

Article

Does the Easing of COVID-19 Restrictive Measures Improve Loneliness Conditions? Evidence from Japan

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Abstract: Given the substantial changes in health and safety protocols and economic activities over the past year, socioeconomic routines have returned to a state of normalcy. Therefore, it is important to conduct a longitudinal study to determine whether these recent changes have left a lasting imprint on loneliness, specifically among those who have experienced post-pandemic loneliness in previous years. We investigated the incidence of loneliness and the risk factors associated with it during the post-pandemic period using recent data. We utilized longitudinal data spanning from 2020 to 2023 and employed mean comparison tests and weighted probit regression models in this analysis. Our study reveals that loneliness continues to be a notable issue, with persistent, post-pandemic, and recent loneliness rates of 47.6%, 4.3%, and 2.2%, respectively. We also observed a slight reduction in both persistent and post-pandemic loneliness compared to the previous year. Younger people continued to experience higher persistent loneliness rates, with no significant age or sex differences in post-pandemic or recent loneliness. Various factors, such as demographics, socioeconomic status, and psychological factors, influence loneliness differently across sexes and age groups. The policy implications include ongoing monitoring, targeted interventions, and support for specific demographic and socioeconomic groups to address post-pandemic loneliness for the sustainable management of the loneliness issue in Japan.



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1. Introduction

Numerous studies have investigated loneliness and the risk factors associated with it during the coronavirus disease 2019 (COVID-19) pandemic [1–3]. However, despite extensive research, conclusive longitudinal evidence for loneliness trends remains lacking. For instance, various meta-analyses and systematic reviews have indicated that loneliness may have increased slightly during the pandemic; however, these findings show heterogeneity across different subgroups [1,4]. Moreover, most studies included in these meta-analyses did not differentiate between persistent and new pandemic-induced loneliness when examining risk factors [1]. This distinction is critical for identifying individuals who were at risk of developing loneliness during the pandemic and formulating targeted interventions. In a longitudinal study conducted by Lal et al. [5] using Japanese data, 52% of the respondents experienced persistent loneliness, whereas 13% developed loneliness during the pandemic. However, recent changes in health and safety measures and economic activities, spurred by widespread vaccination and reduced hospitalization rates [6,7], have ushered in a return to a semblance of normalcy vis-à-vis socioeconomic life [7]. In this evolving context, there is a pressing need for longitudinal studies to assess whether recent changes in health and safety measures and socioeconomic conditions related to the pandemic have had a lasting impact on loneliness, particularly among those who have developed post-pandemic loneliness. The 2023 wave of a panel survey, the Hiroshima University Household Behavioral and

Financial Survey, offers a unique opportunity to examine longitudinal changes in persistent, post-pandemic, and newly developed loneliness in Japan.

Existing studies have produced inconsistent and inconclusive longitudinal evidence on loneliness during the pandemic. Ernst et al. [1] conducted a meta-analysis of 34 studies on pre- and during-pandemic loneliness, revealing a slight increase in loneliness across different sexes and age groups. However, the heterogeneity of the effects of the pandemic on loneliness requires further investigation. Similar findings of a longitudinal increase in loneliness were evident in a meta-analysis of 51 studies by Buecker and Horstmann [4], as well as in a smaller meta-analysis conducted by Prati and Mancini [8]. Some studies have examined loneliness among specific sex and age subgroups. Su et al. [3] conducted a meta-analysis of 30 studies on loneliness and social isolation among older adults and found a significant increase in prevalence during the pandemic. Farrell et al. [9] conducted a meta-analysis of 41 studies, indicating a substantial increase in loneliness among children and adolescents compared with the pre-pandemic period. These results align with the research by Ernst et al. [1], which also indicates a higher incidence of loneliness among adolescents. However, the longitudinal relationship between loneliness and well-being, among other factors, remains complex and heterogeneous. Studies on gender-based loneliness have been relatively less focused on and are more diverse. Even before the pandemic, inconsistencies in findings were noted; some studies reported greater loneliness among males [10,11], while others reported greater loneliness among females [12,13]. The variations in outcomes may be linked to age-related distinctions, as demonstrated by Maes et al.'s meta-analysis [14], which uncovered no gender disparities in middle-aged and older adult populations. In contrast, the findings indicated that, in young adult populations, men experienced higher levels of loneliness compared to women, while among children and adolescents, boys reported greater loneliness than girls. Gender-based loneliness patterns continued to exhibit inconsistencies during the pandemic. For instance, Ernst et al. [1] identified a longitudinal increase in loneliness among females compared to their male counterparts. However, other studies have found that the increase in loneliness is higher among males than among females [15,16]. Finally, geographical variations in the prevalence of loneliness were also observed. For instance, a meta-analysis and systematic review of loneliness studies across 113 countries revealed that adolescent loneliness was highest in the Eastern Mediterranean region, whereas loneliness among middle-aged and adult groups was most pronounced in Eastern European countries [17]. Overall, it remains unclear whether loneliness has increased during the pandemic, as studies have reported various possibilities, including stability, as well as increased and decreased loneliness levels [18–21].

In summary, existing studies have revealed significant heterogeneity in the longitudinal evidence of loneliness during the pandemic, particularly when considering age, gender, and location-based subgroups. Furthermore, there is a notable gap in the research on individuals who have developed post-pandemic loneliness and how they are gradually improving their health and socioeconomic landscapes. To address these gaps in the literature, we conducted a longitudinal study examining persistent, post-pandemic, and recent loneliness. Our investigation uses data from the 2023 wave of the Hiroshima University Household Behavioral and Financial Panel Survey. The research question is whether the ease of pandemic-related health safety and social isolation measures reduced loneliness. We hypothesize that individuals who experienced loneliness during different phases of the pandemic would experience a significant improvement in their well-being after having opportunities for social interaction and returning to their regular economic and social routines. This study contributes to the existing body of knowledge in two ways. First, it offers recent and up-to-date longitudinal evidence of loneliness among the Japanese population, thus facilitating the realization of a deeper understanding of evolving trends in loneliness. Second, it elucidated the conditions of individuals who experienced loneliness during the pandemic, allowing us to discern whether their loneliness was alleviated in response to recent developments in socioeconomic and health environments. Third, our

study has implications for a sustainable healthcare provision as long-term loneliness is a major risk factor for developing further mental health conditions.

2. Data and Methodology

2.1. Data

This study uses data from four consecutive waves of the Household Behavioral and Financial Survey conducted by Hiroshima University in 2020, 2021, 2022, and 2023. Nikkei Research, a distinguished research company in Japan renowned for its expertise, conducted the online panel survey. The representativeness of the panel data was upheld by taking into account essential socioeconomic, demographic, and psychological traits of the population. Additionally, participants were selected through a random sampling method. The study included respondents aged 20 years old. In all waves of the survey, due process was followed to ensure the validation of the survey questions and the reliability of the data. The survey was carried out in the context of the COVID-19 pandemic in four waves (2023, 2022, 2021, and 2020). The initial size of the sample in the four waves was as follows: 17,463 for the first wave, 6103 for the second wave, 4281 for the third wave, and 3410 for the fourth wave. Subsequently, the datasets were merged to exclude records with missing values related to socioeconomic variables such as employment status, financial literacy, household assets, and household income. The final sample comprised 2047 participants.

2.2. Variables

This study focuses on loneliness; its definition aligns with the UCLA methodology established by Hughes et al. [22]. In order to investigate the connection between loneliness and socioeconomic factors, we classified loneliness into four distinct categories: persistent loneliness, which denotes experiencing loneliness continuously over the course of four consecutive years; post-pandemic loneliness, representing the absence of loneliness prior to the pandemic, followed by experiencing loneliness during the pandemic; prolonged pandemic loneliness, indicating the absence of loneliness in the initial two years, followed by experiencing loneliness in the subsequent two years; and recent loneliness, indicating the absence of loneliness in the initial three years, followed by experiencing loneliness starting in 2023. The first three types were adapted from a study by Lal et al. [5].

Our study used various independent variables including demographic, socioeconomic, and psychological characteristics of the survey participants. Similar independent variables have been employed in previous studies, such as Khan and Kadoya [23], Khan et al. [2], and Lal et al. [5]. The definitions of the variables are presented in Table 1. Demographic variables such as sex, age, marital status, child-rearing status, living arrangements (living alone or with others), and geographic location were extracted from the data collected in the 2020 survey wave. Socioeconomic variables encompassing educational attainment, employment status, financial literacy, household income, and household assets were obtained from the datasets collected in 2020 and 2022. Additionally, we utilized financial literacy as a proxy measure for rational financial and health-related behavior. The remaining variables centered around subjective appraisals of health and financial conditions, including self-assessments of health, concerns about the future, contentment with financial circumstances, and a shortsighted perspective on the future.

Table 1. Definitions of variables.

Variables	Definition
Dependent variable	
Loneliness_persistent	Type of variable: Binary; 1 represents experiencing loneliness consistently across the years 2020, 2021, 2022, and 2023, and 0, otherwise.
Loneliness_post-pandemic	Type of variable: Binary; 1 represents the absence of loneliness in 2020, followed by the onset of loneliness in 2021, which persists in 2022 and 2023, and 0, otherwise.
Loneliness_prolonged pandemic	Type of variable: Binary; 1 represents the absence of loneliness in both 2020 and 2021, followed by the onset of loneliness in 2022 and its continuation in 2023, and 0, otherwise.
Loneliness_recent	Type of variable: Binary; 1 represents the absence of loneliness in the years 2020, 2021, and 2022, with the occurrence of loneliness in 2023, while 0, otherwise.
Independent variables	
Being male	Type of variable: Binary; 1 indicates male and 0 indicates female.
Age	Type of variable: continuous; actual age of respondents in 2023
Being divorced recently	Type of variable: Binary; 1 signifies a divorce occurring in 2023, while 0 indicates otherwise.
Having children	Type of variable: Binary; 1 represents having at least one child, while 0 indicates not having any children.
Living alone_started in 2023	Type of variable: Binary; 1 denotes that respondents initiated living alone in 2023, while 0 indicates otherwise.
Living_rural areas	Type of variable: Binary; 1 denotes residing in rural areas (excluding Tokyo special wards or government-designated city areas), while 0 indicates otherwise.
Educ	Type of variable: discrete; educational years
Employment_recently left	Type of variable: Binary; 1 indicates that the individual left a full-time job in 2023, while 0 signifies otherwise.
HHIncome	Type of variable: continuous; Yearly pre-tax household income, inclusive of bonuses. (unit: JPY)
HHIncome_log	Type of variable: continuous; Logarithmic transformation of the change in household income.
HHAssets	Type of variable: continuous; Household-held financial assets. (unit: JPY)
HHAssets_log	Type of variable: continuous; Logarithmic transformation of the change in household assets.
Fin_lit	Type of variable: continuous; Mean scores for responses to three financial literacy questions
Health conditions	Type of variable: ordinal, measured on a five-point scale where 1 indicates does not hold true at all and 5 indicates it is particularly true; Statement: “I am currently in good health and have maintained a general state of health over the past year”.
Change_health conditions	Type of variable: binary; 1 indicates experiencing deteriorating health conditions and 0, otherwise
Anxiety_future conditions	Type of variable: ordinal, measured on a five-point scale where 1 indicates does not hold true at all and 5 indicates it is particularly true; Statement: “I experience concerns about life beyond the age of 65” applies to individuals under the age of 65, while “I have concerns about the future” pertains to those who are 65 years or older.
Anxiety_future conditions_change	Type of variable: binary; 1 indicates increase in anxiety regarding the future and 0, otherwise.
Fin_satisfaction	Type of variable: ordinal, measured on a five-point scale where 1 indicates does not hold true at all and 5 indicates it is particularly true; Statement: “I am satisfied with my financial situation”.
Fin_satisfaction_change	Type of variable: binary; 1 indicates reducing financial satisfaction and 0, otherwise
Depression	Type of variable: ordinal, measured on a five-point scale where 1 indicates does not hold true at all and 5 indicates it is particularly true; Statement: “I frequently experience feelings of depression or have experienced them in the past year”.
Depression_change	Type of variable: binary; 1 indicates deteriorating depression and 0, otherwise
Shortsighted perspective on the future	Type of variable: ordinal, measured on a five-point scale where 1 indicates does not hold true at all and 5 indicates it is particularly true; Statement: “Considering the uncertainty of the future, dwelling on it may be futile”.

Note: Data on males, age, children living in rural areas, education, and financial literacy were retrieved from the 2020 wave.

2.3. Descriptive Statistics

Table 2 presents descriptive statistics for the main variables. The findings revealed that 48% of respondents experienced persistent loneliness, indicating that individuals who were lonely before the pandemic continued to grapple with it throughout the survey. Furthermore, 4%, 1%, and 2% of respondents experienced post-pandemic, prolonged pandemic, and recent loneliness, respectively. In terms of demographic characteristics, approximately 71% of the participants were male, with an average age of 56 years. Approximately 1.9% of participants were separated from their spouses, 60% had children, and 2.4% lived alone. Approximately 56% of respondents resided in rural areas. Regarding socioeconomic characteristics, participants had an average of 15 years of education, with 4.3% leaving full-time employment. The mean score for financial literacy was 0.71, and the average household income and assets were JPY 6.55 million and 24.1 million, respectively. In terms of psychological well-being, 25.5% of respondents rated their health as worse, whereas 27.4% expressed increased anxiety about the future. Additionally, 20.9% reported reduced satisfaction with their financial situation, while 25.8% noted heightened levels of depression, and the average score for their future was 2.65 out of 5.

Table 2. Descriptive statistics.

Variables	Mean/Frequency for Binary Variables	Std. Dev.	Min	Max
Dependent variable				
Loneliness_persistent	0.4763		0	1
Loneliness_post-pandemic	0.0429		0	1
Loneliness_prolonged pandemic	0.0097		0	1
Loneliness_recent	0.0219		0	1
Independent variables				
Being male	0.7107		0	1
Age	55.6360	12.2601	25	86
Being divorced recently	0.0185		0	1
Having children	0.5979		0	1
Living alone_started in 2023	0.0244		0	1
Living_rural areas	0.5603		0	1
Educ	15.0473	2.0886	9	21
Employment_recently left	0.0434		0	1
HHIncome	6,555,203	4,332,850	500,000	21,000,000
HHAssets	24,100,000	31,900,000	1,250,000	125,000,000
Fin_literacy	0.7160		0	1
Health conditions_change	0.2554		0	1
Anxiety_future conditions	0.2735		0	1
Anxiety_future conditions_change	0.2085		0	1
Depression_change	0.2584		0	1
Shortsighted perspective on the future	2.6511		1	5
Observation		2047		

The distributions of persistent, post-pandemic, prolonged pandemic, and recent loneliness according to sex and age are presented in Tables 3–6, respectively. We conducted Chi-square tests between young and old participants of the same sex and across sex and age groups for each dependent variable. Persistent loneliness varied significantly at the 99% confidence level. In particular, both men and women aged <65 years were more likely to experience persistent loneliness than older adults. Furthermore, a disparity by age was observed in post-pandemic loneliness, but only among females, with a higher percentage of younger than older participants. However, there were no statistically significant differences between people experiencing prolonged pandemic loneliness and those experiencing recent loneliness.

Table 3. The prevalence of persistent loneliness among various gender and age groups.

Loneliness_Persistent	Male		Female		Total
	64 Years of Younger	65 Years or Older	64 Years of Younger	65 Years or Older	
0	490	280	236	66	1072
	48.09%	64.22%	47.01%	73.33%	52.37%
	529	156	266	24	975
1	51.91%	35.78%	52.99%	26.67%	47.63%
Total	1019	436	502	90	2047
	100%	100%	100%	100%	100%
Mean difference	Chi squared = 31.90 ***		Chi squared = 21.16 ***		
	Chi squared = 53.68 ***				

Note: *** $p < 0.01$.**Table 4.** The prevalence of post-pandemic loneliness among different gender and age groups.

Loneliness_Post-Pandemic	Male		Female		Total
	64 Years of Younger	65 Years or Older	64 Years of Younger	65 Years or Older	
0	983 96.47%	415 95.18%	472 94.02%	89 98.89%	1959 95.70%
1	36 3.53%	21 4.82%	30 5.98%	1 1.11%	88 4.30%
Total	1019 100%	436 100%	502 100%	90 100%	2047 100%
Mean difference	Chi squared = 1.34		Chi squared = 3.64 *		
	Chi squared = 7.39 *				

Note: * $p < 0.1$.**Table 5.** The prevalence of prolonged-pandemic loneliness among different gender and age groups.

Loneliness_Prolonged-Pandemic	Male		Female		Total
	64 Years of Younger	65 Years or Older	64 Years of Younger	65 Years or Older	
0	1008	432	497	90	2027
	98.92%	99.08%	99.00%	100.00%	99.02%
1	11	4	5	0	20
	1.08%	0.92%	1.00%	0.00%	0.98%
Total	1019	436	502	90	2047
	100%	100%	100%	100%	100%
Mean difference	Chi squared = 0.08		Chi squared = 0.09		
	Chi squared = 1.02				

Table 6. The prevalence of recent loneliness among different gender and age groups.

Loneliness_Recent	Male		Female		Total
	64 Years of Younger	65 Years or Older	64 Years of Younger	65 Years or Older	
0	995	427	493	87	2002
	97.64%	97.94%	98.21%	9667.00%	97.80%
1	24	9	9	3	45
	2.36%	2.06%	1.79%	3.33%	2.20%
Total	1019	436	502	90	2047
	100%	100%	100%	100%	100%
Mean difference	Chi squared = 0.12		Chi squared = 0.91		
	Chi squared = 1.08				

2.4. Methods

We employed the following equations to examine the correlation between different forms of loneliness and the demographic, socioeconomic, and psychological characteristics of the participants:

$$Y_{1i} = f(X_i, \Delta X_i, \varepsilon_i), \quad (1)$$

$$Y_{2i} = f(X_i, \Delta X_i, \varepsilon_i), \quad (2)$$

$$Y_{3i} = f(X_i, \Delta X_i, \varepsilon_i), \quad (3)$$

$$\text{and } Y_{4i} = f(X_i, \Delta X_i, \varepsilon_i), \quad (4)$$

where Y_{1i} represents a measure of persistent loneliness from 2020 to 2023 of the i th participant; Y_{2i} is a measure of post-pandemic loneliness; Y_{3i} represents prolonged pandemic loneliness; Y_{4i} represents recent loneliness; X is a vector indicating the changes in demographic, socioeconomic, and psychological features of individuals; ΔX is a vector indicating the change in demographic, socioeconomic, and psychological features of individuals from 2020 to 2023; and ε is the error term. As the dependent variables were binary, we conducted a weighted logistic regression using sampling weights [2,5]. The sampling weights were calculated by dividing the total population of Japan by the sample population stratified by sex and age.

We conducted correlation and multicollinearity tests because our models were vulnerable to intercorrelation problems among the independent variables (results are available upon request). Our findings reveal weak correlations between the independent variables (substantially lower than 0.70) and no multicollinearity in our models (variance inflation factor < 3).

The change in the short-sighted perspective of the future was not used as an independent variable because the perception of the future usually does not change considerably over time. Instead, we used the respondents' shortsightedness regarding the future in 2023, 2022, 2021, and 2020 for the persistent, post-pandemic, prolonged-pandemic, and recent loneliness models, respectively. The complete specifications of Equations (1) through (4) are shown in Models (5) to (8), respectively. Our models are comparable to those of Lal et al. [5].

$$\begin{aligned} \text{Loneliness_persistent}_i &= \beta_0 + \beta_1 \text{being male}_i + \beta_2 \text{Age}_i + \beta_3 \text{being divorced recently}_i + \beta_4 \text{having children}_i \\ &+ \beta_5 \text{Living alone_started in 2023}_i + \beta_6 \text{living_rural areas}_i + \beta_7 \text{Educ}_i \\ &+ \beta_8 \text{employment_recently left}_i + \beta_9 \log_HHIncome_i + \beta_{10} \log_HHAssets_i + \beta_{11} \text{Fin_lit}_i \\ &+ \beta_{12} \text{health conditions_change}_i + \beta_{13} \text{anxiety_future conditions_change}_i \\ &+ \beta_{14} \text{fin_satisfaction_change}_i + \beta_{15} \text{depression_change}_i \\ &+ \beta_{16} \text{Shortsighted perspective on the future}_i + \varepsilon_i \end{aligned} \quad (5)$$

$$\begin{aligned} \text{Loneliness_post - pandemic}_i &= \beta_0 + \beta_1 \text{being male}_i + \beta_2 \text{Age}_i + \beta_3 \text{being divorced recently}_i + \beta_4 \text{having children}_i \\ &+ \beta_5 \text{Living alone_started in 2023}_i + \beta_6 \text{living_rural areas}_i + \beta_7 \text{Educ}_i \\ &+ \beta_8 \text{employment_recently left}_i + \beta_9 \log_HHIncome_i + \beta_{10} \log_HHAssets_i + \beta_{11} \text{Fin_lit}_i \\ &+ \beta_{12} \text{health conditions_change}_i + \beta_{13} \text{anxiety_future conditions_change}_i \\ &+ \beta_{14} \text{fin_satisfaction_change}_i + \beta_{15} \text{depression_change}_i \\ &+ \beta_{16} \text{Shortsighted perspective on the future}_i + \varepsilon_i \end{aligned} \quad (6)$$

$$\begin{aligned} \text{Loneliness_prolonged - pandemic}_i &= \beta_0 + \beta_1 \text{being male}_i + \beta_2 \text{Age}_i + \beta_3 \text{being divorced recently}_i + \beta_4 \text{having children}_i \\ &+ \beta_5 \text{Living alone_started in 2023}_i + \beta_6 \text{living_rural areas}_i + \beta_7 \text{Educ}_i \\ &+ \beta_8 \text{employment_recently left}_i + \beta_9 \log_HHIncome_i + \beta_{10} \log_HHAssets_i + \beta_{11} \text{Fin_lit}_i \\ &+ \beta_{12} \text{health conditions_change}_i + \beta_{13} \text{anxiety_future conditions_change}_i \\ &+ \beta_{14} \text{fin_satisfaction_change}_i + \beta_{15} \text{depression_change}_i \\ &+ \beta_{16} \text{Shortsighted perspective on the future}_i + \varepsilon_i \end{aligned} \quad (7)$$

$$\begin{aligned}
&Loneliness_recent_i \\
&= \beta_0 + \beta_1 being_male_i + \beta_2 Age_i + \beta_3 being_divorced_recently_i + \beta_4 having_children_i \\
&+ \beta_5 Living_alone_started_in_2023_i + \beta_6 living_rural_areas_i + \beta_7 Educ_i \\
&+ \beta_8 employment_recently_left_i + \beta_9 log_HHIncome_i + \beta_{10} log_HHAssets_i + \beta_{11} Fin_lit_i \\
&+ \beta_{12} health_conditions_change_i + \beta_{13} anxiety_future_conditions_change_i \\
&+ \beta_{14} fin_satisfaction_change_i + \beta_{15} depression_change_i \\
&+ \beta_{16} Shortsighted_perspective_on_the_future_i + \varepsilon_i
\end{aligned} \tag{8}$$

3. Results

We performed weighted logit regression analyses for the following four dependent variables: persistent, post-pandemic, prolonged-pandemic, and recent loneliness. This study was conducted to observe how changes in various demographic, socioeconomic, psychological, and health-related variables were associated with various conditions of loneliness. Table 7 presents the results of full-sample regression analysis. We found negative relationships for age and having children, and a positive relationship for shortsighted perspectives on the future with persistent loneliness; a negative relationship between age and a positive relationship of change in depression level with post-pandemic loneliness; positive relationships for being recently divorced and living in rural areas with prolonged pandemic loneliness; and a negative relationship between change in financial satisfaction and loneliness.

Table 7. Full sample regression results for persistent, post-pandemic, prolonged-pandemic, and recent loneliness.

Independent Variables	Dependent Variables			
	Persistent Loneliness	Post-Pandemic Loneliness	Prolonged-Pandemic Loneliness	Recent Loneliness
Being male	−0.191 (0.195)	−0.132 (0.281)	0.197 (0.598)	0.0225 (0.457)
Age	−0.0132 * (0.00720)	−0.0212 * (0.0110)	0.0203 (0.0284)	0.00986 (0.0152)
Being divorced recently	0.00811 (0.447)	−1.464 (1.112)	2.243 ** (1.002)	0.0598 (0.658)
Having children	−0.446 *** (0.124)	0.197 (0.303)	−0.157 (0.568)	−0.375 (0.373)
Living alone_started in 2023	−0.269 (0.472)	0.653 (0.924)	− (0.568)	−0.288 (0.618)
Living_rural areas	0.214 (0.153)	−0.368 (0.258)	1.306 ** (0.551)	0.286 (0.400)
Educ	0.0391 (0.0504)	−0.0293 (0.0833)	0.161 (0.126)	0.00215 (0.0785)
Employment_recently left	0.310 (0.286)	−0.204 (0.653)	1.105 (1.252)	0.371 (0.894)
Log_HHIncome	0.202 (0.148)	−0.293 (0.266)	0.170 (0.313)	0.173 (0.424)
Log_HHAssets	−0.151 (0.106)	−0.204 (0.160)	0.250 (0.211)	0.116 (0.285)
Fin_lit	0.302 (0.209)	−0.214 (0.418)	0.383 (0.786)	0.203 (0.781)
Health conditions_change	0.109 (0.145)	0.0497 (0.284)	−0.495 (0.820)	0.0736 (0.455)

Table 7. Cont.

Independent Variables	Dependent Variables			
	Persistent Loneliness	Post-Pandemic Loneliness	Prolonged-Pandemic Loneliness	Recent Loneliness
Anxiety_future conditions_change	−0.106 (0.144)	−0.0615 (0.310)	0.531 (0.544)	0.396 (0.402)
Fin_satisfaction_change	0.226 (0.157)	0.0295 (0.287)	−0.592 (0.723)	−0.993 * (0.523)
Depression_change	0.146 (0.145)	1.085 *** (0.280)	−0.377 (0.601)	0.123 (0.396)
Shortsighted perspective on the future	0.121 * (0.0629)	−0.0437 (0.134)	0.383 (0.351)	−0.133 (0.204)
Constant	−0.512 (1.161)	−1.621 (1.591)	−10.64 *** (3.538)	−4.122 *** (1.192)
Observations	2047	2047	1997	2047
Log likelihood	-5.980×10^7	-1.450×10^7	-3.912×10^6	-9.743×10^6
Chi2 statistics	50.92	30.89	79.69	18.55
p-value	$1.63 \times 10^{-0.5}$	0.0139	7.97×10^{-11}	0.293

Note: Robust standard errors are shown in parentheses. *** indicates statistical significance at the $p < 0.01$ level, ** at the $p < 0.05$ level, and * at the $p < 0.1$ level.

To further investigate the influence of age and sex on the relationship between loneliness and socioeconomic factors, we performed subsample analyses based on sex and age. Table 8 shows the regression outcomes of the sex-specific subgroup analysis. The findings indicate that having children is negatively linked to persistent loneliness, whereas a change in depression is positively associated with post-pandemic loneliness, irrespective of gender. Additionally, in the female subgroup, age showed a negative correlation with both post-pandemic and persistent loneliness, whereas having children was negatively linked to recent loneliness, residing in rural areas was negatively linked to post-pandemic loneliness, and educational attainment and leaving full-time employment were positively connected to prolonged pandemic loneliness. In the male subgroup, a change in health status was positively associated with persistent loneliness, and age and a short-term perspective of the future were positively related to prolonged pandemic loneliness.

Table 9 presents the regression findings of the sex-segregated subgroup analyses. These results demonstrate that having children is inversely linked to persistent loneliness and that the change in household assets is positively associated with recent loneliness across both younger and older subgroups. Additionally, in the younger subgroup, changes in household income and a myopic outlook were positively associated with persistent loneliness. Changes in depression were positively correlated with post-pandemic loneliness, while recent divorce was negatively linked. Living in rural areas and leaving full-time employment positively correlated with prolonged pandemic loneliness. In contrast, for the older subgroup, being male and having higher financial literacy were positively associated with post-pandemic loneliness. Changes in household assets and a myopic perspective on the future were positively linked to prolonged pandemic loneliness, whereas changes in household income were negatively associated. Education, changes in household income, and a myopic perspective of the future were negatively correlated with recent loneliness in the older subgroup.

Table 8. Subsample regression results for persistent, post-pandemic, prolonged-pandemic, and recent loneliness by sex.

Variables	Loneliness_Persistent		Loneliness_Post-Pandemic		Loneliness_Prolonged Pandemic		Loneliness_Recent	
	Male	Female	Male	Female	Male	Female	Male	Female
Age	−0.00802 (0.00863)	−0.0249 *** (0.00928)	−0.00611 (0.0141)	−0.0351 *** (0.0130)	0.0699 ** (0.0338)	−0.0317 (0.0295)	0.00604 (0.0187)	0.0215 (0.0185)
Being divorced recently	0.204 (0.552)	−0.0427 (0.603)	0.986 (1.008)	-	-	2.761 (1.795)	0.970 (0.625)	-
Having children	−0.309 ** (0.145)	−0.613 *** (0.201)	0.0424 (0.385)	0.231 (0.439)	−0.495 (0.589)	0.438 (1.295)	0.483 (0.412)	−1.271 * (0.680)
Living alone_started in 2023	0.184 (0.517)	−0.618 (0.692)	−0.907 (1.383)	1.069 (0.883)	-	-	0.207 (0.607)	-
Living_rural areas	0.173 (0.190)	0.139 (0.196)	−0.0842 (0.345)	−0.681 * (0.412)	0.313 (0.627)	-	−0.0389 (0.431)	0.817 (0.671)
Educ	0.0293 (0.0529)	−0.00233 (0.0609)	−0.120 (0.121)	0.0422 (0.113)	0.0719 (0.158)	0.342 *** (0.128)	−0.0752 (0.109)	0.120 (0.112)
Employment_recently left	0.250 (0.296)	0.285 (0.598)	0.352 (0.660)	-	-	2.876 * (1.483)	−1.002 (1.061)	1.471 (1.185)
Log_HHIncome	0.245 (0.195)	0.0873 (0.195)	−0.0533 (0.383)	−0.459 (0.328)	0.285 (0.507)	0.235 (0.703)	−0.0751 (0.874)	0.179 (0.494)
Log_HHAssets	−0.207 (0.127)	−0.0222 (0.136)	−0.0328 (0.239)	−0.285 (0.224)	0.530 (0.354)	0.210 (0.572)	0.256 (0.297)	0.00709 (0.471)
Fin_lit	0.507 (0.333)	0.189 (0.283)	0.743 (0.508)	−0.735 (0.650)	−0.498 (0.808)	1.452 (2.239)	0.148 (1.141)	0.334 (1.085)
Health conditions_change	0.304 * (0.184)	−0.0809 (0.216)	−0.198 (0.406)	0.388 (0.385)	-	0.700 (1.073)	0.473 (0.611)	−0.331 (0.701)
Anxiety_future conditions_change	−0.186 (0.179)	0.0118 (0.226)	0.258 (0.400)	−0.0938 (0.495)	−0.232 (0.607)	1.525 (1.318)	0.525 (0.408)	0.350 (0.751)
Fin_satisfaction_change	0.225 (0.197)	0.222 (0.260)	−0.365 (0.409)	0.256 (0.407)	−0.165 (0.780)	−0.0245 (1.062)	−0.786 (0.587)	−1.368 (1.185)
Depression_change	0.123 (0.184)	0.0934 (0.224)	0.675 * (0.389)	1.270 *** (0.422)	−0.642 (0.803)	0.125 (0.848)	−0.354 (0.456)	0.567 (0.617)
Shortsighted perspective on the future	0.214 *** (0.0725)	0.0311 (0.116)	0.00351 (0.166)	−0.158 (0.203)	0.711 (0.443)	0.0821 (0.451)	0.0808 (0.256)	−0.451 * (0.260)
Constant	−1.298 (1.480)	1.189 (1.157)	−1.891 (2.510)	−1.536 (1.671)	−11.10 ** (4.947)	−10.84 ** (4.881)	−3.641 ** (1.656)	−5.694 *** (2.027)
Observations	1455	592	1455	561	993	296	1455	568
Log likelihood	$-3.190 \times 10^{0.7}$	$-2.730 \times 10^{0.7}$	$-7.294 \times 10^{0.6}$	$-6.609 \times 10^{0.6}$	$-2.141 \times 10^{0.6}$	$-1.106 \times 10^{0.6}$	$-5.253 \times 10^{0.6}$	$-4.053 \times 10^{0.6}$
Chi2 statistics	32.50	30.51	17.16	39.15	21.12	72.66	25.13	50.62
p-value	0.00551	0.0102	0.309	0.000189	0.0321	2.59×10^{-10}	0.0483	$2.33 \times 10^{-0.6}$

Note: Robust standard errors are shown in parentheses. *** indicates statistical significance at the $p < 0.01$ level, ** at the $p < 0.05$ level, and * at the $p < 0.1$ level.

Table 9. Subsample regression results for persistent, post-pandemic, prolonged-pandemic, and recent loneliness by age group.

Variables	Persistent Loneliness		Post-Pandemic Loneliness		Prolonged Pandemic Loneliness		Recent Loneliness	
	Younger People	Older People	Younger People	Older People	Younger People	Older People	Younger People	Older People
Being male	−0.233 (0.174)	0.299 (0.363)	−0.416 (0.304)	1.650 ** (0.830)	−0.260 (0.568)	-	0.0171 (0.510)	0.452 (0.781)
Age	0.0158 (0.0109)	−0.0683 *** (0.0258)	−0.0103 (0.0172)	−0.0920 ** (0.0464)	0.0284 (0.0297)	0.439 * (0.257)	0.0105 (0.0261)	0.0140 (0.0901)
Being divorced recently	0.731 (0.511)	-	−0.630 (0.949)	-	2.503 ** (1.176)	-	0.691 (0.621)	-
Having children	−0.393 *** (0.125)	−0.799 ** (0.366)	0.205 (0.308)	−0.425 (0.675)	−0.0618 (0.600)	−2.516 (2.633)	−0.451 (0.383)	−0.0213 (0.876)
Living alone_started in 2023	−0.189 (0.473)	1.232 (1.199)	0.707 (0.840)	-	-	-	−0.215 (0.729)	-
Living_rural areas	0.254 (0.159)	0.00740 (0.276)	−0.449 (0.295)	−0.261 (0.497)	1.244 ** (0.554)	0.449 (0.756)	0.0849 (0.423)	0.783 (0.884)
Educ	0.00681 (0.0476)	0.0553 (0.0843)	−0.0424 (0.0946)	−0.0708 (0.138)	0.0363 (0.144)	0.402 (0.292)	0.111 (0.0917)	−0.338 * (0.176)
Employment_recently left	0.321 (0.394)	−0.109 (0.458)	-	0.506 (0.694)	2.129 ** (0.979)	-	1.280 (0.913)	-
Log_HHIncome	0.357 ** (0.162)	−0.321 (0.344)	−0.416 (0.344)	0.533 (0.583)	0.456 (0.341)	−3.791 *** (1.338)	0.292 (0.393)	−0.212 (0.801)
Log_HHAssets	−0.113 (0.108)	−0.190 (0.217)	−0.229 (0.172)	0.261 (0.368)	0.238 (0.212)	2.624 * (1.445)	0.574 ** (0.270)	−1.153 *** (0.422)
Fin_literacy	0.394 * (0.210)	−0.100 (0.492)	−0.474 (0.430)	1.766 * (1.013)	0.951 (0.985)	−2.186 (2.825)	0.891 (0.829)	−0.876 (1.160)
Health conditions_change	0.124 (0.156)	0.0295 (0.312)	0.294 (0.302)	−0.708 (0.755)	−0.321 (0.763)	-	−0.138 (0.483)	0.297 (0.729)
Anxiety_future conditions_change	−0.125 (0.148)	−0.219 (0.302)	−0.151 (0.349)	0.424 (0.526)	0.882 (0.548)	0.883 (1.046)	0.311 (0.497)	0.243 (0.654)
Fin_satisfaction_change	0.218 (0.169)	0.303 (0.354)	−0.0470 (0.324)	0.457 (0.500)	0.0310 (0.618)	-	−0.958 (0.615)	−2.149 (1.946)
Depression_change	0.225 (0.160)	0.103 (0.323)	1.074 *** (0.310)	0.996 (0.680)	0.0529 (0.565)	-	0.439 (0.466)	−0.457 (0.755)
Shortsighted perspective on the future	0.112 * (0.0674)	0.0997 (0.166)	−0.0959 (0.161)	0.166 (0.180)	−0.0663 (0.229)	2.865 ** (1.187)	0.0437 (0.244)	−0.590 * (0.355)
Constant	−1.334 (1.216)	3.553 (2.384)	−1.444 (1.957)	1.085 (4.378)	−8.360 *** (2.769)	−49.82 ** (23.12)	−6.951 *** (1.422)	1.278 (4.810)
Observations	1521	517	1475	513	1480	197	1521	470
Log likelihood	−4.190 × 10 ^{0.7}	−1.580 × 10 ^{0.7}	−1.100 × 10 ^{0.7}	−2.790 × 10 ^{0.6}	−2.628 × 10 ^{0.6}	−494,358	−5.988 × 10 ^{0.6}	−2.946 × 10 ^{0.6}
Chi2 statistics	27.95	22.87	31.80	86.67	18.09	62.35	28.08	28.08
p-value	0.0320	0.0870	0.00686	0	0.000712	0.0341	2.09 × 10 ^{−0.7}	0.00882

Note: Robust standard errors are shown in parentheses. *** indicates statistical significance at the $p < 0.01$ level, ** at the $p < 0.05$ level, and * at the $p < 0.1$ level.

4. Discussion

The study of the longitudinal evolution of loneliness during the pandemic period provides valuable insights into its dynamic nature and the correlation with changes in restrictive measures. In particular, understanding the well-being of individuals who experienced loneliness during the initial phase of the pandemic is crucial, including whether their loneliness improves with the relaxation of restrictive measures. Identifying trends and patterns helps us to recognize evolving risk factors associated with loneliness. Consequently, it facilitates the development of intervention programs by both the government and the communities.

Our study highlights the persistent prevalence of loneliness even when pandemic-related restrictions and safety measures have been eased. The prevalence rates of persistent, post-pandemic, and recent loneliness are 47.6%, 4.3%, and 2.2%, respectively. However, when we compared these results with those of Lal et al. [5], who analyzed the previous iteration of the same database, we observed a longitudinal decrease in the prevalence rates for all types of loneliness. This decrease is a positive indicator for the relaxation of restrictive measures. In particular, the reduction in post-pandemic and recent loneliness is pronounced, suggesting that fewer individuals have been falling victim to loneliness in recent times. Additionally, similar to Lal et al. [5], we found a higher prevalence of persistent loneliness among the younger generation, with no significant differences between the younger and older subgroups in terms of post-pandemic or recent loneliness. Although Ernst et al. [1] and Su et al. [3] reported a slight longitudinal increase in loneliness, our study revealed a reduction in the magnitude of persistent, post-pandemic, and recent loneliness by 2023.

We revealed the associations between demographic, socioeconomic, and psychological factors and the four types of loneliness during the COVID-19 pandemic using data collected between 2020 and 2023. Similar to previous studies, our research underscores the heterogeneous risk factors associated with various types of loneliness, particularly among sex- and age-based subgroups [1,3,9,10]. Our results indicate that young people, specifically females, are more likely to experience persistent and post-pandemic loneliness, aligning with the findings that younger individuals experience increased loneliness during the pandemic [9,24]. Conversely, we identified a positive relationship between older men and post-pandemic loneliness, which was corroborated by Su et al. [3] and Wilson-Genderson et al. [25].

Moreover, people living in rural areas and those who were divorced were prone to prolonged pandemic loneliness, particularly among younger age groups. It is conceivable that young people in rural areas may experience greater loneliness due to limited opportunities for social interaction compared to those in urban settings [26]. Our findings on divorce align with those of Lal et al. [5]. Furthermore, our research demonstrates that having children is negatively associated with persistent loneliness, which is consistent with previous findings that individuals who cohabit with their children have a reduced likelihood of experiencing loneliness [5]. We contend that smaller household sizes increase the likelihood of loneliness, which is consistent with the observations of higher levels of loneliness among individuals living alone [25].

Regarding economic factors, we found that older people were more likely to experience loneliness as their household assets increased, whereas younger people felt loneliness as their household assets decreased. Our argument posits that financial conditions have a negative impact on loneliness, which is consistent with previous findings [27]. However, evidence that older individuals with more financial assets report greater loneliness contradicts this argument. This may be explained by the higher levels of risk and uncertainty during the pandemic, causing older adults to experience loneliness despite their favorable financial conditions.

This study has some limitations. First, we relied on self-reported questionnaires to assess individual loneliness rather than employing more objective measurement methods. Nevertheless, this approach is consistent with previous studies, which have deemed it reliable and valid. Second, even though a weighted regression analysis was performed,

the possibility of bias due to unmatched observations in the sub-groups based on sex and age could not be completely ruled out. Third, our survey was conducted online, which could introduce bias arising from differential internet penetration levels among various socioeconomic groups.

5. Conclusions

Our study examined the prevalence of loneliness during the post-pandemic period and revealed that loneliness remains a significant concern, with persistent, post-pandemic, and recent loneliness rates of 47.6%, 4.3%, and 2.2%, respectively. However, we also observed that both persistent and post-pandemic loneliness were slightly reduced compared to the previous year. Among lonely people, younger individuals continue to experience higher persistent loneliness rates, but there are no significant age or sex differences in post-pandemic or recent loneliness rates. Various factors, such as demographics, socioeconomic status, and psychological factors, were found to influence loneliness differently across sex and age groups. For instance, younger people, specifically females, were more likely to experience persistent and post-pandemic loneliness, whereas older men were prone to post-pandemic loneliness. Additionally, rural dwellers and divorcees, specifically young people, were susceptible to prolonged loneliness, whereas having children was associated with reduced persistent loneliness. Household size and financial conditions also played a role, with smaller households being correlated with increased loneliness and economic factors that affect recent loneliness differently for younger and older individuals. These findings shed light on the complex dynamics of loneliness in the post-pandemic period.

The results of the present study have several important policy implications. We emphasize the importance of ongoing monitoring, targeted interventions, and support for specific demographic and socioeconomic groups to address the persistent problem of loneliness in the post-pandemic era. Specifically, offering financial and social assistance to young people, extending support networks to divorcees, and placing a strong emphasis on strengthening family bonds could effectively reduce loneliness during the pandemic.

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