

RESEARCH ARTICLE

Impact of sex and marital status on the prevalence of perceived depression in association with food insecurity

Jung Woo Lee¹, Woo-Kyoung Shin², Yookyung Kim^{1*}¹ Department of Human Ecology, Graduate School, Korea University, Seoul, Republic of Korea,² Department of Preventive Medicine, Seoul National University College of Medicine, Seoul, Republic of Korea* yookyung_kim@korea.ac.kr

Abstract

Background

While both food insecurity and depression have been reported to be closely related to sex and marital status, the impact of sex and marital status on the prevalence of perceived depression in association with food security status has not been evaluated.

Materials & methods

We performed a nationwide population study using data for 19,866 adults obtained from the 2012–2015 Korean National Health and Nutrition Examination Surveys. Household food insecurity status was evaluated using the 18-item Food Security Survey Module. Perceived depression was measured using one item questionnaire or the 9-item Patient Health Questionnaire (PHQ-9). We cross-sectionally analyzed associations between perceived depression and variables, including socio-demographic factors and food security status. The prevalence of perceived depression was compared according to sex, marital status, and food security status. We applied survey sampling weights in all analyses.

Results

The overall prevalence of perceived depression was 10.5%. Prevalence rates of perceived depression in the high food security group, marginal food security group, low food security group, and very low food security group were 8.9%, 13.6%, 19.7%, and 35.0%, respectively ($P < 0.001$). Of total participants, 1.8% were categorized as having both perceived depression and food insecurity. After adjusting for confounding covariates, female sex (adjusted odds ratio [aOR]; 2.37), never married (aOR; 1.37), divorced/widowed/separated (aOR; 1.50), low food security (aOR; 1.72), and very low food security (aOR; 3.65) were associated with increased risk of perceived depression. Men with very low food security and divorced/widowed/separated status were most likely to have perceived depression (53.2%), followed by women with very low food security and divorced/widowed/separated status (48.7%),

OPEN ACCESS

Citation: Lee JW, Shin W-K, Kim Y (2020) Impact of sex and marital status on the prevalence of perceived depression in association with food insecurity. PLoS ONE 15(6): e0234105. <https://doi.org/10.1371/journal.pone.0234105>

Editor: Yuka Kotozaki, Iwate Medical University, JAPAN

Received: August 1, 2019

Accepted: May 19, 2020

Published: June 11, 2020

Peer Review History: PLOS recognizes the benefits of transparency in the peer review process; therefore, we enable the publication of all of the content of peer review and author responses alongside final, published articles. The editorial history of this article is available here: <https://doi.org/10.1371/journal.pone.0234105>

Copyright: © 2020 Lee et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Data Availability Statement: Data can be freely downloaded without restriction from the website of the Korea Center for Chronic Disease and Control Institutional Data Access: <https://knhanes.cdc.go.kr/knhanes/eng/index.do>

Funding: The authors received no specific funding for this work.

Competing interests: The authors have declared that no competing interests exist.

women with very low food security and married status (42.0%), and women with low food security and divorced/widowed/separated status (33.3%).

Conclusions

Female sex and marital status of divorced/widowed/separated were strongly associated with perceived depression. These two factors and food insecurity synergistically contributed to perceived depression.

Introduction

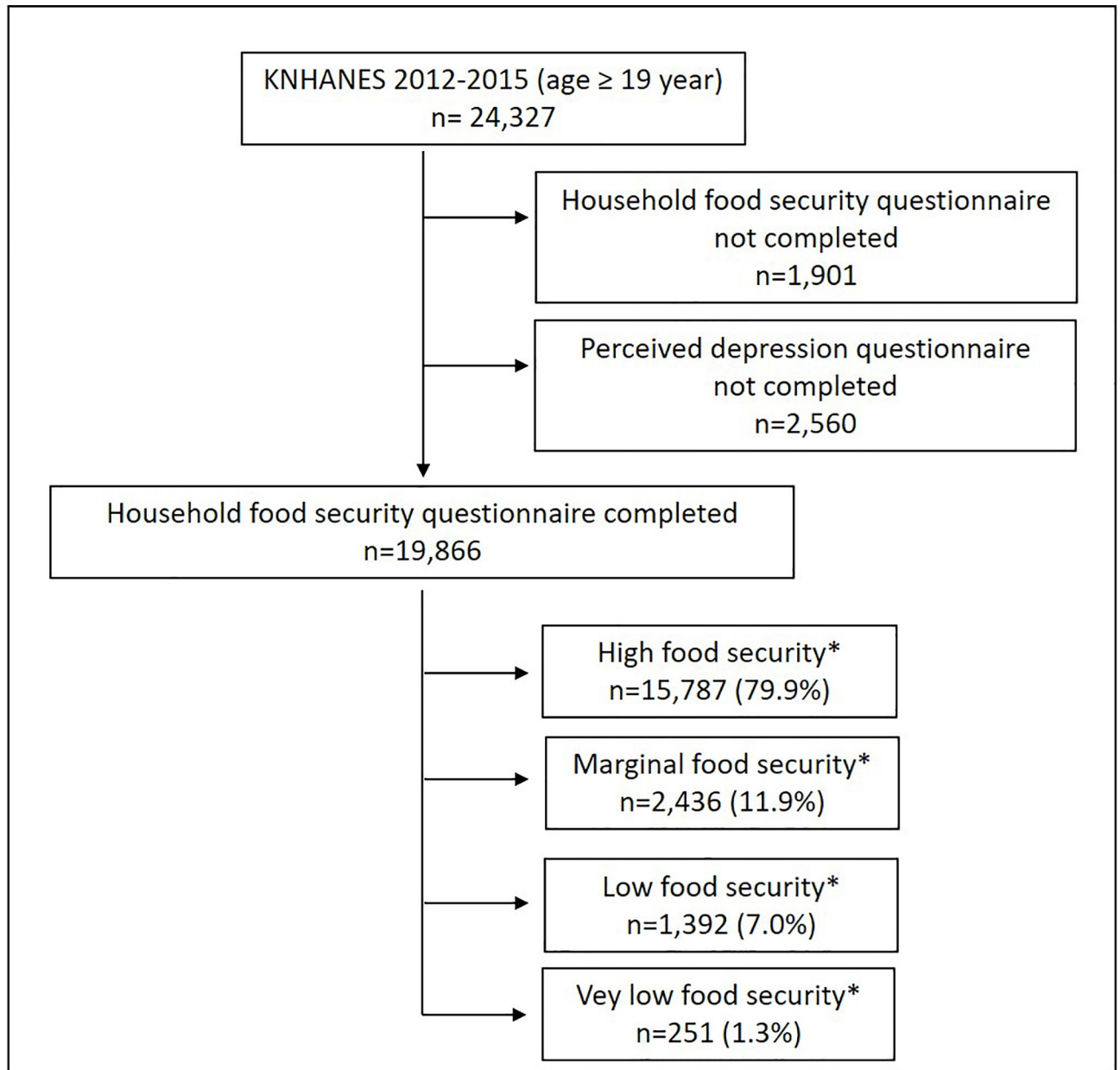
Food insecurity is defined as limited access to food at the level of individuals or households due to lack of money or other resources [1]. Food insecurity components include insufficient food quantity, inadequate quality, unsafety, and cultural unacceptability [2]. Beyond hunger and increased risk of malnutrition, food insecurity is closely associated with a higher prevalence of chronic diseases such as diabetes mellitus, obesity, hypertension, hyperlipidemia, and metabolic syndrome [3, 4]. Globally, it has been estimated that nearly 821 million people remain food-insecure [1]. Even in the high-income region, more than 10% of all households are suffering from food insecurity [5, 6]. Food insecurity has been recognized as one of the key social determinants of health and a contemporarily important public health issue.

Food insecurity has been associated with unhealthy dietary patterns, including higher consumption of sugar/carbohydrate/meat/alcohol and lower consumption of fish/seafood [7]. Recent cross-sectional and longitudinal studies have shown that unhealthy dietary patterns can adversely affect psychological health [8–11]. Growing evidence has shown that food insecurity is closely linked to depression [12–15]. Both food insecurity and depression can negatively affect the lives of individuals. They can be strongly affected by socioeconomic factors, of which female sex and dissolution of marriage have been recognized as robust risk factors for food insecurity [16, 17] and depression [18–20]. However, to the best of our knowledge, no study has reported the impact of sex or marital status on the prevalence of depression across food insecurity categories. A better understanding of those associations could help us develop and evaluate strategies for economic and social support. Therefore, the objective of this study was to examine the impact of sex and marital status on the prevalence of perceived depression in association with food security status in Korean adults using nationwide population-based data.

Materials and methods

Design and study population

We used nationwide population-based cross-sectional data from the Korean National Health and Nutrition Examination Surveys (KNHANES). The KNHANES is a continuous, nationally representative survey conducted by the Korea Centers for Disease Control and Prevention (KCDC) [21]. KNHANES was designed to assess the health and nutrition status of the Korean people. It surveys non-institutionalized civilian Korean population. The KNHANES comprises in-person health interviews, health examinations, and a nutrition survey. We used 2012–2015 KNHANES data. Among 24,327 adult participants aged 19 years or older, we excluded participants whose household food security data ($n = 1,901$) or perceived depression data ($n = 2,560$) were missing. The final analytic sample consisted of 19,866 adults (Fig 1). The KNHANES was



*% was calculated by applying sampling weights assigned

Fig 1. Enrollment process for adults with reasons for exclusion.

<https://doi.org/10.1371/journal.pone.0234105.g001>

approved by the Ethics Committee of the KCDC. All participants provided informed consent. We used only publicly available data at <http://knhanes.cdc.go.kr/knhanes>.

Measures

Food security status. Food security status was measured at the household level using an 18-item food insecurity questionnaire, which had been modified from the US Household Food Security Survey Module [22]. Responses to these items were scored. Food security was then

categorized as high food security, marginal food security, low food security, and very low food security. We considered households with low or very low food security as food-insecure.

Perceived depression. Perceived depression was assessed using the 9-item Patient Health Questionnaire (PHQ-9) (the year of 2014) or one-item questionnaire (the year of 2012, 2013, or 2015) which asked subject in a dichotomous manner (yes/no) on whether he or she felt sadness or despair enough to disturb daily life for more than 14 days consecutively over the past year. A dichotomous variable indicating no perceived depression (one-item questionnaire: no or PHQ-9 total score < 10) or perceived depression (one-item questionnaire: yes or PHQ-9 total score \geq 10) [23] was created.

Marital status. Marital status was divided into five categories: never married, married, divorced, widowed, or separated. We reclassified these into three categories: never married, married (reference group), or divorced/widowed/separated.

Other covariates. Other sociodemographic covariates included age, education attainment, household income, smoking, alcohol intake, and physical activity. Age was classified into four categories: 19–39 years, 40–59 years (reference group), and more than 60 years. Education attainment was recoded into \leq elementary school, middle school, high school, and \geq college education (reference group). Household income was divided into quartiles for lowest, lower-middle, upper-middle, or highest (reference group). Smoking status was categorized as current smoker, past smoker, and never smoker (reference group). Alcohol intake was categorized as heavy, moderate, and none (reference group). Those who drank at least seven glasses for men or 5 glasses for women at a time and more than twice per week were considered as heavy alcohol drinkers. Physical activity was divided into regular (reference group), intermittent, and none. Vigorous exercise more than four days per week was considered as having regular exercise. Anthropometric measurements were conducted by trained staff members. Body mass index (kg/m^2) was calculated as weight divided by the square of height.

Statistical analyses

Data are presented as a percentage with a standard error for categorical variables and mean with a standard error for continuous variables. Unadjusted differences in socio-demographic characteristics across food security categories were tested using Rao-Scott Chi-square test or one-way analysis of variance (ANOVA). Multiple logistic regression was used to calculate the odds ratio and 95% confidence interval for perceived depression after adjusting for confounding covariates. Potential confounding covariates included sex, age, education attainment, marital status, income, smoking, alcohol, physical activity, food security status, and body mass index. We then compared the difference of perceived depression prevalence according to sex, marital status, and food insecurity status. Based on the statistical guidelines of the KCDC, we applied survey sampling weights in all analyses. We used SURVEY commands in SAS to account for the complex sampling strategy and produce output that was representative of the total Korean population. All statistical analyses were performed using SAS 9.4 software (SAS Institute, Cary, NC, USA). A *P* value of < 0.05 was considered statistically significant.

Results

Fig 1 includes the distribution of food security status of finally enrolled 19,866 participants. Approximately half (49.3%) of these participants were males. The mean age of all participants was 45.8 years. Percentages (standard error) of those with high food security, marginal food security, low food security, and very low food security were 79.9% (0.6), 11.9% (0.4), 7.0% (0.3), 1.3% (0.1), respectively. Table 1 shows the characteristics of participants stratified by household food security status. Food-insecure participants (low food security or very low food

Table 1. Characteristics of participants stratified by household food security status.^a

Variable	Food secure n = 18,223		Food insecure n = 1,643		Total n = 19,866	P value ^b
	High food security n = 15,787	Marginal food security n = 2,436	Low food security n = 1,392	Very low food security n = 251		
Sex						< 0.001
Male	50.1 (0.4)	47.5 (1.1)	43.5 (1.6)	45.6 (3.6)	49.3 (0.4)	
Female	50.0 (0.4)	53.0 (1.1)	56.5 (1.6)	54.4 (3.6)	50.7 (0.4)	
Age, mean years	45.2 (0.2)	48.6 (0.5)	47.5 (0.6)	49.1 (1.4)	45.8 (0.2)	< 0.001
19–39	39.8 (0.7)	33.9 (1.4)	34.1 (1.7)	29.9 (3.8)	38.6 (0.6)	
40–59	41.0 (0.6)	36.1 (1.2)	41.3 (1.7)	42.9 (3.6)	40.5 (0.5)	
> 60	19.2 (0.5)	29.9 (1.3)	24.6 (1.4)	27.3 (3.4)	20.9 (0.4)	
Marital status						< 0.001
Never married	22.6 (0.6)	23.5 (1.3)	22.5 (1.6)	22.8 (3.3)	22.7 (0.5)	
Married	69.4 (0.6)	60.6 (1.4)	54.4 (1.9)	39.3 (4.1)	66.9 (0.6)	
Divorced/separated/ widowed	8.0 (0.3)	15.8 (0.9)	23.1 (1.5)	37.9 (4.0)	10.3 (0.3)	
Education attainment						< 0.001
≤ elementary school	13.7 (0.4)	25.6 (1.1)	28.1 (1.5)	39.0 (4.2)	16.4 (0.4)	
Middle school	8.3 (0.3)	12.4 (0.9)	11.7 (1.1)	14.3 (2.9)	9.1 (0.3)	
High school	38.6 (0.6)	40.0 (1.4)	41.2 (1.8)	31.2 (4.3)	38.8 (0.5)	
≥ College	39.5 (0.7)	22.0 (1.3)	19.0 (1.5)	15.5 (3.3)	35.7 (0.6)	
Income						< 0.001
1st quartile (lowest)	10.4 (0.4)	27.8 (1.6)	32.7 (2.0)	58.3 (4.8)	14.6 (0.5)	
2nd quartile	22.4 (0.6)	34.1 (1.7)	40.0 (2.3)	27.9 (4.4)	25.0 (0.6)	
3rd quartile	31.3 (0.7)	24.3 (1.5)	20.6 (1.8)	12.7 (3.7)	29.5 (0.6)	
4th quartile (highest)	35.9 (0.9)	13.7 (1.3)	6.7 (1.4)	1.1 (1.1)	30.8 (0.8)	
Smoking						< 0.001
current	22.0 (0.5)	25.2 (1.2)	27.3 (1.6)	31.5 (3.9)	22.9 (0.4)	
past	21.0 (0.4)	17.9 (0.9)	17.3 (1.2)	16.8 (2.9)	20.4 (0.3)	
none	56.9 (0.5)	56.8 (1.3)	55.4 (1.6)	51.7 (4.0)	56.7 (0.4)	
Alcohol intake						< 0.001
Heavy	19.6 (0.5)	16.8 (1.1)	16.3 (1.3)	16.8 (3.6)	19.0 (0.4)	
Moderate	51.9 (0.6)	46.5 (1.4)	45.1 (1.8)	33.5 (3.8)	50.5 (0.5)	
None	28.5 (0.5)	36.7 (1.4)	38.6 (1.7)	49.7 (4.2)	30.5 (0.5)	
Physical activity						< 0.001
None	38.3 (0.6)	42.4 (1.4)	45.7 (1.8)	51.8 (4.2)	39.4 (0.5)	
Intermittent	33.6 (0.5)	32.1 (1.3)	31.6 (1.7)	28.9 (3.9)	33.2 (0.5)	
Regular	28.2 (0.5)	25.5 (1.1)	22.7 (1.4)	19.3 (3.3)	27.3 (0.4)	
Body mass index						0.01
Underweight	4.4 (0.2)	4.6 (0.6)	5.2 (0.7)	6.6 (1.9)	4.5 (0.7)	
Normal weight	63.6 (0.5)	61.8 (1.3)	59.0 (1.6)	56.7 (3.9)	62.9 (0.4)	
Overweight	32.0 (0.5)	33.6 (1.3)	35.8 (1.6)	36.7 (3.7)	32.5 (0.4)	
Perceived depression						< 0.001
No	91.1 (0.3)	86.4 (0.8)	80.3 (1.4)	65.0 (3.9)	89.5 (0.3)	
yes	8.9 (0.3)	13.6 (0.8)	19.7 (1.3)	35.0 (3.9)	10.5 (0.3)	

^aData are presented as weighted percentage (standard error).

^bP values for differences between food-secure participants and food-insecure participants.

<https://doi.org/10.1371/journal.pone.0234105.t001>

Table 2. Unadjusted and adjusted odds ratio and 95% confidence interval for perceived depression.

	Unadjusted odds ratio (95% confidence interval)	P value	(95% confidence interval)	P value
Sex				
Male	1		1	
Female	2.06 (1.48–2.86)	<0.001	2.39 (2.00–2.92)	< 0.001
Marital status				
Never married	1.66 (1.16–2.39)	0.01	1.37 (1.14–1.64)	< 0.001
Married	1		1	
Divorced/separated/widowed	2.70 (2.03–3.60)	<0.001	1.48 (1.24–1.76)	< 0.001
Food security status				
High	1		1	
Marginal	2.46 (1.63–3.73)	<0.001	1.34 (1.12–1.60)	0.001
Low	3.79 (2.41–5.93)	<0.001	1.75 (1.42–2.16)	< 0.001
Very low	8.24 (4.11–16.55)	<0.001	3.74 (2.62–5.33)	< 0.001
Education				
≤ elementary school	2.21 (1.51–3.23)	<0.001	1.71 (1.40–2.10)	< 0.001
Middle school	1.10 (0.65–1.87)	0.72	1.82 (1.45–2.30)	< 0.001
High school	1.25 (0.87–1.80)	0.23	1.27 (1.07–1.51)	0.01
≥ College	1		1	
Household income				
1st quartile (lowest)	3.53 (2.25–5.53)	<0.001	1.33 (1.07–1.66)	0.01
2nd quartile	1.37 (0.88–2.13)	0.17	0.96 (0.79–1.17)	0.69
3rd quartile	0.78 (0.50–1.25)	0.33	0.93 (0.76–1.13)	0.45
4th quartile (highest)	1		1	
Smoking				
current	1.21 (0.84–1.74)	0.30	1.72 (1.36–2.17)	< 0.001
past	0.57 (0.38–0.87)	0.01	1.38 (1.12–1.71)	< 0.01
none	1		1	
Alcohol intake				
Heavy	0.84 (0.51–1.41)	0.52	1.03 (0.84–1.27)	0.76
Moderate	0.62 (0.45–0.85)	0.001	0.86 (0.75–0.99)	0.03
None	1		1	

<https://doi.org/10.1371/journal.pone.0234105.t002>

security groups) were more likely to be female, divorced/widowed/separated, current smoker, and non-heavy alcohol drinker. Food-insecure participants also had lower educational attainment, lower-income, and lower physical activity. The overall prevalence of perceived depression was 10.5%. A point estimate of the prevalence of perceived depression in the year 2014 was lower than that of the other three years combined (6.5% vs. 11.9%, $P < 0.001$). The difference in point estimates was 5.4% (95% confidence interval: 4.2–6.7%). Of total participants, 1.8% were categorized as having both perceived depression and food insecurity. Prevalence rates of perceived depression in the high food security group, marginal food security group, low food security group, and very low food security group were 8.9%, 13.6%, 19.7%, 35.0%, respectively ($P < 0.001$).

Table 2 shows the unadjusted and adjusted odds ratio (aOR) and 95% confidence interval for perceived depression. Multiple logistic regression showed that female sex (aOR: 2.39), never married (aOR: 1.37), divorced/widowed/separated (aOR: 1.48), low food security (aOR: 1.75), and very low food security (aOR: 3.74) were associated with a greater likelihood of experiencing perceived depression. Other significant factors included non-college education

attainment (aOR: 1.27–1.82), lowest household income (aOR: 1.33), current smoking (aOR: 1.72), and past smoking (aOR: 1.38). Age, body mass index, and physical activity were not significantly associated with perceived depression. A separate analysis of data in the year 2014 and the other years (2012, 2013, or 2015) also showed similar results (S1 Table).

The prevalence of perceived depression in association with sex, marital status, and food security status is shown in Table 3 and Fig 2. Men with very low food security and divorced/widowed/separated status were most likely to have perceived depression (53.2%), followed by women with very low food security and divorced/widowed/separated status (48.7%), married women with very low food security (42.0%), and women with low food security and divorced/widowed/separated status (33.3%). These findings were consistent throughout the study period (S2 Table).

Discussion

We demonstrated that female sex and divorced/widowed/separated marital status independently had a strong impact on the prevalence of perceived depression in adults. When one or more of these factors showed a link with food insecurity, the likelihood of perceived depression was much greater. These findings indicate that sex, marital status, and food security status should be taken into account together as key factors for perceived depression.

We found strong dose-response pattern associations for food insecurity and perceived depression in adults. That is, the magnitude of the association was the strongest among those who had very low food security (35.0%), followed by those with low food security (19.7%) and marginal food security (13.6%). These findings are consistent with results of prior studies [24–27]. The strength of the current study was that we used large population-based data not confined to socio-economically vulnerable subgroups. Given the cross-sectional design, however, we could not provide any conclusion of a causal relationship between food insecurity and perceived depression. Several longitudinal studies have shown that food insecurity and depression are related in a bidirectional manner [15, 28, 29]. Since food insecurity is a modifiable factor, food insecurity interventions may yield benefits for the prevention, early detection, and management of depressive symptoms. Recently, a USA group has demonstrated that participation in a Supplemental Nutrition Assistance Program (SNAP) can significantly reduce psychological distress after six months of participation [30]. An evaluation of a poverty-alleviation program for the ultra-poor in Bangladesh has also shown that food insecurity is the most

Table 3. Prevalence of perceived depression in association with sex-marital status and food security status^a.

	High food security	Marginal food security	Low food security	Very low food security	Total	P value
Male						
never married (n = 1,495)	8.8 (1.0)	3.9 (1.5)	19.1 (4.2)	24.3 (9.7)	9.0 (0.8)	< 0.001
married (n = 6,313)	5.5 (0.4)	5.8 (1.0)	8.1 (1.6)	11.3 (5.2)	5.7 (0.4)	0.13
divorced/widowed/separated (n = 497)	12.8 (2.4)	15.6 (5.0)	22.8 (5.8)	53.2 (10.9)	17.6 (2.1)	< 0.001
Subtotal (n = 8,305)	6.7 (0.4)	5.6 (0.8)	13.1 (1.8)	28.4 (5.6)	7.2 (0.4)	<0.001
Female						
never married (n = 1,478)	12.8 (1.1)	17.8 (3.3)	21.7 (4.9)	17.4 (7.9)	14.1 (1.0)	0.07
married (n = 7,835)	9.7 (0.5)	20.9 (1.7)	20.6 (2.1)	42.0 (7.2)	11.8 (0.5)	< 0.001
divorced/widowed/separated (n = 2,248)	16.3 (1.2)	22.4 (2.6)	33.3 (3.8)	48.7 (6.4)	21.4 (1.1)	< 0.001
Subtotal (n = 11,561)	11.1 (0.4)	20.8 (1.3)	24.8 (1.9)	40.5 (4.9)	13.7 (0.4)	<0.001

^aData are presented as weighted percentage (standard error).

<https://doi.org/10.1371/journal.pone.0234105.t003>

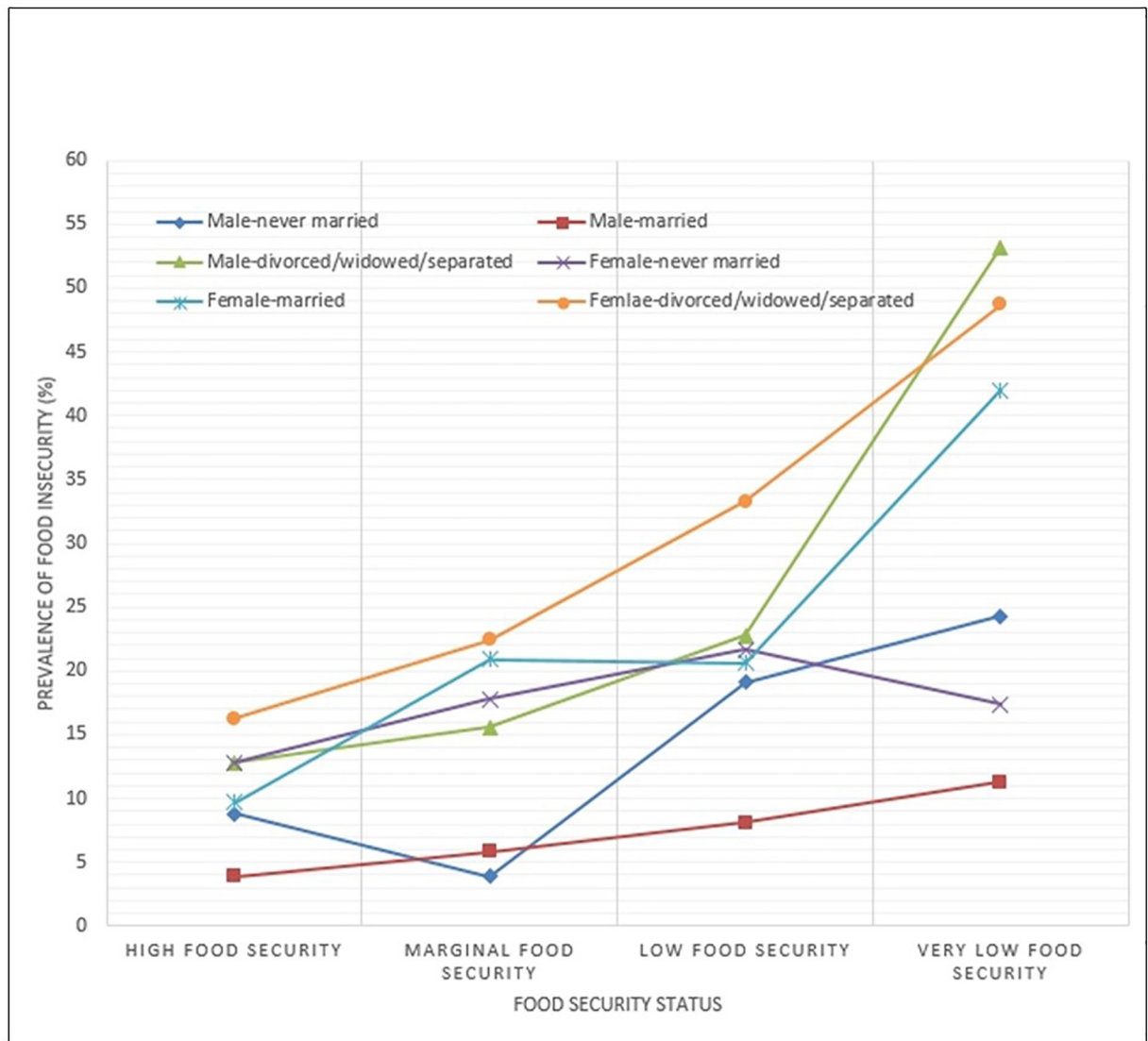


Fig 2. Prevalence of perceived depression in association with sex, marital status, and food security status.

<https://doi.org/10.1371/journal.pone.0234105.g002>

important mediator for relieving psychosocial distress [31]. Further food insecurity interventional studies employing a study design relevant to regional socioeconomic context and population are warranted.

The novel aspect of this study is the investigation of the simultaneous effect of sex, marital status, and food insecurity on perceived depression. While male sex was a strong protective factor for perceived depression, men with very low food security and divorced/widowed/separated status had the highest risk of perceived depression (53.2%). Even in the same group of men with very low food security, the rate of perceived depression widely ranged from 11.3% (married men) to 53.2% (divorced/widowed/separated men). Our findings indicate that concurrent analysis of significant factors for perceived depression and detailed subgroup analysis can be helpful for the determination of target population for support.

Our study has several limitations. First, as stated earlier, the cross-sectional study design precluded our ability to make a causal relationship. Second, we used a one-item questionnaire

in the year of 2012, 2013, or 2015 and PHQ-9 for the year of 2014. A point estimate of the prevalence of perceived depression in the year 2014 was lower than that of the other three years combined. Different usage of screening tool might have been associated with some biases. However, when we analyzed the data in the year 2014 and the other years, the main findings were similar regardless of the study period, supporting our conclusion. Third, the amount or impact of inadequate nutritional intake was not directly evaluated. Fourth, we grouped households with marginal food security as food secure group. There have been arguments that households with marginal food security have poorer adverse health outcomes than households with high food security [32]. Finally, we grouped subjects with divorced, widowed, or separated status into one group because of a relatively small number of each group of participants. Each status might have a differential impact on the perceived depression.

In conclusion, female sex and divorced/widowed/separated marital status were independent predictors for perceived depression in Korean adults. Food insecurity was closely associated with perceived depression in a dose-response fashion and synergistically contributed to a higher prevalence of perceived depression. These findings suggest that multidisciplinary efforts including economical, nutritional, and psychiatric support should be preferentially focused on these high-risk groups.

Supporting information

S1 Table. Adjusted odds ratio and 95% confidence interval for perceived depression.

(DOC)

S2 Table. Prevalence of perceived depression in association with sex-marital status and food security status^a.

(DOC)

Author Contributions

Conceptualization: Jung Woo Lee, Woo-Kyoung Shin, Yookyung Kim.

Data curation: Jung Woo Lee, Woo-Kyoung Shin, Yookyung Kim.

Formal analysis: Jung Woo Lee, Woo-Kyoung Shin, Yookyung Kim.

Writing – original draft: Jung Woo Lee.

Writing – review & editing: Woo-Kyoung Shin, Yookyung Kim.

References

1. Food and Agriculture Organization of United Nations. The state of food insecurity and nutrition in the world 2018. Available from: <http://www.fao.org/3/i9553en/i9553en.pdf>
2. Leroy JL, Ruel M, Frongillo EA, Harris J, Ballard TJ. Measuring the Food Access Dimension of Food Security: A Critical Review and Mapping of Indicators. *Food Nutr Bull.* 2015; 36:167–95. <https://doi.org/10.1177/0379572115587274> PMID: 26121701
3. Parker ED, Widome R, Nettleton JA, Pereira MA. Food security and metabolic syndrome in U.S. adults and adolescents: findings from the National Health and Nutrition Examination Survey, 1999–2006. *Ann Epidemiol.* 2010; 20:364–70. <https://doi.org/10.1016/j.annepidem.2010.02.009> PMID: 20382337
4. Seligman HK, Laraia BA, Kushel MB. Food insecurity is associated with chronic disease among low-income NHANES participants. *J Nutr.* 2010; 140:304–10. <https://doi.org/10.3945/jn.109.112573> PMID: 20032485
5. Tarasuk V, Mitchell A, Dachner N. Household food insecurity in Canada, 2014. Toronto: Research to identify policy options to reduce food insecurity (PROOF). Available from: <https://proof.utoronto.ca/wp-content/uploads/2016/04/Household-Food-Insecurity-in-Canada-2014.pdf>

6. Gunderse C, Zilick JP. Food insecurity research in the United States: where we have been and where we need to go. *Appl Econ Perspect Policy*. 2018; 40:119–35.
7. Morales ME, Berkowitz SA. The Relationship between Food Insecurity, Dietary Patterns, and Obesity. *Curr Nutr Rep*. 2016; 5:54–60. <https://doi.org/10.1007/s13668-016-0153-y> PMID: 29955440
8. Knuppel A, Shipley MJ, Llewellyn CH, Brunner EJ. Sugar intake from sweet food and beverages, common mental disorder and depression: prospective findings from the Whitehall II study. *Sci Rep*. 2017; 7:6287. <https://doi.org/10.1038/s41598-017-05649-7> PMID: 28751637
9. Zhang Y, Yang Y, Xie MS, Ding X, Li H, Liu ZC, et al. Is meat consumption associated with depression? A meta-analysis of observational studies. *BMC Psychiatry*. 2017; 17:409.
10. Guo X, Park Y, Freedman ND, Sinha R, Hollenbeck AR, Blair A, et al. Sweetened beverages, coffee, and tea and depression risk among older US adults. *PLoS One*. 2014; 9:e94715. <https://doi.org/10.1371/journal.pone.0094715> PMID: 24743309
11. Grosso G, Micek A, Marventano S, Castellano S, Mistretta A, Pajak A, et al. Dietary n-3 PUFA, fish consumption and depression: A systematic review and meta-analysis of observational studies. *J Affect Disord*. 2016; 205:269–81. <https://doi.org/10.1016/j.jad.2016.08.011> PMID: 27544316
12. Davison KM, Kaplan BJ. Food insecurity in adults with mood disorders: prevalence estimates and associations with nutritional and psychological health. *Ann Gen Psychiatry*. 2015; 14:21. <https://doi.org/10.1186/s12991-015-0059-x> PMID: 26185523
13. Garg A, Toy S, Tripodis Y, Cook J, Cordella N. Influence of maternal depression on household food insecurity for low-income families. *Acad Pediatr*. 2015; 15:305–10. <https://doi.org/10.1016/j.acap.2014.10.002> PMID: 25454368
14. Davison KM, Gondara L, Kaplan BJ. Food Insecurity, Poor Diet Quality, and Suboptimal Intakes of Folate and Iron Are Independently Associated with Perceived Mental Health in Canadian Adults. *Nutrients*. 2017; 9:274
15. Huddleston-Casas C, Charnigo R, Simmons LA. Food insecurity and maternal depression in rural, low-income families: a longitudinal investigation. *Public Health Nutr*. 2009; 12:1133–40. <https://doi.org/10.1017/S1368980008003650> PMID: 18789167
16. Russell J, Flood V, Yeatman H, Mitchell P. Prevalence and risk factors of food insecurity among a cohort of older Australians. *J Nutr Health Aging*. 2014; 18:3–8. <https://doi.org/10.1007/s12603-013-0339-6> PMID: 24402381
17. Hanson KL, Sobal J, Frongillo EA. Gender and marital status clarify associations between food insecurity and body weight. *J Nutr*. 2007; 137:1460–5. <https://doi.org/10.1093/jn/137.6.1460> PMID: 17513407
18. Grigoriadis S, Robinson GE. Gender issues in depression. *Ann Clin Psychiatry*. 2007; 19:247–55. <https://doi.org/10.1080/10401230701653294> PMID: 18058282
19. Whiteford HA, Degenhardt L, Rehm J, Baxter AJ, Ferrari AJ, Erskine HE, et al. Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. *Lancet*. 2013; 382:1575–86. [https://doi.org/10.1016/S0140-6736\(13\)61611-6](https://doi.org/10.1016/S0140-6736(13)61611-6) PMID: 23993280
20. Cho MJ, Seong SJ, Park JE, Chung IW, Lee YM, Bae A, et al. Prevalence and correlates of DSM-IV mental disorders in South Korean adults: The Korean Epidemiologic Catchment Area Study 2011. *Psychiatry Investig*. 2015; 12:164–70. <https://doi.org/10.4306/pi.2015.12.2.164> PMID: 25866515
21. Kim Y. The Korea National Health and Nutrition Examination Survey (KNHANES): current status and challenges. *Epidemiol Health*. 2014; 36:e2014002. <https://doi.org/10.4178/epih/e2014002> PMID: 24839580
22. Kim K, Hong SA, Kwon SO, Choi BY, Kim GY, Oh SY. Development and validation of food security measure. *Kor J Community Nutr*. 2011; 16:771–81.
23. Manea L, Gilbody S, McMillan D. Optimal cut-off score for diagnosing depression with the Patient Health Questionnaire (PHQ-9): a meta-analysis. *CMAJ*. 2012; 184:E191–6. <https://doi.org/10.1503/cmaj.110829> PMID: 22184363
24. Tuthill EL, Sheira LA, Palar K, Frongillo EA, Wilson TE, Adedimeji A, et al. Persistent food insecurity is associated with adverse mental health among women living with or at risk of HIV in the United States. *J Nutr*. 2019; 149:240–8. <https://doi.org/10.1093/jn/nxy203> PMID: 30753638
25. Jessiman-Perreault G, McIntyre L. The household food insecurity gradient and potential reductions in adverse population mental health outcomes in Canadian adults. *SSM Popul Health*. 2017; 3:464–72. <https://doi.org/10.1016/j.ssmph.2017.05.013> PMID: 29349239
26. Jones AD. Food insecurity and mental health status: a global analysis of 149 countries. *Am J Prev Med*. 2017; 53:264–73. <https://doi.org/10.1016/j.amepre.2017.04.008> PMID: 28457747
27. Leung CW, Epel ES, Ritchie LD, Crawford PB, Laraia BA. Food insecurity is inversely associated with diet quality of lower-income adults. *J Acad Nutr Diet*. 2014; 114:1943–53 e2. <https://doi.org/10.1016/j.jand.2014.06.353> PMID: 25091796

28. Lent MD, Petrovic LE, Swanson JA, Olson CM. Maternal mental health and the persistence of food insecurity in poor rural families. *J Health Care Poor Underserved*. 2009; 20:645–61. <https://doi.org/10.1353/hpu.0.0182> PMID: 19648695
29. Palar K, Kushel M, Frongillo EA, Riley ED, Grede N, Bangsberg D, et al. Food insecurity is longitudinally associated with depressive symptoms among homeless and marginally-housed individuals living with HIV. *AIDS Behav*. 2015; 19:1527–34. <https://doi.org/10.1007/s10461-014-0922-9> PMID: 25351185
30. Oddo VM, Mabli J. Association of participation in the supplemental nutrition assistance program and psychological distress. *Am J Public Health*. 2015; 105:e30–5.
31. Jalal CS, Frongillo EA, Warren AM. Food Insecurity Mediates the Effect of a Poverty-Alleviation Program on Psychosocial Health among the Ultra-Poor in Bangladesh. *J Nutr*. 2015; 145:1934–41. <https://doi.org/10.3945/jn.115.210799> PMID: 26108542
32. Cook JT, Black M, Chilton M, Cutts D, Ettinger de Cuba S, Heeren TC, et al. Are food insecurity's health impacts underestimated in the U.S. population? Marginal food security also predicts adverse health outcomes in young U.S. children and mothers. *Adv Nutr*. 2013; 4:51–61. <https://doi.org/10.3945/an.112.003228> PMID: 23319123