Longitudinal Trajectories of Depressive Symptoms and Their Associations With Risks of Underweight and Obesity in Women:

A Population-Based Longitudinal Study in Korea

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Abstract

Objective: We explored depressive symptom trajectories and their associations with underweight and obesity in Korean women.

Methods: This prospective cohort study involved 7,691 women enrolled in the Korean Longitudinal Survey of Women and Families, with a follow-up period spanning from 2014 to 2020. Depressive symptoms were evaluated through the 10-item version of the Center of Epidemiologic Studies Depression Scale. Growth mixture modeling was employed to identify trajectories of depressive symptoms. Multinomial logistic regressions were conducted to investigate the correlation between depression trajectories and the evolving risks of underweight and obesity over the study period.

Results: Five distinct trajectory classes were observed ("persistent low symptoms": N = 5,236, 68.1%; "decreasing symptoms": N = 930, 12.1%; "transient high symptoms": N = 421, 5.5%; "increasing symptoms" N = 825, 10.7%; and "persistent high symptoms": N = 279, 3.6%). Those with a low socioeconomic status, comorbidity, and who were divorced or widowed were more likely to follow the persistent high symptom trajectory. Among the 5 trajectories, the risks of underweight and obesity steadily increased in women following the trajectory with persistent high symptoms. For these women, the odds ratio (OR) of underweight increased from 2.27 (95% CI, 1.32–3.92) in 2014 to 3.39 (1.91–6.05) in 2020. They were not associated with obesity in 2014 (OR [95% CI]: 1.38 [0.61–3.11]) but exhibited an elevated risk of obesity in 2020 (3.76 [1.97–7.17]).

Conclusion: We observed considerable heterogeneity in the trajectories of depressive symptoms among women, and individuals with persistent high depressive symptoms face an escalating risk of both underweight and obesity.

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Depression is currently a major public health concern. According to the Global Burden of Disease Study, approximately 258 million people are newly diagnosed with depression annually.[1] In particular, South Korea is one of the countries with the highest increase in the incidence of depression in recent decades.[1] Additionally, women are known to be vulnerable to depression, exhibiting an approximately 1.7-fold higher lifetime prevalence of depression than men.[2]

Previous studies have found that depressive symptom trajectories are associated with various adverse health outcomes. Those who follow a trajectory with persistent high depressive symptoms are more likely to attempt suicide.[3] A trajectory with increasing depressive symptoms is significantly related to an elevated risk of incident stroke and dementia.[4] In addition to neuropsychiatric outcomes, a persistent high or increasing depressive symptom trajectory is associated with an increased risk of all-cause mortality and cancer incidence.[5] Therefore, identifying trajectory subgroups of depressive symptoms and investigating the demographic and socioeconomic predictors of these trajectories are crucial for managing the mental health of the population and preventing associated adverse health outcomes.

Depressive symptoms are closely related to body weight, and this relationship is bidirectional. Previous meta-analyses have confirmed that depression is a major predictor of obesity, and vice versa.[6,7] Several social and

Clinical Points

- In our population-based cohort, the risk of both underweight and obesity in women following the trajectory with persistent high depressive symptoms steadily increased during follow-ups.
- Active monitoring and intervention are required for women with prolonged high depressive symptoms.

behavioral factors mediate this relationship. For example, those with depression are more likely to disengage from social activities and are prone to eating in response to negative emotions (emotional eating), which can contribute to the development of overweight and obesity.[8] However, depression is related not only to weight gain but also to weight loss and a decrease in appetite.[9] Some epidemiologic studies have suggested a U-shaped relationship between depressive symptoms and body mass index (BMI), wherein both underweight and obese individuals exhibit a high level of depressive symptoms.[10,11] However, limited trajectory studies have assessed how the risk of underweight and obesity changes following trajectories with high depressive symptoms, and the results have been mixed. One study suggested that trajectories with high depressive symptoms are positively associated with underweight and negatively associated with obesity,[12] whereas another study determined that trajectories with high depressive symptoms are related to a subsequent increase in BMI among women.[13] A British study[14] found that depression was related to subsequent underweight only in men and did not predict obesity in both sexes.

Although previous studies have analyzed the longitudinal trajectories of depressive symptoms in women, studies based on samples representing the general female population are scarce. Most studies have investigated perinatal depressive symptoms[13,15,16] or depressive symptom trajectories in older women.[4,17] Thus, we aimed to (1) identify distinct latent trajectories of depressive symptoms, (2) explore the association between baseline predictors and trajectory membership, and (3) explore the association between depressive symptom trajectory and the risks of underweight and obesity.

METHODS

Study Population

The study population was drawn from the Korean Longitudinal Survey of Women and Families (KLoWF). The data are collected every other year. The target population of the KLoWF is all Korean women aged 19–64 years. The KLoWF uses 2-stage stratified sampling, in which enumeration districts are a primary sampling unit and households are a secondary sampling unit. Thus, the study participants are representative of all Korean women aged 19–64 years. In total, 9,997 participants were included in the first wave (2007). Participants from the fifth (2014) to eighth (2020) waves were included in this study because the current form of the survey questionnaires on depressive symptoms was introduced in the fifth wave (2014). Trained interviewers conducted the surveys through one-on-one face-to-face interviews.

Of the 7,745 participants in the fifth wave (2014), those with missing baseline characteristics were excluded (N = 56). Thus, 7,691 study samples were included in our analysis. Of the 7,691 people who participated in the 2014 survey, 6,985 (87.7%) also participated in the 2016 survey; 6,616 (83.1%) in the 2018 survey; and 6,196 (77.8%) in the 2020 survey. A total of 27,488 observations were used, meaning that each participant participated in approximately 3.45 surveys on average.

Data Availability and Ethics Statement

Raw KLoWF data are openly published at https://gsis.kwdi.re.kr/klowf/portal/eng/mainPage.do. This study was approved by the Institutional Review Board of the author's institution (No. 4–2022–1414).

Measures

Depressive symptoms. Depressive symptoms were measured using the 10-item version of the Center for Epidemiologic Studies Depression Scale (CESD-10). The validity and reliability of the Korean version of the CESD-10 have been established in a previous study.[18] CESD-10 consists of 10 items regarding respondents' depressive conditions, and the response to each item is based on an integer between 0 ("never or rarely") and 3 ("all of the time"). The summed score of the CESD-10 ranges from 0 to 30, where a higher score indicates a higher level of depressive symptoms. A CESD-10 score ≥10 corresponds to a clinically significant high level of depressive symptoms.[18]

Outcomes. In each survey, the participants' BMI was calculated using their self-reported height (m) and weight (kg). The World Health Organization guideline defines BMI ≥ 30 kg/m^2 as obesity, whereas BMI ≥ 25 kg/m^2 is defined as obesity in the Asia-Pacific region.[19] To reduce arbitrariness, we defined 25 kg/m^2 ≤ BMI < 30 kg/m^2 as "Class I obesity" and BMI ≥ 30 kg/m^2 as "Class II obesity," considering both cutoffs. This classification and nomenclature are consistent with the recent Korean criteria, established by the Korean Society for the Study of Obesity.[20] Underweight was defined as BMI < 18.5 kg/m^2 according to the guideline by the Korean Society for the Study of Obesity.[20]

Covariates. Baseline predictors were obtained at the baseline year 2014. Age was categorized into "<40," "40–49," "50–59," or "≥60." Education was categorized into completion of "middle school or below," "high school," or "college or above." Total household income was categorized

into 4 quartiles: "Q1," "Q2," "Q3," or "Q4." Marital status was categorized into "married," "unmarried," or "other (divorced or widowed)." Employment status was categorized into "employee," "unemployed," "self-employed," or "other." Comorbidity was defined as a diagnosis of at least 1 of the following diseases by a physician: cardiovascular, cerebrovascular, musculoskeletal, digestive, or respiratory disease.

Statistical Analyses

The preliminary analyses involved the following 2-step procedure. First, we fitted latent growth models (LGMs) that assumed no latent subgroups to determine the most appropriate growth functions for depressive symptoms. The no-growth, linear, and quadratic models were sequentially fitted. For the model comparison, the root-mean-square error of approximation, comparative fit index, Tucker-Lewis index, and standardized root-mean-squared residual were calculated. After selecting the most appropriate form of growth, we fitted growth mixture models (GMMs) with different numbers of latent trajectory classes to identify the most appropriate number of latent classes.[21] For selecting the most appropriate GMM, the Akaike information criterion, Bayesian information criterion, sample size–adjusted Bayesian information criterion, entropy, Lo-Mendell-Rubin–adjusted likelihood ratio test, and parametric bootstrapped likelihood ratio test were used. An entropy of more than 0.8 indicates a good classification quality.[22] In addition to fit indices, substantive interpretability, parsimony, and theoretical justification should be considered when choosing the number of latent classes.[23] GMM employs the full information maximum likelihood strategy to use cases with missing data.

After selecting the number of latent classes of depressive symptom trajectory, individuals were assigned to the most probable subgroups. We then explored the relationship between the baseline characteristics and each trajectory membership via the R3STEP procedure in Mplus (version 8.8; Muthén & Muthén, Los Angeles, CA), which involves multinomial logistic regression to estimate the odds ratios (ORs) and 95% CIs.[24]

Finally, we explored the association between depressive symptom trajectories and the risks of underweight and obesity in each survey year. We employed multinomial logistic regressions adjusted for the covariates in each wave of concern. The "*multinom*" function in the "*nnet*" package in the R software (version 4.2.2; R Foundation for Statistical Computing, Vienna, Austria) was used. All statistical analyses were performed using Mplus and R.

We conducted several additional analyses. First, we investigated the association between trajectories of depressive symptoms and Class I or II obesity (BMI ≥ 25 kg/m^2). Second, we explored BMI trajectories and their relationship with the risk of depressive symptoms, defined as CESD-10 ≥ 10. Using a methodology identical to that employed for determining the trajectories of depressive symptoms, we derived BMI trajectories and subsequently evaluated their association with the risk of depressive symptoms each year through logistic regression.

Table 1.
Baseline Characteristics of the Cohort Sample

Characteristics	Sample N = 7,691 (100%)
Age, y	
<40	2,015 (26.2%)
40–49	2,142 (27.9%)
50–59	1,712 (22.3%)
≥60	1,822 (23.7%)
Education	
Middle school or below	2,314 (30.1%)
High school	3,559 (46.3%)
College or above	1,818 (23.6%)
Marital status	
Married	5,719 (74.4%)
Unmarried	1,040 (13.5%)
Other	932 (12.1%)
Household income	
Q1	2,288 (29.7%)
Q2	2,049 (26.6%)
Q3	1,923 (25.0%)
Q4	1,431 (18.6%)
Employment status	
Employee	2,319 (30.2%)
Self-employed	828 (10.8%)
Other	1,088 (14.1%)
Unemployed	3,456 (44.9%)
Having comorbidity	
No	6,141 (79.8%)
Yes	1,550 (20.2%)

RESULTS

Descriptive Analyses

Table 1 presents the baseline characteristics of the study participants. The mean scores of the CESD-10 were 4.52 in 2014, 4.22 in 2016, 4.50 in 2018, and 4.85 in 2020.

Preliminary Analyses

Supplementary Table 1 shows the model fit statistics for the different LGMs. Supplementary Table 2 shows the model fit statistics for the GMMs with different numbers of latent classes. The rationale for selecting the 5-class model is presented in the Supplementary Material.

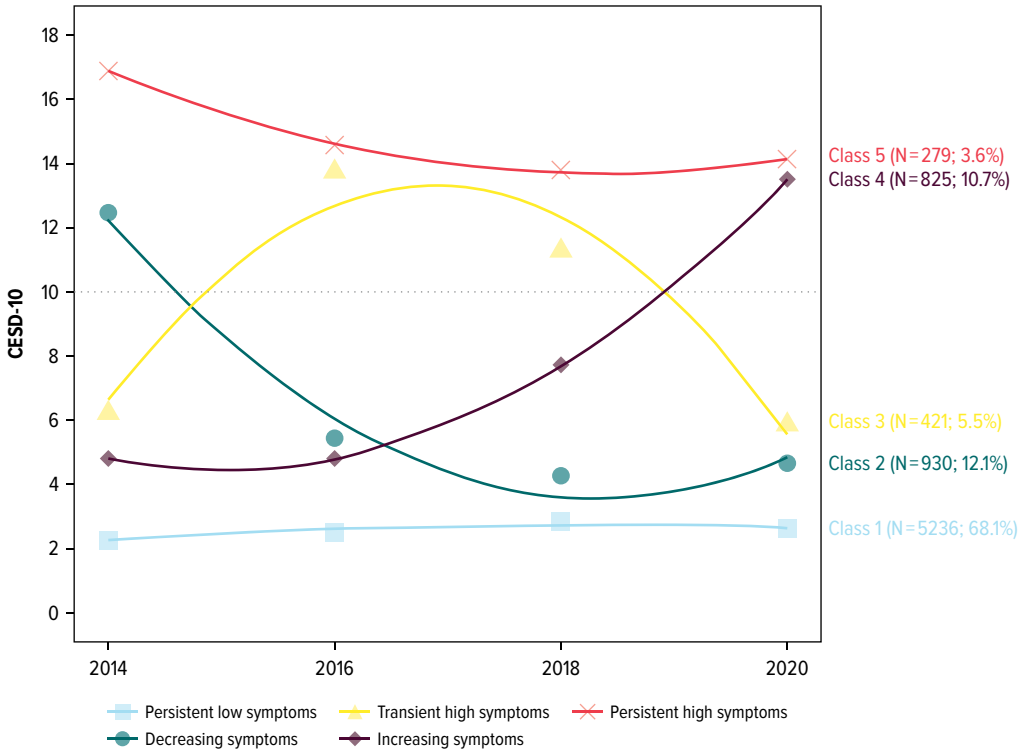
GMM Analyses

Figure 1 depicts the 5 trajectories of depressive symptoms, which can be characterized as follows:

- Class 1 (persistent low symptoms): women who belonged to this class (N = 5,236; 68.1%) reported

Figure 1.

Trajectory Classes From the 5-Class Growth Mixture Model for Depressive Symptoms (N = 7,691)



Abbreviation: CESD = Center for Epidemiologic Studies Depression Scale.

stably low levels of depressive symptoms (CESD-10 < 10) during the observation period.

- Class 2 (decreasing symptoms): women who belonged to this class (N = 930; 12.1%) initially reported high levels of depressive symptoms (CESD-10 > 10), but their depressive symptoms decreased thereafter.
- Class 3 (transient high symptoms): women who belonged to this class (N = 421; 5.5%) followed an inverse U-shaped curve. They initially reported low depressive symptoms. Subsequently, a transient increase in depressive symptoms was observed, followed by a decrease in the final survey year.
- Class 4 (increasing symptoms): women who belonged to this class (N = 825; 10.7%) initially reported low levels of depressive symptoms, but their depressive symptoms increased thereafter.
- Class 5 (persistent high symptoms): women who belonged to this class (N = 279; 3.6%) reported persistently high levels of depressive symptoms during the observation period.

Predictors of Trajectory Membership

Table 2 shows the results of the multinomial logistic regression, which presents the association between the baseline characteristics and each depressive symptom trajectory class. Compared with the reference group (persistent low symptoms), low education level, low household income, being divorced or widowed, being unemployed, and having comorbidities were related to the trajectory with persistent high depressive symptoms.

Depressive Symptom Trajectory and Risks of Underweight and Obesity

Figure 2 presents the prevalence trend of underweight and obesity according to the trajectory classes during follow-ups. Among those who followed the trajectory with persistent high depressive symptoms, the prevalence of both underweight and Class II obesity increased during the study period.

Table 3 presents the association between the depressive symptom trajectories and the risks of underweight and obesity in each survey year. Among women who followed the trajectory with persistent high depressive symptoms, the adjusted OR of underweight steadily increased from 2.27 (95% CI, 1.32–3.92) in 2014 to 3.39 (95% CI, 1.91–6.05) in 2020. In addition, women who followed the trajectory with persistent high symptoms were not associated with an increased risk of

Table 2.

Association of Baseline Predictors With the Trajectory Membership. Class 5 (Persistent Low Symptoms) Was the Reference Group in the Multinomial Logistic Regression

Characteristics	Class 1 "Persistent high symptoms" OR (95% CI)	Class 2 "Increasing symptoms" OR (95% CI)	Class 3 "Transient high symptoms" OR (95% CI)	Class 4 "Decreasing symptoms" OR (95% CI)
Age				
<40	Reference	Reference	Reference	Reference
40–49	2.20 (0.87–5.59)	1.87 (1.24–2.80)	2.66 (1.26–5.61)	1.07 (0.78–1.48)
50–59	2.10 (0.96–5.81)	2.60 (1.73–3.90)	4.43 (2.02–9.74)	1.45 (1.40–2.01)
≥60	1.62 (0.61–4.29)	2.94 (1.94–4.46)	3.86 (1.71–8.72)	1.04 (0.72–1.51)
Education				
Middle school or below	1.92 (0.71–5.23)	1.59 (0.86–2.96)	0.83 (0.35–1.96)	1.38 (0.75–2.55)
High school	1.26 (0.56–2.85)	1.09 (0.78–1.52)	0.82 (0.53–1.26)	1.06 (0.80–1.41)
College or above	Reference	Reference	Reference	Reference
Marital status				
Married	Reference	Reference	Reference	Reference
Unmarried	1.08 (0.42–2.75)	0.68 (0.40–1.15)	1.08 (0.51–2.30)	0.82 (0.56–2.55)
Other	4.68 (3.15–6.96)	1.77 (1.30–2.41)	1.94 (1.29–2.91)	2.55 (1.88–3.44)
Household income				
Q1	15.98 (5.90–43.28)	2.79 (1.98–3.93)	3.85 (2.32–6.39)	3.27 (2.32–4.59)
Q2	5.62 (2.11–14.99)	2.02 (1.46–2.79)	2.11 (1.29–3.45)	2.38 (1.75–3.22)
Q3	1.79 (0.59–5.46)	1.33 (0.95–1.87)	1.71 (1.05–2.80)	1.44 (1.05–1.98)
Q4	Reference	Reference	Reference	Reference
Employment status				
Employee	Reference	Reference	Reference	Reference
Self-employed	0.82 (0.39–1.71)	1.66 (1.19–2.31)	1.17 (0.72–1.91)	0.78 (0.52–1.15)
Other	1.21 (0.62–2.36)	1.37 (0.99–1.89)	1.02 (0.65–1.61)	0.86 (0.62–1.20)
Unemployed	1.92 (1.14–3.22)	1.08 (0.82–1.41)	1.20 (0.75–1.70)	1.07 (0.85–1.36)
Having comorbidity				
No	Reference	Reference	Reference	Reference
Yes	17.16 (11.41–25.82)	3.27 (2.35–4.55)	3.29 (2.16–5.03)	6.18 (4.58–8.35)

Abbreviation: OR = odds ratio.

Figure 2.

Prevalence of Underweight, Class I Obesity, and Class II Obesity of 5 Depressive Symptom Trajectories

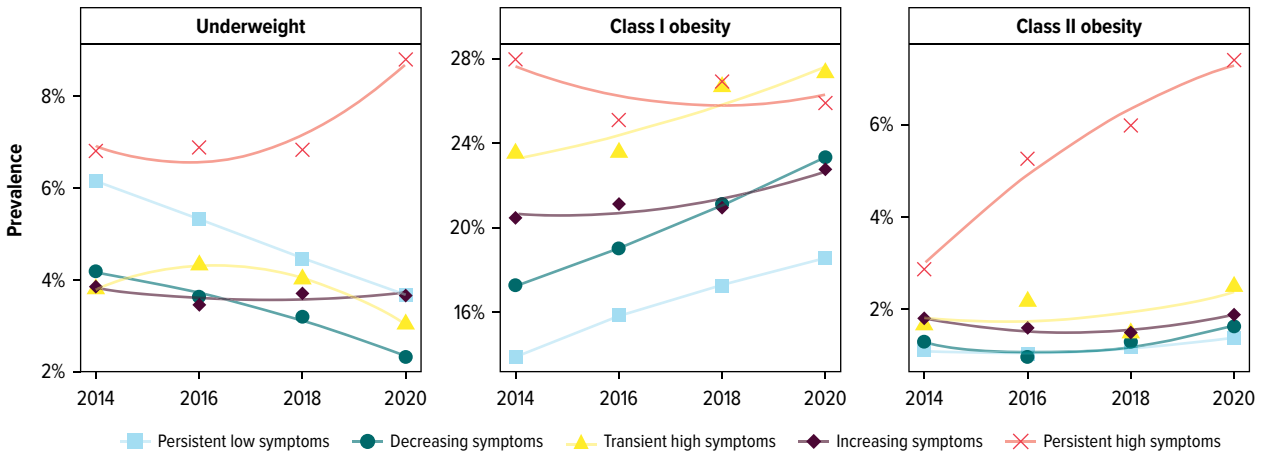


Table 3.

Association Between Depressive Symptom Trajectories and Risks of Underweight and Obesity According to Each Survey Year

	2014	2016	2018	2020
	OR (95% CI)[a]	OR (95% CI)[a]	OR (95% CI)[a]	OR (95% CI)[a]
Underweight (BMI < 18.5 kg/m²)				
Persistent low symptoms	Reference	Reference	Reference	Reference
Decreasing symptoms	0.84 (0.58–1.20)	0.90 (0.60–1.35)	0.95 (0.61–1.47)	0.71 (0.41–1.21)
Transient high symptoms	1.01 (0.59–1.71)	1.28 (0.76–2.14)	1.44 (0.83–2.49)	1.13 (0.59–2.15)
Increasing symptoms	1.01 (0.69–1.50)	0.98 (0.65–1.49)	1.18 (0.78–1.80)	1.21 (0.79–1.86)
Persistent high symptoms	2.27 (1.32–3.92)	2.71 (1.51–4.88)	3.04 (1.66–5.55)	3.39 (1.91–6.05)
Class I obesity (25 kg/m² ≤ BMI < 30 kg/m²)				
Persistent low symptoms	Reference	Reference	Reference	Reference
Decreasing symptoms	0.93 (0.76–1.14)	0.91 (0.74–1.11)	1.01 (0.83–1.23)	1.10 (0.90–1.34)
Transient high symptoms	1.35 (1.05–1.73)	1.15 (0.89–1.48)	1.30 (1.01–1.67)	1.30 (1.01–1.69)
Increasing symptoms	1.07 (0.88–1.30)	0.96 (0.79–1.17)	0.93 (0.76–1.13)	0.95 (0.78–1.16)
Persistent high symptoms	1.37 (1.01–1.84)	1.03 (0.75–1.43)	1.15 (0.83–1.59)	1.13 (0.80–1.59)
Class II obesity (BMI ≥ 30 kg/m²)				
Persistent low symptoms	Reference	Reference	Reference	Reference
Decreasing symptoms	0.79 (0.41–1.50)	0.60 (0.27–1.36)	0.92 (0.46–1.83)	1.01 (0.53–1.92)
Transient high symptoms	1.09 (0.48–2.45)	1.55 (0.73–3.26)	1.09 (0.46–2.60)	1.52 (0.73–3.17)
Increasing symptoms	1.11 (0.61–2.02)	1.09 (0.56–2.10)	0.90 (0.46–1.76)	1.02 (0.56–1.85)
Persistent high symptoms	1.38 (0.62–3.11)	3.08 (1.51–6.26)	3.59 (1.82–7.08)	3.76 (1.97–7.17)

[a]Age, education, marital status, household income, employment status, and comorbidity were adjusted.
Abbreviations: BMI = body mass index, OR = odds ratio.

Class II obesity in 2014 (OR [95% CI]: 1.38 [0.62–3.11]) but exhibited an increased risk of Class II obesity in 2020 (OR [95% CI]: 3.76 [1.97–7.17]). Women with transient high symptoms exhibited a high risk of Class I obesity.

Additional Analysis

Supplementary Table 3 indicates that the OR of the association between the trajectory of persistent high depressive symptoms and obesity was attenuated compared to the main analysis. Individuals belonging to the trajectory of persistent high depressive symptoms showed a marginally increased likelihood of having Class I or II obesity (BMI ≥ 25 kg/m²). Supplementary Figure 1 shows the 4 trajectories of BMI within the cohort sample. In comparison to those with a persistent low BMI (Class 1: 95.4%), individuals experiencing high (Class 3: 1.7%) or increasing (Class 4: 1.9%) BMI trajectories exhibited a higher likelihood of having depression, although the observed association was modest (Supplementary Table 4).

DISCUSSION

Our study aimed to identify the latent trajectories of depressive symptoms in women and their association with underweight and obesity. Although approximately two-thirds of the total sample exhibited persistent low depressive symptoms, some women had increasing or high depressive symptoms. Low socioeconomic status was significantly associated with risky trajectories. Moreover, the risk of both underweight and obesity in women following a trajectory of persistent high depression steadily increased during follow-ups.

Our study derived 5 distinct patterns of depressive symptom trajectories. A persistent low or high depressive symptom trajectory is a class that has been consistently observed in previous studies.[25,26] In most previous studies, the trajectory of stably low depressive symptoms accounted for more than 50% of the sample, whereas the trajectory of stably high depressive symptoms accounted for the smallest proportion.[25,26] An increasing or decreasing trajectory was also a pattern commonly observed in previous studies; however, this trajectory often presented as stably moderate symptoms.[27,28] In contrast, a trajectory with transient high symptoms has been uncommonly observed in previous studies.[4,29] In summary, the results of the trajectory analyses in this study are consistent with those of the current literature on the trajectory of depressive symptoms.

Women with low education and household income were more likely to follow a trajectory with persistent high symptoms. Our results were consistent with those of previous studies that education and income were related to high depressive symptoms[30,31]; however, our study contradicts a previous study that demonstrated that income was not associated with following the trajectories with high depressive symptoms among women of childbearing age.[13] Additionally, being divorced or widowed is related to risky trajectories, reinforcing that marital instability is a major predictor of trajectories with high depressive symptoms in women.[28]

Our findings confirmed that women belonging to the trajectory with persistent high depressive symptoms followed a notably different body weight trajectory than women belonging to other trajectories. The steady increase in the prevalence of Class I obesity, which is observed in most trajectories except for that with persistent high symptoms, accords with the conventional knowledge that the amount of adipose tissue increases with age in women, increasing the risk of obesity.[32] However, in the case of Class II obesity, an increase in obesity prevalence over time was noticeable only in the trajectory with persistent high symptoms, suggesting that depressive symptoms strongly affected obesity risk in women belonging to this trajectory. In the case of underweight, the prevalence decreased in women following trajectories with persistent low symptoms and decreasing symptoms, whereas the prevalence increased in women following the trajectory with persistent high symptoms. This difference in the trend of underweight according to the depressive symptom trajectories suggests that persistent high depressive symptoms may hinder the transition from underweight to normal weight in women.[10,11]

Our findings differ from those of previous latent trajectory studies that analyzed the association between depressive symptom trajectories and body weight. First, a Taiwan study argued that a chronic, high depression trajectory was positively associated with underweight and negatively with obesity.[12] The reverse association between depression and obesity observed in the Taiwan study might be attributed to the social context of Taiwan and China, where obese people report better mental health (so-called "jolly fat").[33] In contrast, the present study was conducted in Korea, where the U-shaped association between body weight and depression symptoms is observed.[11] Second, a previous Korean study found that women who followed the trajectories with high depressive symptoms experienced an increase in BMI during follow-ups.[13] However, our results suggest that women following the trajectories with high depressive symptoms are associated with not only obesity but also an increased risk of underweight.

Our findings are congruent with the characteristics of depression, which is associated with both a decrease and an increase in body weight and food intake.[9] Clinically, it has been observed that depression can lead to varying changes in appetite, wherein some individuals experience a loss of appetite, while others tend to eat more.[34,35] These differences in appetite may be attributable to underlying pathophysiological changes linked to depression. The subtypes of depression characterized by either increased or decreased appetite exhibit distinct profiles of metabolic and endocrine biomarkers, such as leptin and ghrelin.[36,37] Moreover, different characteristics in the reward circuitry have been observed across depression subtypes with increased or decreased appetite.[38,39] These neurobiological mechanisms that underlie the different profiles of appetite can account for the 2 contrasting patterns of weight change observed in women within trajectories with persistent high depressive symptoms. This is also consistent with results of previous epidemiologic studies that reported that both underweight and obesity were associated with high depressive symptoms.[10,11]

Our study had several limitations. First, because body weight and height were self-reported, there is a possibility of reporting bias, especially because survey participants might underreport their body weight.[40] Second, owing to the observational nature of this study, we were unable to rule out the possibility of unmeasured confounders introducing biased estimations in our analysis. For example, previous studies have indicated that experiencing trauma and the use of psychotropic drugs are closely associated with both depressive symptoms and obesity, especially in women.[41] Due to the lack of information, we could not incorporate these factors into our analyses, potentially resulting in an overestimation of the association between the trajectory of persistent high depressive symptoms and obesity. Third, we did not consider the bidirectional association between depressive symptoms and body weight. Therefore, we hope that further studies consider the bidirectional associations between depression and body weight, as well as the mediating effects of health behaviors, such as dietary habits or physical activity.

CONCLUSION

Our study identified 5 distinct trajectories of depressive symptoms among women. Those with a low socioeconomic status or comorbidities were more likely to follow the trajectories with high depressive symptoms. Women following the trajectory with high depressive symptoms had increased risks of underweight and obesity. Therefore, interventions should aim to improve the mental health of women with prolonged high depressive symptoms and lead them to a healthy weight.

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Supplementary Material

Article Title: Longitudinal Trajectories of Depressive Symptoms and Their Associations With Risks of Underweight and Obesity in Women: A Population-Based Longitudinal Study in Korea

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LIST OF SUPPLEMENTARY MATERIAL FOR THE ARTICLE

DISCLAIMER

Supplementary Table 1. Comparison of latent growth models

Model fit Statistics	No-growth model	Linear model	Quadratic model
RMSEA	0.064	0.048	0.026
CFI	0.947	0.981	0.999
TLI	0.960	0.978	0.993
SRMR	0.045	0.024	0.006

RMSEA: root mean square error of approximation; CFI: comparative fit index; TLI: Tucker-Lewis index; SRMR: standardized root mean squared residual

Compared with the no-growth and linear models, the quadratic model showed better model fit statistics for all four fit indices. Therefore, the quadratic GMM was selected.

Supplementary Table 2. Model fit statistics by growth mixture models with different numbers of latent classes

Model statistics	Number of latent classes				
	2	3	4	5	6
AIC	159723.685	159055.977	158268.182	157581.864	157292.942
BIC	159820.954	159181.037	158421.033	157762.507	157501.376
SABIC	159776.465	159123.837	158351.122	157679.884	157406.042
LMR LRT (*p* value)	< 0.001	< 0.001	0.037	< 0.001	0.159
BLRT (*p* value)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Entropy	0.848	0.777	0.802	0.804	0.808
Proportion of each class					
1	83.5%	76.7%	74.7%	68.1%	62.7%
2	16.5%	10.4%	10.2%	12.1%	13.7%
3		12.9%	9.9%	10.7%	9.7%
4			5.2%	5.5%	5.5%
5				3.6 %	3.1%
6					2.3%

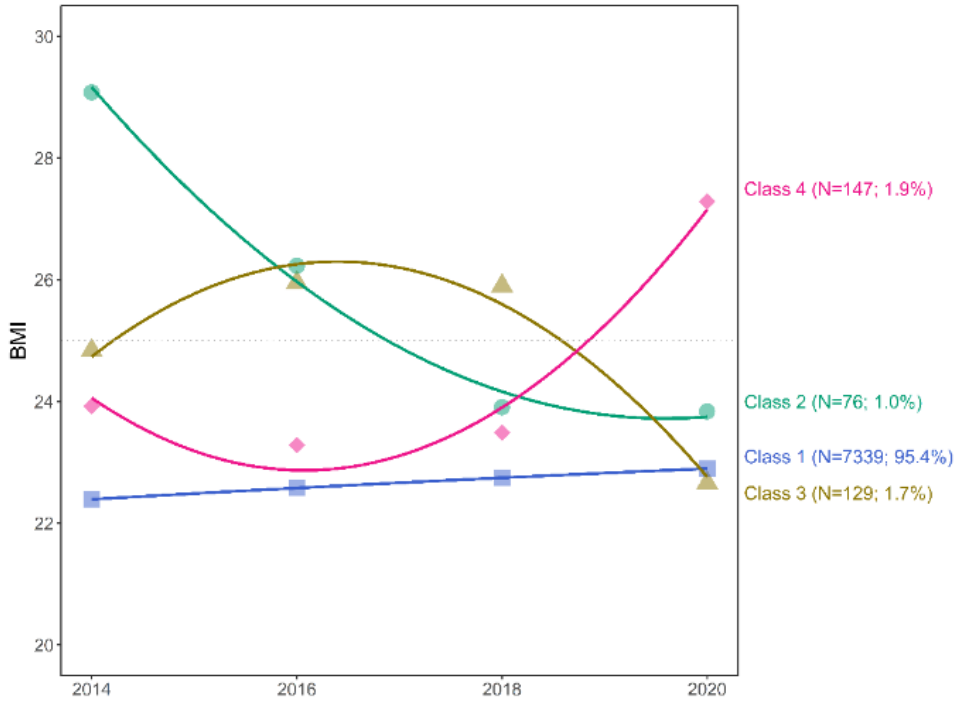
The AIC, BIC, and SABIC decreased as the number of latent classes increased. The rates of change in AIC, BIC, and SABIC remained constant as the number of classes increased from 2 to 5; however, the rate of change became flat when the number of classes reached 6. Furthermore, the LMR-LRT of six-class model was greater than 0.05. Based on the changes in AIC, BIC, and SABIC values, as well as entropy and LMR-LRT p-value, the five-class GMM was selected as the optimal choice.

Supplementary Table 3 Association between depressive symptom trajectories and risks of underweight and obesity according to each survey year. Models adjusted for age, education, marital status, household income, employment status, and comorbidity.

	2014	**2016**	**2018**	**2020**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Underweight (BMI < 18.5 kg/m^2)				
Persistent low symptoms	Reference	Reference	Reference	Reference
Decreasing symptoms	0.84 (0.58–1.20)	0.90 (0.60–1.36)	0.95 (0.61–1.47)	0.71 (0.41–1.21)

Transient high symptoms	1.01 (0.59–1.72)	1.28 (0.76–2.14)	1.44 (0.83–2.49)	1.13 (0.59–2.15)
Increasing symptoms	1.01 (0.69–1.50)	0.98 (0.65–1.49)	1.19 (0.78–1.80)	1.21 (0.79–1.86)
Persistent high symptoms	2.27 (1.32–3.92)	2.71 (1.51–4.87)	3.03 (1.66–5.54)	3.39 (1.90–6.03)
Class I or II obesity (BMI ≥ 25 kg/m^2)				
Persistent low symptoms	Reference	Reference	Reference	Reference
Decreasing symptoms	0.92 (0.76–1.12)	0.89 (0.73–1.09)	1.00 (0.83–1.22)	1.09 (0.90–1.33)
Transient high symptoms	1.33 (1.04–1.70)	1.17 (0.91–1.50)	1.29 (1.01–1.64)	1.32 (1.03–1.70)
Increasing symptoms	1.07 (0.88–1.30)	0.97 (0.80–1.18)	0.93 (0.77–1.12)	0.96 (0.79–1.16)
Persistent high symptoms	1.37 (1.02–1.83)	1.17 (0.86–1.59)	1.31 (0.97–1.78)	1.33 (0.97–1.83)

BMI: body mass index; OR: odds ratio; CI: confidence interval



Supplementary Figure S1 Trajectory of body mass index (N=7691)

Supplementary Table 4 Association between trajectories of body mass index and risks of depressive symptoms (CES-D-10 ≥10) according to each survey year.

	2014	2016	2018	2020
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Depressive symptoms				
Class 1	Reference	Reference	Reference	Reference
Class 2	1.01 (0.94–1.09)	0.99 (0.92–1.07)	1.07 (0.98–1.16)	1.07 (0.97–1.17)
Class 3	1.10 (1.03–1.17)	1.07 (1.01–1.13)	1.09 (1.02–1.16)	1.08 (1.01–1.15)
Class 4	1.03 (0.97–1.09)	1.01 (0.97–1.08)	0.97 (0.91–1.03)	1.06 (1.00–1.13)

Models adjusted for age, education, marital status, household income, employment status, and comorbidity.