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The Association between Housing Characteristics and Depression among Single-Person Households: A Longitudinal Study Using Data from the Korea Welfare Panel Study

MinAh Baek
Soonchunhyang University
EunJeong Kang
marchej72@gmail.com
Soonchunhyang University
HyeWon Lee
Soonchunhyang University
SunJeong Kim
Soonchunhyang University

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Abstract

Background

The proportion of single-person households in South Korea has risen sharply, from 26.8% of all households in 2014 to 34.5% in 2023, and this group is disproportionately affected by depression relative to multi-person households. Housing has been identified as an important, yet under-examined, social determinant of mental health in this population. Most prior studies, however, have relied on a single composite indicator of housing deprivation—typically unmet minimum housing standards or excessive housing-cost burden—so it remains unclear which specific housing conditions drive the association with depression. This study examined the longitudinal association between multiple, disaggregated housing characteristics and depression among single-person households, and tested whether satisfaction with social relationships moderates this association.

Methods

Data were drawn from four consecutive waves (2020–2023; waves 15–18) of the Korea Welfare Panel Study (KoWePS). A balanced panel of 2,186 individuals who lived in single-person households throughout the four-year period was constructed. Housing characteristics included housing area, monthly housing-cost burden, housing tenure stability, housing location (above-/below-ground), five components of the structural, performance, and environmental criteria specified in Korea's Minimum Housing Standards (heat/fire/moisture resistance; ventilation/lighting/heating; noise/vibration/odor/air pollution; natural-disaster safety; and fire-evacuation structures and facilities), and housing environment satisfaction. Depression was measured with the Korean version of the 11-item Center for Epidemiologic Studies Depression Scale (CES-D 11). Descriptive statistics were calculated, and a Hausman test was used to compare fixed-effects and random-effects specifications. Fixed-effects panel logistic regression was then used to estimate the association between housing characteristics and depression, and interaction terms were added to test the moderating role of social relationship satisfaction.

Results

Poorer subjective health was significantly associated with a higher likelihood of depression (coef. = 0.523, $p < .001$). Among housing characteristics, unmet standards for heat/fire/moisture resistance (coef. = 0.292, $p < .05$) and for fire-evacuation structures and facilities (coef. = 0.443, $p < .001$) were significantly associated with higher depression, whereas greater housing environment satisfaction was associated with lower depression (coef. = -0.221, $p < .001$). Higher satisfaction with social relationships (coef. = -0.494, $p < .001$) and family relationships (coef. = -0.344, $p < .001$) was also associated with lower depression. Housing area, housing-cost burden, tenure stability, housing location, ventilation/lighting/heating, noise/vibration/odor/pollution, and natural-disaster safety were not significantly associated with depression. The interaction between social relationship satisfaction and

unmet fire-evacuation standards was significant (coef. = -0.430, $p < .001$), indicating that strong social relationships buffered the adverse mental-health effect of inadequate fire-evacuation facilities.

Conclusions

Among the components of Korea's minimum housing standards, deficiencies specifically related to fire and structural safety—rather than housing area, cost burden, or tenure type—were most consistently associated with depression in single-person households, and strong social relationships mitigated this risk. These findings support disaggregating housing-deprivation indicators in future research and policy, and point to fire-safety retrofitting, minimum-standard enforcement for single-occupancy housing, and community-based social-relationship programs as concrete levers for improving the mental health of single-person households.

Background

Single-person households have become the most common household type in many countries, comprising an estimated 20–30% of households worldwide [1]. This trend is especially pronounced in South Korea, where the share of single-person households rose from 26.8% in 2014 to 34.5% in 2023, while the number of multi-person households declined over the same period [2]. Statistics Korea projects that this share will reach 39.6% by 2050 [3]. The rapid growth of single-person households across all age groups is driven, among young adults, by weakened traditional family norms, rising youth unemployment, and delayed age at first marriage [4, 5]; among middle-aged adults, by divorce, bereavement, and unstable employment [6, 7]; and among older adults, by population aging and the erosion of multigenerational co-residence [8, 9]. This growth has drawn increasing attention to the social risks associated with living alone.

Compared with multi-person households, single-person households have lower income and educational attainment [10, 11], report poorer health behaviors such as smoking and heavy drinking [12, 13], and rate their subjective health more negatively [10, 12]. Korea's poverty statistics indicate that the poverty rate among single-person households is roughly four times that of multi-person households, placing this group at elevated risk of social exclusion across income, housing, health, and social participation [14]. Among the difficulties single-person households face, poor mental health—particularly depression—has emerged as a serious social problem [15]. Single-person households report greater psychological distress than their multi-person counterparts [16] and are more vulnerable to depressive symptoms and suicidal ideation [7, 11], a pattern attributed in part to their older average age, lower education, lower household income, and poorer subjective health [10, 17].

Social relationships have been examined extensively as a factor that shapes the mental health of single-person households, although the construct itself is defined inconsistently across studies and is used interchangeably with social support or social network [18, 19]. Social relationships have been shown to interact with depression to reduce suicidal ideation [20], to partially mediate the association between

experiences of discrimination and depression [21], and—when measured as contact frequency with family, friends, and neighbors—to moderate depression only through contact with friends, and not through family or neighbors [22].

Among the many correlates of mental health in single-person households, housing has attracted growing attention in recent years [23]. A substantial share of single-person households live in substandard housing such as goshiwon (small, low-cost lodging), one-room studios (officetels/one-rooms), and rooftop or semi-basement units [24], and report worse environmental housing conditions than the general population [25]. Renting—particularly monthly-rent tenure—predominates among single-person households, raising the risk of housing exclusion [6], and their housing-cost burden is proportionally higher than that of multi-person households [26].

Housing is a fundamental human need whose influence extends beyond physical shelter to residents' life satisfaction and to their psychological, social, and economic well-being, and ultimately to their mental health [27, 28]. Bonnefoy [29] proposed that inadequate housing fails to protect residents from external stressors such as noise and environmental hazards, generating chronic distress that manifests as anxiety, depression, and insomnia. Because the particular living arrangements of single-person households may amplify these disadvantages relative to multi-person households [30], the mental-health consequences of poor housing may be especially pronounced in this group. However, most existing research on single-person households has focused on the causes of household formation and on economic status and consumption patterns [31, 32], and housing-related studies have concentrated primarily on housing satisfaction and housing type [33, 34]; empirical research directly linking housing to mental health has only emerged since the 2020s.

Domestic studies that have examined the housing–depression association among single-person households report that housing-cost burden and housing instability are positively associated with depression among middle-aged and older adults [35]; that residents of officetels and one-room units, and especially monthly-rent tenants, report higher depressive symptoms among young single-person households [36]; and that excessive housing-cost burden has the strongest association with depression among young single-person households, whereas failing to meet minimum housing standards has the strongest association among older single-person households [23].

Prior work has predominantly focused on specific age groups such as youth or older adults [35, 37] and has typically operationalized housing deprivation as a single binary indicator—whether any one of the minimum housing standards is unmet—rather than disaggregating its components [37, 38]. Korea's Minimum Housing Standards, legislated in 2004 under the Housing Act, specify criteria for minimum floor area, essential facilities, and structural, performance, and environmental conditions. Which of these specific components drives the association with depression has rarely been examined, because most prior studies have measured only whether any of the three broad criteria was unmet.

To address this gap, the present study used Korea Welfare Panel Study data on single-person households across all age groups to empirically examine the longitudinal associations between specific

housing characteristics—the five structural, performance, and environmental components of the Minimum Housing Standards, together with housing area, housing-cost burden, housing tenure stability, and housing location—on depression, and to analyze this association longitudinally. The specific aims were: (1) to examine the association between housing characteristics and depression among single-person households; and (2) to test whether satisfaction with social relationships moderates this association.

Methods

Data source and study design

This study used data from the Korea Welfare Panel Study (KoWePS), a longitudinal household survey jointly conducted by the Korea Institute for Health and Social Affairs and the Seoul National University Institute of Social Welfare since 2006. The KoWePS is a nationally representative panel that covers all regions of Korea, including Jeju Island, and both rural (farming/fishing) and urban areas, and it oversamples low-income households (those below 60% of median income), giving it the largest low-income sample among Korean panel surveys [39]. The survey collects detailed information on income, housing, health care, employment, and welfare receipt on an annual basis. Because the KoWePS includes a wide range of housing-related items alongside a validated depression measure and its established correlates, it was judged well suited to the aims of this study. Waves 15 through 18 (corresponding to survey years 2020–2023), the most recent waves in which all variables of interest were available, were used for analysis.

The data used in this study are from the Korea Welfare Panel Study (KoWePS), a publicly available dataset for academic research purposes, managed by the Korea Institute for Health and Social Affairs (KIHASA) and Seoul National University. The data can be accessed by registering and applying through the official KoWePS website: https://www.koweps.re.kr:442/data/data/list.do

Study population

The analytic sample comprised individuals living in single-person households. The four annual waves were merged at the individual level and converted into a balanced panel, restricting the sample to individuals who were surveyed in all four waves (waves 15–18). Individuals who transitioned to a multi-person household at any point during this period, and cases with missing data on any study variable, were excluded. Of 3,123 individuals in single-person households across waves 15–18, 806 were excluded for not being surveyed in all four waves, yielding 2,317 individuals in the balanced panel; a further 42 were excluded for missing values and 89 for transitioning to a multi-person household, leaving a final analytic sample of 2,186 individuals. The selection process is summarized in Fig. 1.

Measures

Outcome variable: Depression

Depression was measured using the Korean version of the 11-item Center for Epidemiologic Studies Depression Scale (CES-D 11), an abbreviated form of Radloff's original 20-item CES-D developed through factor-analytic validation [40]. The CES-D 11 asks respondents about their feelings over the past week; each item is rated on a 4-point scale ("rarely," "occasionally," "frequently," "most of the time"), recoded to 0–3 following the KoWePS user guide, with the two positively worded items reverse-scored [41]. Item scores were summed and multiplied by 20/11 so that higher scores indicate greater depressive symptoms; a cutoff of 16 or higher, consistent with prior studies, was used to classify depression [42, 43]. Internal consistency in this sample was high (Cronbach's α = 0.888).

Independent variables: Housing characteristics

Housing area was defined using the minimum floor-space standard for a one-person household specified in Article 17 of the Framework Act on Housing (14 m²); households meeting this standard were coded 0, and those below it were coded 1. Housing tenure stability was defined as stable (= 0) if the household owned its dwelling or the dwelling was registered under a non-household-member's name, and unstable (= 1) for jeonse (lump-sum deposit lease) or monthly-rent tenure. Housing-cost burden was measured as the rent-to-income ratio (RIR)—monthly housing cost divided by monthly disposable income—and coded as excessive (= 1) if RIR exceeded 30%, consistent with prior studies [23, 35, 38], and adequate (= 0) otherwise. Monthly disposable income was calculated as household disposable income divided by 12; monthly housing cost combined rent, utility costs (heating, electricity, water), housing-management costs (facility maintenance, management fees, brokerage and moving costs, septic-tank fees), and one-twelfth of the annual interest on housing-related debt.

Housing location was coded as above-ground (= 0) or below-ground/semi-basement (= 1). The physical condition of housing (structure, performance, and environment) was assessed from the KoWePS item asking about the condition of the dwelling's structure, performance, and environment across five components specified in the Minimum Housing Standards: (1) heat, fire, heat-insulation, and moisture resistance; (2) sound insulation, ventilation, lighting, and heating; (3) noise, vibration, odor, and air pollution; (4) safety from natural disasters; and (5) safe electrical facilities and safe evacuation structures/facilities in case of fire. Each component was coded as adequate (= 0) or inadequate (= 1). Housing environment satisfaction was measured on a 6-point scale (0–5), with higher scores indicating greater satisfaction.

Moderator: Social relationship satisfaction

Social relationship satisfaction, the study's moderating variable, was selected because it captures the social environment surrounding housing, such as relationships with neighbors and the surrounding community [44, 45]. It was measured with a single item asking respondents to rate their satisfaction with

their social relationships on a 5-point Likert scale ranging from "very dissatisfied" (1) to "very satisfied" (5), with higher scores indicating greater satisfaction.

Covariates

Covariates included sex, age, monthly income, subjective health, chronic disease status, education, marital status, occupation, region, and family relationship satisfaction. Monthly income was defined as equivalized disposable household income divided by 12. Subjective health was dichotomized as good or poor. Chronic disease was defined as taking medication for three months or longer. Education was categorized as less than high school, high school, or college and above. Marital status was categorized as currently married, never married, or other (widowed, separated, or divorced). Occupation was categorized as managerial/professional, clerical, service/sales, agricultural/skilled-trade, elementary occupations, or economically inactive (unemployed). Region was categorized as metropolitan city, small/medium city, or rural area. Family relationship satisfaction was measured with the same 5-point Likert scale used for social relationship satisfaction.

Statistical analysis

Because panel data involve repeated observations of the same individuals, the possibility of endogeneity and correlated error terms across waves must be addressed. Panel regression is commonly estimated with either a random-effects model, which treats unobserved, time-invariant individual heterogeneity as a random draw uncorrelated with the regressors and yields efficient estimates when this assumption holds, or a fixed-effects model, which removes time-invariant individual-level heterogeneity entirely and estimates effects from within-person change over time, yielding consistent coefficient estimates even when the individual-level error term is correlated with the regressors.

A Hausman test was used to select between these specifications, testing the null hypothesis that the individual-level error term is uncorrelated with the regressors; rejection of the null indicates that the fixed-effects model is more appropriate. The Hausman test rejected the null hypothesis for the main-effects model ($\chi^2 = 286.62$, $p < .001$), indicating that a fixed-effects specification was appropriate.

Descriptive statistics were first computed to characterize the study sample. The four annual waves of KoWePS data were merged at the individual level and restructured into balanced-panel (long) format. A fixed-effects panel logistic regression model was then estimated to evaluate the association between housing characteristics and depression while controlling for time-invariant individual heterogeneity. Finally, interaction terms between social relationship satisfaction and the housing characteristics that were significant in the main model were added to a second fixed-effects panel logistic regression model to test the moderating effect of social relationship satisfaction; a Hausman test again supported the fixed-effects specification for this model ($\chi^2 = 216.06$, $p < .001$). Variance inflation factors (VIF) were examined to assess multicollinearity among predictors (mean VIF = 1.49, all values below the conventional threshold of 5), and pairwise Spearman correlations among study variables were below 0.6

for all pairs, indicating no substantial multicollinearity. Data management was conducted in SAS 9.4, and all statistical analyses were conducted in Stata version 16.0 [46, 47]. Statistical significance was evaluated at the 95% confidence level (α = .05).

Results

General characteristics of the study population

The final analytic sample comprised 2,186 individuals living in single-person households. Women accounted for the majority of the sample (72.9%), and men for 27.1%. Mean age increased from 64.9 years (SD = 19.0) in 2020 to 67.9 years (SD = 19.0) in 2023. Approximately 66% of participants had less than a high-school education, while 16.5–16.6% held a college degree or higher. Roughly 75% or more of participants were widowed, separated, or divorced, about 21% were never married, and about 3% were currently married. The proportion reporting good subjective health declined slightly, from 66.6% in 2020 to 65.5% in 2023, while more than 96% reported at least one chronic disease. Mean monthly income rose from 1.63 million KRW (SD = 204.6) in 2020 to 1.723 million KRW (SD = 135.9) in 2023. About 39% of participants resided in metropolitan cities and 37% in small or medium cities.

With respect to housing characteristics, approximately 58% of participants reported stable housing tenure, and more than 98% met the minimum housing-area standard. The proportion with an excessive housing-cost burden rose from 17.8% in 2020 to 18.8% in 2023. More than 97% resided above ground. Over 80% met the physical-condition standards for most structural/environmental components, but only about 70–82% met the standard for safe fire-evacuation structures and facilities. Using the CES-D 11 cutoff of 16, the proportion classified as depressed rose from 24.6% in 2020 to a peak of 27.7% in 2022 before declining to 24.9% in 2023. Mean housing environment satisfaction ranged from 3.57 to 3.63 across waves (SD 0.72–0.77); mean social relationship satisfaction ranged from 3.58 to 3.63 (SD 0.66–0.72); and mean family relationship satisfaction ranged from 3.70 to 3.76 (SD 0.71–0.75). Full descriptive statistics are presented in Table 1.

Table 1
General characteristics of the study population (N = 2,186)

Variable	2020 n (%)	2021 n (%)	2022 n (%)	2023 n (%)
Sex				
Male	593 (27.1)	593 (27.1)	593 (27.1)	593 (27.1)
Female	1,593 (72.9)	1,593 (72.9)	1,593 (72.9)	1,593 (72.9)
Subjective health				
Good	1,456 (66.6)	1,369 (62.6)	1,397 (63.9)	1,431 (65.5)
Poor	730 (33.4)	817 (37.4)	789 (36.1)	755 (34.5)
Chronic disease				
No	65 (3.0)	68 (3.1)	74 (3.4)	75 (3.4)
Yes	2,121 (97.0)	2,118 (96.9)	2,112 (96.6)	2,111 (96.6)
Education				
< High school	1,440 (65.9)	1,440 (65.9)	1,439 (65.8)	1,438 (65.8)
High school	384 (17.5)	384 (17.5)	386 (17.7)	385 (17.6)
≥ College	362 (16.6)	362 (16.6)	361 (16.5)	363 (16.6)
Marital status				
Married	75 (3.4)	63 (2.9)	68 (3.1)	65 (3.0)
Never married	469 (21.5)	468 (21.4)	461 (21.1)	454 (20.8)
Other (widowed/separated/divorced)	1,642 (75.1)	1,655 (75.7)	1,657 (75.8)	1,667 (76.2)
Occupation				
Managerial/professional	163 (7.5)	163 (7.5)	172 (7.9)	179 (8.2)
Clerical	77 (3.5)	76 (3.5)	76 (3.5)	75 (3.4)
Service/sales	184 (8.4)	156 (7.1)	158 (7.2)	162 (7.4)
Agriculture/skilled trade	265 (12.1)	246 (11.3)	241 (11.0)	241 (11.0)
Elementary occupation	356 (16.3)	329 (15.1)	362 (16.6)	353 (16.2)
Economically inactive (unemployed)	1,141 (52.2)	1,216 (55.6)	1,177 (53.8)	1,176 (53.8)
Region				
Metropolitan city	860 (39.3)	854 (39.1)	847 (38.8)	850 (38.9)
Small/medium city	807 (36.9)	811 (37.1)	821 (37.6)	817 (37.4)

Variable	2020 n (%)	2021 n (%)	2022 n (%)	2023 n (%)
Rural	516 (23.7)	521 (23.8)	518 (23.7)	519 (23.7)
Housing area				
Meets minimum standard	2,156 (98.6)	2,161 (98.9)	2,166 (99.1)	2,161 (98.9)
Below minimum standard	30 (1.4)	25 (1.1)	20 (0.9)	25 (1.1)
Monthly housing cost burden				
Adequate (RIR ≤ 30%)	1,797 (82.2)	1,850 (84.6)	1,827 (83.6)	1,776 (81.2)
Excessive (RIR > 30%)	389 (17.8)	336 (15.4)	359 (16.4)	410 (18.8)
Housing tenure stability				
Stable	1,258 (57.6)	1,274 (58.3)	1,274 (58.3)	1,272 (58.2)
Unstable	928 (42.4)	912 (41.7)	912 (41.7)	914 (41.8)
Housing location				
Above ground	2,132 (97.5)	2,136 (97.7)	2,139 (97.9)	2,136 (97.7)
Below ground/semi-basement	54 (2.5)	50 (2.3)	47 (2.1)	50 (2.3)
Heat/fire/damp resistance				
Adequate	1,837 (84.0)	1,822 (83.4)	1,852 (84.7)	1,841 (84.2)
Inadequate	349 (16.0)	364 (16.6)	334 (15.3)	345 (15.8)
Ventilation/lighting/heating				
Adequate	1,917 (87.7)	1,890 (86.5)	1,924 (88.0)	1,916 (87.6)
Inadequate	269 (12.3)	296 (13.5)	262 (12.0)	270 (12.4)
Noise/vibration/odor/air pollution				
Adequate	2,033 (93.0)	2,018 (92.3)	2,024 (92.6)	2,020 (92.4)
Inadequate	153 (7.0)	168 (7.4)	162 (7.4)	166 (7.6)
Natural-disaster safety				
Adequate	2,107 (96.4)	2,078 (95.1)	2,112 (96.6)	2,090 (95.6)
Inadequate	79 (3.6)	108 (4.9)	74 (3.4)	96 (4.4)
Fire-evacuation structure/facilities				
Adequate	1,696 (77.5)	1,712 (78.3)	1,791 (81.9)	1,658 (75.9)
Inadequate	493 (22.5)	474 (21.7)	395 (18.1)	528 (24.1)

Variable	2020 n (%)	2021 n (%)	2022 n (%)	2023 n (%)
Depression (CES-D 11, cutoff ≥ 16)				
Non-depressed	1,648 (75.4)	1,594 (72.9)	1,581 (72.3)	1,642 (75.1)
Depressed	538 (24.6)	592 (27.1)	605 (27.7)	544 (24.9)

Variable, Mean (SD)	2020	2021	2022	2023
Age, years	64.9 (19.0)	65.8 (19.0)	66.9 (19.0)	67.9 (19.0)
Monthly household income (10,000 KRW)	163.0 (204.6)	161.3 (126.4)	164.4 (137.2)	172.3 (135.9)
Housing environment satisfaction	3.59 (0.75)	3.57 (0.77)	3.59 (0.74)	3.63 (0.72)
Social relationship satisfaction	3.62 (0.67)	3.58 (0.72)	3.58 (0.70)	3.63 (0.66)
Family relationship satisfaction	3.73 (0.72)	3.70 (0.75)	3.73 (0.72)	3.76 (0.71)
Note. RIR = rent-to-income ratio. Percentages are column percentages within each survey year.				

Preliminary diagnostics

Variance inflation factors for all predictors ranged from 1.03 to 2.52 (mean VIF = 1.49), well below the conventional threshold of 5, indicating no problematic multicollinearity. Spearman correlations among all study variables were below the conventional threshold of 0.7 ($|r| < 0.6$ for all pairs), and correlations among the housing-characteristic variables themselves were generally below 0.3, supporting adequate independence among predictors. The full correlation matrix is available from the corresponding author on request.

Effect of housing characteristics on depression

The Hausman test rejected the null hypothesis of no systematic difference between the fixed-effects and random-effects coefficients ($\chi^2 = 286.62$, $p < .001$; Table 2), indicating that the fixed-effects model was the more appropriate specification.

Table 2
Hausman specification test results

Test statistic	Model 1 (main effects)	Model 2 (moderation)
Hausman χ^2	286.62	216.06
df	24	26
p value	< 0.001	< 0.001
Model selected	Fixed-effects	Fixed-effects

Results of the fixed-effects panel logistic regression are presented in Table 3. Poorer subjective health was significantly associated with higher odds of depression (coef. = 0.523, SE = 0.091, z = 5.75, p < .001). Among the disaggregated housing characteristics, unmet standards for heat/fire/moisture resistance (coef. = 0.292, SE = 0.135, z = 2.16, p < .05) and unmet standards for fire-evacuation structures and facilities (coef. = 0.443, SE = 0.109, z = 4.06, p < .001) were significantly associated with higher depression. Housing area, monthly housing-cost burden, housing tenure stability, housing location, ventilation/lighting/heating, noise/vibration/odor/air pollution, and natural-disaster safety were not significantly associated with depression. Housing environment satisfaction was inversely associated with depression (coef. = -0.221, SE = 0.060, z = -3.68, p < .001), as were social relationship satisfaction (coef. = -0.494, SE = 0.064, z = -7.70, p < .001) and family relationship satisfaction (coef. = -0.344, SE = 0.068, z = -5.05, p < .001). Participants in rural areas reported significantly higher depression than those in metropolitan cities (coef. = -1.827, SE = 0.923, z = -1.98, p < .05), while no significant difference was observed between metropolitan and small/medium cities. Age, income, and occupation were not significantly associated with depression in this model. The overall model was statistically significant (LR $\chi^2 = 264.52$, p < .001).

Table 3
Fixed-effects panel logistic regression: association between housing characteristics and depression

Variable	Coef.	S.E.	z	Sig.
Age	-0.091	0.710	-1.28	
Monthly income	-0.000	0.004	-0.06	
Occupation (ref. managerial/professional)				
Clerical	0.210	0.928	0.23	
Service/sales	-0.293	0.659	-0.45	
Agriculture/skilled trade	-0.188	0.667	-0.28	
Elementary occupation	-0.137	0.624	-0.22	
Economically inactive	-0.026	0.607	-0.04	
Region (ref. metropolitan city)				
Small/medium city	-0.238	0.498	-0.48	
Rural	-1.827	0.923	-1.98	*
Marital status (ref. married)				
Never married	1.006	1.164	0.86	
Other (widowed/separated/divorced)	0.461	0.515	0.90	
Subjective health	0.523	0.091	5.75	***
Chronic disease	-0.419	0.279	-1.50	
Housing area (below minimum standard)	0.657	0.607	1.08	
Monthly housing cost burden	0.125	0.114	1.10	
Housing tenure instability	0.055	0.263	0.21	
Housing location (below ground)	-0.013	0.561	-0.02	
Heat/fire/damp resistance (unmet)	0.292	0.135	2.16	*
Ventilation/lighting/heating (unmet)	0.233	0.155	1.50	
Noise/vibration/odor/pollution (unmet)	-0.076	0.170	-0.45	
Natural-disaster safety (unmet)	0.156	0.196	0.80	
Fire-evacuation structure/facilities (unmet)	0.443	0.109	4.06	***
Housing environment satisfaction	-0.221	0.060	-3.68	***

Variable	Coef.	S.E.	z	Sig.
Social relationship satisfaction	-0.494	0.064	-7.70	***
Family relationship satisfaction	-0.344	0.068	-5.05	***
Survey year	0.022	0.029	0.77	

**p < .05; **p < .01; ***p < .001. Reference categories are noted in parentheses.*

Moderating effect of social relationship satisfaction

To test whether social relationship satisfaction moderates the association between housing characteristics and depression, interaction terms between social relationship satisfaction and the two housing characteristics that were significant in the main model—heat/fire/moisture resistance and fire-evacuation structures/facilities—were added to the fixed-effects panel logistic regression. A Hausman test again supported the fixed-effects specification ($\chi^2 = 216.06$, $p < .001$; Table 2).

As shown in Table 4, the interaction between social relationship satisfaction and unmet fire-evacuation standards was significantly associated with lower depression (coef. = -0.430, SE = 0.142, z = -3.03, $p < .001$), indicating that stronger social relationships attenuated the adverse effect of inadequate fire-evacuation facilities on depression. The interaction between social relationship satisfaction and unmet heat/fire/moisture resistance was not statistically significant (coef. = -0.075, SE = 0.161, z = -0.46, $p = .65$). Housing environment satisfaction (coef. = -0.230, $p < .001$) and family relationship satisfaction (coef. = -0.343, $p < .001$) remained significantly associated with lower depression in this model, while the direct effect of social relationship satisfaction was attenuated in the presence of the interaction term.

Table 4
Moderating effect of social relationship satisfaction on the association between housing characteristics and depression

Variable	Coef.	S.E.	z	Sig.
Subjective health	0.511	0.091	5.59	***
Heat/fire/damp resistance (unmet)	0.554	0.578	0.96	
Fire-evacuation structure/facilities (unmet)	1.965	0.515	3.82	***
Housing environment satisfaction	-0.230	0.060	-3.81	***
Social relationship satisfaction	0.138	0.221	0.63	
Family relationship satisfaction	-0.343	0.068	-5.02	***
Social relationship × Heat/fire/damp resistance	-0.075	0.161	-0.46	
Social relationship × Fire-evacuation facilities	-0.430	0.142	-3.03	***

**p < .05; **p < .01; ***p < .001.*

Discussion

Principal findings and interpretation

This study used four consecutive waves (2020–2023) of the Korea Welfare Panel Study to examine the longitudinal association between housing characteristics and depression among single-person households. The KoWePS is well suited to this purpose because it includes a wide range of housing-related variables and repeatedly surveys the same individuals over time. A fixed-effects specification was used because it removes the influence of time-invariant, unobserved individual characteristics (e.g., sex, personality) and isolates the effect of within-person change in housing characteristics on depression; this approach has been widely used in prior panel studies [42, 48–50] and was judged appropriate for the present research question.

Several limitations should be noted. First, because this study relied on self-reported survey data, housing-characteristic variables may be subject to more subjective bias than objective measures, and depression scores may vary with respondents' situational context at the time of the survey. In addition, the CES-D 11 retrospectively assesses emotions over the preceding week, which may introduce recall bias. Second, a supplementary analysis of multi-person households (Appendix) found that housing characteristics were also significantly associated with depression in that group, indicating that the housing–depression association is not unique to single-person households. However, the maximum mean depression score observed among multi-person households (5.77) was substantially lower than that observed among single-person households (10.40), suggesting that the mental-health impact of housing characteristics may nonetheless be comparatively larger for single-person households. Third, this study did not stratify the sample by life stage; the association between housing characteristics and depression may differ across young, middle-aged, and older single-person households, and future research should compare these associations across age groups.

Notwithstanding these limitations, this study extends prior research—which has generally relied on a single composite indicator of whether any minimum housing standard was unmet—by treating housing area and each of the five structural, performance, and environmental components of the Minimum Housing Standards as separate variables. This disaggregated approach allowed the identification of specific housing conditions associated with depression among single-person households over time, and may serve as a foundation for policies aimed at improving housing conditions and mental health in this population.

Interpretation of findings

Single-person households continue to increase in number even as Korea's overall population is projected to decline due to low fertility and population aging, because the growth of single-person households is expected to increase the total number of households; this underscores the need for housing-policy alternatives tailored to this group. This study analyzed the longitudinal association between housing

characteristics and depression among single-person households in order to inform such housing-environment improvements.

The fixed-effects panel logistic regression found that unmet standards for heat, fire, and moisture resistance were significantly associated with increased depression, consistent with prior evidence that inadequate physical housing conditions generate psychological stress that affects mental and overall health [51–53]. This suggests a need for government efforts to update the Minimum Housing Standards and to establish baseline requirements for heat, fire, and moisture resistance as part of housing-welfare policy targeting substandard housing [54].

Unmet standards for safe fire-evacuation structures and facilities were also significantly associated with increased depression, consistent with the view that inadequate or unsafe evacuation facilities generate persistent anxiety with adverse mental-health consequences [28]. Current fire-safety regulations do not clearly define "one-room" (one-person) housing as a distinct category of specified fire-protected premises, and while extinguishers, sprinklers, and alarms are mandated as basic fire equipment, financial support for additional safety devices such as gas shut-off valves and heat detectors in housing that lacks adequate evacuation facilities could help prevent fire-related disasters and increase residents' sense of psychological safety [55].

Housing environment satisfaction was significantly associated with lower depression. Housing environment encompasses not only the physical conditions inside the dwelling but also the surrounding living environment—social, economic, cultural, and physical/non-physical aspects of the neighborhood [56]. Improving housing environment satisfaction therefore requires attention to conditions both inside and outside the dwelling, including expanded financial support for renovating aging housing stock and improvements to neighborhood infrastructure and green space, particularly in areas with high concentrations of single-person households.

Social relationship satisfaction was significantly associated with lower depression, and moderation analysis showed that it attenuated the adverse effect of unmet fire-evacuation standards on depression. This is consistent with prior work indicating that social relationships buffer stress and provide psychological support that can prevent or reduce depression among single-person households [1, 57]. Programs that strengthen social networks tailored to the needs of single-person households [1], community-based initiatives that encourage voluntary local gatherings and activities, expansion of shared-housing models for young single-person households and public silver housing for older single-person households, and "intergenerational shared housing" models piloted abroad that bring together residents of different ages may help activate intergenerational exchange and reduce social isolation [58].

Housing area, housing location, housing-cost burden, housing tenure stability, ventilation/lighting/heating, noise/vibration/odor/air pollution, and natural-disaster safety were not significantly associated with depression. Descriptive results showed that most single-person households already met the minimum housing-area standard and predominantly resided above ground, which may partly explain the null findings for these two variables; single-person households may also

prioritize a functional, appropriately sized living space over sheer floor area, which could attenuate any association with depression [59, 60].

The null finding for housing-cost burden contrasts with prior research reporting a significant positive association between housing-cost burden and depression [42]. It is possible that the monthly-housing-cost measure used in this study did not fully capture the burden experienced by respondents, or that some participants were receiving housing-subsidy support that offset this burden. Housing tenure stability is itself a multidimensional construct shaped by length of residence, contract type, and the likelihood of future relocation, and the variable used here may not have fully captured these dimensions.

The remaining structural/performance/environmental components—ventilation/lighting/heating, noise/vibration/odor/air pollution, and natural-disaster safety—were also not significantly associated with depression, which diverges from prior studies reporting that failing to meet minimum housing standards overall increases depression [23, 38]. For natural-disaster safety specifically, the low observed frequency of natural disasters during the study period, or a limited psychological/social impact of this factor on participants, may account for the null result.

Overall, these findings help clarify which specific components of Korea's Minimum Housing Standards are most associated with depression. Future research could incorporate qualitative methods to more deeply understand the mechanisms linking housing characteristics to depression, and should compare single-person households that receive housing-cost assistance with those that do not, to clarify how policy support shapes the housing–depression association.

Conclusions

This study analyzed data from 2,186 single-person households in the Korea Welfare Panel Study and found, first, that unmet standards for heat/fire/moisture resistance and for safe fire-evacuation structures and facilities were significantly associated with increased depression. Second, housing environment satisfaction, social relationship satisfaction, and family relationship satisfaction were each significantly associated with reduced depression. Third, social relationship satisfaction attenuated the adverse effect on depression of unmet fire-evacuation standards. These findings extend prior research on minimum housing standards and depression by disaggregating housing-deprivation indicators, and they can inform housing-environment improvement policies, community-based social-relationship programs, and, more broadly, efforts to build healthier cities that support the well-being of single-person households.

Declarations

Ethics approval and consent to participate

This study is a secondary analysis of the Korea Welfare Panel Study (KoWePS), a nationally approved statistics survey (Statistics Korea National Approved Statistics No. 331009, approved October 16, 2006)

jointly conducted by the Korea Institute for Health and Social Affairs and the Seoul National University Institute of Social Welfare. The original survey protocol and data collection were carried out under the oversight of these agencies, and all respondents provided informed consent at the time of the original survey, in accordance with the Declaration of Helsinki. This study used only de-identified, publicly available secondary data from this already-approved panel survey; the authors had no direct contact with participants and no access to identifying information. Under Article 13 of the Enforcement Rules of Korea's Bioethics and Safety Act, research using data that are already publicly available and cannot be used to identify individuals is exempt from institutional review board (IRB) review; accordingly, separate IRB approval was not required for this study.

Consent for publication

Not applicable.

Availability of data and materials

The data used in this study are from the Korea Welfare Panel Study (KoWePS), a publicly available dataset for academic research purposes, managed by the Korea Institute for Health and Social Affairs (KIHASA) and Seoul National University. The data can be accessed by registering and applying through the official KoWePS website: https://www.koweps.re.kr:442/data/data/list.do

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

MB conceived the study, analyzed and interpreted the panel data, and drafted the manuscript. EK supervised the study design and analysis and critically revised the manuscript. Both authors read and approved the final manuscript.

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Figures

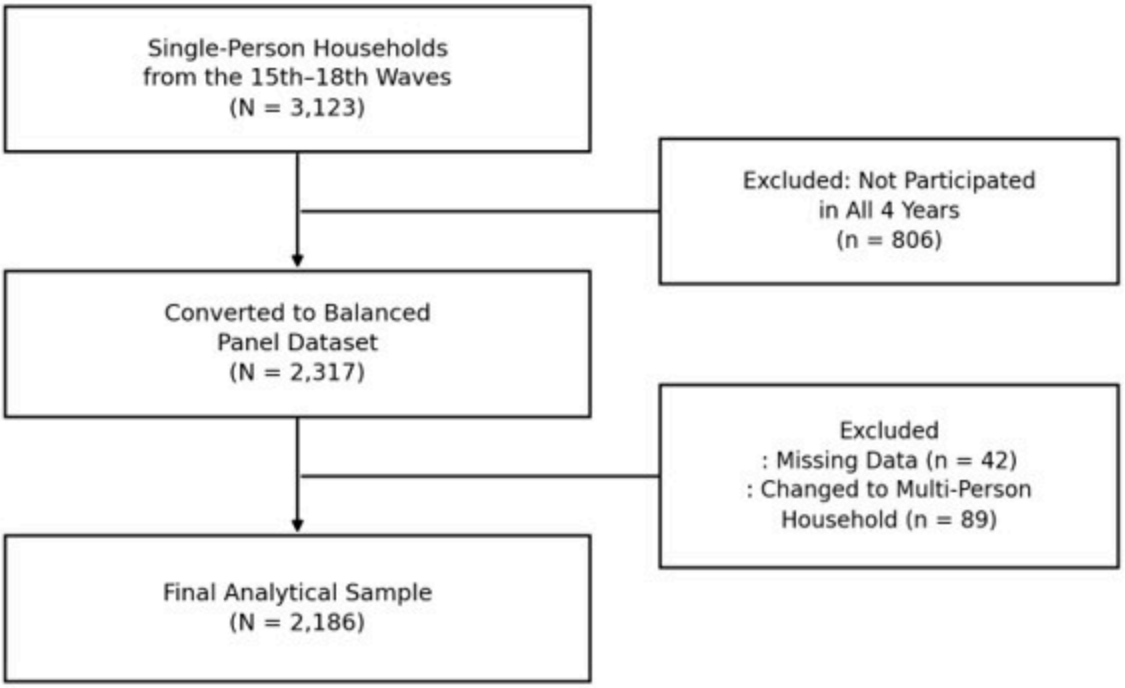


Figure 1

Flowchart of participant selection.