



Depressive symptoms among single-person households: roles of dietary habits and frequency of eating meals with others

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ABSTRACT

The global prevalence of single-person households is rapidly increasing. However, emerging evidence indicates that individuals living alone are at greater risk of experiencing depressive symptoms. Therefore, this study aims to investigate the mediating roles of dietary quality and eating companionship in the relationship between household type and depressive symptoms. Data from the 2016, 2018, and 2020 Korean National Health and Nutrition Examination Survey were analyzed, comprising 13,357 participants aged ≥ 20 years. Depressive symptoms were measured using the Patient Health Questionnaire-9 (PHQ-9), dietary quality with the Korean Healthy Eating Index, and eating companionship through the frequency of eating alone. Logistic regression and causal mediation analyses were performed, adjusting for demographic and socioeconomic variables. Sampling weights were applied to ensure national representativeness. Individuals in single-person households exhibited significantly higher odds of experiencing mild-to-severe (PHQ-9 ≥ 5) and moderate-to-severe (PHQ-9 ≥ 10) depressive symptoms compared with those in multi-person households across all age groups. Lower dietary quality and a higher frequency of eating alone were significantly associated with increased depressive symptoms. Causal mediation analysis indicated that dietary quality accounted for 8.4 % and 10.7 % of the associations with mild-to-severe and moderate-to-severe depressive symptoms, respectively, while the frequency of eating alone mediated 30.3 % and 38.5 % of these associations. Poor dietary quality and frequent solitary eating mediate the association between living alone and depressive symptoms. Public health interventions that encourage healthier eating habits and promote shared mealtimes may help alleviate depressive symptoms among the increasing population of individuals living alone.

1. Introduction

Single-person households are among the fastest-growing household types globally. In 2022, they accounted for over 40 % of all households in several European countries—such as Finland, Sweden, Denmark, and Germany—with similar upward trends in the Netherlands, France, and Italy (Eurostat, 2023). In the United States, the share of single-person households rose from 7.7 % in 1940 to 29 % in recent years (U.S. Census Bureau, 2023). South Korea has also experienced significant growth in single-person households, which now constitute 34.5 % of all households—an 81 % increase since 2010 (Statistics Korea, 2023). According to Statistics Korea, this trend is projected to persist due to declining marriage rates, increasing divorce and separation rates, and

population aging (Statistics Korea, 2023). Consequently, greater attention should be paid to the health implications of living alone.

Shifts in household composition significantly influence individual health outcomes (Noonan et al., 2023). Compared with multi-person households, single-person households face a higher risk of developing metabolic syndrome (Lee & Shin, 2021). Among middle-aged adults, living alone is associated with a greater likelihood of chronic diseases (Lee & Kim, 2023), while older adults in single-person households are more vulnerable to stroke, myocardial infarction, and other chronic conditions than their counterparts who live with others (Lim & Lee, 2019). In the United States, adults aged 18–64 who live alone and experience chronic loneliness or social isolation exhibit a 16 % increase in all-cause mortality and 33 % increase in mortality from heart disease

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(Lee & Singh, 2021).

Living alone also adversely affects mental health. Recent research shows that the social isolation and loneliness frequently experienced by individuals in single-person households can alter brain structure and function, thereby increasing susceptibility to mental disorders (Noonan et al., 2023). These psychosocial factors are associated with higher risks of depression, anxiety, and suicidal behavior (Gisle & Van Oyen, 2013; Lim et al., 2023; Näher et al., 2020; Pulkki-Råback et al., 2012; Zhang et al., 2024).

Household type is also strongly associated with dietary habits. Individuals who live alone tend to consume less diverse diets, eat more animal protein and saturated fats, and generally exhibit poorer eating habits than those in multi-person households (Lee & Shin, 2021). Additionally, the social isolation commonly associated with living alone is related to irregular meal patterns and lower overall dietary quality (Conklin et al., 2014).

Dietary patterns are strongly associated with mental health outcomes, including depression. Evidence from previous studies reveals that poor diet quality is associated with a higher risk of depressive symptoms, while adherence to the Mediterranean diet—rich in fruits, vegetables, fish, and whole grains—lowers the risk of depression (Adan et al., 2019; Firth et al., 2019; Lai et al., 2014; Opie et al., 2015; Pano et al., 2021).

This study aims to investigate the role of dietary habits in mental health—particularly depression—among the growing population of single-person households. Specifically, it examines whether dietary quality and shared mealtimes mediate the association between household type and depressive symptoms, with the objective of identifying potential dietary interventions to support mental health in this population.

2. Methods

2.1. Data sources

Data from the Korea National Health and Nutrition Examination Survey (KNHANES) was analyzed in this study, an annual, nationwide cross-sectional survey conducted by the Korea Disease Control and Prevention Agency (KDCA) since 1998. KNHANES is designed to produce nationally representative and reliable statistics on the health and nutritional status of the Korean population. KNHANES employs a two-stage stratified cluster sampling design. All analyses accounted for the complex sampling design, allowing for generalization of results to the national population. Sampling weights were applied to maintain representativeness.

2.2. Study participants

Data from adults aged ≥ 20 years who participated in the 2016, 2018, and 2020 cycles of the KNHANES was analyzed in this study. The initial sample included 23,501 individuals who completed the health survey. Exclusion criteria were applied as follows: individuals under 20 years of age ($n = 4690$); those missing data on the Patient Health Questionnaire-9 (PHQ-9) or Healthy Eating Index (HEI) ($n = 9230$); those lacking information on key covariates—such as depression diagnosis or treatment, marital status, education level, income, employment status, household type, and eating companionship ($n = 7980$); and those previously diagnosed with or treated for depression ($n = 855$). After exclusions, 13,357 participants remained in the final analytic sample.

2.3. Definition of household type

Household type was categorized based on responses to the survey question, “What type of household do you belong to?” Participants who reported living alone were classified as single-person households. Those reporting residence as a couple (respondent and spouse), couples with

unmarried children, single parents with unmarried children, or within multi-generational households (three or more generations) were classified as multi-person households (United Nations Statistics Division, 2008).

2.4. Definition of depressive symptoms

Depressive symptoms were assessed using the Patient Health Questionnaire-9 (PHQ-9), a validated screening tool for depression. Scores of 5, 10, 15, and 20 indicate thresholds for mild, moderate, moderately severe, and severe depressive symptoms, respectively (Kroenke et al., 2001). In this study, PHQ-9 scores ≥ 5 were classified as mild-to-severe depressive symptoms, while scores ≥ 10 were considered moderate-to-severe symptoms.

2.5. Definition of dietary quality

Dietary quality was evaluated using the Korean Healthy Eating Index (KHEI), a tool developed by the KNHANES to evaluate diet quality in relation to national dietary guidelines. The KHEI is specifically designed to reflect the dietary habits of the Korean population (Yun et al., 2022). For logistic regression analysis, KHEI scores were categorized into quartiles: lowest, lower-middle, upper-middle, and highest.

2.6. Definition of communal eating

Eating companionship was assessed using responses to the question of the participants: “During the past year, when eating breakfast, lunch, or dinner, did you generally eat with others?” Participants who reported eating all three meals alone throughout the past year were classified as “Ate alone.” Those who reported eating at least one meal with others were classified as “Did not eat alone.”

2.7. Statistical analysis

Descriptive statistics were used to summarize participant characteristics. Continuous variables are presented as means with standard deviations (SDs), and categorical variables as frequencies with percentages. Univariate and multivariate logistic regression analyses were conducted to examine the associations between household type and (1) depressive symptoms, (2) dietary quality (HEI), and (3) eating companionship, as well as the associations of (4) dietary quality and (5) eating companionship with depressive symptoms. Subgroup analyses were stratified by age group (20–49, 50–64, and ≥ 65 years) and sex (males and females) to identify vulnerable populations for depressive symptoms and to assess whether the associations differed across demographic groups. This approach aims to support the development of more targeted public health interventions. Causal mediation analysis was conducted to assess whether dietary quality and eating companionship mediated the relationship between household type and depressive symptoms.

All multivariate models were adjusted for age, sex, education level, income level, and employment status. These covariates were selected based on prior literature and causal reasoning, as they are considered potential common causes of both the exposure and the outcome, satisfying the criteria for confounding adjustment. Sex was categorized as male or female, and age was categorized into three groups: 20–49 years, 50–64 years, and ≥ 65 years. Education level was based on the highest level of education completed and grouped into three categories: $\leq$ elementary school, $\leq$ high school graduate, and $\geq$ college. Personal income was divided into quartiles (low, mid-low, mid-high, and high) using thresholds provided by KNHANES. Employment status was classified as “Not employed in the past year,” “Non-daytime worker,” or “Daytime worker” according to participants’ current economic activity.

Logistic regression analyses were conducted using SAS statistical software (version 9.4; SAS Institute Inc., Cary, NC, USA), while

mediation analyses were performed using Rsoftware (version 4.0.3) with the Medflexpackage. A p-value of <0.05 was considered statistically significant.

2.8. Ethical considerations

The study protocol was approved by the Institutional Review Board of Chung-Ang University (IRB No. 1041078-20241012-HR-291). The requirement for informed consent was waived, as the analysis utilized de-identified data that are publicly available.

3. Results

3.1. Baseline characteristics of study participants

Overall, 13,357 participants were included in the analysis. Table S1 shows the baseline characteristics of the study participants. Of these, 5763 (43.2 %) were males and 7594 (56.8 %) were female participants. The largest age group was 20–49 years, comprising 6142 participants (46.0 %). Most participants (87.6 %, n = 11,701) lived in multi-person households, with no significant difference in household distribution by sex. The mean HEI score was 62.79 (SD = 13.43). Overall, 28.4 % (n = 3789) of participants reported eating all meals alone over the past year. The proportion of females who ate alone (31.5 %) was significantly higher than that of males (24.2 %) (p < 0.001). The mean PHQ-9 score for all participants was 2.26 (SD = 3.32). Female participants had significantly higher scores (mean = 2.58 and SD = 3.51) than male participants (mean = 1.84 and SD = 3.00; p < 0.001). Mild-to-severe depressive symptoms (PHQ-9 ≥ 5) were reported by 17.0 % of participants (n = 2264), with a significantly higher prevalence in females (20.0 %) than in males (12.9 %; p < 0.001). Moderate-to-severe depressive symptoms (PHQ-9 ≥ 10) were observed in 4.3 % of participants (n = 569), again more prevalent among females (5.9 %) than in males (3.1 %; p < 0.001).

3.2. Association between single-person households and depressive symptoms

The association between single-person households and depressive symptoms was examined using logistic regression, with PHQ-9 scores classified as mild-to-severe (≥5) and moderate-to-severe (≥10) (Table 1). After adjusting for confounding variables, individuals aged 20–49 years living alone had significantly higher odds of experiencing mild-to-severe (odds ratio [OR] = 1.43; 95 % confidence interval [CI]: 1.11–1.85) and moderate-to-severe (OR = 1.75; 95 % CI: 1.08–2.81) depressive symptoms compared with those in multi-person households. Among participants aged 50–64 years, those in single-person households exhibited higher odds of both mild-to-severe (OR = 1.70; 95 % CI: 1.25–2.31) and moderate-to-severe (OR = 3.00; 95 % CI: 1.82–4.97)

depressive symptoms. Similarly, individuals aged ≥65 years who lived alone had increased odds of mild-to-severe (OR = 1.38; 95 % CI: 1.08–1.76) and moderate-to-severe (OR = 1.57; 95 % CI: 1.11–2.23) depressive symptoms. Sex-stratified analysis indicated that males residing in single-person households had significantly higher odds of experiencing depressive symptoms across all age groups. In contrast, among females, a significant association was observed only in the 50–64 age group for moderate-to-severe depressive symptoms.

3.3. Association between single-person households status, healthy eating index quartiles, and shared mealtime practices

Table 2 presents the results of logistic regression analyses, which examine the association between single-person household type and dietary quality, as measured using HEI quartiles. The HEI quartiles were defined as follows: 1st (low) = less than 53.2; 2nd (mid-low) = 53.2 to 62.9; 3rd (mid-high) = 63.0 to 72.1; and 4th (high) = 72.2 or higher. After adjusting for confounding variables, participants aged 20–49 years who lived alone had significantly higher odds of falling into the lowest HEI quartile (OR = 1.73; 95 % CI: 1.22–2.45) compared with those in multi-person households. In the 50–64 age group, single-person households were more likely to be in both the lowest (OR = 1.94; 95 % CI: 1.32–2.84) and third quartiles (OR = 1.46; 95 % CI: 1.02–2.09). Among participants aged ≥65 years, living alone was also associated with increased odds of being in the lowest HEI quartile (OR = 1.56; 95 % CI: 1.14–2.15). When the analysis was stratified by sex, male participants aged 20–49 years who lived alone had significantly higher odds of being in the lowest (OR = 2.97; 95 % CI: 1.73–5.10) and second (OR = 2.29; 95 % CI: 1.30–4.03) HEI quartiles compared with their counterparts in multi-person households. Similarly, males aged 50–64 years who lived alone had increased odds of being in the lowest (OR = 3.70; 95 % CI: 1.99–6.90) and third (OR = 2.49; 95 % CI: 1.33–4.65) quartiles. For male participants aged ≥65 years, single-person household status was related to higher odds of falling into the lowest quartile (OR = 2.26; 95 % CI: 1.43–3.67). In contrast, no statistically significant associations between household type and HEI quartile were observed among females in any age group.

Logistic regression analysis further revealed that, across all age groups and for both sexes, individuals in single-person households had significantly higher odds of eating all meals alone compared with those in multi-person households (Table 2).

3.4. Association between healthy eating index quartiles and depressive symptoms

Logistic regression analyses were performed to assess the association between dietary qualities, as measured via HEI quartiles and depressive symptoms (Table 3). After adjusting for confounding variables, participants aged 20–49 years in the lowest and second HEI quartiles had

Table 1
Association between single-person households and depressive symptoms by age group.

	20–49 years				50–64 years				≥65 years			
	Unadjusted		Adjusted ^a		Unadjusted		Adjusted ^a		Unadjusted		Adjusted ^a	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Mild-to-severe Depressive Symptoms (PHQ-9 Score ≥ 5)												
Total	1.39	1.09–1.78	1.43	1.11–1.85	2.01	1.48–2.73	1.70	1.25–2.31	1.83	1.46–2.28	1.38	1.08–1.76
Males	1.53	1.10–2.13	1.47	1.04–2.08	3.26	2.05–5.18	2.35	1.50–3.68	2.36	1.48–3.76	2.11	1.32–3.37
Females	1.53	1.09–2.14	1.35	0.94–1.94	1.33	0.90–1.97	1.13	0.77–1.66	1.39	1.06–1.82	1.20	0.90–1.61
Moderate-to-severe Depressive Symptoms (PHQ-9 Score ≥ 10)												
Total	1.70	1.06–2.74	1.75	1.08–2.81	4.01	2.49–6.46	3.00	1.82–4.97	2.40	1.75–3.30	1.57	1.11–2.23
Males	2.09	1.19–3.69	2.07	1.17–3.67	7.73	3.47–17.22	3.73	1.58–8.81	2.54	1.34–4.81	2.04	1.05–3.96
Females	1.56	0.73–3.36	1.33	0.61–2.92	2.35	1.31–4.22	1.93	1.06–3.51	1.98	1.34–2.94	1.41	0.92–2.17

Multi-person households served as the reference group in logistic regression analysis.

OR, odds ratio; CI, confidence interval; PHQ-9, Patient Health Questionnaire-9.

^a Adjusted for household type, sex, education, personal income, and occupation.

Table 2
Association between single-person household status, healthy eating index quartiles, and shared mealtime patterns by age group.

		20–49 years				50–64 years				≥65 years			
		Unadjusted		Adjusted ^a		Unadjusted		Adjusted ^a		Unadjusted		Adjusted ^a	
		OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
HEI quartiles^{b, c}													
Total													
HEI	Q ₁	2.07	1.47–2.91	1.73	1.22–2.45	2.20	1.51–3.22	1.94	1.32–2.84	1.97	1.47–2.62	1.56	1.14–2.15
	Q ₂	1.53	1.06–2.21	1.37	0.94–2.00	1.33	0.93–1.91	1.24	0.85–1.81	1.32	1.06–1.65	1.03	0.80–1.32
	Q ₃	1.12	0.75–1.68	1.04	0.69–1.55	1.43	1.01–2.02	1.46	1.02–2.09	1.20	0.94–1.51	1.10	0.85–1.43
	Q ₄							Ref					
Males													
HEI	Q ₁	3.10	1.82–5.29	2.97	1.73–5.10	4.17	2.30–7.57	3.70	1.99–6.90	2.80	1.81–2.32	2.26	1.43–3.67
	Q ₂	2.35	1.34–4.12	2.29	1.30–4.03	1.94	1.04–3.60	1.85	0.97–3.55	1.23	0.79–1.93	1.04	0.66–1.65
	Q ₃	1.67	0.92–3.02	1.64	0.90–2.97	2.33	1.28–4.23	2.49	1.33–4.65	1.11	0.69–1.78	1.06	0.66–1.72
	Q ₄							Ref					
Females													
HEI	Q ₁	1.09	0.72–1.63	0.86	0.56–1.31	1.12	0.70–1.81	1.03	0.62–1.72	1.75	1.21–2.55	1.14	0.76–1.71
	Q ₂	0.85	0.53–1.36	0.75	0.46–1.21	1.08	0.68–1.72	1.04	0.63–1.72	1.52	1.11–2.07	0.96	0.68–1.37
	Q ₃	0.67	0.40–1.11	0.64	0.38–1.07	1.00	0.64–1.56	0.99	0.62–1.57	1.36	1.04–1.78	1.12	0.82–1.51
	Q ₄							Ref					
Eating with others^b													
Total													
Eating with others	No	6.31	4.98–7.99	6.58	5.16–8.39	6.31	4.85–8.21	6.07	4.60–8.01	28.59	21.35–38.28	26.51	19.61–35.84
	Yes							Ref					
Males													
Eating with others	No	7.10	5.32–9.48	7.23	5.40–9.69	7.25	4.90–10.72	6.26	4.13–9.48	24.33	15.68–37.75	27.30	16.78–44.42
	Yes							Ref					
Females													
Eating with others	No	5.56	3.86–8.01	5.67	3.93–8.17	5.80	4.00–8.41	6.10	4.13–9.02	28.28	19.33–41.35	27.18	18.34–40.29
	Yes							Ref					

OR, odds ratio; CI, confidence interval; HEI, healthy eating index.
^a Adjusted for household type, sex, education, personal income, and occupation.
^b Multi-person households served as the reference group in logistic regression analysis.
^c Multinomial logistic regression was performed.

significantly higher odds of experiencing mild-to-severe depressive symptoms compared with those in the highest (4th) quartile (OR = 1.42; 95 % CI: 1.12–1.81 and OR = 1.29; 95 % CI: 1.02–1.64, respectively). Additionally, individuals in the lowest quartile had markedly greater odds of reporting moderate-to-severe depressive symptoms (OR = 2.36; 95 % CI: 1.37–4.04). In the 50–64 age group, participants in the lowest HEI quartile were also more likely to experience mild-to-severe (OR = 1.76; 95 % CI: 1.29–2.41) and moderate-to-severe depressive symptoms (OR = 2.63; 95 % CI: 1.42–4.85) compared with those in the highest quartile. Among participants aged ≥65 years, those in the lowest HEI quartile had significantly higher odds of experiencing moderate-to-severe depressive symptoms (OR = 2.04; 95 % CI: 1.30–3.21). In sex-stratified analyses, no significant associations were observed among males. However, females in the lowest HEI quartile had significantly greater odds of experiencing mild-to-severe and moderate-to-severe depressive symptoms relative to those in the highest quartile.

3.5. Association between eating alone and depressive symptoms

Logistic regression analysis revealed that eating alone was significantly associated with increased odds of mild-to-severe and moderate-to-severe depressive symptoms across all age groups (Table 4), even after adjusting for confounders. Among participants aged 20–49 years, eating alone was linked to higher odds of mild-to-severe (OR = 1.34; 95 % CI: 1.13–1.59) and moderate-to-severe depressive symptoms (OR = 1.64; 95 % CI: 1.24–2.18); for those aged 50–64 years, the odds were 1.37 (95 % CI: 1.11–1.70) and 2.26 (95 % CI: 1.42–3.59), respectively. Among those aged 65 years and older, eating alone was also significantly associated with increased odds of mild-to-severe (OR = 1.33; 95 % CI: 1.06–1.66) and moderate-to-severe depressive symptoms (OR = 1.68; 95 % CI: 1.17–2.42).

In the sex-stratified analyses, eating alone was significantly associated with higher odds of mild-to-severe and moderate-to-severe

depressive symptoms among males in all age groups except the 50–64-year age group. Among females, a significant association was observed only in the 50–64-year group for mild-to-severe depressive symptoms. Although ORs indicated elevated risks in females aged 20–49 years (OR = 1.16; 95 % CI: 0.94–1.44) and ≥65 years (OR = 1.23; 95 % CI: 0.95–1.60), these associations were not statistically significant. However, eating alone was significantly associated with increased odds of moderate-to-severe depressive symptoms among females in these same age groups (OR = 1.60; 95 % CI: 1.12–2.23 for 20–49 years, OR = 1.61; 95 % CI: 1.04–2.50 for ≥65 years).

3.6. Mediating effects of healthy eating index and eating with others on the association between household type and depressive symptoms

3.6.1. Mediating effect of healthy eating index on the association between single-person households and depressive symptoms

Mediation analysis revealed that household type demonstrated significant total effects on both mild-to-severe (OR = 1.55; 95 % CI: 1.33–1.81) and moderate-to-severe depressive symptoms (OR = 1.87; 95 % CI: 1.38–2.36) (Fig. 1). The indirect effects mediated by dietary quality (measured via HEI) were also significant: OR = 1.03 (95 % CI: 1.02–1.05) for mild-to-severe depressive symptoms and OR = 1.07 (95 % CI: 1.04–1.09) for moderate-to-severe symptoms. The direct effects of living alone (single-person household), independent of HEI, remained significant for both mild-to-severe (OR = 1.51; 95 % CI: 1.31–1.73) and moderate-to-severe depressive symptoms (OR = 1.75; 95 % CI: 1.33–2.17). Dietary quality mediated 8.4 % of the association for mild-to-severe and 10.7 % for moderate-to-severe depressive symptoms.

3.6.2. Mediating effect of eating with others on the association between single-person households and depressive symptoms

Mediation analysis revealed significant total effects of household type on mild-to-severe (OR = 1.58; 95 % CI: 1.26–1.98) and moderate-

Table 3
Association between HEI quartiles and depressive symptoms by age group.

		20–49 years				50–64 years				≥65 years			
		Unadjusted		Adjusted ^a		Unadjusted		Adjusted ^a		Unadjusted		Adjusted ^a	
		OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Mild-to-severe Depressive Symptoms (PHQ-9 Score ≥ 5)													
Total													
HEI	Q ₁	1.54	1.23–1.93	1.42	1.12–1.81	1.80	1.34–2.43	1.76	1.29–2.41	1.50	1.12–2.01	1.32	0.97–1.78
	Q ₂	1.32	1.05–1.66	1.29	1.02–1.64	1.28	0.97–1.69	1.29	0.97–1.72	1.04	0.78–1.38	0.91	0.68–1.22
	Q ₃	1.10	0.86–1.42	1.11	0.86–1.42	1.06	0.79–1.42	1.11	0.82–1.49	1.18	0.91–1.53	1.13	0.86–1.49
	Q ₄							Ref					
Males													
HEI	Q ₁	1.52	0.99–2.31	1.41	0.91–2.19	1.84	1.08–3.13	1.61	0.92–2.84	1.66	1.01–2.72	1.27	0.76–2.12
	Q ₂	1.23	0.81–1.88	1.20	0.78–1.85	1.24	0.76–2.01	1.11	0.67–1.84	1.01	0.60–1.70	0.78	0.45–1.37
	Q ₃	1.21	0.76–1.93	1.19	0.74–1.90	0.98	0.60–1.62	0.99	0.59–1.66	1.27	0.77–2.08	1.11	0.66–1.86
	Q ₄							Ref					
Females													
HEI	Q ₁	1.74	1.32–2.29	1.40	1.05–1.86	2.07	1.45–2.95	1.85	1.29–2.65	1.54	1.07–2.22	1.37	0.95–1.97
	Q ₂	1.48	1.12–1.97	1.33	0.99–1.78	1.51	1.06–2.13	1.37	0.97–1.95	1.13	0.79–1.62	0.99	0.69–1.42
	Q ₃	1.08	0.79–1.45	1.03	0.76–1.39	1.22	0.85–1.76	1.16	0.81–1.67	1.22	0.89–1.68	1.14	0.83–1.56
	Q ₄							Ref					
Moderate-to-severe Depressive Symptoms (PHQ-9 Score ≥ 10)													
Total													
HEI	Q ₁	2.58	1.53–4.35	2.36	1.37–4.04	2.69	1.51–4.79	2.63	1.42–4.85	2.54	1.64–3.92	2.04	1.30–3.21
	Q ₂	1.57	0.89–2.77	1.52	0.86–2.69	1.81	0.96–3.41	1.81	0.94–3.49	1.68	1.07–2.65	1.37	0.87–2.16
	Q ₃	1.56	0.82–2.97	1.56	0.82–2.96	1.23	0.65–2.34	1.34	0.69–2.58	1.26	0.77–2.04	1.16	0.70–1.92
	Q ₄							Ref					
Males													
HEI	Q ₁	2.53	0.97–6.57	2.54	0.94–6.87	2.51	0.76–8.36	2.09	0.60–7.26	1.77	0.71–4.38	1.29	0.50–3.38
	Q ₂	1.71	0.61–4.77	1.73	0.61–4.97	1.85	0.52–6.65	1.47	0.42–5.12	1.64	0.72–3.74	1.30	0.55–3.07
	Q ₃	2.33	0.81–6.71	2.40	0.84–6.94	1.11	0.30–4.09	1.28	0.34–4.73	0.94	0.36–2.46	0.8	0.30–2.17
	Q ₄							Ref					
Females													
HEI	Q ₁	2.95	1.56–5.58	2.27	1.18–4.36	3.20	1.67–6.15	2.96	1.55–5.65	3.19	1.95–5.22	2.49	1.50–4.14
	Q ₂	1.59	0.80–3.14	1.36	0.69–2.68	2.01	0.99–4.06	1.91	0.92–3.94	1.81	1.03–3.18	1.39	0.79–2.42
	Q ₃	1.17	0.56–2.48	1.06	0.50–2.27	1.43	0.68–2.99	1.38	0.65–2.96	1.52	0.88–2.61	1.32	0.77–2.28
	Q ₄							Ref					

OR, odds ratio; CI, confidence interval; HEI, healthy eating index; PHQ-9, Patient Health Questionnaire-9.
^a Adjusted for household type, sex, education, personal income, and occupation.

Table 4
Association between eating alone and depressive symptoms by age group.

		20–49 years				50–64 years				≥65 years			
		Unadjusted		Adjusted ^a		Unadjusted		Adjusted ^a		Unadjusted		Adjusted ^a	
		OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Mild-to-severe Depressive Symptoms (PHQ-9 Score ≥ 5)^b													
Total		1.44	1.22–1.70	1.34	1.13–1.59	1.58	1.28–1.96	1.37	1.11–1.70	1.65	1.35–2.02	1.33	1.06–1.66
Males		1.73	1.31–2.29	1.62	1.22–2.15	1.77	1.21–2.59	1.44	0.99–2.08	1.82	1.22–2.72	1.69	1.12–2.56
Females		1.22	0.98–1.51	1.16	0.94–1.44	1.38	1.06–1.78	1.31	1.01–1.70	1.32	1.03–1.69	1.23	0.95–1.60
Moderate-to-severe Depressive Symptoms (PHQ-9 Score ≥ 10)^b													
Total		1.79	1.36–2.36	1.64	1.24–2.18	2.85	1.83–4.44	2.26	1.42–3.59	2.25	1.60–3.17	1.68	1.17–2.42
Males		1.93	1.18–3.15	1.74	1.03–2.95	16.29	6.40–41.50	12.43	4.90–31.5	2.10	1.10–4.01	1.93	1.01–3.66
Females		1.68	1.18–2.40	1.60	1.12–2.23	1.12	0.66–1.90	1.01	0.59–1.77	1.95	1.30–2.93	1.61	1.04–2.50

OR, odds ratio; CI, confidence interval; PHQ-9, Patient Health Questionnaire-9.
^a Adjusted for household type, sex, education, personal income, and occupation.
^b Multi-person households served as the reference group in the logistic regression analysis.

to-severe depressive symptoms (OR = 1.85; 95 % CI: 1.29–3.06) (Fig. 2). Indirect effects mediated by the frequency of eating with others were also significant: OR = 1.15 (95 % CI: 1.08–1.22) for mild-to-severe and OR = 1.27 (95 % CI: 1.13–1.40) for moderate-to-severe depressive symptoms. Direct effects, independent of eating companionship, remained significant for mild-to-severe (OR = 1.38; 95 % CI: 1.17–1.63) and moderate-to-severe depressive symptoms (OR = 1.46; 95 % CI: 1.15–1.88). Eating companionship mediated 30.3 % of the association for mild-to-severe and 38.5 % for moderate-to-severe depressive symptoms.

4. Discussion

In this study, individuals living in single-person households had a higher risk of depressive symptoms than those in multi-person households, with this association significantly mediated by dietary quality (measured using the HEI) and eating companionship. People living alone had poorer dietary quality and were more likely to eat alone. Both of these factors were associated with an increased risk of depressive symptoms. Dietary quality mediated 8.4 % and 10.7 % of the association with mild-to-severe and moderate-to-severe depressive symptoms, respectively. Conversely, the frequency of eating companionship mediated 30.3 % and 38.5 %, respectively. These findings highlight the

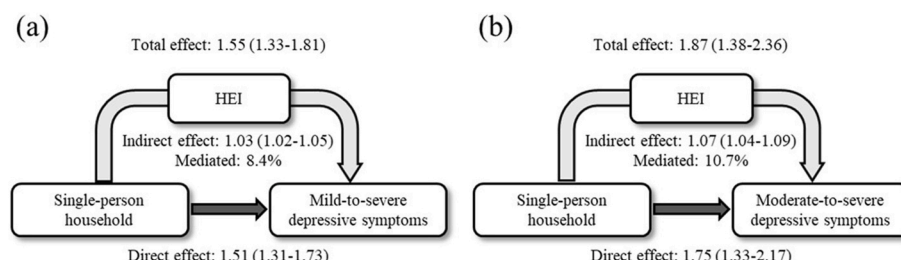


Figure 1. Mediating effect of HEI on the association between household type and depressive symptoms. Values are presented as odds ratios (95% confidence intervals). (A) Participants with mild-to-severe depressive symptoms. (B) Participants with moderate-to-severe depressive symptoms. Abbreviation: HEI, Healthy Eating Index.

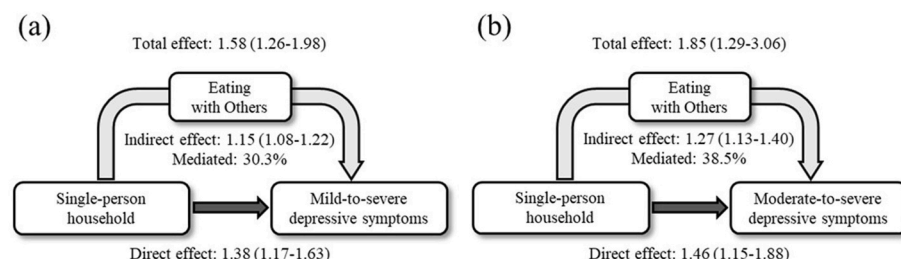


Figure 2. Mediating effect of eating with others on the association between household type and depressive symptoms. Values are presented as odds ratios (95% confidence intervals). (A) Participants with mild-to-severe depressive symptoms. (B) Participants with moderate-to-severe depressive symptoms.

potential value of promoting healthier eating habits and shared meals to improve mental health outcomes in single-person households.

The proportion of single-person households has increased rapidly in recent years globally and in South Korea (U.S. Census Bureau, 2023; Eurostat, 2023). Statistics Korea (2023) projects that single-person households will comprise 40 % of all households in South Korea by 2050. This demographic shift is associated with increased risks of social isolation and loneliness, which adversely affects physical and mental health (Bzdok & Dunbar, 2020; Gisle & Van Oyen, 2013; Kim et al., 2024; Näher et al., 2020; Noonan et al., 2023).

Depression is among the most frequently reported mental health issues among individuals living alone and is consistently more prevalent in this group than in those living with others (Fang et al., 2024; Kim & Lee, 2022; Pulkki-Råback et al., 2012). These mental health challenges extend beyond individual well-being, contributing to societal burden and reduced productivity. These findings underscore the urgent need for targeted public health and policy interventions to mitigate the mental health risks associated with the rising number of single-person households.

Single-person households experience greater social isolation and loneliness than those of multi-person households, both strongly associated with various mental health issues, including depression (Fang et al., 2024; Hawkey & Capitanio, 2015; Holt-Lunstad et al., 2015; Kim & Lee, 2022; Park et al., 2024). Living alone is also linked to lower perceived quality of life and increased psychological distress (Kim et al., 2024; Kim & Lee, 2022; Lim & Lee, 2019; Song et al., 2018). Additionally, individuals in single-person households often adopt unhealthy diets and irregular lifestyles (Conklin et al., 2014; Gang et al., 2023; Lee & Kim, 2023; Lee & Shin, 2021; Lidfeldt et al., 2005), which can harm physical and mental health (Adan et al., 2019; Du et al., 2024; Ekinci & Sanlier, 2023; Firth et al., 2019; Gibson-Smith et al., 2020; Kim et al., 2023; Lai et al., 2014; Lim & Lee, 2019; Opie et al., 2015; Pano et al., 2021; Zhang et al., 2024). Prior studies report that single-person households face higher all-cause and cardiovascular mortality, primarily due to increased loneliness and social isolation, which further exacerbate mental health conditions such as depression (Hawkey & Capitanio, 2015; Holt-Lunstad et al., 2015; Jensen et al., 2019; Lim et al., 2023; Song et al., 2018). These findings suggest that social isolation, reduced

quality of life, irregular lifestyles, and declining physical health collectively increase the risk of depression in single-person households.

Subgroup analyses by sex revealed a stronger association between living alone and depressive symptoms in males than in females. This is consistent with previous findings indicating a higher depression risk among middle-aged single males (OR = 6.262) than in middle-aged single females (OR = 3.114) (Kim & Lee, 2022). These sex differences may reflect disparities in quality of life, social relationships, and health-related behaviors. Earlier studies indicate that male participants more often experience lower quality of life, a key predictor of depressive symptoms (Kim et al., 2024; Song et al., 2018), and are more prone to social isolation. Disrupted social networks adversely influence mental health and behaviors such as dietary practices (Kroenke et al., 2001; Zhang et al., 2024). These psychological and social vulnerabilities likely contribute to the heightened depression risk among single-person male households.

Our study also confirms that single-person households generally have poorer dietary quality and eat alone more often than multi-person households, consistent with previous findings. The European EPIC study reports that individuals aged 50 years and older living alone consumed fewer fruits and vegetables (Conklin et al., 2014). Similarly, KNHANES data shows that single-person households consume more animal protein and fats but fewer vegetables, seaweed, and fish, along with lower dietary diversity and less frequent meals (Park et al., 2024). Studies from the United States and Japan also report more frequent solitary eating among individuals living alone (Sobal & Nelson, 2003; Takeda et al., 2018). Poor dietary quality (Chegini et al., 2022; Kim et al., 2023; Wang et al., 2021; Xu et al., 2024; Yoon & Oh, 2021) and infrequent shared meals (Kim et al., 2020; Park & Lee, 2021; Son et al., 2020; Tani et al., 2015) are associated with a higher risk of depression.

Several biological mechanisms may explain these mediating effects. Poor dietary quality can lead to deficiencies in essential nutrients such as B vitamins and omega-3 fatty acids, critical for neurotransmitter synthesis and mood regulation, thereby adversely affecting mental health (Chegini et al., 2022; Kim et al., 2023; Wang et al., 2021; Xu et al., 2024; Yoon & Oh, 2021). Additionally, a poor-quality diet may trigger systemic inflammation and oxidative stress, further contributing to depressive symptoms (Chegini et al., 2022; Kim et al., 2023; Wang et al.,

2021; Xu et al., 2024; Yoon & Oh, 2021). Single-person households often consume more refined grains and preserved foods (e.g., pickled vegetables) instead of whole grains and fresh produce, resulting in poor nutrition and increased depression risk (Lee & Shin, 2021). Furthermore, solitary eating may worsen social isolation and elevate stress hormones such as cortisol, adversely affecting mental health (Chegini et al., 2022; Kim et al., 2020; Park & Lee, 2021; Sobal & Nelson, 2003; Son et al., 2020; Tani et al., 2015). The lack of social interaction during meals may also reduce the release of mood-related neurotransmitters such as serotonin and dopamine (Kim et al., 2020; Park & Lee, 2021; Son et al., 2020; Takeda et al., 2018; Tani et al., 2015). Moreover, eating alone may disrupt appetite regulation and eating pace, potentially leading to overeating, poor nutrition, and obesity, which may indirectly worsen depressive symptoms (Adan et al., 2019; Lee & Shin, 2021; Sobal & Nelson, 2003; Tani et al., 2015; Xu et al., 2024).

This study has some strengths. First, the use of nationally representative KNHANES data enhances the generalizability of the findings. Second, this is the first study to quantitatively assess the mediating roles of dietary quality and eating companionship in the association between household type and depressive symptoms, valuable evidence for guiding mental health policies. Third, stratified analyses by age and sex enabled the identification of particularly vulnerable subgroups.

However, some limitations should be acknowledged. First, the cross-sectional design limits causal inference among variables. Second, the use of self-reported depressive symptoms may have introduced misclassification bias. If this misclassification was nondifferential, it may have biased the effect estimates toward the null. However, if reporting accuracy differed by subgroup, then differential misclassification may have occurred, potentially leading to over- or underestimation of subgroup-specific associations. Future studies should adopt longitudinal designs and incorporate clinical assessments to enhance validity.

5. Conclusion

Our findings underscore the importance of dietary quality and shared meals in shaping policy interventions to prevent depression in single-person households. They emphasize the need for precise prevention strategies, including community-based meal programs and targeted nutrition education, to alleviate social isolation and support mental health. Given the limitations of cross-sectional analysis in inferring causality, longitudinal studies are needed to provide more robust evidence.

CRediT authorship contribution statement

Soyoung Lee: Writing – original draft, Conceptualization. **Hyewon Park:** Writing – original draft, Visualization, Validation, Formal analysis, Data curation. **Chung Ho Kim:** Writing – review & editing, Software, Methodology, Formal analysis. **Bomi Park:** Writing – review & editing, Supervision, Resources, Project administration, Investigation.

Ethical statement

The study protocol was approved by the Institutional Review Board of Chung-Ang University (IRB No. 1041078-20241012-HR-291). The requirement for informed consent was waived because the analysis was based on de-identified, publicly available data.

Financial disclosure statement

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Declaration of competing interest

The authors declare the following financial interests/personal

relationships which may be considered as potential competing interests: Hyewon Park reports a relationship with Chung-Ang University that includes: funding grants. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Glossary

KNHANES, Korean National Health and Nutrition Examination Survey; PHQ-9, Patient Health Questionnaire-9; KHEI, Korean Healthy Eating Index; HEI, Healthy Eating Index; SD, standard deviation; OR, odds ratio; CI, confidence interval.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2025.101856>.

Data availability

The datasets analyzed in this study are publicly available from the Korea Disease Control and Prevention Agency (KDCA) at: <https://knhanes.kdca.go.kr/knhanes/eng/index>.

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