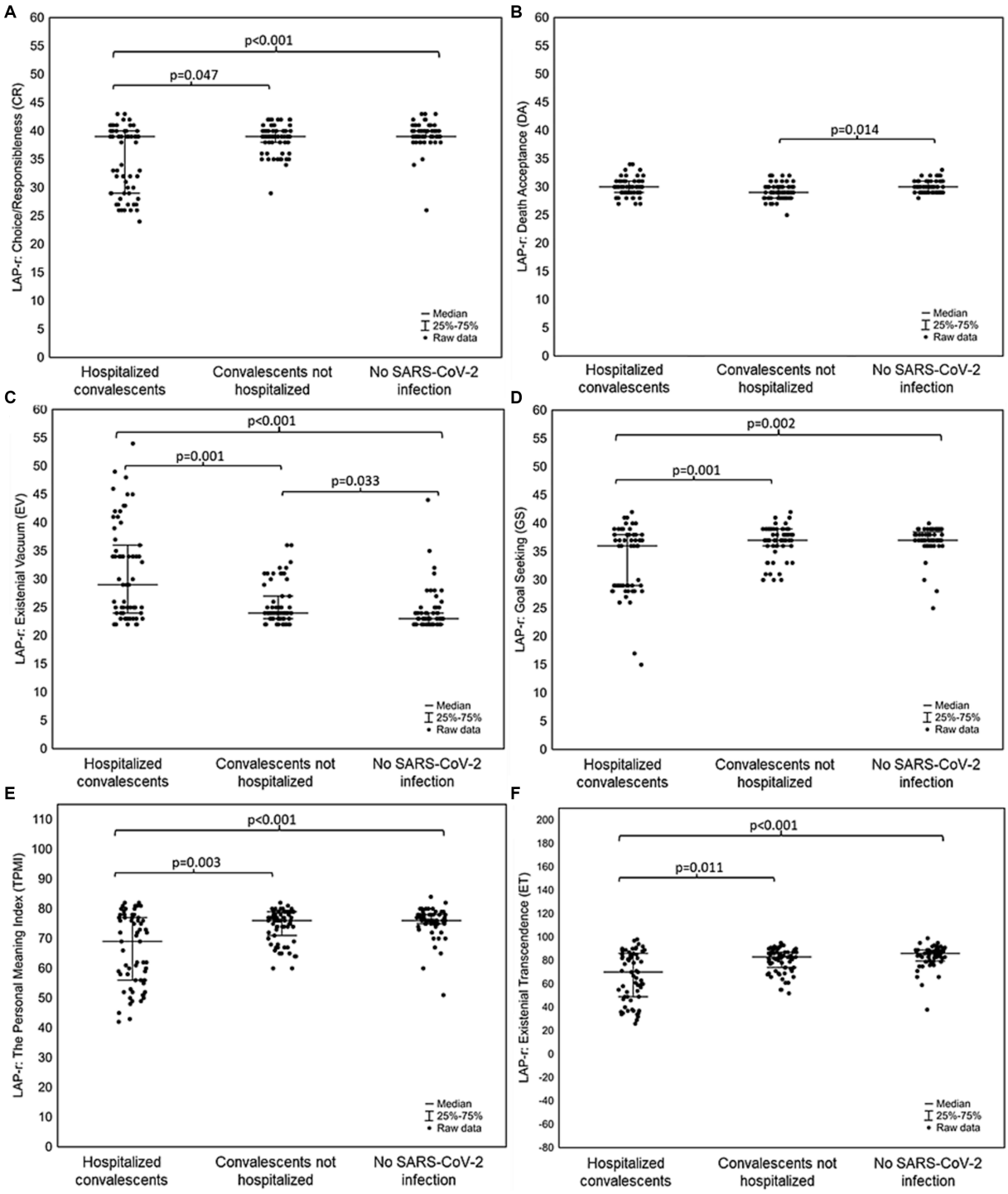

FIGURE 2
Differences between convalescents who were hospitalized due to SARS-CoV-2 infection, convalescents who did not require hospitalization due to SARS-CoV-2 infection and people who had never had a SARS-CoV-2 infection in **(A)** dimension LAP-r scale: Choice/Responsibleness (CR); **(B)** dimension of the LAP-r scale: Death Acceptance (DA); **(C)** dimension of the LAP-r scale: Existential Vacuum (EV); **(D)** dimension of the LAP-r scale: Goal Seeking (GS); **(E)** dimension of the LAP-r scale: The Personal Meaning Index (TPMI); **(F)** dimension of the LAP-r scale: Existential Transcendence (ET).

Choice/Responsibleness (CR) and BDI-II ($R = -0.710$, $p < 0.001$) and CR and DJGLS ($R = -0.744$, $p < 0.001$).

In all study groups, strong, statistically significant, positive correlations were found between the severity of depression on the BDI-II scale and the sense of loneliness on the DJGLS scale, where the strongest correlation was shown for convalescent patients who had required hospitalization due to SARS-CoV-2 ($R = 0.935$, $p < 0.001$) (Figure 3), and a weaker, but still strong, correlation was shown in patients who did not have SARS-CoV-2 infection ($R = 0.775$, $p < 0.001$) (Figure 5).

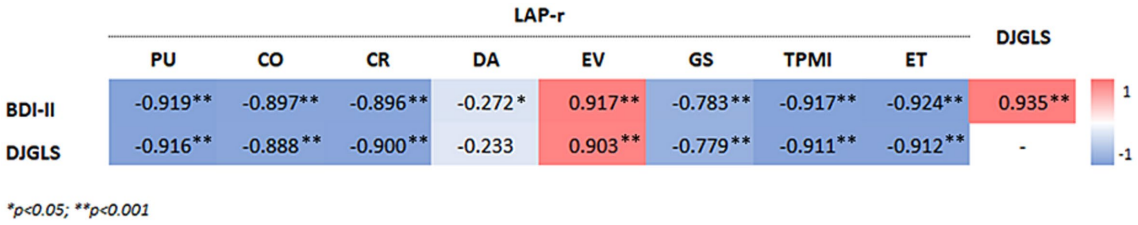

FIGURE 3
The relationship between the severity of depression on the BDI-II scale and the sense of loneliness on the DJGLS scale and the dimensions on the LAP-r scale, as well as the relationship between the sense of loneliness on the DJGLS scale and the dimensions on the LAP-r scale for convalescent patients who were hospitalized for SARS-CoV-2 infection.

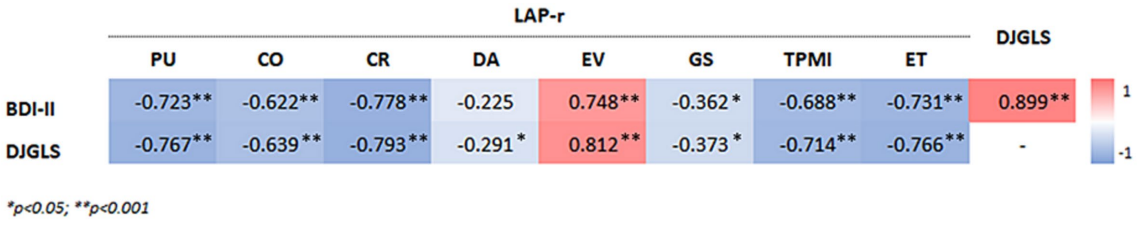

FIGURE 4
Relationship between the severity of depression in the BDI-II scale and the feeling of loneliness in the DJGLS scale and the dimensions in the LAP-r scale, as well as the relationship between the sense of loneliness in the DJGLS scale and the dimensions in the LAP-r scale for convalescent patients who did not require hospitalization with due to SARS-CoV-2 infection.

4 Discussion

Our results are one of the first in the world studies of this kind on loneliness and a sense of meaning in life in post-Covid convalescents. Hospitalization in the intensive care unit, a life-threatening condition, oxygen therapy and sometimes intubation, as well as the atmosphere around the pandemic, were a very strong stressor that could trigger a reaction to severe stress in the form of adaptive syndrome or post-traumatic stress disorder (29). These syndromes, in the absence of adequate support in a widespread atmosphere of danger, led in a simple way to anxiety and mood disorders and a feeling of loneliness (30). During a pandemic, an infected person automatically becomes stigmatized and excluded, which may further exacerbate the studied variables (31). Experiencing a pandemic is a new phenomenon, unknown to science for a hundred years, requiring reliable research in the field of social psychology, clinical psychology and sociology (32). The global pandemic has created a global sense of existential crisis, which at the level of the individual requires a reformulation of concepts such as life, death, worldview or sense of meaning in life. It would be worth getting to know the determinants and intermediary variables regarding the mental functioning of seriously ill people in the pandemic. Such a disease differs quantitatively and qualitatively as well as contextually from a severe disease that can affect anybody outside the pandemic period. An interesting observation from our research is the fact that people who have been hospitalized have lower dimensions of the sense of meaning in life. The above probably means that SARS-CoV-2, hospitalization and a sense of danger are the cause of the breakdown of the life line in these subjects. It manifests itself not only in depression and a feeling of loneliness, but above all in the loss of life goals and existential vacuum. The problem can also be looked at from a different perspective. People with a vaguely formulated sense of meaning in life, depressed and lonely may possibly be more susceptible to a severe course of the disease. It is known from health psychology that personal stress coping resources are an important element of resilience and resistance to illness (33). The personal resources for coping with stress and difficult situations play a key role in the incidence of numerous diseases, their course and prognosis (33). Our study will not determine whether depression, loneliness and a low sense of meaning in life in the case of hospitalized people with SARS-CoV-2 are primary—the lack of resources as the cause of the disease—or secondary (severe course of the disease as the cause of depression, loneliness and low sense of meaning in life). The answer to this question requires many years of follow-up and prospective cohort studies in anticipation of the development of the next pandemics. Such research would be worth conducting, especially since the influence of the psyche on resistance to diseases is discussed more and more frequently. Psychoneuroimmunology dealing with this issue is a subdiscipline from the borderline of medicine and psychology (34, 35).

In subjects after hospitalization, the dimension of existential vacuum correlated positively with depression and a sense of loneliness. All three variables, in our opinion, are the result of both severe illness and the situation in which patients find themselves. As observed in the hospitalized group, the dimensions of purpose, personal meaning and balance of life attitudes correlated negatively with the severity of depression. In the group of people who had been infected with the SARS-CoV-2 virus without hospitalization, the correlations were similar to those in the group of hospitalized people. It is interesting that in this group of respondents, as in the group of

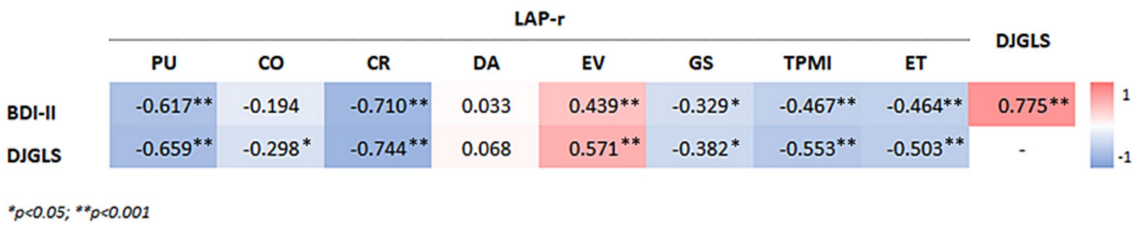

FIGURE 5
The relationship between the severity of depression in the BDI-II scale and the feeling of loneliness in the DJGLS scale and the dimensions in the LAP-r scale, as well as the relationship between the sense of loneliness in the DJGLS scale and the dimensions in the LAP-r scale for patients who have never had a SARS-CoV-2.

hospitalized patients, a positive correlation of the intensity of existential vacuum with the severity of depression and the intensification of the sense of loneliness was observed. Therefore, it should be cautiously concluded that the structure of the psyche of the examined people defined in the form of a network of correlations in both groups is similar, and the differences are quantitative only. This phenomenon can be explained on the one hand by a similar psychological profile of people who have had the SARS-CoV-2 infection. On the other hand, quantitative differences can be explained by the severity of the course and the form of treatment (hospitalization vs. staying at home). The people who have never been infected with the SARS-CoV-2 virus had a different psychical structure. In this group, the acceptance of death did not correlate with depression, and the intensity of the life control dimension correlated negatively with depression and the feeling of loneliness. It can therefore be suggested cautiously that the psychological profile of people who have had SARS-CoV-2 and the profile of people who have not contracted SARS-CoV-2 is to some extent different. The above thesis requires empirical verification. The analogous phenomenon of the relationship between the psychological profile and the incidence of certain diseases is widely known in clinical psychology. For instance, the type A (36–38) and D (39) behavior patterns predispose to the development of cardiovascular diseases, including primarily ischemic heart disease (40). In turn, cancer is more common in people who are conciliatory and suppress their aggression (41). Based on the analysis of the results obtained by us regarding the SARS-CoV-2 convalescents, we postulate the existence of a specific psychological profile conducive to susceptibility to the coronavirus infection. Among the numerous works on COVID-19, there are no publications referring to the correlations between the personality structure and susceptibility to the disease. On the other hand, the psychological effects of SARS-CoV-2 infection and the impact of the pandemic on the mental health of caregivers of patients are widely discussed (42, 43). Our results are consistent with those of the papers published in the recent years, which also demonstrated an increase in loneliness and depressive symptoms during the COVID-19 pandemic (16, 17).

The question concerning the treatment options for anxiety and depression as well as the increased sense of loneliness in the course of the pandemic should be asked. In addition to antidepressants, it seems that cognitive behavioral therapy and mindfulness-based cognitive behavioral therapy should be crucial. This is all the more justified because the cause of the disorders is an exogenous factor (isolation, anxiety, the atmosphere accompanying the pandemic), and not endogenous, as in the typical course of unipolar or bipolar affective disorder (44, 45).

4.1 Limitations of the study

Our study is more of a pilot study than a population study in character. The results obtained by us and the correlations described should be replicated by other researchers on a larger sample of people. Aware of these limitations, we have drawn quite cautious conclusions concerning the results of the study.

The study is based on two centers and applies only to the population of Central Poland. The results obtained by us might have been different if they had been performed on a different population with a different genetic heritage and living in different than Polish cultural conditions.

In the control group, it was not checked whether the persons qualified for it had had an asymptomatic or unnoticed infection with the SARS-CoV-2 virus. There are also no data on the percentage of people vaccinated against SARS-CoV-2 infection in the particular study groups.

The analysis did not take into account such variables as the presence of chronic complications after infection with the SARS-CoV-2 virus – such as memory disorders, chronic fatigue syndrome, complications like thrombosis, pulmonary fibrosis or others. However, taking into consideration so many variables would require much larger study groups with the numbers of subjects calculated from the statistical model.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by The Bioethics Committee of the Medical University of Lodz–consent no. RNN/137/22/KE, Poland. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

KS: Writing – original draft, Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization. TP: Funding acquisition, Supervision, Writing – review & editing. AM: Funding acquisition, Supervision, Writing – review & editing. MS: Writing – review & editing. MR: Writing – review & editing. KK: Writing – review & editing. IS: Writing – review & editing. MK: Supervision, Visualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2023.1296385/full#supplementary-material

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Reevaluating hikikomori: challenging assumptions and redefining loneliness in Japan

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Introduction: Loneliness in Japan, accentuated by demographic challenges and the hikikomori phenomenon (extreme social withdrawal), has raised concerns. This study critically examines loneliness dynamics, questioning assumptions embedded in hikikomori classifications. The term "hikikomori," originally signifying prolonged home stay, requires nuanced exploration, especially regarding outgoing behaviors' relationship with loneliness.

Objectives: Investigating the intricate connection between outgoing behaviors and loneliness, this study questions the effectiveness of existing hikikomori classifications. Aiming to understand if these classifications accurately represent the loneliness spectrum across age groups, the research emphasizes the significance of comprehending loneliness dynamics amid societal challenges. The study explores an array of factors influencing loneliness, including demographics, mental health, and outgoing behaviors, advocating for a reassessment of assumptions linked to hikikomori classifications.

Methods: This secondary analysis employed data from a nationwide Internet addiction survey conducted in July 2012. A sample of 623 participants, representative of Japanese internet users aged 16 and above, underwent factor analysis. Loneliness was assessed using the UCLA Loneliness Scale, and exposure variables included demographic, mental health, outgoing behaviors, and lifestyle factors. Statistical analyses encompassed descriptive statistics, one-way ANOVA, chi-square tests, and logistic regression.

Results: Significant differences were observed in loneliness scores based on sex, age, marital status, employment, and outgoing behaviors. Mental health factors, including dissatisfaction with life and romance, life stress, and psychological distress, emerged as strong contributors to loneliness. The study challenges existing hikikomori classifications, suggesting they may not fully encapsulate the loneliness experiences of individuals engaged in routine school or work activities.

Conclusion: Findings underscore the need for a reevaluation of hikikomori, emphasizing loneliness as a complex and multifaceted issue in Japan. The study advocates for nuanced strategies to address loneliness, considering diverse demographic vulnerabilities. Limitations include the pre-pandemic sample and potential unmeasured confounding factors.

KEYWORDS

loneliness, hikikomori, social withdrawal, outgoing behaviors, mental health

Introduction

The subject of loneliness has gained recognition and garnered particular attention, exacerbated by an amalgamation of demographic challenges and the emergence of the social phenomenon known as hikikomori. This study delves into the intricate dynamics of loneliness, both during the pre-pandemic era and in response to the amplified loneliness during the COVID-19 pandemic.

Hikikomori, a term associated with extreme social withdrawal, is often intertwined with loneliness and isolation. Initially perceived as a uniquely Japanese phenomenon, hikikomori was defined as staying at home and refraining from social activities for over six months, without a preliminary psychosis background (1). Over time, the "hikikomori support guidelines" expanded the definition to include individuals who may go out but lack meaningful social interactions (2, 3). The duration defining hikikomori has also been variably considered, ranging from 3-6 months in some studies (4–7).

Outgoing patterns have traditionally served as a means to differentiate hikikomori individuals from those who are not. These patterns have given rise to two distinct categories: the non-hikikomori group, including individuals who maintain regular work or school attendance or engage in various social activities, and the hikikomori group, comprising individuals who predominantly remain at home, with limited outings for personal interests or nearby errands (8–10). However, beneath this classification lies a fundamental question: Does the characterization of outgoing behaviors effectively encapsulate the diverse experiences of loneliness among hikikomori individuals? This pivotal query forms the basis for our exploration of the intricate relationship between outgoing behaviors and loneliness.

For example, in previous studies (8–10) on hikikomori prevalence, participants selected one of eight outgoing patterns:

1. Going out for work or school every day.
2. Going out for work and school 3-4 days a week.
3. Going out for fun frequently.
4. Sometimes going out to maintain relationships with others.
5. Mainly staying home yet sometimes going out for tasks concerning self-interest.
6. Mainly staying home yet could go out to neighboring convenient shops.
7. Can come out from the room but cannot go out from the house.
8. Almost never going out from the room.

Participants who selected options 5-8 were classified as hikikomori. Analyzing these criteria, option no. 4 might resemble an individual who primarily stays home but attends funerals and significant family events to show respect and maintain minimal social interactions with others. As for option no. 5, it may resemble the phenomenon of a freelancer or home-based Otaku (meaning: a person obsessed with computers or particular aspects of popular culture to the detriment of their social skills) (11). Those previously classified as non-hikikomori for choosing options 1-4 might not accurately be non-hikikomori. Leveraging the broadened definition of hikikomori in 2010 (3), those who choose option 2 may reflect a socially withdrawn person attending school or work for a limited time each week. People who choose option no. 4 can almost be identified as hikikomori according to the definition, and option no. 5 may fulfill the definition of hikikomori, yet there is a positive motivation for the condition. These criteria have not rightly reflected the motivation or interest of a person, thus failing to represent hikikomori accurately. Therefore, I question the rationale and utility of these criteria in classifying hikikomori characters. This crucial inquiry forms the basis for this exploration of the intricate relationship between outgoing behaviors and loneliness.

Concerns about hikikomori span across all ages, necessitating a critical assessment to determine if its classification genuinely reflects the full spectrum of loneliness experiences in Japan. It is also crucial to ascertain whether the degree of loneliness is consistent across all age groups.

Amid the pandemic, the profound implications of loneliness for mental health have come to the forefront, intensifying research and raising significant concerns (12) The impact of loneliness has been especially pronounced in Japan, where comprehensive online surveys have unveiled a surge in loneliness, with notable disparities between women and men (12). Recognizing the severity of harmful effects on mental and physical well-being due to loneliness or social isolation, a new law (to be implemented on 2024.4.1) has been enacted to establish principles, state responsibilities, and policy matters for loneliness and isolation measures, Act No.45 of 2023 (13). These measures aim to prevent loneliness and isolation, provide prompt support, and promote efforts to break free from these states.

However, the critical distinction between pre-pandemic and pandemic-induced loneliness emerges as a central theme of inquiry. While the latter may wane as pandemic-related restrictions ease, the former may endure, warranting a comprehensive understanding of its prevalence and implications.

Previous research has associated loneliness with diverse factors such as unemployment (14) and hikikomori (15, 16), the role of outgoing patterns in this context remains a relatively uncharted territory. Similarly, the connections between life satisfaction, marital status, age, and loneliness have demonstrated multifaceted and at times, contrasting relationships (17–21). These complex interactions underscore the need to revisit and reconsider long-held assumptions surrounding these factors when examining loneliness in Japan.

In light of these considerations, this study embarks on a comprehensive investigation into the contributors to loneliness in Japan. It takes into account a spectrum of demographic factors, including age, marital status, education, occupational status, and outgoing patterns. This study aims to investigate loneliness by examining various outgoing behaviors, questioning the usefulness of outgoing patterns in classifying hikikomori, and highlighting the need for a more nuanced approach. Additionally, this research critically examines the classification of hikikomori as an indicator of social isolation and loneliness, aiming to disentangle the intricate web of loneliness in Japanese society. The findings challenge

preconceived notions about the hikikomori label as a comprehensive representation of loneliness experiences in Japan. As Japan grapples with the pressing issue of loneliness, this study calls for a reexamination of hikikomori, challenging assumptions, and redefining loneliness within the complex dimensions of the country.

Methods

Sample recruitment

In this study, I conducted a secondary analysis of data derived from a July 2012 Internet addiction population survey (22). The original survey aimed to create a representative sample by mirroring the national population of Internet users aged 16 and above in 2010 (23). Participants were recruited through Macromill, an Internet survey company with a database of 1,086,904 registered users in May 2012. The registered users were stratified by sex and age, assigned pseudorandomized numbers, and sorted accordingly, resulting in a randomized data list.

Participants were initially categorized by sex and age groups and then randomly chosen from the user database. Invitations to participate in the survey were sent to 4,886 registered users via email, resulting in 623 participants (with a successful response rate of 12.7%) after data cleaning. Prior to taking the survey, participants were required to provide consent. Access to the online survey followed a 'first come, first served' basis, disabling the survey link once the quota for an effective sample size for the gender and age range had been met. Considering the total time for survey completion, invitation emails were sent at 9 am on Saturday, July 28, 2012, aiming to accommodate working individuals and students. The sampling quota was estimated to be fulfilled by the following Monday, approximately within 48–52 hours. Ethical approval for the initial study was obtained from the Research Ethics Committee of the Graduate School of Medicine at the University of Tokyo.

Outcome variable. Loneliness was assessed using a 20-item 4-Likert scale (UCLA Loneliness Scale) (α = 0.87–0.91) (24).

Exposure variables. These variables were considered to understand the complex interplay of factors contributing to loneliness in the study population, allowing for a comprehensive analysis of the issue.

Demographic variables: sex (men, women), age categories (16-19, 20-29, 30-39, 40-49, 50-59, 60 and above), educational level (compulsory education, high school/vocational school education, university education), single, preferred not to tell), employment variables (working, housework, studying, not working), marital status (married/cohabitated/dating, widowed/divorced/separated.

Mental health variables: satisfactions (romance satisfaction in the current romance stats, life satisfaction in the current job/school/situation), life stress in the current job/school/situation, psychological distress (6-item 5-Likert scale (K6) (α = 0.85, 0-8=no/mild, 9-24=moderate/severe) (25).

Outgoing behaviors variables

Building upon the original set of outgoing patterns used to distinguish hikikomori individuals from those who are not (8–10), this study introduces a novel array of outgoing behavior variables. These variables encompass diverse levels of social engagement and outdoor activities, spanning individuals who are frequently active outside to those who predominantly prefer indoor settings. The new categories include individuals who:

1. Go out for work or school and frequently engage in other activities outside the home.
2. Go out for work or school and attend to other errands as needed.
3. Go out for work or school but refrain from going out for other reasons.
4. Do not go to work or school but frequently engage in outings for leisure or other activities.
5. Mostly stay at home but occasionally go out for social events like ceremonies or weddings.
6. Usually stay at home but go out only when the activity is related to personal interest.
7. Typically stay at home but venture out to nearby places like convenience stores or rarely leave their room/home.

Participants were asked to select one criterion that best represented their outgoing pattern in the past six months. Those who chose option 7 were classified as hikikomori.

Lifestyle variables: various everyday Internet use habits (e.g., study/work, stress release, killing time, communication, associating, expanding hobbies and network of friends, resourcing, sharing problems, building community networks, online dating, assessing pornography, using anonymous online bulletin boards, blogging and SNS, releasing personal updates and work presentations, assessing Youtube or iTunes, using P2P and FTP, online gaming, online survey or quiz, financial transaction, and online shopping or auctions).

Statistical analysis

The statistical analysis commenced with an examination of descriptive statistics, which encompassed measures such as the mean, median, mode, and the assessment of normality for the UCLA Loneliness Score. These scores were subsequently categorized into "lower scores" and "higher scores," with a specific focus on the latter as the dependent variable of interest. Following this categorization, we performed a one-way ANOVA to facilitate the comparison of means. Chi-square test were used to explore the relationship between loneliness and its exposure variables. To ensure the validity of our statistical tests, we assessed the homogeneity of variances using Levene's and Welch's tests. Additionally, we calculated effect sizes, employing Cohen's

classification for eta-squared to gauge the magnitude of effects. Specifically, we categorized effects as small (.01), medium (.06), or large (.14). Furthermore, we explored the strength and direction of linear relationships between variables through the Pearson correlation test. Concurrently, logistic regression analysis was carried out, taking into consideration two distinct models. Model 1 incorporated all relevant demographic variables (items that had statistically significant influence on loneliness in chi-square test for independence) as potential confounding variables, and Model 2 included all relevant internet use habits and all relevant demographic variables as potential confounding factors. This comprehensive statistical analysis provides valuable insights into the factors influencing higher UCLA loneliness scores within our diverse sample.

Results

UCLA Loneliness scores exhibited a range of 20 to 80 within the sample, with a mean score of 42.4 (SD=12.1, 5% trimmed mean=41.9), a median score of 41.0, and a mode of 40. Scores between 20 and 40 were classified as "lower scores," while scores between 41 and 80 were designated "higher scores." Correlations among most variables were characterized by small effect sizes (r<.30), with exceptions observed in the relationships between marital status and age (r=.343, p<.001), as well as between romance satisfaction (r=.330, p<.001).

Demographic variables. Significant differences were observed in the UCLA loneliness scores among various factors (Table 1). Sex: Men had higher UCLA loneliness scores, with a mean of 44.4 (SD = 12.5), while women had a lower mean score of 40.2 (SD = 11.4). The effect size (eta squared) was small at 0.03, indicating a small but significant difference in loneliness scores between the sexes. Age: Age groups exhibited significant differences in loneliness scores ($p < 0.001$). Notably, individuals in their 10s and 60s showed higher loneliness scores than other age groups. For example, those in their 10s had a mean loneliness score of 47.1 (SD = 14.3), while individuals in their 60s had a mean score of 39.5 (SD = 10.6). Employment status: Employment status significantly differed in UCLA loneliness scores ($p < 0.001$). Individuals not working had the highest loneliness scores, with a mean of 47.9 (SD = 13.9), while those working had the lowest mean score of 42.0 (SD = 11.8). The effect size was moderate at 0.04. Marital status: A significant difference was observed among different marital status categories ($p < 0.001$). Participants who were single had the highest UCLA loneliness scores, with a mean of 48.9 (SD = 14.3). In contrast, those who were married, cohabited, or dating had the lowest mean score of 39.6 (SD = 10.2). The effect size was relatively large at 0.09, indicating a substantial difference in loneliness scores based on marital status.

Mental health variables. Marital status satisfaction: The level of satisfaction with one's marital status also yielded a significant difference in loneliness scores ($p < 0.001$). Participants who were unsatisfied or preferred not to reveal their satisfaction had higher UCLA loneliness scores, with a mean of 46.0 (SD = 12.4), compared to those who were satisfied, with a mean score of 40.1 (SD = 11.4). The effect size was moderate at 0.05. Life satisfaction: The satisfaction with one's current situation significantly impacted loneliness scores ($p < 0.001$). Participants who were unsatisfied with their current situation had higher UCLA loneliness scores, with a mean of 47.1 (SD = 12.3), compared to those who were satisfied, with a mean score of 37.8 (SD = 10.1). The effect size was relatively large at 0.15. Life stress: The presence of stress in the current situation significantly affected loneliness scores ($p < 0.001$). Those who reported stress had higher UCLA loneliness scores, with a mean of 45.2 (SD = 12.3), compared to individuals without stress, who had a mean score of 38.8 (SD = 10.9). The effect size was moderate at 0.07. **K6 scores:** The psychological distress measured by K6 scores showed a significant difference ($p < 0.001$). Individuals with higher distress (K6 scores >9) had substantially higher UCLA loneliness scores, with a mean of 53.6 (SD = 12.4), compared to those with lower distress (K6 scores 0-8), who had a mean score of 39.9 (SD = 10.6). The effect size was large at 0.19.

Outgoing behaviors. Different patterns of outgoing behavior also demonstrated significant differences in loneliness scores ($p = 0.028$). Participants who attended school/work and were outgoing had the lowest mean loneliness score (38.6, SD = 11.3), while individuals who only attended school/work but did not go out had the highest mean score (52.1, SD = 12.0). The effect size was close to moderate at 0.05.

Internet use habits. Significant differences in UCLA loneliness scores were observed based on varying online activities (Table 2). Notably, the frequency of using the internet for stress release and killing time showed significant associations with loneliness. Participants who used the internet to release stress (mean=44.4, SD=13.6) or kill time (mean=44.0, SD=13.2) "often/always" reported higher levels of loneliness compared to those who did so "rarely/never." A similar pattern emerged for online dating, assessing pornography, using anonymous online bulletin boards, and accessing platforms like Youtube/iTunes. In these cases, frequent engagement with these online activities was associated with increased loneliness scores. However, it's important to note that the effect sizes for these associations were relatively small, indicating that while statistically significant, the practical significance may be limited.

The logistic regression results were presented in Table 3. In Model 1, sex, age, marital status and employment status were adjusted for confounding factors. Demographic variables. Men had significantly higher odds of experiencing the outcome compared to women (OR: 1.96, 95% CI: 1.26-3.06). Several age groups showed significant associations with the outcome. Participants in their 10s had substantially higher odds of experiencing the outcome (OR: 16.02, 95% CI: 4.51-56.90). Those in their 20s (OR: 4.05, 95% CI: 1.79-9.15), 30s (OR: 3.21, 95% CI: 1.53-6.75), 40s (OR: 3.62, 95% CI: 1.70-7.71), and 50s (OR: 3.51, 95% CI: 1.62-7.59) also had significantly higher odds compared to those aged 60 years and above. Individuals who were single had significantly higher odds of experiencing the outcome (OR: 3.34, 95% CI: 1.98-5.63) compared to those who were married, cohabited, or dating. Being employed (working) (OR: 0.36, 95% CI: 0.19-0.68). and students (OR: 0.10, 95%CI: 0.03-0.32) were associated with significantly lower odds of experiencing moderate high to severe

TABLE 1 Distributions of UCLA loneliness scores with different demographics, mental health, and outgoing behaviors subgroups.

		UCLA loneliness scores			Mean	SD	Eta squared
		lower scores	higher scores	*p* value			
Sex	men	213 (47.1%)	110 (64.3%)	<.001	44.4	12.5	0.03
	women	239 (52.9%)	61 (35.7%)		40.2	11.4	
Areas	Hokkaido	18 (4%)	10 (5.8%)	0.656	46.1	12.9	0.01
	Tohoku	18 (4%)	7 (4.1%)		42.0	11.8	
	Kanto	177 (39.2%)	66 (38.6%)		42.3	12.3	
	Chubu	59 (13.1%)	31 (18.1%)		44.0	13.1	
	Kinki	109 (24.1%)	36 (21.1%)		41.5	11.7	
	Chukoku	20 (4.4%)	7 (4.1%)		43.1	11.5	
	Shikoku	15 (3.3%)	5 (2.9%)		40.3	10.7	
	Kyushu	36 (8%)	9 (5.3%)		40.7	11.6	
Age	10's	23 (5.1%)	21 (12.3%)	<.001	47.1	14.3	0.03
	20's	68 (15%)	32 (18.7%)		44.5	13.8	
	30's	93 (20.6%)	37 (21.6%)		42.2	12.2	
	40's	87 (19.2%)	37 (21.6%)		42.2	11.5	
	50's	73 (16.2%)	27 (15.8%)		42.1	11.3	
	60's	108 (23.9%)	17 (9.9%)		39.5	10.6	
Educational level	Compulsory education	6 (1.3%)	2 (1.2%)	0.844	44.0	14.6	0.01
	High school/ technical school education	192 (42.5%)	77 (45.0%)		43.4	11.8	
	Univeresity level education	254 (56.2%)	92 (53.8%)		41.5	12.3	
Employment	Working	263 (58.2%)	97 (56.7%)	<.001	42.0	11.8	0.04
	Housework	102 (22.6%)	19 (11.1%)		39.2	9.8	
	Studying	39 (8.6%)	20 (11.7%)		43.5	13.4	
	Not working	48 (10.6%)	35 (20.5%)		47.9	13.9	
Marital status	Married/cohabited/dating	321 (71%)	72 (42.1%)	<.001	39.6	10.2	0.09
	Widowed/divorced/separated	41 (9.1%)	22 (12.9%)		43.9	13.2	
	Single	64 (14.2%)	60 (35.1%)		48.9	14.3	
	Preferred not tell	26 (5.8%)	17 (9.9%)		46.3	11.8	
Romance satisfaction	Satisfied	304 (67.3%)	81 (47.4%)	<.001	40.1	11.4	0.05
	Unsatisfied	26 (5.8%)	17 (9.9%)		46.0	12.6	
	Preferred not to tell	122 (27.0%)	73 (42.7%)		46.3	11.8	
Life satisfaction	Satisfied	273 (60.4%)	42 (24.6%)	<.001	37.8	10.1	0.15
	Unsatisfied	179 (39.6%)	129 (75.4%)		47.1	12.3	
Life stress	Not stress	226 (50%)	52 (30.4%)	<.001	38.8	10.9	0.07
	Stress	226 (50%)	119 (69.6%)		45.2	12.3	
Psychological distress	K6 scores less than 9	408 (90.3%)	104 (60.8%)	<.001	39.9	10.6	0.19
	K6 scores >9	44 (9.7%)	67 (39.2%)		53.6	12.4	

(Continued)

TABLE 1 Continued

		UCLA loneliness scores			Mean	SD	Eta squared
		lower scores	higher scores	*p* value			
Outgoing behaviors	goes out for work or school and frequently goes out for other reasons as well	113 (25%)	28 (16.4%)	0.028	38.6	11.3	0.05
	goes out for work or school and goes out when there are other errands to attend to	186 (41.2%)	65 (38%)		42.1	11.9	
	goes out for work or school but doesn't go out for other reasons	7 (1.5%)	9 (5.3%)		52.1	12.0	
	doesn't go to work or school but frequently goes out for leisure or other activities	21 (4.6%)	8 (4.7%)		41.3	10.6	
	mostly stays at home but occasionally goes out for social events like ceremonies or weddings	29 (6.4%)	15 (8.8%)		45.0	12.5	
	usually stays at home but goes out only when it's related to personal interest	79 (17.5%)	36 (21.1%)		44.4	12.0	
	typically stays at home but goes to nearby places like convenience stores or rarely leave room/home	17 (3.8%)	10 (5.8%)		47.0	14.0	

Chi-square test were used to explore the relationship between loneliness and its exposure variables. To ensure the validity of our statistical tests, the homogeneity of variances using Levene's and Welch's tests were assessed. One-way ANOVA to facilitate the comparison of means. Effect sizes, employing Cohen's classification for eta-squared were calculated to gauge the magnitude of effects, small (.01), medium (.06), or large (.14). (N=623).

loneliness compared to those who were not working. Individuals who were unsatisfied with their romance status had 2.65 times higher odds (95% CI: 1.29 to 5.46) of experiencing higher levels of loneliness compared to those who were satisfied with their romance. Participants who were unsatisfied with their job had 3.48 times higher odds (95% CI: 2.27 to 5.33) of experiencing higher levels of loneliness compared to those who were satisfied.

Life Stress: Participants who reported being stressed had significantly higher odds of experiencing the outcome (OR: 1.95, 95% CI: 1.28-2.96). K6 Scores: Participants with K6 scores greater than 9 had significantly higher odds of experiencing the outcome (OR: 4.76, 95% CI: 2.91-7.81) compared to those with scores less than 9. Outgoing behaviors: Participants who reported "going out for work or school but doesn't go out for other reasons" (OR: 3.96, 95% CI: 1.25-12.51), "mostly stays at home but occasionally goes out for social events like ceremonies or weddings" (OR: 2.93, 95% CI: 1.16-7.43), "typically stays at home but goes to nearby places like convenience stores or rarely leave room/home" (OR: 1.98, 95% CI: 1.26-3.12),had significantly higher odds of experiencing the outcome compared to those who "goes out for work or school and frequently goes out for other reasons as well." The effect of satisfaction in life and romance on loneliness were not statistically significant.

The inclusion of Internet use patterns in Model 2 did not substantially change the interpretation of results for most predictor variables when compared to Model 1. However, participants who "usually stay at home but goes out only when it's related to personal interest" had significantly higher odds of experiencing the outcome (OR: 2.27, 95% CI: 1.12 to 4.61) compared to the reference group, while the impact of participants who "typically stays at home but goes to nearby places like convenience stores or rarely leave room/home" on loneliness lost its significance. These results indicate that several demographic and lifestyle factors, including sex, age, marital status, employment status, and outgoing behaviors, were associated with the outcome even after adjusting for Internet use habits as confounding variables.

Discussions

The significant findings of this study underscore the intricate relationship between demographic, mental health, outgoing behaviors, and internet use patterns with loneliness in the Japanese population. Men, young individuals, singles, and non-working participants faced higher odds of experiencing loneliness. Mental health factors, such as dissatisfaction with life and romance, life stress, and psychological distress, were strong contributors.

The nuanced findings on outgoing behaviors challenge conventional assumptions, revealing that even individuals attending school/work regularly can experience profound loneliness if their outgoing activities are limited. Notably, the impact of outgoing patterns on loneliness is distinct from other mental health factors. Additionally, the impact of internet use habits, while statistically significant, needs careful interpretation due to relatively small effect sizes.

The influence of demographics on loneliness

The gender dimension stands out, with men being at higher risk of loneliness compared to women. This finding may be

TABLE 2 Distributions of UCLA loneliness scores among different Internet use habits.

		UCLA loneliness scores					
		lower scores	higher scores	*p* value	Mean	SD	Eta squared
Official purpose (study/work)	rarely/never	211 (46.7%)	72 (42.1%)	0.238	43.0	12.1	
	sometimes	81 (17.9%)	26 (15.2%)		41.9	12.0	0.00
	often/always	160 (35.4%)	73 (42.7%)		41.8	12.2	
Stress release	rarely/never	201 (44.5%)	60 (35.1%)	0.001	40.9	12.0	
	sometimes	128 (28.3%)	38 (22.2%)		42.2	10.2	0.02
	often/always	123 (27.2%)	73 (42.7%)		44.4	13.6	
Killing time	rarely/never	105 (23.2%)	25 (146%)	0.005	38.9	10.6	
	sometimes	123 (27.2%)	37 (21.6%)		41.8	10.3	0.03
	often/always	224 (49.6%)	109 (63.7%)		44.0	13.2	
Communication	rarely/never	223 (49.3%)	96 (56.1%)	0.267	43.7	12.3	
	sometimes	116 (25.7%)	41 (24%)		42.0	11.7	0.02
	often/always	113 (25%)	34 (19.9%)		39.8	11.8	
Associating	rarely/never	359 (78.8%)	128 (74.9%)	0.026	42.2	12.3	
	sometimes	59 (13.1%)	17 (9.9%)		41.8	11.4	0.00
	often/always	37 (8.2%)	26 (15.2%)		44.4	11.9	
Expanding hobbies and network of friends	rarely/never	341 (75.4%)	132 (77.2%)	0.549	42.6	12.2	
	sometimes	56 (12.4%)	16 (9.4%)		41.3	10.0	0.00
	often/always	55 (12.2%)	23 (13.5%)		41.8	13.7	
Resourcing	rarely/never	26 (5.8%)	5 (2.9%)	0.258	42.1	8.7	
	sometimes	59 (13.1%)	19 (11.1%)		42.6	11.0	0.00
	often/always	367 (81.2%)	147 (86%)		42.4	12.5	
Sharing problems	rarely/never	376 (83.2%)	135 (78.9%)	0.46	42.0	12.2	
	sometimes	50 (11.1%)	23 (13.5%)		44.1	11.1	0.01
	often/always	26 (5.8%)	13 (7.6%)		44.5	12.6	
Building community network	rarely/never	388 (85.8%)	153 (89.5%)	0.421	42.8	12.4	
	sometimes	27 (6%)	9 (5.3%)		40.6	9.5	0.01
	often/always	37 (8.2%)	9 (5.3%)		38.7	10.6	
Online dating	rarely/never	441 (97.6%)	158 (92.4%)	0.011	42.1	12.1	
	sometimes	5 (1.1%)	5 (2.9%)		47.5	10.4	0.01
	often/always	6 (1.3%)	8 (4.7%)		50.6	12.9	
Assessing pornography	rarely/never	371 (82.1%)	121 (70.8%)	0.008	41.5	11.9	
	sometimes	49 (10.8%)	31 (18.1%)		45.4	12.5	0.02
	often/always	32 (7.1%)	19 (11.1%)		45.8	13.0	
Using anonymous online bulletin boards (2ch etc.)	rarely/never	316 (69.9%)	93 (54.4%)	<.001	40.9	11.3	
	sometimes	87 (19.2%)	40 (23.4%)		44.0	12.2	0.03
	often/always	49 (10.8%)	38 (22.2%)		46.9	14.4	
Blogging and SNS	rarely/never	219 (48.5%)	83 (48.5%)	0.894	42.3	12.1	0.00
	sometimes	86 (19%)	35 (20.5%)		43.3	11.4	

(Continued)

TABLE 2 Continued

		UCLA loneliness scores					
		lower scores	higher scores	*p* value	Mean	SD	Eta squared
	often/always	147 (32.5%)	53 (31%)		41.9	12.7	
Release personal updates and work presentations	rarely/never	380 (84.1%)	139 (81.3%)	0.246	42.4	12.2	
	sometimes	32 (7.1%)	19 (11.1%)		44.2	11.7	0.00
	often/always	40 (8.8%)	13 (7.6%)		40.6	11.8	
Assessing Youtube/iTunes etc.	rarely/never	210 (46.5%)	54 (31.6%)	0.003	40.8	11.0	
	sometimes	114 (25.2%)	53 (31%)		44.1	12.3	0.01
	often/always	128 (28.3%)	64 (37.4%)		43.1	13.3	
P2P and FTP	rarely/never	364 (80.5%)	128 (74.9%)	0.298	42.3	12.4	
	sometimes	42 (11.5%)	25 (14.6%)		42.7	10.3	0.00
	often/always	36 (8%)	18 (10.5%)		42.6	12.7	
Online gaming	rarely/never	382 (84.5%)	134 (78.4%)	0.05	41.9	12.2	
	sometimes	43 (9.5%)	17 (9.9%)		43.5	10.7	0.01
	often/always	27 (6%)	20 (11.7%)		46.0	12.8	
Online survey or quiz	rarely/never	27 (6%)	12 (7%)	0.891	46.0	12.6	
	sometimes	78 (7.3%)	29 (17%)		42.2	11.7	0.01
	often/always	347 (76.8%)	130 (76%)		42.1	12.2	
Financial transaction	rarely/never	227 (50.2%)	96 (56.1%)	0.294	43.2	12.5	
	sometimes	110 (24.3%)	41 (24%)		42.9	11.6	0.01
	often/always	115 (25.4%)	34 (19.9%)		40.0	11.7	
Online shopping/auctions	rarely/never	99 (21.9%)	33 (19.3%)	0.393	41.6	10.8	
	sometimes	174 (38.5%)	60 (35.1%)		42.5	11.6	0.00
	often/always	179 (29.6%)	78 (45.6%)		42.7	13.2	

Chi-square test were used to explore the relationship between loneliness and various everyday internet use habits. To ensure the validity of our statistical tests, the homogeneity of variances using Levene's and Welch's tests were assessed. One-way ANOVA to facilitate the comparison of means. Effect sizes, employing Cohen's classification for eta-squared were calculated to gauge the magnitude of effects, small (.01), medium (.06), or large (.14). (N=623).

indicative of potential differences in social support networks or coping mechanisms between genders. Younger individuals, particularly those in their 10s and 20s, faced significantly higher odds of loneliness, possibly due to life transitions, social pressures, or changes in social relationships common during these age periods, highlighting the vulnerability of young adults to loneliness. Moreover, the marital and romantic status played a crucial role, with singles reporting higher odds of loneliness compared to those who were married, cohabiting, or dating (18). This supports the idea that romantic relationships can serve as protective factors against loneliness. Interestingly, employment status also emerged as a significant predictor, with being employed associated with lower odds of loneliness (18). This could be attributed to the social interactions and support systems that come with a regular job, underscoring the importance of occupational engagement in reducing loneliness.

The impact of psychological factors on loneliness is evident

Those with unsatisfactory romance and job situations, higher stress levels, and elevated psychological distress (K6 scores >9) were more likely to experience loneliness. This reaffirms the connection between mental well-being and loneliness (21), highlighting that dissatisfaction in both personal and professional spheres can contribute to feelings of social isolation.

Challenging hikikomori classification

Historically, hikikomori individuals have been categorized based on their outgoing behaviors, with a clear distinction between those who attend school or work regularly and engage in

TABLE 3 Logistic Regression Analysis of Factors Influencing Loneliness.

		Model 1			Model 2		
		OR	95%CI		OR	95%CI	
Sex	men	1.96	1.26	3.06	1.82	1.11	3.00
	women	ref					
Age	10's	16.02	4.51	56.90	13.03	3.47	48.99
	20's	4.05	1.79	9.15	2.96	1.23	7.17
	30's	3.21	1.53	6.75	2.61	1.18	5.77
	40's	3.62	1.70	7.71	2.40	1.55	7.46
	50's	3.51	1.62	7.59	3.30	1.50	7.28
	60 years and above	ref			ref		
Educational level	compulsory education	ref			ref		
	high school/vocational school education	1.65	0.30	9.08	2.16	0.35	13.16
	university level education	1.62	0.30	8.91	2.07	0.34	12.69
Employment	working	0.36	0.19	0.68	0.36	0.19	0.69
	housework	0.50	0.22	1.16	0.54	0.229	1.25
	studying	0.10	0.03	0.32	0.10	0.03	0.33
	not working	ref			ref		
Marital status	married/cohabited/dating	ref			ref		
	widowed/divorced/separated	2.04	1.09	3.84	1.89	0.99	3.60
	single	3.34	1.98	5.63	2.94	1.71	5.03
	preferred not to tell	2.37	1.16	4.82	2.22	1.06	4.72
Romance satisfaction	Satisfied	ref			ref		
	Unsatisfied	2.65	1.29	5.46	2.50	1.17	5.35
	Preferred not to tell	1.50	0.97	2.32	1.51	0.97	2.36
Life satisfaction	Satisfied	ref			ref		
	Unsatisfied	3.48	2.27	5.33	3.50	2.26	5.41
Life stress	Not stress	ref			ref		
	Stress	1.95	1.28	2.96	1.96	1.27	3.02
Psychological distress	K6 scores >9	4.76	2.91	7.81	4.63	2.78	7.69
	K6 scores less than 9	ref			ref		
Outgoing behaviors	goes out for work or school and frequently goes out for other reasons as well	ref			ref		
	goes out for work or school and goes out when there are other errands to attend to	1.40	0.82	2.39	1.43	0.83	2.47
	goes out for work or school but doesn't go out for other reasons	3.96	1.25	12.51	4.13	1.27	13.39
	doesn't go to work or school but frequently goes out for leisure or other activities	1.81	0.61	5.34	1.82	0.59	5.61
	mostly stays at home but occasionally goes out for social events like ceremonies or weddings	2.93	1.16	7.43	3.19	1.23	8.28
	usually stays at home but goes out only when it's related to personal interest	1.80	0.64	5.03	2.27	1.12	4.61
	typically stays at home but goes to nearby places like convenience stores or rarely leave room/home	1.98	1.26	3.12	2.09	0.71	6.12

Model 1 incorporated all relevant demographic variables (items that had statistically significant influence on loneliness in chi-square test for independence) as potential confounding variables, and Model 2 included all relevant internet use habits and all relevant demographic variables as potential confounding factors. (N=623).

social activities and those who predominantly stay at home. This classification has been a defining criterion for identifying hikikomori individuals. However, our findings suggest that this classification may not accurately capture the experience of loneliness among hikikomori.

This study observed that different patterns of outgoing behavior significantly influenced loneliness scores. Notably, individuals who attended school or work but did not engage in other social activities had the highest mean loneliness scores, indicating a higher level of loneliness. Furthermore, logistic regression analysis revealed that those who reported "going out for work or school but doesn't go out for other reasons," "mostly staying at home but occasionally going out for social events," or "typically staying at home but going to nearby places like convenience stores or rarely leaving their room/home" had significantly higher odds of experiencing loneliness compared to those who were outgoing in multiple aspects of life. These results challenge the conventional understanding of hikikomori solely based on outgoing behaviors. It appears that loneliness can exist even among individuals who attend school or work regularly but do not engage in additional social activities. This prompts us to reconsider whether the current classification of hikikomori adequately represents the loneliness experienced by these individuals.

The intention is not to dismiss existing criteria but to encourage a reassessment of their adequacy in representing the loneliness experienced by individuals with specific outgoing patterns. The study acknowledges the complexity of this relationship and questions the helpfulness of the current classification in fully understanding and addressing the loneliness experienced by those labeled as hikikomori.

Implications

In-Depth Exploration of Hikikomori Experiences: To address the nuances uncovered, further exploration of the emotional and psychological experiences of individuals classified as hikikomori is crucial. Interventions should prioritize understanding and addressing loneliness within this population.

Nuanced Strategies for Combatting Loneliness: Amid the ongoing challenges of COVID-19, interventions aimed at combating loneliness, especially within the hikikomori context, should adopt nuanced strategies. Recognizing the emotional and psychological intricacies is vital for effective public health initiatives.

Strengths and limitations

The strength of this study is in the pre-stratification of gender and age and pseudo-randomization during the sample recruitment; therefore, the sample is reasonably representative of the national population in terms of demographic distribution. Second, the sample size was considerably big overall, comprising large samples of male and female participants (N>200), improving the results' stability. Third, the recruitment was done online through a survey company, which assured the anonymity of participants, reducing chances of reporting bias associated with the participants' attempt to "look good" or "look smart" in fear of being evaluated. However, online recruitment has limited the generalization of the results to the general population of Internet users. Also, caution should be exercised when applying these findings to diverse populations or considering longitudinal trends as the characteristics and behaviors of Internet users can evolve over time. Sample may represent the people who feel comfortable completing an online study but not those who are not. Finally, the technical limitations in the survey prevented the assessment of the characteristics of non-responders and the dropouts; selection bias was not excluded. The study acknowledges the potential influence of unmeasured confounding factors that were not included in the analysis. Uncontrolled variables could impact the relationship between exposure variables and loneliness, introducing bias or affecting the generalizability of the findings.

Conclusion

This study has provided valuable insights into the multifaceted nature of loneliness in the Japanese population. It has identified several significant contributors to loneliness, including sex, age, marital status, employment status, and outgoing behaviors. These findings underscore the need for a comprehensive approach to understanding and addressing loneliness, as it is influenced by a complex interplay of demographic and lifestyle factors. The results also shed light on the potential inadequacies of the current classification of hikikomori, as it may not fully capture the loneliness experienced by individuals who attend school or work regularly but do not engage in additional social activities. For future implications, these findings have important implications for policymakers, healthcare providers, and researchers. To combat the loneliness epidemic in Japan, interventions and support mechanisms need to be tailored to the specific needs of different demographic groups. This may include targeted programs for young adults, women, or individuals with specific outgoing patterns. Additionally, our results call for a reevaluation of the hikikomori classification to ensure that individuals' emotional well-being is adequately addressed within this framework.

Further research is warranted to delve deeper into the emotional experiences of hikikomori individuals and to explore the potential role of the COVID-19 pandemic in exacerbating loneliness. Longitudinal studies could provide valuable insights into the persistence of loneliness and its post-pandemic implications. Moreover, efforts to develop and implement effective interventions to alleviate loneliness in Japan should be a priority. This study opens the door for a more connected and inclusive future, emphasizing the importance of addressing loneliness as a critical public health issue in Japan and beyond.

Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: Data Use Agreements: Access to the datasets may require

the signing of data use agreements or contracts specifying the terms and conditions for data usage, including restrictions on sharing, redistribution, or publication of the data. Requests to access these datasets should be directed to roselineyong@med.akita-u.ac.jp.

Author contributions

RY: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The reviewer KK declared a past collaboration with the author RY to the handling editor.

Publisher's note

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COVID-19 restrictions promoted the newly occurring loneliness in older people – a prospective study in a memory clinic population

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Introduction: A high burden and many negative outcomes for older people were associated with the COVID-19 pandemic. Social isolation and loneliness are prevalent health problems impacting well-being and quality of life and may have increased due to pandemic-related restrictions. Methods: This study investigate the influence of the COVID-19 pandemic on loneliness in people visiting a mem40ory clinic between March 2020 and September 2022. We conducted a prospective, single-center, questionnaire-based observational follow-up study to assess potential predictors of newly occurring, pandemic-related loneliness. Next to a newly developed COVID-19 questionnaire, a comprehensive neuropsychological test battery, the Neuropsychiatric Inventory and the Geriatric Depression Scale were used.

Results: In total 426 people (mean age: 76.48 years, 12.9% cognitively intact, 33.1% diagnosed with Mild Cognitive Impairment, 49.8% diagnosed with dementia, and 4.2% diagnosed with depression) completed the COVID-19 questionnaire at baseline and 166 at follow-up. Newly occurring loneliness was indicated by 22.3% of baseline participants and by 24.1% of follow-up participants. Results of logistic regression analysis showed that living alone (OR 5.452) and having less contact with friends (OR 2.771) were most predictive of the occurrence of loneliness. The use of digital communication media as an alternative strategy for social interaction was lowest in dementia patients (6-13%).

Discussion: In conclusion, personal contacts and a close friendship network appear to be more decisive to prevent loneliness in older people than does the use of digital communication media. However, promoting an intensified use of digital communication media may be useful to counteract loneliness, especially in dementia patients.

KEYWORDS

dementia, mild cognitive impairment, loneliness, aging, social isolation

1 Introduction

Starting in 2020, the total number of people affected by the novel coronavirus disease (COVID-19) and the number of associated deaths increased worldwide. Older persons suffering from dementia or cardiovascular diseases were at highest risk of death (1–3). As the pandemic progressed, an increasing number of publications reported worsening cognitive function and neuropsychiatric symptoms in patients with dementia (4–7). Among older adults, public health policy measures such as social distancing may have increased the risk for newly developing mental health disorders (8–11).

Social isolation (an objective measure of missing social relationships) and loneliness (subjective perception of social isolation or "social pain") are serious but underappreciated public health concerns that are particularly common in older people. Of note, they are associated with numerous negative consequences for this population (12–14). For example, prior studies suggest that social isolation is an important risk factor for Mild Cognitive Impairment (MCI) and dementia (15, 16) and accordingly, the advocacy brief of the World Health Organization (17) concludes that "social isolation and loneliness among older people are growing public health and public policy concerns which have been made more salient by the COVID-19 pandemic". Pre-pandemic research had already shown that loneliness and social isolation are very common in this population. Being female, living alone, low education and poor mental and physical health have been reported to be important risk factors in this regard (14–16, 18). Data on specific risk factors for newly occurring loneliness during the COVID-19 pandemic, among both cognitively healthy and impaired older people, are scarce.

It is known that loneliness and social isolation are independently associated with poor health outcomes. (19). In line with othes we have, recently shown that the COVID-19 pandemic had a negative impact on the psychological condition of the general population of Tyrol (Austria) and South Tyrol (Italy) and that the degree of loneliness significantly predicted psychological distress in the short-term (20).

Close family relationships and their collaboration with professional caregivers are important aspects of well-being in the lives of older people and people with dementia, and may prevent social isolation and cognitive decline (21–23). Furthermore, numerous studies have reported on the protective effects of social activities as stimuli to increase physical health and cognitive functions in older people (24). Higher levels of social interaction are associated with fewer neuropsychiatric symptoms in this population (25). Accordingly, the negative impact of the pandemic on older adults is largely due to strict COVID-19 action plans, including social and physical distancing, quarantine, and social isolation (26). Limited access to alternative sources of medical and psychological support, such as telemedicine services or digital communication technologies, is another relevant aspect in addition to the lack of face-to-face contact. Older people without dementia, and especially those with dementia, often live alone and use the Internet or social media rather infrequently (27), whereas the use of digital communication media could have a high potential to combat social isolation in late life (28). Although government restrictions have most likely saved lives, the potential negative effects of these restrictions on the well-being of older adults and people with dementia remain unclear. Therefore, prospective and retrospective clinical studies are urgently needed to determine the short- and long-term effects of the COVID-19 pandemic on loneliness and social isolation in older people in general and dementia patients in particular. To fill this gap, the current prospective observational study assessed the prevalence of new-onset loneliness and associated risk factors in outpatients of an Austrian memory clinic during the COVID-19 pandemic. We hypothesized that reduced cognitive, social, and physical activities might have increased this prevalence in older persons in general and especially in those with dementia. Therefore, we investigated whether demographics and numerous social factors associated with COVID-19 restrictions were predictive in this regard. We hypothesized that a detailed evaluation of self-reports as assessed by a questionnaire together with a clinical and neuropsychological examination in our memory clinic would provide comprehensive information about the vulnerable population of older people with cognitive decline. We aimed to gain a deeper understanding of what kinds of changes in personal social networks of older persons and patients with MCI or dementia with newly occurring loneliness experienced. Further, this study aimed to explore the impact of using digital communication media as possible strategy to avoid loneliness.

2 Methods

2.1 Study design and participants

This was a prospective, single-center, questionnaire-based study. We used a newly developed questionnaire (COVID-19 questionnaire, patient form) to assess the subjective perception of the impact of the COVID-19 pandemic on social life, areas of care, and information seeking.

The study population consisted of elderly persons with a scheduled appointment at the Memory Clinic of the Department of Psychiatry I at the Medical University of Innsbruck for the assessment of memory complaints or as part of their regular routine check-ups. The survey was conducted between 11th May 2020 and 30th September 2022. All study participants received the newly developed COVID-19 questionnaire (for detail see (29)) by mail one week before the scheduled appointment. They were asked to bring the completed questionnaire to the appointment.

Next to comprehensive neuropsychological assessment, rating scales assessing neuropsychiatric symptoms, depression, social and care situation as well as a clinical interview were done as part of standard clinical procedure.

Inclusion criteria comprised an age ≥ 65 years. Individuals were excluded if they were unable to adequately understand the questionnaires due to moderate or severe cognitive impairment, language barrier, or unwillingness to answer the questions. Written informed consent was obtained from the participants and the study

was approved by the Ethics Committee of the Medical University of Innsbruck, Austria.

2.2 Classification and diagnostic of patient groups

Patients were classified as "Cognitively intact" (CI) if they did not fall below the threshold of 1 standard deviation (SD) below the mean of normative data derived from a representative sample in the neuropsychological test battery and a Clinical Dementia Rating Scale (CDR) (30) score of 0. MCI was diagnosed according to the criteria of Petersen et al. (31), i.e. in patients reporting subjective memory complaints over the previous 6 months and showing impaired memory function (verbal or figural) in the neuropsychological assessment >1.5 SD below the mean of normative data and additionally having a CDR score between 0 and 0.5. Dementia of any etiology (Alzheimer´s dementia (AD), vascular dementia (VD), Dementia due to Chorea Huntington, alcohol-related dementia, Pick's disease) was diagnosed (ICD-10 criteria) in case of 1) presence of subjective memory complaints over the past 6 months, 2) neuropsychological impairment > 2 SD in one memory function (verbal or figural memory) and at least one other cognitive domain, 3) impairment in activities of daily living as assessed by clinical interview, and 4) a CDR score ≥ 1. For statistical analysis, study participants were assigned to the following diagnostic subcategories: CI, MCI, DEM (including dementia of any etiology).

2.3 Power considerations

The power calculation for the primary analysis was conducted with G*Power (version 3.9.2.1) and PASS (version 20) and is based on the type-one error probability of $\alpha = 5\%$ and a power of $1\text{-}\beta = 80\%$. A sample size of 410 participants included will be sufficiently large to detect an OR of 1.62 or higher with a continuous covariate x at the position $x \pm \sigma$ (one standard deviation above/below the mean). This presupposes the assumption, that the p_0 (probability of loneliness feelings) under the null hypothesis lies in the range of 0.1 to 0.9. Furthermore, it is assumed that the squared multiple correlation among covariates is $R^2 = 0.1$. For dichotomous covariates OR ≥ 1.96 are detectable, if the above conditions apply. Hence, the effect sizes to be detected lie in the small to medium range, according to Cohen's classification (32).

2.4 Newly developed COVID-19 questionnaire

The entire survey was related to changes coinciding with the beginning of the COVID-19 pandemic and the start of related restrictions in Austria in March 2020, and the planned visit to the memory clinic. Results of the assessment within the first year of the COVID-19 pandemic have been published previously (29). Briefly, the questionnaire collected general information about the respondent's living situation (living alone or with a partner or family), marital status, and caregiving situation, as well as the date the questionnaire was completed. Questions on changes in social living (social factors) and on emotional well-being (emotional factors) since the beginning of the COVID-19 pandemic have been rated on a three-part ordinal scale ranging from 0-2 (0 = absent, 1 = sometimes present/occasionally, 2 = frequently present).

2.5 Assessment of emotional factors including newly occurring loneliness associated with the COVID-19 pandemic

The questionnaire assessed changes of emotional factors since the beginning of the COVID-19 pandemic and the timing of filling in the questionnaire. It included questions on pandemic-associated changes in emotional symptoms such as loneliness, anxiety, stress and concerns for self and loved ones associated with the COVID-19 pandemic. Study participants were asked to rate every question on emotional factors on the three-part ordinal scale ranging from 0-2. Newly occurring loneliness was assessed by the question: "Did you feel lonely for the first time since the start of the COVID-19 pandemic in March 2020?". People who reported suffering from occasional or frequent loneliness since the beginning of the COVID-19 pandemic were included in the loneliness "yes" group. Details of the COVID-19 questionnaire for patients on the impact of the COVID-19 pandemic (English translation from German) are presented in S3.

2.6 Assessment of social factors associated with the COVID-19 pandemic

The questionnaire assessed changes of social factors since the beginning of the COVID-19 pandemic and the timing of filling in the questionnaire. It included questions about pandemic-related changes, such as face-to-face, telephone, or digital contact with friends and family, participation in events, and the occurrence of disputes. Participants were asked to rate each emotional factor question on a three-point ordinal scale from 0 to 2.

2.7 Assessment of neuropsychological functioning

Within the clinical routine at the memory clinic, all study participants completed a comprehensive neuropsychological test battery including subtests of the "Consortium to Establish a Registry for Alzheimer's Disease" (CERAD) battery (33), as well as the Mini-Mental State Examination (MMSE) (34). Results of the MMSE were used as cognitive measure for statistical analysis.

2.8 Assessment of neuropsychiatric functioning and depression

The frequency (range: 0-4 points), severity (1-3 points), and emerging caregiver burden (0-5 points) of twelve neuropsychiatric

and behavioral symptoms were assessed using the Neuropsychiatric Inventory (NPI) (35). Depressive symptoms were assessed using the 30-items version of the Geriatric Depression Scale (GDS) (36).

2.9 Statistical analysis

Statistical analysis was conducted with R (version 4.2) and IBM SPSS (version 29). The significance level was set to $\alpha = 5\%$. The analytical focus was placed on a comparison of the patients diagnosed as cognitive intact, with MCI, and with dementia regarding demographic, clinical characteristics, time of assessment, loneliness, emotional and social factors. These patient groups were compared by means of Kruskal-Wallis Test for metric variables and Chi-square test for categorical variables. *Post-hoc* comparisons were adjusted by Dunn-Bonferroni method. Additionally, we were interested in investigating differences between patients who reported feeling lonely since the COVID-19 pandemic with those who did not. Therefore, the Mann-Whitney-U test and spearman correlation for metric variables and again, the Chi-square test for categorical variables was employed.

Principal component analysis (PCA) with orthogonal Varimax rotation was used to reduce the number of variables from the social factor questionnaire. The threshold for the Eigenvalue was set to ≥ 1, the threshold for the measure of sampling adequacy was set to ≥ 0.5 for the assessment of individual indicators, the Kaiser-Meyer-Olkin criteria was used to evaluate if the overall data is suitable for PCA. By means of Bartlett's test, sphericity was tested. Extracted factors were than generated by combining the respective items to a scale, consecutively assessing the scale's reliability with McDonald's Omega (ω). Subsequently, the two social scales and item 8 were then entered as independent variables into the logistic regression model.

Initially, a univariate binary logistic regression was conducted, using the dependent variable of newly occurring loneliness "yes" and potential predictor variables (demographic and social factors) as inputs. Independent variables attaining a p-value below 0.15 were also included in the multivariable logistic regression analysis. The goodness-of-fit was assessed with the Hosmer-Lemeshow-test. Reported Odds Ratios (OR) with a 95% confidence interval including a value of 1.0 indicate that there is no association between the respective independent variable and newly occurring loneliness since the start of the COVID-19 pandemic. An OR < 1.0 indicates decreased odds for the occurrence of feeling lonely, whereas an OR > 1.0 indicates increased odds for the newly occurrence of loneliness. For the visualization of the variables effects, a forest-plot was generated.

3 Results

Between May 2020 and September 2022, 560 patients meeting inclusion and exclusion criteria came to the Memory Clinic (Department of Psychiatry I) of the Medical University of Innsbruck for an appointment to assess memory complaints or as part of their regular routine check-up. The survey was conducted between 11th May 2020 and 30th September 2022. Out of this sample, 471 individuals (84.1%) completed the COVID-19 questionnaire. Thirty-eight questionnaires were excluded from statistical analysis due to >15% missing items. Finally, the data of 433 individuals (mean age 76.51> 15% years, SD 9.40, range 65-91) could be included in the analyses. Of all people who visited our memory clinic during the study period, a valid response rate of 76.1% was achieved.

Baseline clinical and demographic data of study participants are summarized in Table 1. Of the 433 participants 63 (14.5%) were cognitively intact, 158 (36.9%) were diagnosed with MCI, and 212 (48.6%) were diagnosed with dementia (170 AD, 26 VD, 16 dementia with other etiology). Sex distribution, living situation, and marital status were balanced between groups. Age and education were highest and MMSE scores were lowest in the dementia group. The GDS score was highest in the MCI group. The dementia group had the highest NPI scores.

3.1 Analysis of non-responders and excluded questionnaires

Of the 560 individuals who were scheduled to visit the Memory Clinic during the study period, 89 (5 CI, 11 MCI, 73 DEM) did not complete the COVID-19 questionnaires but underwent clinical and neuropsychological testing. The most common reasons for not completing the questionnaire were that they had forgotten to fill it out, did not understand the questions, or felt overwhelmed by the questions. A minority of respondents were annoyed by the questionnaire. Responding and non-responding individuals showed no significant differences in terms of cognitive, demographic or social variables. Another 38 questionnaires were excluded from statistical analysis due to >15% of missing items.

3.2 New occurrence of loneliness and demographics, cognitive and behavioral symptoms, living and care situation

In total, 98 study participants (22.6%) reported on newly occurring loneliness since the beginning of the COVID-19 pandemic in March 2020.

The group comparison showed significant overall differences for the variables sex, living situation, material status and care situation. Results showed a significantly higher percentage of newly occurring loneliness in women compared to men and in individuals living alone compared to those living with a partner or family. Only 14% of married participants but more than 30% of widowed, single and divorced/separated participants reported newly occurrence of loneliness since the beginning of the COVID-19 pandemic. Study participants with newly occurring loneliness were lower educated and achieved higher scores in the GDS and in the NPI. Care situation, age, and MMSE scores were not associated with newly occurring loneliness. Detailed results are presented in Table 2.

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TABLE 1 Clinical and demographic characteristics and social factors of the study sample.

Patients characteristics	Total N=433	Groups CI N=63	MCI N=158	DEM N=212	Test statistic[a]	df	*p*-value	*Post-hoc*-test[b]
	Mean ± SD (%)							
Age (y)	76.51 ± 9.40	71.08 ± 9.98	73.34 ± 10.41	80.49 ± 6.23	*H*=76.838	2	<0.001	DEM*** > MCI, CI
Education (y)	10.79 ± 2.86	11.44 ± 2.44	10.99 ± 3.02	10.45 ± 2.81	*H*=15.402	2	<0.001	DEM*** < CI
MMSE total score	23.76 ± 5.69	29.05 ± 1.36	26.52 ± 2.86	20.05 ± 5.67	*H*=227.011	2	<0.001	DEM*** < MCI***< CI***
GDS total score	9.76 ± 6.27	9.29 ± 6.14	11.25 ± .10	8.78 ± 5.41	*H*=7.582	2	0.023	MCI* > DEM
NPI total score	9.47 ± 9.82	5.36 ± 6.05	8.96 ± 7.72	10.96 ± 11.53	*H*=10.675	2	0.005	DEM**> CI, CI*<MCI
Male	153 (35.3)	25 (39.7)	54 (34.2)	74 (34.9)	χ^2 = 0.631	2	0.729	
Female	280 (64.7)	38 (60.3)	104 (65.8)	138 (65.1)				
Living situation								
Alone	154 (35.6)	20 (31.7)	58 (36.7)	76 (35.8)	χ^2 = 0.499	2	0.779	
With partner/family	279 (64.4)	43 (68.3)	9100 (63.3)	136 (64.2)				
Marital status								
Single	41 (9.5)	7 (11.1)	18 (11.4)	16 (7.5)	χ^2 =10.666	6	0.099	
Married	216 (50.3)	38 (60.3)	81 (51.3)	99 (47.7)				
Divorced/Separated	57 (13.2)	9 (14.3)	21 (13.3)	27 (12.7)				
Widowed	117 (27.0)	9 (14.3)	38 (24.1)	70 (33.0)				
Care situation								
No	228 (25.7)	56 (88.9)	107 (67.7)	65 (30.7)	χ^2 =99.384	8	<0.001	
Outpatient care	76 (17.6)	2 (3.2)	12 (7.6)	62 (29.2)				
24h care	15 (3.5)	1 (1.6)	2 (1.3)	12 (5.7)				
Day care	4 (0.9)	0 (0)	3 (1.9)	1 (0.5)				
Family care	110 (25.4)	4 (6.3)	34 (21.5)	72 (34.0)				

[a]Kruskal-Wallis test was used for metric and Chi-square test for nominal variables.
[b]Dunn-Bonferroni-Test corrected for multiple comparison.
*p<0.05, **p<0.01, ***p < 0.001.
SD, standard deviation; CI, cognitively intact; MCI, Mild Cognitive Impairment; DEM, dementia; DEP, depression; MMSE, Mini Mental State Examination; GDS, Geriatric Depression Scale; NPI, Neuropsychiatric Inventory.

3.3 Newly occurring loneliness and its association with social factors, cognition, depression, and age

A comparison of study participants with vs. without newly occurring loneliness revealed higher scores in all social factors measured in the former group with the exception of "communication via video telephony or social media" and "helping others more often". Correlation analysis showed that the reporting of a higher frequency of communication via video telephony or social media was associated with higher MMSE scores, higher GDS scores, higher education and lower age. More active phone contacts were associated with a higher MMSE scores and younger age. More disputes with family members or friends was associated with higher NPI scores and lower age. In contrast, helping others more often was associated with lower age, higher MMSE score and higher education. For details see Table 3 and Supplementary Table S1.

3.4 Group comparison of newly occurring loneliness and other emotional factors

The assessment of loneliness was part of the emotional factor questionnaire. The group comparison showed highest scores of newly occurring loneliness in MCI patients followed by dementia

TABLE 2 Comparison of demographic, cognitive and behavioral symptoms, living and care situation of study participants with and without newly occurring loneliness.

Patients characteristics	Newly occurring loneliness since the beginning of the pandemic in March 2020		Test statistic[a]	df	p-value
	(yes) N=98	(no) N=335			
	Mean ± SD				
Age (y)	75.29 ± 9.67	76.87 ± 9.31	Z= -1.427	—	0.154
Education (y)	9.82 ± 2.19	11.07 ± 2.96	Z= -3.793	—	<0.001
MMSE total score	23.08 ± 5.89	23.95 ± 5.63	Z= -1.480	—	0.139
GDS total score	12.87 ± 6.74	8.92 ± 5.87	Z= -4.515	—	<0.001
NPI total score	12.09 ± 7.67	8.73 ± 10.23	Z= -4.444	—	<0.001
	N/%				
Diagnosis groups					
CI	9 (9.2)	54 (16.1)	χ^2 =4.507	2	0.105
MCI	43 (43.9)	115 (34.3)			
DEM	46 (46.9)	166 (49.6)			
Sex					
Male	20 (20.4)	133 (39.7)	χ^2 =12.352	1	<0.001
Female	78 (79.6)	202 (60.3)			
Living situation					
Alone	63 (64.3)	91 (27.2)	χ^2=45.592	1	<0.001
With partner/family	35 (35.7)	244 (72.8)			
Marital status					
Single	12 (12.2)	29 (8.7)	χ^2 =16.177	3	<0.001
Married	32 (32.7)	186 (55.5)			
Divorced/separated	19 (19.4)	38 (11.3)			
Widowed	35 (35.7)	82 (24.5)			
Care situation					
No	42 (42.9)	186(55.5)	χ^2 =8.824	4	0.066
Outpatient care	23 (23.5)	53 (15.8)			
24h care	6 (6.1)	9 (2.7)			
Day care	0 (0)	4 (1.2)			
Family care	27 (27.6)	83 (24.8)			

[a]Mann-Whitney U-test was used for metric and Chi-square test for nominal variables.
SD, standard deviation; MMSE, Mini Mental State Examination; GDS, Geriatric Depression Scale; NPI, Neuropsychiatric Inventory.

and cognitively intact participants. Group comparisons of participants who rated new-onset loneliness as sometimes or often present vs. never present showed no differences between diagnostic groups. Analysis of the occurrence of different other emotional symptoms showed significant between-group differences in terms of feeling burdened and anxious with highest rates in MCI patients. Further, dementia patients achieved the highest ratings in terms of feeling safe and secure. Details of between-group comparison of newly occurring loneliness and emotional factors are presented in Supplementary Table S2.

3.5 Correlation of social and emotional factors with time of assessment

The COVID-19 questionnaire was completed 1 to 29 month after the beginning of the COVID-19 pandemic in Austria. 8-25

TABLE 3 Comparison of newly occurring loneliness and social factors and its correlation with cognition, behavior, mood and demographics.

Question: Did you have the following consequences due to the COVID-19 pandemic starting in March 2020 on an social level?	Newly occurring loneliness since the beginning of the pandemic in March 2020			Mann-Whitney U-test		Spearman correlation with total score				
	total N=433	yes N=98	no N=355			MMSE total score	GDS total score	NPI total score	Age (y)	Education (y)
	Mean ± SD Range 0-2[a]			Test statistic	*p*-value	ρ	ρ	ρ	ρ	ρ
I had less contact with friends	1.27 ± 0.75	1.56 ± 0.64	1.18 ± 0.76	Z =-4.415	<0.001	-0.071	0.042	0.043	-0.091	-0.036
I had less contact with family members	1.01 ± 0.77	1.33 ± 0.78	0.92 ± 0.74	Z =-4.629	<0.001	-0.089	0.035	0.004	-0.066	-0.017
I could not participate in events	0.93 ± 0.86	1.15 ± 0.88	0.86 ± 0.84	Z =-2.905	0.004	0.055	0.064	-0.026	-0.012	-0.088
I helped others more often	0.26 ± 0.54	0.20 ± 0.45	0.27 ± 0.56	Z =-0.748	0.455	0.207***	0.103	-0.009	-0.276***	0.114*
I called others more often	0.74 ± 0.77	0.98 ± 0.82	0.67 ± 0.75	Z =-3.325	<0.001	0.178***	0.080	-0.003	-0.156***	-0.015
I was called less often	0.42 ± 0.64	0.58 ± 0.72	0.38 ± 0.61	Z =-2.38	0.006	-0.033	0.113*	0.015	-0.079	-0.012
I have communicated with video calls and/or social media	0.46 ± 0.74	0.51 ± 0.78	0.44 ± 0.73	Z =-0.774	0.439	0.364***	0.113*	-0.032	-0.487***	0.120*
I had more disputes with family members or friends	0.23 ± 0.52	0.33 ± 0.61	0.21 ± 0.48	Z =-1.968	0.049	-0.056	0.092	0.228***	-0.116*	-0.034
I have felt more social cohesion	0.65 ± 0.74	0.49 ± 0.65	0.69 ± 0.76	Z =2.183	0.029	0.088	-0.033	-0.027	-0.061	-0.030

[a]0 = never, 1 = occasionally, 2 = frequently, *p<0.05, ***p < 0.001.
SD, standard deviation; MMSE, Mini Mental State Examination; GDS, Geriatric Depression Scale; NPI, Neuropsychiatric Inventory.

(mean 15) questionnaires were filled in per month. The regional lockdown policy in Austria included a first hard lockdown from 16 March to 1 April 2020 with gradual easing of restrictions until 1 May 2020, a second "light" lockdown with some restrictions from 21 September 2020 to 3 November 2020, and two further strict lockdowns from 17 November to 6 December 2020 and from 26 December 2020 to 7 February 2021. From 19 May 2021 to 26 July 2022, so-called "3G restrictions" (requirement of either COVID-19 immunization, a negative COVID-19 test, or a recent COVID-19 infection) were active. A strict lockdown was imposed in Austria for a total of 10 weeks. Correlation analysis of social factors with month of assessment revealed a negative correlation of communication via video telephony or social media (Pearsons-correlation, p= 0.021, r = - 0.111) in all diagnosis group and of the feeling of social cohesion only in dementia patients (Pearsons-correlation, p= 0.005, r = -0.198). Correlation analysis of emotional factors with month of assessment showed a positive correlation of worsening of memory complaints (Pearsons-correlation, p= 0.015, r = 0.193) and the occurrence of nightmares (Pearsons-correlation, p= 0.003, r = 0.232) solely in MCI patients. Reported increase of burden due to the COVID-19 pandemic (Pearsons-correlation, p= 0.046, r = -0.252) showed a negative correlation with month of assessment solely in the cognitively intact participants. All other social and emotional factors as well as loneliness showed no association with time of questionnaire completion.

3.6 Principal component analysis of the social factor questionnaire

In total, 401 out of 433 cases were used for the PCA. The measures of sampling adequacy ranged between 0.62 and 0.79, indicating satisfactory values. The Kaiser-Meyer-Olkin criteria was 0.68, Bartlett's test was statistically significant (χ^2 (36) = 416.28, p < 0.001). Initially, three components have been extracted (Table 4) explaining a total variance of 52.9%. We then calculated the three components scales: scale one consisted of item 1, 2, and 3; scale two consisted of item 4, 5, 6, and 7 and scale three, item 8 and 9. Scale's reliabilities was not satisfactory for the third scale (ω = 0.170). Next, a two component solution was generated explaining a total variance of 41.5% (Table 4). Due to a weak loading on component one, the item 8 has been excluded from the scale building procedure, hence the social factors scale (one) scale one was generated with items 1, 2, 3, and 9; scale two with item 4, 5, 6, and 7, both with satisfactory internal and social factors scale (two) consistency. These two scales

and item 8 (after dichotomization) were then used as independent variables within the logistic regression analysis.

3.7 Predictors of newly occurring loneliness: results of univariate and multivariable logistic regression analysis

Univariate logistic regression analysis showed, that the second social factors scale did not attain a p-value below 0.15 ($p = 0.632$), therefore it was not included in the multivariable analysis. In total, 410 cases were included in the analysis investigate the joint effect of independent variables on feelings of loneliness. Results including a forest-plot are presented in Figure 1. Compared to the null-model there was a statistically significant increment in predictive value due to the inclusion of the independent variables ($\chi^2[15] = 95.68$, $p < 0.001$; Nagelkerke $R^2 = 0.317$; correct classification = 81.5%), the goodness-of-fit assessed with the Hosmer-Lemeshow-test ($\chi^2[8] = 9.00$, $p = 0.343$) was satisfactory. Since the "day care" category from the care situation variable included four cases only, the OR obtained in the analysis was undetermined due to almost complete separation [for details see: Heinze, 2006 (37)].

Results indicate that patients living alone are 6.25 times more likely that feelings of loneliness occurred, compared to patients living with their family, friends or within a residential home. Additionally, patients with higher scores on the first social factors scale were more likely to experience loneliness during the measurement period. Having at least sometimes disputes with family members or friends was also associated with higher odds experiencing feelings of loneliness. Although this effect appears to be strong, a wide confidence interval indicates that it could be much weaker or stronger. Marital status, diagnosis and care situation were no significant predictors.

4 Discussion

This prospective, observational, questionnaire-based study examined the impact of the COVID-19 pandemic and its limitations on newly occurring loneliness and factors related to social isolation in a memory clinic population between the pandemic beginning in March 2020 and September 2022. To this end, we assessed the perspective of older people with and without cognitive disorders on e.g. social and emotional factors during the first two and a half years of the pandemic. Further, we explored the relationship between the use of digital communication media as an alternative strategy for social interaction and cognitive deficits as well as patients' living situation.

As expected, clinical and demographic characteristics of the study sample revealed mild to moderate cognitive deficits in approximately 80% of participants according to a diagnosis of MCI or dementia with the highest prevalence of AD. Although the gender distribution was comparable between diagnostic groups, the almost double proportion of women in the MCI and dementia groups is consistent with data from the literature (38). Similarly, a recent report by Livingston et al. corroborates the lowest level of education found in dementia patients (39).

Pre-pandemic studies assessing the prevalence of loneliness in the high aged population are heterogeneous and report that approximately 5% to 50% of individuals aged over 60 experience some degree of loneliness in the course of life (40). In line with these findings, 22.6% of our sample reported newly occurring loneliness since the beginning of the COVID-19 pandemic. Notably, this subgroup was predominantly female, had a lower level of education, lived more often alone, and reported less personal social contacts compared to the remaining group. In more detail, regression analysis revealed that living alone and social factors such as having less contact with the family and friends, less participating in events, and having many disputes with family members or friends since the beginning of the COVID-19 pandemic were significant predictors of newly occurring loneliness. Again, these results are in line with pre-pandemic data that had reported an increased risk for loneliness among older females living alone and having little social relationships (15, 16, 18, 41, 42).

In contrast to our data, most large studies assessing loneliness in the general population in Europe used online surveys and/or did not provide detailed information on clinical data and pre-diagnosed neurocognitive disorders (41–44). A recent meta-analysis of studies conducted in low- and middle-income countries reported an association between MCI and loneliness (45). However, the high

TABLE 4 Results of rotated component matrix showing the tree and two component solution of social factors.

Social Factor Questionnaire Items	Component					
	1		2		3	
1. I had less contact with friends (SFS-1)	.834	*.845*				
2. I had less contact with family members (SFS-1)	.782	*.792*				
3. I could not participate in events (SFS-1)	.643	*.652*				
4. I helped others more often (SFS-2)			.645	*.644*		
5. I called others more often (SFS-2)	.313	*.339*	.623	*.640*		
6. I have communicated with video calls and/or social media (SFS-2)			.613	*.617*		
7. I have felt more social cohesion (SFS-2)			.598	*.586*		
8. I had more disputes with family members or friends	.265				*.913*	
9. I was called less often (SFS-1)	.483	*.359*			*.485*	
Reliability: ω	.681	*.702*	.502	*.502*	*.170*	

SFS-1, Social factors scale one; SFS-2, Social factors scale two.
Italic figures represent the three component solution, non-italic figures represent the two factor solution.

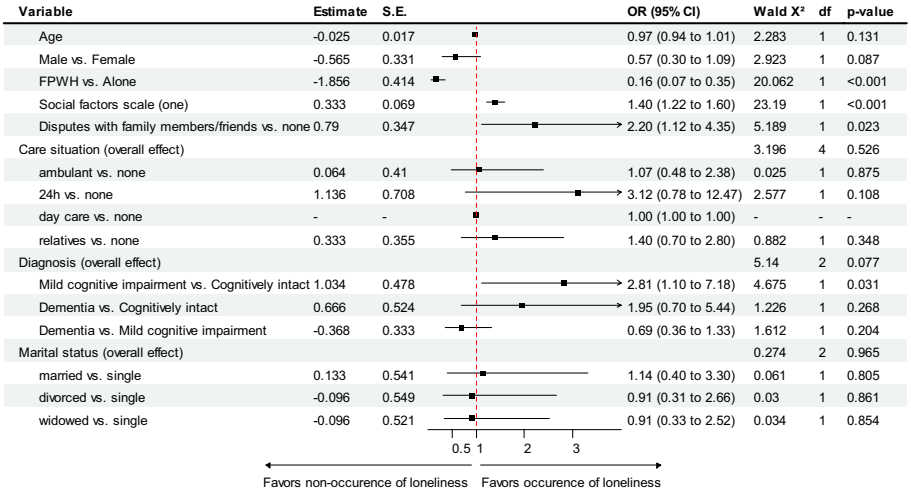

FIGURE 1
Predictors of newly occurring loneliness following the beginning of the COVID-19 pandemic – results of multivariable logistic regression analysis. FPWH = Living with family, partner or within a residential home, S.E. = Standard error, OR = Odds Ratio, df = degree of freedom, CI = Confidence interval.

rate of loneliness in dementia patients participating in the current study is only partially consistent with the literature (46). Some previous studies found that loneliness is a risk factor for dementia and cognitive decline (47–49), while others did neither find an association between cognitive functioning and loneliness nor higher rates of loneliness e.g. in AD patients (22). Clearly, patients with dementia are particularly prone to loneliness due to cognitive deficits and associated limited possibilities for a number of social activities. Accordingly, the high percentage of newly occurring loneliness in MCI and dementia patients due to the COVID-19 pandemic indicate a reduced ability to develop new coping strategies. It remains to be seen whether interventions which have previously been shown to increase mental health in adults such as supportive text message programs (e.g., Text4Hope) (50) may reduce loneliness and increase well-being in geriatric populations as well.

After the beginning of the pandemic, numerous studies focused on the possible negative impact of public health policy measures on older people (for review see (11, 51)). However, studies assessing the occurrence of loneliness in temporal relation to the beginning of the pandemic are scarce (52–54). Surprisingly, we found no change in the rate of newly occurring loneliness in the course of the assessment period of 29 month. However, MCI patients assessed later in the course of the pandemic reported more frequently nightmares and more memory problems since the beginning of the pandemic. We suggest, that MCI patients are high vulnerable to restrictions such as social distancing. Especially this group of people is still well able to counteract deficits through social, cognitive and physical activities and therefore may have lost a very high number their resources.

Previous studies addressing the fear of dying related to the COVID-19 pandemic are generally rare and have mostly been conducted at the beginning of the pandemic (55) or did not consider the older population (56). Contrary to our expectations, despite the availability of new treatment options and vaccination in the course of the pandemic, the fear of dying was very low in our study population independently of time of assessment and diagnosis. This study found that numerous social factors such as having less contact with family members and friends, less phone calls, and more disputes with family members or friends were associated with the new onset of loneliness in older adults. Social networks have been reported to be important in preventing social isolation and loneliness in people with AD (22) and a recent study found that feeling lonely, especially perceived lack of close relationships, was associated with an 18% increased risk of all-cause mortality in older adults living alone (57). Data of an International Social Survey Program published by Lay-Yee et al. reported that raising social cohesion may prevent loneliness (58), however, it remains to be seen, whether this is also true among patients with dementia.In line with previous publications (59), the use of digital communication media was more frequent in younger and higher educated study participants. We hypothesize that this may be caused by the fact that people with cognitive decline may have hindered the learning of digital alternative strategies for social interaction.

Although digital communication in general has the potential to improve the well-being of older adults, a recent Cochrane meta-analysis reported that the evidence for the effectiveness of digital communication via video calling interventions to reduce loneliness is highly uncertain (60). After the beginning of the pandemic, telemedicine has been shown to be helpful in dementia care. Nevertheless, the elderly population has always been considered "hard to reach" for digital technologies due to lack of interest or cognitive deficits. Our findings suggest that despite technological advances, the use of digital communication media is still not very widespread and is common among older people with cognitive decline. We suggest that digital communication may provide a number of benefits for older people to prevent social isolation.

4.1 Limitations and strengths:

One limitation of this study is its retrospective design, in which participants were asked to recall facts or symptoms from the past. Especially in a study population that includes patients with memory deficits, the validity of the data collected in this way may be limited. However, in order to address this recall bias, we excluded study participants with moderate or severe cognitive impairment as well as those with a high percentage of missing items. In addition, the clinical evaluation, cognitive testing, and completion of the COVID-19 questionnaire occurred at approximately the same time, allowing a good estimate of the validity of the data and responses. Another limitation is the single-center design and the inclusion of a highly selected population of memory clinics in one region of Austria. Therefore, our results cannot be generalized to the elderly population in general or to people living in other countries with different restrictions due to the pandemic. Furthermore, the association between new-onset loneliness and both emotional and behavioral symptoms cannot be established causally due to the lack of a control group. The assessment of newly occurring loneliness using a single question and not a validated questionnaire can be seen as a limitation but also as a strength of our study. Validated instruments include the risk of over-complexity for patients with cognitive deficits and we therefore decided to use a limited number of short and easy-to-understand questions directly related to the time of the pandemic to collect data related to different areas of everyday life and emotional and social state.

5 Conclusion

The COVID-19 pandemic has a significant negative impact on many areas of everyday life of the older population. Patients with cognitive decline who live alone are at high risk for both loneliness and social isolation, which, in turn, promote the worsening of cognitive deficits and behavioral symptoms. Personal contacts and a close friendship network more than digital communication appeared to be decisive new-onset loneliness in this study. It remains to be seen whether digital communication tools tailored to the individual needs e.g. of dementia patients may be helpful to counteract loneliness and social isolation.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Ethics Committee of the Medical University of Innsbruck, Austria. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

MD: Conceptualization, Data curation, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. TS: Data curation, Formal Analysis, Methodology, Writing – review & editing. AH: Writing – review & editing, Conceptualization, Supervision, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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A preliminary study on the neurocognitive deficits associated with loneliness in young adults

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The experience of loneliness is universal and may have an adverse effect on neurocognitive functioning even at a younger age. Using a comprehensive neurocognitive functioning test (NCFT) battery, we examined the possible negative effects of loneliness on neurocognitive functioning in young adults. The high-loneliness and low-loneliness groups were screened using the UCLA Loneliness Scale v. 3, and measures pertaining to the domains of intelligence, attention, memory, executive function, and psychomotor functioning were tested and compared. As depression and anxiety were significantly higher in the high-loneliness group, an analysis of covariance was conducted. As a result, the high-loneliness group showed significantly poor performance on measures of executive function and attention prior to controlling for depression and anxiety, and executive function retained its significance even after controlling for these variables. Additional analysis showed that depression and anxiety did not significantly mediate the relationship between loneliness and neurocognitive functioning. Such results suggest that loneliness is likely to negatively affect executive functioning and attention in early adulthood and then progressively spread to other domains of cognitive functioning, as reported in the older adult population. The limitations and implications of the present study were considered and addressed.

KEYWORDS

loneliness, neurocognitive functioning, executive function, attention, depression, young adults

Introduction

Positive emotional exchange with others is a source of happiness for most people. However, when this exchange does not sufficiently meet our needs and expectations, we often feel frustrated and lonely. In some cases, loneliness can accompany physiological changes and even somatic symptoms associated with depression (1). However, the impact of loneliness may be more profound, as past studies on the mostly older adult population have consistently reported that its negative effect may even extend to neurocognitive functioning (2). Vulnerability toward loneliness, however, is universal and exposure to chronic loneliness may have an adverse effect on neurocognitive functioning even at a younger age. Accordingly, we examined the possible negative effects of loneliness on neurocognitive functioning in the young adult population.

Loneliness has been found to be a significant risk factor for cognitive decline, such that the severity of loneliness was found to be inversely related to performance on cognitive tests (3). In a prospective study on the older adult population, those with high levels of loneliness showed significantly higher cognitive deficits compared with those with low levels of loneliness (4). Similarly, both chronic and transient loneliness were predictive of the negative

consequences for cognitive functioning and the health of the brain in the older adult population (5). The cognitive domains adversely affected by loneliness in the older adult population included memory, attention, language, and executive function (6, 7). Some inconsistencies in the results, nonetheless, are present such that some studies [e.g., (8)] have reported a bidirectional relationship between loneliness and cognition, while a prospective study by McHugh Power et al. (9) found that attention may affect loneliness but not vice versa. A recent meta-analysis of older adults without dementia (10) found that loneliness was associated with poorer global cognition, episodic memory, working memory, visuospatial function, processing speed, and semantic verbal fluency.

As described above, most past studies on the association between loneliness and neurocognitive functioning deficits have focused mostly on the older adult population. For example, a recent systematic review (11) that examined "the impact of social isolation and loneliness on memory in middle- and older-aged adults" in PubMed, Scopus, and PsycINFO databases until January 2022 found 11 studies whose minimum age of participants was 50 years and only 1 study with the age of the participants being ≥45 years. More recently, a few studies that extended their investigations to include middle-aged populations in their 40s have reported significant findings on the relationship between loneliness and cognitive functioning (12–16). Specifically, loneliness was linked with impairments in executive functioning (16) and memory (12, 13, 15, 16) but not in global cognition, verbal learning, and fluency (12). In this population, persistent loneliness has been found to be associated with smaller parietal, temporal, and hippocampus volumes, which are responsible for memory and executive dysfunction (16). In addition, a higher level of education has been identified as the mediating factor (12, 15) supporting the view that cognitive reserve may serve as a protective factor (17).

In contrast, the effect of loneliness on the neurocognitive functioning of the young adult population has not been extensively examined, even though this age group may be particularly vulnerable to loneliness (18). Loneliness in the younger population is likely to show significant relationships with a narrow band of deficits in neurocognitive functioning compared with the middle-aged counterpart because of the progressive nature of the deficits in cognitive functions (19). A study based on college students has reported the negative effect of loneliness on their social cognition, which caused biased information processing about social relationships and their outcomes (20). It is, however, unclear whether loneliness holds implications for other cognitive functions as found in their middle-aged counterparts.

The negative effect of depression has been examined more extensively in the younger population and may provide some insights since loneliness has been closely linked with depression (21). In general, the domains of attention, verbal memory, visual memory, verbal reasoning/knowledge, and IQ were found to be affected by depression (22). In a recent longitudinal study, depression and anger symptoms were found to be associated with declines in episodic memory and executive functioning (23). Such cognitive domains should be more vulnerable to the adverse effects of loneliness than others in this population, although the relationship between loneliness and depression is likely to be bidirectional (24). However, it should also be mentioned here that some studies have demonstrated that loneliness does not always lead to depression. For example, variables such as self-disgust have been identified to mediate between loneliness, depression, and anxiety (25), and positive coping styles have also been found to alleviate the effect of loneliness on depression (26, 27). Accordingly, in order to delineate the pure effect of loneliness on neurocognitive functioning in a young population, it may be essential to address the effect of depression and anxiety, which may mediate between loneliness and performance on neurocognitive functioning test (NCFT) battery (28, 29).

We, therefore, conducted a preliminary study on the effect of chronic loneliness in a university student population using a comprehensive neurocognitive functioning test battery, which included measures of general IQ, memory, attention, executive functioning, and psychomotor speed. These cognitive domains largely overlap those suggested by the American Psychiatric Association (30) to be considered when assessing cognitive functioning in mental disorders. And since the performance on these cognitive tasks is invariably affected by the emotional state of the subjects (31), we have controlled for depression and anxiety using an ANCOVA. In addition, we also carried out a *post-hoc* mediational analysis to examine the possible influence of those variables on the association between loneliness and cognitive deficits.

Methods

Participants

The study was conducted on an initial pool of 365 undergraduate students residing in Gwangju, Korea. The participants completed the initial survey, which included demographic information and psychological scales, including Russell's UCLA Loneliness Scale v. 3 [RULS v.3: (32, 33)]. Then, 2 months later, they were asked to complete RULS v.3 again. Only those who scored in either the highest or lowest quartiles of this scale at both times were asked to participate in additional NCFT, whereby three people were excluded because they were no longer in the top quartile. As a result, 33 (male = 45%) out of 99 (male = 41%, age = 20.90, SD = 2.29; RULS v.3 mean = 22.09, SD = 11.39, range 4 ~ 24) participants in the lowest quartile and 21 (male = 35%) out of 101 (male = 40%, age = 21.16, SD = 2.66; RULS v.3 mean = 38.24, SD = 7.52, range 27 ~ 57) participants in the highest quartile at the second measurement phase agreed to further procedure, respectively. There was no significant difference in terms of age, education, and gender ratio ($\chi^2 = 0.28$, n.s.) between the highest- and the lowest-quartile groups who took the NCFT (see Table 1). As a note, in the lowest quartile, there was no significant difference in the RULS v.3 score between those who agreed and those who refused to participate in the NCF testing ($t = 1.66$, n.s.), but in the highest quartile, those who agreed to NCF testing had a significantly lower RULS v.3 score than those who refused ($t = 2.53$*). There was no significant difference between those who agreed and those who refused to participate in age for both the highest quartile ($t = -0.12$, n.s.) and the lowest quartile ($t = 0.83$, n.s.), respectively. None of the participants reported being under treatment or medication for any psychiatric problems, and all were right-handed.

Procedure

This study was conducted with the approval of the research ethics committee of Chonnam National University (IRB No.:

TABLE 1 Group differences in Neuro-cognitive measures according to independent groups *t*-test or Mann-Whitney U test.

Variables		Possible Range	Cronbach's α	Low-Loneliness M(SD)	High-Loneliness M(SD)	*t or U*
Age (yrs.)				20.90 (2.29)	21.09 (2.18)	−0.29
Education (yrs.)				12.42 (0.79)	12.52 (0.98)	−0.41
Loneliness		0~60	*0.93*	15.58 (6.20)	35.38 (4.61)	−18.70***
Depression		0 ~ 60	*0.91*	10.27 (7.17)	24.67 (13.06)	−4.63**
Anxiety		20 ~ 80	*0.93*	27.12 (8.56)	37.85 (8.56)	−4.56**
IQ	K-WAIS Vocabulary	0 ~ 57	*0.65* *0.65*	39.97 (3.80)	40.10 (3.80)	−0.12
	Block design	0 ~ 66	*0.93*	55.70 (8.40)	53.00 (11.21)	1.09
Attention	K-WAIS Digit span forward	0 ~ 16	*0.85*	13.67 (1.65)	12.52 (1.75)	2.42*
	Digit symbol-coding	0 ~ 135	-	98.33 (17.15)	93.43 (14.85)	−1.50
Memory	ROCF Copy	0 ~ 36	*0.64* –	35.54 (0.65)	35.64 (0.59)	−0.91
	Immediate	0 ~ 36	–	27.89 (4.65)	26.50 (4.07)	−1.48
	Delayed	0 ~ 36	–	27.40 (5.05)	26.16 (3.72)	−1.71
	AVLT Immediate recall error	–	*0.77* –	0.18 (0.58)	0.23 (0.43)	−1.63
	Delayed recognition error	–	–	0.12 (0.33)	0.19 (0.51)	−0.18
Executive function	WCST Perseveration	–	–	41.06 (7.56)	46.33 (9.00)	−2.32*
	STROOP Word error	–	*0.70*	0.06 (0.24)	0.19 (0.40)	−1.36
	Color-word error	–		0.18 (0.53)	0.24 (0.54)	−0.51
	Color-nonword error	–		0.15 (0.44)	0.62 (0.74)	−2.69**
	Color-word mismatch error	–		0.36 (0.70)	1.05 (1.07)	−2.32*
	Interference error			0.30 (0.73)	0.86 (1.12)	−1.94†
Psycho-Motor	TMT A trial error	–	*0.38*	0.09 (0.29)	0.00 (0.00)	1.79
	B trial error	–		0.15 (0.44)	0.24 (0.54)	−0.57

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, †$p < 0.07$.
AVLT, Auditory Verbal Learning Test; IQ, General Intelligence; K-WAIS, Korean-Wechsler Intelligence Scale; ROCF, Rey-Osterrieth Complex Figure Drawing Test; TMT, Trail Making Test; WCST, Wisconsin Card Sorting Test.

1040198-160422-HR-027-03), and all procedures were administered after the participants had signed the written informed consent form.

Each participant first completed self-reported measures of depression and anxiety and subjective loneliness for a preliminary validation study on the RULS v.3 (32, 33). For the measure of depression, the Center for Epidemiologic Studies Depression Scale [CES-D: (34)], consisting of 20 items scored on a 4-point scale with higher scores indicating more severe levels of depression was used. The internal reliability of Cronbach's $\alpha = 0.93$ was obtained in our study. Anxiety was measured with the State–Trait Anxiety Inventory-X-2 [STAI-X-2: (35)], composed of 20 items rated on a 4-point scale, with a higher score indicating higher levels of trait anxiety. We obtained Cronbach's $\alpha = 0.91$ in our study. Finally, subjective loneliness was measured twice using RULS v.3 in a 2-month interval, whereby Cronbach's $\alpha = 0.95$ and $\alpha = 0.93$ were obtained, respectively. Only the participants with loneliness scores in the top and bottom quartiles in both measurement phases were asked to participate in the neurocognitive testing procedure. Those who agreed to participate were individually tested within 2 weeks using the neurocognitive functioning test battery, which consisted of and was sequenced as follows: (1) Block Design, (2) Auditory Verbal Learning Test [AVLT: (36)], (3) Rey-Osterrieth Complex Figure Drawing Test [ROCF: (37)], (4) Digit Span, (5) Trail Making Test-A and B [TMT-A, B: (38)], (6) Stroop Task (39), (7) Vocabulary, (8) Digit Symbol Coding Test, and (9) Wisconsin Card Sorting Test [WCST: (40)]. Among the test battery, the Block Design, Digit Span, Vocabulary, and Symbol Writing tests were taken from the Korean-Wechsler Intelligence Scale – fourth edition [K-WAIS-IV: (41)]. (For a detailed description of the NCFT battery and its normative data on the outcomes by groups, refer to Supplementary materials 1 and 2, respectively).

Statistical analysis

First, descriptive statistics were carried out on the performance of each group (Table 1), and the normality of the outcome measures was examined (see Supplementary material 2). For the measures with an abnormal distribution according to the Shapiro–Wilk test (42), we applied the Mann–Whitney U-test. Otherwise, we applied the independent group t-test. Accordingly, we found the high-loneliness group to have significantly higher scores in depression ($t = -4.63$, $p < 0.001$) and anxiety ($t = -4.56$, $p < 0.001$) than their low-loneliness counterparts (see Table 1). Hence, we further examined the group differences in the normally distributed variables found to be significant by carrying out the analysis of covariance (ANCOVA) controlling for depression, anxiety, and both, respectively. For those that did not meet the assumption of normality, we carried out the non-parametric Quade's ANCOVA (43). In addition, we carried out a *post-hoc* mediation analysis to examine the role of depression and anxiety in the association of loneliness and outcome variables that exhibited significant differences between the groups by using Hayes Process Macro (44) for normally distributed variables. As for the variables that did not meet the assumptions of normality, the robust bootstrap test ROBMED for mediation analysis was used (45) since it is less sensitive to deviations from model assumptions such as outliers and heavily tailed distributions. All statistical analyses were carried out with SPSS 28.0 (IBM SPSS, Armonk, NY).

Results

Group differences in neurocognitive functioning

Besides anxiety and depression, we found significant group differences in a number of neurocognitive measures. As shown in Table 1, the high-loneliness group showed poorer performance in the K-WAIS digit span forward trial compared with the low-loneliness counterpart ($t = 2.42^*$), which is related to attentional functioning. The high-loneliness group also showed significantly more WCST perseveration responses ($t = -2.32^*$), Stroop color/non-word trial errors ($U = -2.69^{**}$), and color/word mismatch trial errors ($U = -2.32^*$). These measures are largely associated with executive functioning.

Group comparison of neurocognitive functioning using analysis of covariance and non-parametric Quade's ANCOVA

For the significant variable whose assumption of normality was met (i.e., K-WAIS Digit Span Forward and WCST perseveration), we carried out an ANCOVA controlling for depression and anxiety on the neurocognitive variables. For non-normal measures (i.e., Stroop color-non-word error and color-word mismatch error), we applied Quade's non-parametric ANCOVA (43). As shown in Table 2, when controlling for depression, WCST perseveration and Stroop color/non-word error maintained their statistical significance. Controlling for anxiety, all variables retained their statistical significance except for the Stroop color/word mismatch error. Finally, when both depression and anxiety were controlled as covariates, WCST perseveration and Stroop color/non-word error still maintained their statistical significance.

Mediation effects of depression and/or anxiety between loneliness and neurocognitive functioning

As a result of conducting a *post-hoc* mediation analysis of depression and anxiety on the variables with significant group differences, we did not uncover any significant mediation effects of either variable on the relationships between loneliness and significant neurocognitive measures, respectively.

TABLE 2 Analysis of covariance (ANCOVA) or Quade's non-parametric ANCOVA on neurocognitive measures controlling for depression and/or anxiety.

Covariate	Dependent variable	SS	df	MS	*F*	*p*	η^2
Depression	WCST perseveration	291.33	1	291.33	4.31*	*0.04*	0.08
	K-WAIS digit span forward	10.01	1	10.01	3.44	*0.07*	0.06
	STROOP color/non-word error	699.02	1	699.02	5.26*	*0.03*	0.09
	Color/word mismatch error	586.28	1	586.28	3.30	*0.08*	0.06
Anxiety	WCST perseveration	274.11	1	276.14	4.08*	*0.05*	0.07
	K-WAIS digit span forward	12.77	1	12.77	4.39*	*0.04*	0.08
	STROOP color/non-word error	734.16	1	734.16	5.56*	*0.02*	0.10
	Color/word mismatch error	562.88	1	562.88	3.19	*0.08*	0.06
Depression + Anxiety	WCST perseveration	274.11	1	274.11	3.98*	*0.05*	0.07
	K-WAIS digit span forward	10.14	1	10.14	3.42	*0.07*	0.06
	STROOP color/non-word error	673.20	1	673.20	5.07*	*0.03*	0.09
	Color/word mismatch error	537.75	1	537.75	3.04	*0.09*	0.06

*$p < 0.05$, K-WAIS, Korean-Wechsler Intelligence Scale; WCST, Wisconsin Card Sorting Test.

Discussion

In this study, we examined whether loneliness may have significant implications on the mental functioning of a young population by using a comprehensive NCF test battery. In the initial analysis, the high-loneliness group showed more severe levels of depression and anxiety as well as poorer performance in measures related to executive functioning and attention, which was in line with previous findings on cognitive decline attributed to loneliness (7, 46). Even when controlling for depression and anxiety as covariates, the high-loneliness group showed significantly poorer performance in tasks related to executive functioning than their low-loneliness counterparts.

The neurocognitive variables that significantly differed between the high- and low-loneliness groups prior to controlling for depression and anxiety were K-WAIS Digit Span forward, WCST perseverative response, Stroop color-non-word error, and color/word mismatch error. These measures involve attentional functioning, which has also been reported to show deficits in depression (47).

The high-loneliness group showed significantly poorer performance in the WCST perseverative response and Stroop color-non-word error, even when depression and anxiety were controlled as covariates. The perseverative response in WCST reflects difficulty in set-shifting or an inability to recognize changes in the selection rule. The Stroop test, on the other hand, generally reflects accuracy in the processing of mismatching cues and controlled behavioral inhibition. The reason for the color/word mismatch error losing its statistical significance when controlled for depression and/or anxiety can be attributed to the limited sample and design of the study, besides the presence of their negative effects on performance. Our overall results suggest that young people high in loneliness may be more vulnerable to problems related to impulsive and addictive behaviors (48).

While we included measures of IQ, memory, and psychomotor functioning in our test battery, we did not obtain any significant group differences in these measures. Hence, it can be suggested that the negative impact of loneliness on cognitive functioning during early adulthood may begin with executive functioning and attention and then progressively spread to other domains of cognitive functioning, as reported in the older adult populations (6, 7). Future studies should apply more comprehensive measures of executive functioning and attention to various age groups to confirm our results.

In addition, we have controlled for depression and anxiety through the ANCOVA and carried out a separate mediational analysis on the effects of both variables on the association between loneliness and neurocognitive functioning, using non-parametric tests where appropriate. The results consistently confirmed that loneliness has a direct effect on the measures of executive functioning and attention, although the lack of a significant mediational effect of depression and anxiety should be confirmed in future research with a larger sample. Furthermore, studies to identify possible mediating variables between loneliness and neurocognitive functioning deficits may provide valuable implications for interventions to alleviate the negative effects of loneliness on cognitive functioning in the young adult population.

Finally, our study was one of the first investigations into the link between loneliness and cognitive functioning in a relatively young population using a comprehensive neurocognitive functioning test battery. Nonetheless, there are a few limitations of this preliminary study that should be considered when interpreting the results. First, our results should be confirmed using larger samples of different age groups and demographic backgrounds to ensure generalizability. Second, this study is cross-sectional in design, so caution should be taken when inferring causality between loneliness and neurocognitive functioning until further longitudinal studies have been conducted. Third, the measure of loneliness that we used is largely a subjective measure; hence, more objective measures of social isolation should be applied in future studies to validate our results. Finally, some measures in our battery may be overlapped and reflect more than one functional domain, e.g., the K-WAIS Digit Symbol Coding task may reflect both psychomotor speed and visual working memory. Future studies should aim to apply more refined measures of neurocognitive functioning to confirm and expand our results.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the research Ethics Committee of Chonnam National University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

EJ: Data curation, Formal analysis, Investigation, Writing – original draft. SH: Conceptualization, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2024.1371063/full#supplementary-material

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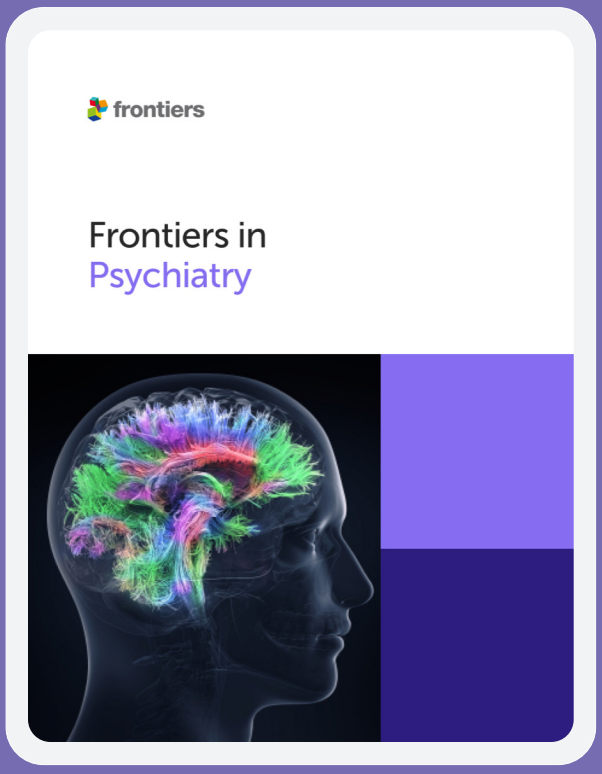

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