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Associations between weight-control methods and depression among Korean adolescents: a study based on a national dataset

Jaehyun Kong [1,2*], Kyeongmin Lee [2,3*], Sooji Lee [1,2*], Soeun Kim [2,4],
Jinyoung Jeong [1,2], Yejun Son [2,4], Hayeon Lee [2,5], Louis Jacob [6,7,8],
Masoud Rahmati [9,10,11], Guillaume Fond [9], Laurent Boyer [9], Lee Smith [12],
Elena Dragioti [13], Selin Woo [1,2], Jiyoung Hwang [1,2§], and
Dong Keon Yon [1,2,3,4,14§]

[1]Department of Medicine, Kyung Hee University College of Medicine, Seoul 02447, Korea
[2]Center for Digital Health, Medical Science Research Institute, Kyung Hee University Medical Center, Kyung Hee University College of Medicine, Seoul 02447, Korea
[3]Department of Regulatory Science, Kyung Hee University, Seoul 02447, Korea
[4]Department of Precision Medicine, Kyung Hee University College of Medicine, Seoul 02447, Korea
[5]Department of Electronics and Information Convergence Engineering, Kyung Hee University, Yongin 17104, Korea
[6]Department of Physical Medicine and Rehabilitation, Université Paris Cité, Lariboisière-Fernand Widal Hôpital, AP-HP, Paris 75010, France
[7]Inserm U1153, Epidemiology of Ageing and Neurodegenerative Diseases (EpiAgeing), Université Paris Cité, Paris 75006, France
[8]Research and Development Unit, Parc Sanitari Sant Joan de Déu, Sant Boi de Llobregat 08830, Barcelona, Spain
[9]CEReSS-Health Service Research and Quality of Life Center, Assistance Publique des Hôpitaux de Marseille, Aix-Marseille University, Marseille 13005, France
[10]Department of Physical Education and Sport Sciences, Faculty of Literature and Human Sciences, Lorestan University, Khorramabad 6813833946, Iran
[11]Department of Physical Education and Sport Sciences, Faculty of Literature and Humanities, Vali-E-Asr University of Rafsanjan, Rafsanjan 7718897111, Iran
[12]Centre for Health, Performance and Wellbeing, Anglia Ruskin University, Cambridge CB1 1PT, UK
[13]Research Laboratory Psychology of Patients, Families, and Health Professionals, Department of Nursing, School of Health Sciences, University of Ioannina, Ioannina 451 10, Greece
[14]Department of Pediatrics, Kyung Hee University Medical Center, Kyung Hee University College of Medicine, Seoul 02447, Korea

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§**Corresponding Authors:**

Dong Keon Yon
Department of Pediatrics, Kyung Hee University College of Medicine, 23 Kyungheedae-ro, Dongdaemun-gu, Seoul 02447, Korea.
Tel. +82-2-961-0680
Fax. +82-504-495-8196
Email. yonkkang@gmail.com

Jiyoung Hwang
Center for Digital Health, Medical Science Research Institute, Kyung Hee University College of Medicine, 23 Kyungheedae-ro, Dongdaemun-gu, Seoul 02447, Korea.
Tel. +82-2-961-0680
Fax. +82-504-495-8196
Email. cindy.jyhwang@gmail.com

*Jaehyun Kong, Kyeongmin Lee, and Sooji Lee contributed equally to this work.

ORCID iDs
Jaehyun Kong 🔵
https://orcid.org/0009-0009-8079-8414

ABSTRACT

BACKGROUND/OBJECTIVES: The increasing prevalence of overweight and obesity has become a significant global burden, with more than 40% of the global adult population attempting to lose weight. Previous studies on the impact of weight-control methods on mental health, especially among adolescents, are limited. Thus, this study aimed to investigate the association between various weight-control methods and depression among adolescents, with the goal of informing healthier weight management decisions and promoting effective methods.

SUBJECTS/METHODS: This nationwide study utilized data from the Korea Youth Risk Behavior Web-based Survey, including a sample of 418,254 adolescents collected over 12 yrs (2007–2019). We conducted a weighted complex sample analysis to compare depression rates associated with specific weight-control methods, including exercise, fasting (≥ 24 h), eating less, taking prescription/non-prescription weight-loss medication, taking laxatives or

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Kyeongmin Lee (ID)
https://orcid.org/0009-0004-0379-2151
Sooji Lee (ID)
https://orcid.org/0009-0002-1413-378X
Soeun Kim (ID)
https://orcid.org/0009-0009-5874-417X
Jinyoung Jeong (ID)
https://orcid.org/0009-0001-8849-7941
Yejun Son (ID)
https://orcid.org/0009-0001-3939-2983
Hayeon Lee (ID)
https://orcid.org/0009-0000-2403-6241
Louis Jacob (ID)
https://orcid.org/0000-0003-1071-1239
Masoud Rahmati (ID)
https://orcid.org/0000-0003-4792-027X
Guillaume Fond (ID)
https://orcid.org/0000-0003-3249-2030
Laurent Boyer (ID)
https://orcid.org/0000-0003-1229-6622
Lee Smith (ID)
https://orcid.org/0000-0002-5340-9833
Elena Dragioti (ID)
https://orcid.org/0000-0001-9019-4125
Selin Woo (ID)
https://orcid.org/0000-0001-7961-2074
Jiyoung Hwang (ID)
https://orcid.org/0000-0002-7778-374X
Dong Keon Yon (ID)
https://orcid.org/0000-0003-1628-9948

Conflict of Interest

The authors declare no potential conflicts of interests.

Author Contributions

Conceptualization: Kong J, Lee K, Lee S, Yon DK; Data curation: Kong J, Lee K, Lee S, Hwang J, Yon DK; Formal analysis: Kong J, Lee K, Lee S, Hwang J, Yon DK; Investigation: Kong J, Lee K, Lee S, Hwang J, Yon DK; Supervision: Yon DK; Writing - original draft: Kong J, Lee K, Lee S, Yon DK; Writing - review & editing: Kong J, Lee K, Lee S, Kim S, Jeong J, Son Y, Lee H,

diuretics, vomiting, one-food diet, taking oriental medicine, and diet foods.

RESULTS: Of the 418,254 participants, 45.96% (192,246) were male. Among male participants, fasting (≥ 24 h; weighted odds ratio [wOR], 1.43; 95% confidence interval [CI], 1.36–1.51) and vomiting (wOR, 1.49; 95% CI, 1.35–1.66) were associated with an increased risk of depression. Among female participants, prescribed (wOR, 0.82; 95% CI, 0.74–0.90) and non-prescribed (wOR, 0.89; 95% CI, 0.82–0.97) weight-loss medication reduced the risk of depression. However, fasting (≥ 24 h; wOR, 1.47; 95% CI, 1.41–1.52) vomiting (wOR, 1.45; 95% CI, 1.36–1.55) significantly increased the risk of depression.

CONCLUSION: The risk of depression varies depending on the weight-control method, with a consistent trend observed across both sexes. Methods such as vomiting, fasting, taking oriental medicine for weight loss, and consuming diet foods increased the risk of depression, while weight-loss medications were associated with reduced depression symptoms in females. These findings highlight the need for further research on weight-control medications and policies that support effective weight management while reducing depressive effects.

Keywords: Diet; depression; adolescents; risk factors; South Korea

INTRODUCTION

The global prevalence of overweight individuals has become a significant public health concern, leading to an increase in weight-control attempts. A previous study reported that over 40% of adults worldwide have attempted to lose weight [1]. In South Korea, obesity rates among both adults and adolescents have increased from 2009 to 2021, with the rate among adolescents reaching 13.5% [2]. Adolescence, characterized by rapid physical and emotional changes, is a period when interest in weight management intensifies due to developmental changes and societal pressures [3,4]. Consequently, adolescents attempt various weight-control methods that can be inappropriate or harmful to health [3]. Moreover, individuals with obesity are more vulnerable to depression than the general population [5,6]. Therefore, assisting adolescents in managing their weight in a healthy manner is crucial to their physical and mental well-being.

A previous meta-analysis reported that some weight management strategies were associated with improved quality of life. However, evidence regarding the impacts on anxiety, self-esteem, and stress was insufficient [7]. Another study found that unhealthy weight-loss strategies such as smoking, vomiting, laxative use, fasting, and prescription pill misuse could lead to adverse outcomes [8]. However, this study was limited by its small sample size and the exclusion of participants under 18 yrs, leaving a gap in understanding these risks among adolescents [8]. Thus, we aimed to investigate the association between various weight-control methods and depression among adolescents, thereby, aiding in making healthier decisions regarding weight management. This study analyzed how ten weight-control methods employed by male and female adolescent participants were associated with the risk of depression using data from the Korea Youth Risk Behavior Web-based Survey (KYRBS). We analyzed whether these ten weight-control methods increased or decreased the risk of depression and how these associations differed by sex. Based on these findings, we proposed policies to promote healthy weight management and prevent depression in adolescents.

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SUBJECTS AND METHODS

Patient selection and data collection

Our study used data from the KYRBS conducted by the Korea Disease Control and Prevention Agency (KDCA) and the Ministry of Education. This survey aimed to generate statistics on the health behaviors of Korean adolescents [9,10].

The KYRBS employs a 3-step sample extraction process that includes population stratification, sample distribution, and sample selection. In the population stratification phase, the population was divided into 117 strata using 39 regional districts and 3 school levels as stratification variables, thereby minimizing sampling error. Proportional allocation was applied in the sample distribution phase. Finally, sample selection involved stratified cluster sampling. In the first extraction, schools were selected as primary sampling units within each stratum using a permanent random number method. In the second extraction, classes were chosen with one class per grade randomly selected from each sampled school. This process resulted in student participation with an average response rate exceeding 95%.

Our study included data collected over 12 yrs from 2007 to 2019, excluding 2018 due to the absence of inquiries regarding weight-control methods. The dataset comprised responses from 845,714 participants. During this period, various questions, including those pertaining to weight-control methods, were asked. The research protocol was approved by the Institutional Review Board of Kyung Hee University (KHSIRB-24-510(EA)) and the KDCA (2014-06EXP-02-P-A). Written consent was obtained from all participants and their parents or guardians. Our study complied with the principles of the Declaration of Helsinki [11].

Endpoints

A survey examining weight-control methods was conducted targeting students who had made efforts to control their weight in the past 30 days [12]. Weight control included weight loss, gain, and maintenance. These weight-control methods were categorized into 10 distinct types: exercise, fasting (≥ 24 h), eating less, taking prescription and non-prescription weight-loss medications, taking laxatives or diuretics, vomiting, one-food diet, oriental medicine, and diet foods.

Covariates

This study includes 10 covariates in the analysis: grades (7th–9th and 10th–12th), sex (male and female), region of residence (urban and rural) [13], body mass index (BMI) group (underweight, normal, overweight, and obese) [14], economic status of households (low, middle-low, middle, middle-high, and high), school performance (low, middle-low, middle, middle-high, and high), stress level (low, middle-low, middle, middle-high, and high), subjective health status (unhealthy, normal, healthy, and very healthy), smoking status within 1 mon of the survey (non-smoker and smoker), and alcohol consumption within 1 mon of the survey (non-drinker, 1–5 days/mon, and 6–30 days/mon). BMI was calculated using self-reported weight and height of the participants, with weight in kilograms divided by the square of height in meters. BMI was categorized into 4 groups according to the 2017 Korean National Growth Charts: underweight (< 5th percentile), normal (5th–84th percentile), overweight (85th–94th percentile), and obese (≥ 95th percentile) [15]. Household economic status, school performance, and stress levels were categorized into 5 groups: low (< 20th percentile), middle-low (20th–39th percentile), middle (40th–59th percentile), middle-high (60th–79th percentile), and high (≥ 80th percentile). Subjective health status was divided into

4 groups based on students' self-reports: unhealthy (< 25th percentile), normal (25th–49th percentile), healthy (50th–74th percentile), and very healthy (≥ 75th percentile).

Statistical analyses

Using the KYRBS data collected through a stratified cluster sampling process, we conducted a weighted complex sample analysis to identify the prevalence of depression in adolescents and its correlation with adolescent characteristics. Samples for each variable were presented as weighted percentages and 95% confidence intervals (CIs) [16]. To enhance the robustness and reliability of our findings, we considered various factors, including weighting, clustering, and stratification, throughout the analysis. When analyzing the correlation between weight-control methods and depression in adolescent girls and boys, we included variables such as grade, area of residence, BMI, school grades, stress level, subjective health status, smoking status, alcohol consumption, and economic status of households as covariates and treated them as potential confounding variables. An adjusted multivariate logistic regression model was used for the analysis. This analysis extracted statistical measures such as β-coefficients and standard deviations, weighted odds ratio (wOR) and their 95% CIs. This approach allowed us to further explore the complex relationship between weight-control methods and depression and to compare depression rates associated with specific weight-control methods between adolescent girls and boys. All statistical analyses were performed using SAS software (version 9.4; SAS Institute Inc., Cary, NC, USA). All statistical tests were 2-sided, and a 2-sided P-value below 0.05 was considered statistically significant [17].

RESULTS

Analyzing the demographic profile of the Korean population

Table 1 present the general characteristics of the study group, including both crude and weighted rates. In total, 418,254 participants were included in the KYRBS. Among these participants, 46.94% (95% CI, 46.14–47.75) were male, and 53.06% (95% CI, 52.25–53.87) were female. Based on their BMI, 5.93% (95% CI, 5.83–6.02) of the participants were underweight, 72.29% (95% CI, 72.09–72.49) were normal, 10.04% (95% CI, 9.93–10.15) were overweight, and 8.84% (95% CI, 8.72–8.96) were obese.

wORs for depression in male participants

Fig. 1 display the association between weight-control methods and risk factors for depression in male participants, as represented by the wOR. Various diet methods were investigated, including exercise, fasting (≥ 24 h), eating less, taking prescription and non-prescription weight-loss medications, taking laxatives or diuretics, vomiting, one-food diet, and diet foods. Fasting (≥ 24 h), vomiting, one-food diet, taking oriental medicine, and diet foods significantly increased the risk of depression as follows: fasting (≥ 24 h) group (wOR, 1.43; 95% CI, 1.36–1.51), vomiting group (wOR, 1.49; 95% CI, 1.35–1.66), one-food diet group (wOR, 1.17; 95% CI, 1.10–1.25), taking oriental medicine group (wOR, 1.23; 95% CI, 1.17–1.29), and diet foods group (wOR, 1.22; 95% CI, 1.16–1.29).

wORs for depression in female participants

Fig. 2 illustrate the impact of various weight-control methods and risk factors on depression in female participants, along with the wOR values. Taking prescription weight-loss medication had a wOR of 0.82 (95% CI, 0.74–0.90) and taking non-prescription weight-loss medication had a wOR of 0.89 (95% CI, 0.82–0.97). Conversely, fasting (≥ 24 h), vomiting,

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Table 1. Korean population characteristics based on Korea Youth Risk Behavior Web-Based Survey data (n = 418,254), incorporating weighted values

| Characteristics	Total	Depression	
		Yes	No
Overall	418,254	145,025	273,229
Grade			
7th–9th grade (middle school)	50.80 (50.32–51.29)	47.75 (47.16–48.34)	52.43 (51.94–52.93)
10th–12th grade (high school)	49.20 (48.71–49.68)	52.25 (51.66–52.84)	47.57 (47.07–48.06)
Sex			
Male	46.94 (46.14–47.75)	39.91 (39.07–40.75)	50.70 (49.88–51.53)
Female	53.06 (52.25–53.87)	60.09 (59.25–60.93)	49.30 (48.47–50.12)
Region of residence			
Urban	93.71 (93.44–93.98)	93.56 (93.27–93.84)	93.80 (93.52–94.08)
Rural	6.29 (6.02–6.56)	6.44 (6.16–6.73)	6.20 (5.92–6.48)
BMI group[1]			
Underweight	5.93 (5.83–6.02)	5.89 (5.74–6.04)	5.95 (5.84–6.06)
Normal	72.29 (72.09–72.49)	73.53 (73.24–73.82)	71.63 (71.40–71.86)
Overweight	10.04 (9.93–10.15)	9.34 (9.16–9.52)	10.41 (10.27–10.54)
Obese	8.84 (8.72–8.96)	7.90 (7.72–8.07)	9.35 (9.21–9.49)
Unknown	2.90 (2.84–2.96)	3.35 (3.24–3.46)	2.66 (2.59–2.74)
Economic status of households[2]			
Low	4.53 (4.45–4.62)	6.94 (6.78–7.11)	3.25 (3.16–3.33)
Middle-low	15.67 (15.51–15.83)	19.11 (18.84–19.37)	13.84 (13.66–14.01)
Middle	46.08 (45.88–46.29)	43.52 (43.21–43.83)	47.45 (47.20–47.70)
Middle-high	25.61 (25.40–25.81)	23.22 (22.93–23.52)	26.88 (26.65–27.11)
High	8.11 (7.98–8.24)	7.21 (7.03–7.39)	8.59 (8.44–8.74)
School performance[2]			
Low	11.63 (11.51–11.75)	15.05 (14.82–15.27)	9.81 (9.67–9.94)
Middle-low	25.73 (25.56–25.90)	28.33 (28.05–28.61)	24.35 (24.15–24.55)
Middle	27.89 (27.72–28.06)	26.42 (26.14–26.69)	28.68 (28.48–28.88)
Middle-high	23.81 (23.66–23.97)	21.19 (20.94–21.44)	25.21 (25.02–25.41)
High	10.93 (10.80–11.06)	9.02 (8.83–9.21)	11.95 (11.80–12.11)
Stress level[2]			
Low	2.46 (2.40–2.52)	0.90 (0.84–0.96)	3.29 (3.20–3.37)
Middle-low	13.45 (13.31–13.59)	4.34 (4.21–4.47)	18.31 (18.13–18.50)
Middle	40.93 (40.75–41.11)	28.59 (28.32–28.87)	47.51 (47.29–47.73)
Middle-high	30.99 (30.81–31.18)	41.91 (41.61–42.22)	25.17 (24.96–25.37)
High	12.17 (12.04–12.30)	24.25 (23.98–24.52)	5.72 (5.62–5.83)
Subjective health status[3]			
Unhealthy	6.92 (6.83–7.02)	11.35 (11.16–11.55)	4.56 (4.46–4.65)
Normal	24.52 (24.35–24.70)	29.69 (29.41–29.98)	21.77 (21.57–21.96)
Healthy	46.87 (46.68–47.05)	42.72 (42.41–43.02)	49.08 (48.86–49.30)
Very healthy	21.69 (21.50–21.88)	16.24 (15.99–16.48)	24.60 (24.37–24.82)
Smoking status			
Non-smoker	77.15 (76.88–77.41)	69.79 (69.42–70.17)	81.07 (80.79–81.34)
Smoker	22.85 (22.59–23.12)	30.21 (29.83–30.58)	18.93 (18.66–19.21)
Alcohol consumption			
Non-drinker	78.62 (78.40–78.84)	71.18 (70.85–71.51)	82.59 (82.36–82.82)
1–5 days/mon	16.15 (15.98–16.32)	21.00 (20.73–21.27)	13.56 (13.38–13.75)
6–30 days/mon	5.23 (5.13–5.33)	7.82 (7.63–8.01)	3.85 (3.74–3.95)

Values are presented as weighted % (95% confidence interval).

BMI, body mass index.

[1]BMI was divided into 4 groups according to the 2017 Korean National Growth Charts: underweight (< 5th percentile), normal (5th–84th percentile), overweight (85th–94th percentile), and obese (≥ 95th percentile).

[2]School performance, stress level, and economic status of households were divided into 5 groups: low (< 20th percentile), middle-low (20th–39th percentile), middle (40th–59th percentile), middle-high (60th–79th percentile), and high (≥ 80th percentile).

[3]Subjective health status was divided into 4 groups based on students' self-reports: unhealthy (< 25th percentile), normal (25th–49th percentile), healthy (50th–74th percentile), and very healthy (≥ 75th percentile).
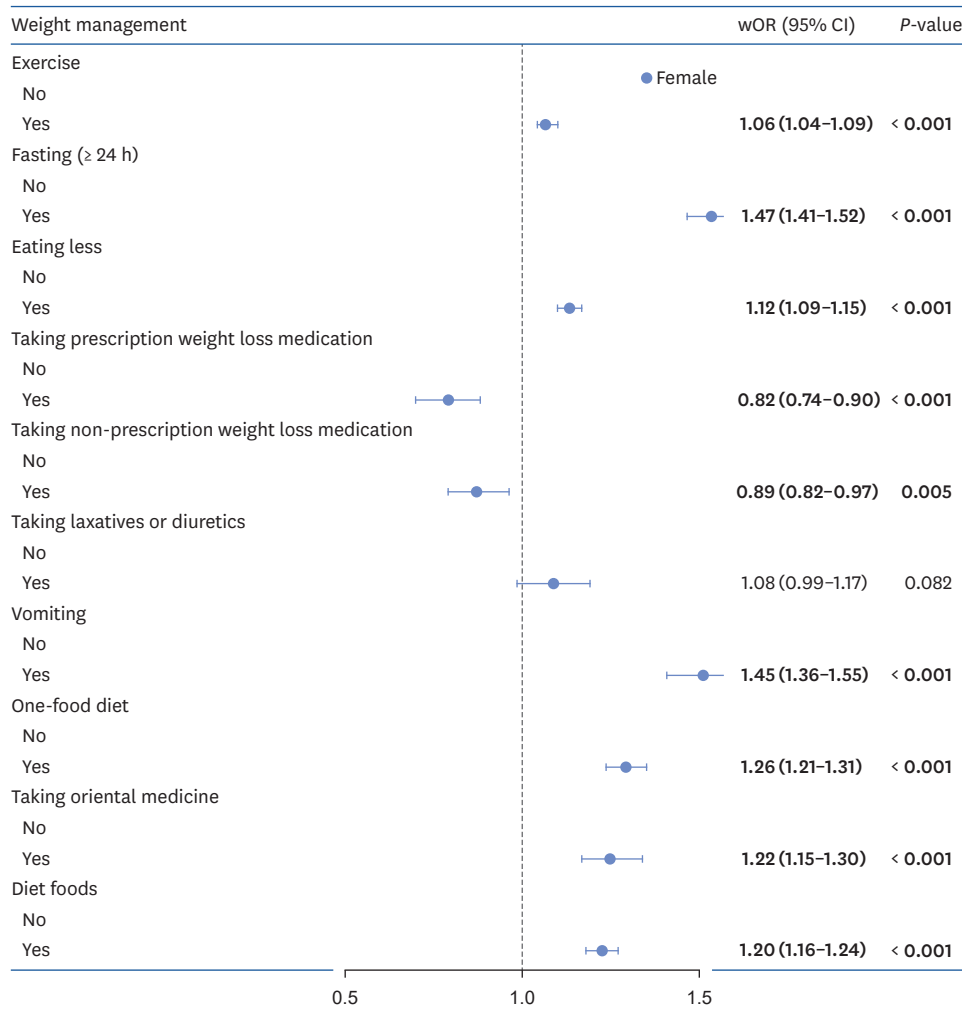
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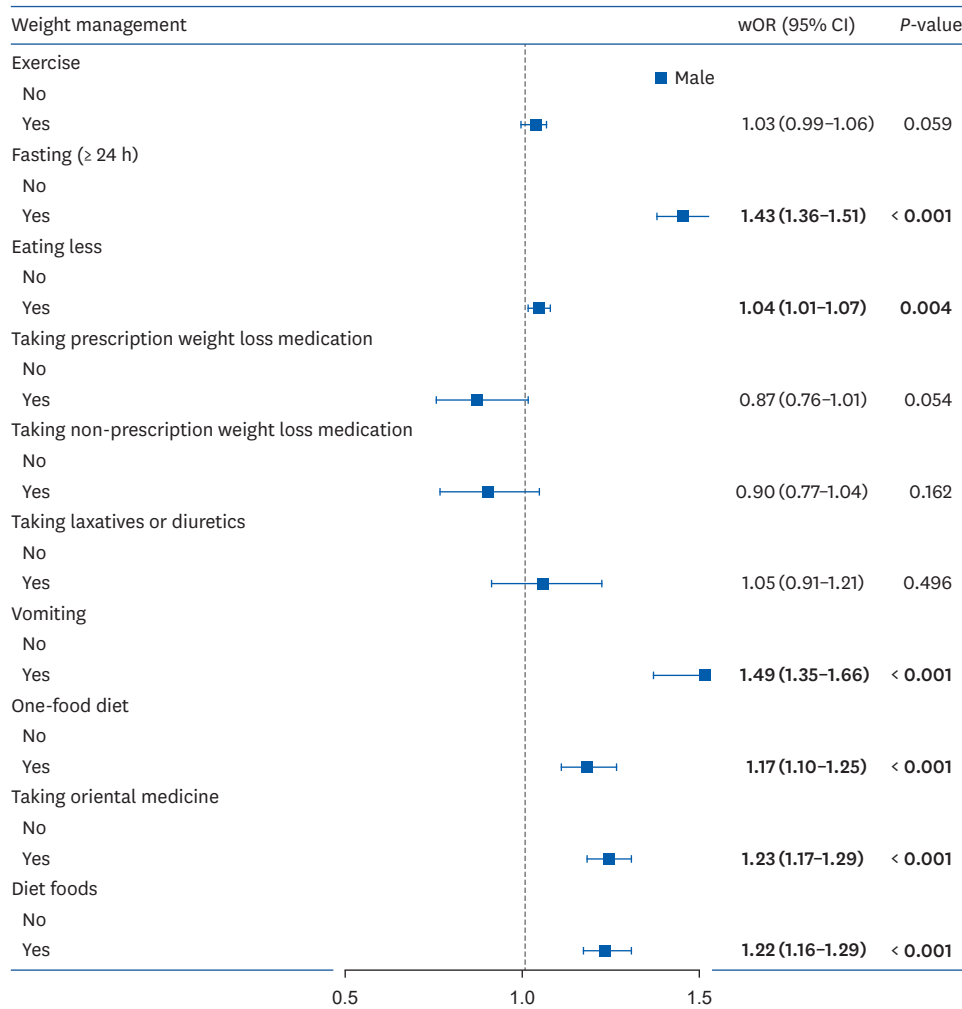
Fig. 1. Weighted odds ratios for depression in male participants based on different weight management practices. Numbers in bold indicate a significant difference ($P < 0.05$). This study includes 10 covariates in the analysis: grades (7th–9th grade and 10th–12th grade), sex (male and female), region of residence (urban and rural), BMI (underweight, normal, overweight, and obese), economic status of households (low, middle-low, middle, middle-high, and high), school performance (low, middle-low, middle, middle-high, and high), stress level (low, middle-low, middle, middle-high, and high), subjective health status (unhealthy, normal, healthy, and very healthy), smoking status within 1 mon of the survey (non-smoker and smoker), and alcohol consumption within 1 mon of the survey (non-drinker, 1–5 days/mon, and 6–30 days/mon).
CI, confidence interval; wOR, weighted odds ratio; BMI, body mass index.

one-food diet, taking oriental medicine, and diet foods significantly increased the risk of depression as follows: fasting (≥ 24 h) group (wOR, 1.47; 95% CI, 1.41–1.52), vomiting group (wOR, 1.45; 95% CI, 1.36–1.55), one-food diet group (wOR, 1.26; 95% CI, 1.21–1.31), taking oriental medicine group (wOR, 1.22; 95% CI, 1.15–1.30), and diet foods group (wOR, 1.20; 95% CI, 1.16–1.24).

DISCUSSION

This study investigated the correlation between various weight-control methods and depression in South Korean adolescents. We analyzed a sample of 418,254 individuals from 800 schools across the country over 12 yrs. Our findings revealed that fasting and vomiting were associated with an increased risk of depression in male participants. For female

Fig. 2. Weighted odds ratios for depression in female participants based on different weight management practices. Numbers in bold indicate a significant difference ($P < 0.05$). [1]This study includes 10 covariates in the analysis: grades (7th–9th grade and 10th–12th grade), sex (male and female), region of residence (urban and rural), BMI group (underweight, normal, overweight, and obese), economic status of households (low, middle-low, middle, middle-high, and high), school performance (low, middle-low, middle, middle-high, and high), stress level (low, middle-low, middle, middle-high, and high), subjective health status (unhealthy, normal, healthy, and very healthy), smoking status within 1 mon of the survey (non-smoker and smoker), and alcohol consumption within 1 mon of the survey (non-drinker, 1–5 days/mon, and 6–30 days/mon).
CI, confidence interval; wOR, weighted odds ratio; BMI, body mass index.

participants, while prescribed and non-prescribed weight-loss medications reduced the risk of depression, fasting and vomiting significantly increased it. These findings suggest the need for additional research on weight-control medications and the development of policies promoting weight-control strategies without increasing the risk of depression.

Contrary to previous studies that suggested a positive effect of exercise on mental health, our results did not show a significant impact of exercise on depression [18]. This discrepancy may be attributed to the potential neglect of other healthy lifestyle habits (such as regular meals and sufficient sleep) when exercise is performed solely for weight control [19]. Additionally, self-reported surveys may introduce bias in reporting both the intensity and frequency of exercise [19]. Previous research has indicated that the failure in weight loss attempts and subsequent weight gain can lower self-esteem, potentially leading to depression [20]. This highlights the significance of adopting a holistic approach to lifestyle changes for effective weight control.

Both male and female participants exhibited an increased risk of depression associated with fasting, vomiting, taking oriental medicine, and consuming diet foods. Fasting and vomiting, in particular, were more strongly associated with depression than other methods. This may be attributed to nutritional deficiencies and hormonal changes resulting from irregular and imbalanced meals [21,22]. These findings align with previous studies linking nutritional deficiencies to depression, highlighting the crucial role of specific nutrients, such as folic acid, omega-3 fatty acids, and B vitamins in mental health [23]. Furthermore, nutritional deficiencies can lead to hormonal changes that contribute to depression [24].

The finding that individuals employing vomiting as a weight-control method have a higher risk of depression is consistent with previous research findings [8]. Bulimia nervosa, an eating disorder characterized by repeated binge eating followed by excessive compensatory behaviors such as vomiting or using laxatives, is significantly associated with depression [24]. The behavioral similarities between individuals using vomiting as a weight-control method and those with bulimia nervosa may explain thisassociation [25].

Participants who followed the one-food diet or ate less had an increased likelihood of depression, with a more pronounced effect in female participants. These methods can increase the risk of depression by compromising the intake of essential nutrients for weight control and inducing excessive restrictions and stress [21]. In particular, women often adopt extreme weight-control methods, such as reducing the amount of food or eating only one type of food, because of greater social expectations and pressures about body shape [26]. Although these approaches may result in short-term weight loss, they can negatively impact physical health and increase emotional stress in the long term, potentially leading to weight cycling [26]. Repeated failure in weight-loss attempts can lead to feelings of despair and diminished self-esteem [26].

Our study has several limitations. First, as it is based on self-reported survey data, there is potential for recall and social desirability bias. However, this self-report approach aligns with the depression indicator in the KYRBS conducted by the KDCA. Moreover, previous research suggests that self-reported measures of depression are sufficiently reliable, minimizing the potential impact of these biases on our findings [27]. Second, as this was a cross-sectional study based on survey data, we could not establish a causal relationship between depression and weight-control methods. However, several previous studies indicated a bidirectional influence between these factors [8,28]. Finally, as this study focused on school-attending adolescents, we were unable to gather information from those not enrolled in educational institutions.

Despite these limitations, our study provides insights into "mentally healthy" weight-control methods that could benefit a broad population [29]. First, our study was based on a large-scale sample size obtained from 800 schools nationwide over 12 yrs. Second, by analyzing a wide range of weight-control methods, including exercise, diet, health supplements, medication, and lifestyle habits, we provided broad guidance for individuals attempting to manage their weight. Third, to our knowledge, this is the first study to analyze the impact of various weight-control methods on adolescent depression, deepening the understanding of the relationship between the desire for weight control in adolescents and depression.

Our study demonstrates how weight-control methods affect adolescent depression, providing guidance on weight management decisions. Among male participants, while most weight-control methods had a negative impact on depression, eating less was associated with the least adverse

effect. Similarly, for female participants, although most weight-control methods increased the risk of depression, exercising and eating less showed the least association with depression.

Interestingly, both prescription and non-prescription weight-loss medications reduced depression in female participants. However, weight-loss medications can have various side effects, such as gastrointestinal disorders [30]. Moreover, research on the side effects of obesity treatment drugs used solely for aesthetic purposes is scarce. Therefore, caution should be exercised when prescribing weight-loss medications. Our findings provide crucial evidence for reassessing policies regarding medication use in weight control. Additionally, education and the provision of information are necessary to reduce the incidence of depression among adolescents.

Adolescents often experience significant body image concerns and exhibit a preference for high-sugar foods, making it difficult to control weight [31]. Therefore, their social environment plays a crucial role in guiding weight control [32]. Support is essential for adopting "healthy" weight-control methods, such as dietary management and exercise, while discouraging "unhealthy" methods, such as vomiting and the one-food diet. The provision of appropriate school meals and weight-control education is imperative. Furthermore, weight-control programs run by public agencies should be readily accessible to facilitate systematic weight management among adolescents.

This study examined the associations between various weight-control methods and depression among adolescents. The risk for depression varied by method employed, with similar trends observed in both male and female participants. These findings may inform the development of weight management programs by schools and policymakers, potentially promoting healthier weight-control practices among adolescents and helping them choose better ways to manage their weight.

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