Factors affecting the use of herbal medicines for weight loss in overweight and obese adolescents

Mi Hong Yim[1] and Boram Lee[2]*

[1]Digital Health Research Division, Korea Institute of Oriental Medicine, Daejeon, Republic of Korea, [2]KM Science Research Division, Korea Institute of Oriental Medicine, Daejeon, Republic of Korea

Objectives: Herbal medicine (HM) is widely used to treat obesity in adolescents worldwide since the currently available interventions have low compliance and lack long-term effects and safety data. This study aimed to analyze the factors affecting HM use for weight loss in overweight and obese adolescents.

Methods: A total of 46,336 adolescents were included in this cross-sectional study based on the Korea Youth Risk Behavior Web-Based Survey. Three models of HM use for weigh loss were developed by sequentially adding predisposing, enabling, and need factors according to Andersen's model using multiple logistic regression analyses considering the complex sampling design.

Results: Male and female high school students and students from low perceived household economic status were less likely to use HM for weight loss. Students whose fathers had a college degree or higher, depressed mood, and two or more chronic allergic diseases were more likely to use HM. Male students who perceived their body image as fat or very fat tended to use HM less than those who perceived their body image as very thin, thin, or moderate. Obese female students tended to use HM more than overweight female students.

Conclusion: These results can be used as the bases to promote HM use, provide ideas for future research, and strengthen the health insurance coverage extension for weight loss interventions.

KEYWORDS

herbal medicine, pediatric obesity, Korea youth risk behavior web-based survey, andersen's behavioral model, real-world data

1. Introduction

Over the past few decades, the rapid increase in the number of adolescents that are overweight or obese has become a major public health problem (1). Recent data shows that the number of children and adolescents with obesity worldwide has increased dramatically over the past 40 years, with a ten-fold increase in girls and a twelve-fold increase in boys, highlighting the urgent need for effective programs and policies to address this growing epidemic (2). Additionally, about 70%–80% of adolescents with obesity had obesity in adulthood (3). Adolescent obesity can also lead to an increased risk of chronic diseases, such as metabolic syndrome, increasing the worldwide socio-economic burden (4).

Currently, lifestyle interventions, including exercise, dietary, and behavioral therapy, are recommended for adolescents with obesity (5, 6). However, it has been reported that patients did not achieve weight loss in a long-term real-world clinical study (7) and that severely obese adolescents were reluctant to practice the lifestyle interventions (8). Liraglutide and bariatric surgery is also considered for severely obese adolescents; however, long-term

safety and efficacy data are lacking (1, 9, 10). Due to these limited treatment options, there is a demand for complementary and integrative medicine (CIM) (11).

Herbal medicine (HM) is one of the most common CIM therapies for weight loss worldwide (11, 12). It has been reported that people prefer HM as a treatment option due to reasons such as dissatisfaction with conventional treatment, past positive experiences, and family traditions (13). HM can reduce weight by suppressing the appetite, promoting lipid metabolism, inhibiting pancreatic lipase activity, increasing lipolysis, and preventing adipogenesis (14). In addition, several studies on HM use and the comparative effectiveness and safety of HM in obese adolescent patients, have been conducted (12, 15). However, studies on the factors affecting HM use for weight loss in adolescents have not been conducted yet.

Recently, the demand for high-quality healthcare services has gradually increased, and the government's healthcare policies to provide them have also expanded. Policies established based on scientific evidence using real-world data (RWD) analyses at the national level have gradually increased worldwide (16). Analyzing the factors influencing the use of HM for weight loss using RWD can be used as a basis for establishing policies for efficient resource allocation, clinicians, and researchers by identifying the HM usage and presenting data that can increase the usage rate.

Therefore, this study aimed to analyze the factors affecting HM use for weight loss in overweight and obese adolescents using the Korea Youth Risk Behavior Web-Based Survey (KYRBS) and to use the data for clinical use, future research plans, and policy establishment.

2. Methods

2.1. Data source and study participants

This study used the KYRBS, a national school-based representative cross-sectional survey conducted annually by the Korea Disease Control and Prevention Agency, to evaluate the health risk behaviors of Korean adolescents since 2005 (17). The KYRBS was designed to represent Korean school adolescents using a complex sampling design, including multistage sampling, stratification, and clustering (17). The KYRBS was collected using anonymous self-administered web-based questionnaires with administrative support from the Ministry of Education and had a response rate of over 95% (17). The questionnaires included questions on health risk behaviors such as socioeconomic status, dietary behaviors, physical activity, obesity and weight control, tobacco and alcohol use, mental health, and allergic disease diagnoses. School students aged 12 to 18 completed the questionnaires online in a school computer laboratory during one class period following the instructions of a trained teacher on the survey procedure after checking online informed consent (17). The reports, microdata, and publications of the KYRBS are available to the public on the KYRBS website [http://www.kdca. go.kr/yhs/]. Since the KYRBS did not collect any identifiable information about human participants and was publicly accessible, it was not considered human subject research. The Korea Institute of Oriental Medicine review board approved this study as an exemption from review (I-2206/006-003).

The study included overweight and obese adolescents who had tried any method to lose weight over the past 30 days. We used KYRBS from 2011 to 2019, excluding 2018, because questions on how to lose weight were not included in the 2018 KYRBS and after 2020. A total of 547,474 adolescents participated in the 2011 to 2017 and 2019 KYRBS. We excluded 461,220 adolescents who were not overweight or obese and 38,043 adolescents who had not tried to lose weight over the past 30 days. Additionally, 1,875 adolescents who did not consent to answer family questions were excluded. In total, 46,336 adolescents were included (**Figure 1**).

2.2. Outcome and explanatory variables

The study's outcome was whether overweight and obese adolescents used HM for weight loss. HM use for weight loss was based on two questions: "Have you made efforts to control your weight over the past 30 days" and "What methods have you used to lose weight." The overweight and obese adolescents who answered "I have tried to lose weight" to the first question and "I have used HM" to the second question were classified as the HM use group. The adolescents who answered other weight control methods (regular exercise, fasting for at least 24 h, eating less, prescription weight loss medication, over-the-counter weight loss medication, laxatives or diuretics, vomiting after eating, monotrophic diet, or dietary supplements) to the second question were classified as the HM non-use group. Overweight adolescents were defined as adolescents with a body mass index (BMI) at between the 85th and the 95th percentile, and obese adolescents were defined as adolescents with a BMI at or above the 95th percentile for age and sex.

The explanatory variables were selected based on Andersen's theoretical framework to investigate the factors affecting the use of HM for weight loss in overweight and obese adolescents (18, 19). Andersen's Behavioral Model of Health Services Use has been frequently applied to substantial studies to determine the effects of health services use (19). The explanatory variables included demographic and socio-economic characteristics, mental health, quality of life, and health behaviors. According to Andersen's model, we classified the explanatory variables into three categories of factors: predisposing, enabling, and need. Predisposing factors represented individual characteristics that existed prior to health services use (20), including school grade, region, and perceived academic record. Enabling factors indicated the resources for making health services use possible (21, 22), including residential areas, current residence type, perceived household economic status, and father's and mother's education level. Need factors refer to the perceived physical, mental, and diagnosed health statuses (23), including variables regarding health status (perceived health status, perceived body image, BMI, and sleep satisfaction), dietary behaviors (breakfast and fast food consumption for the past seven days, and nutrition education for the past 12 months), mental health (perceived

FIGURE 1
Flowchart for study participant selection.
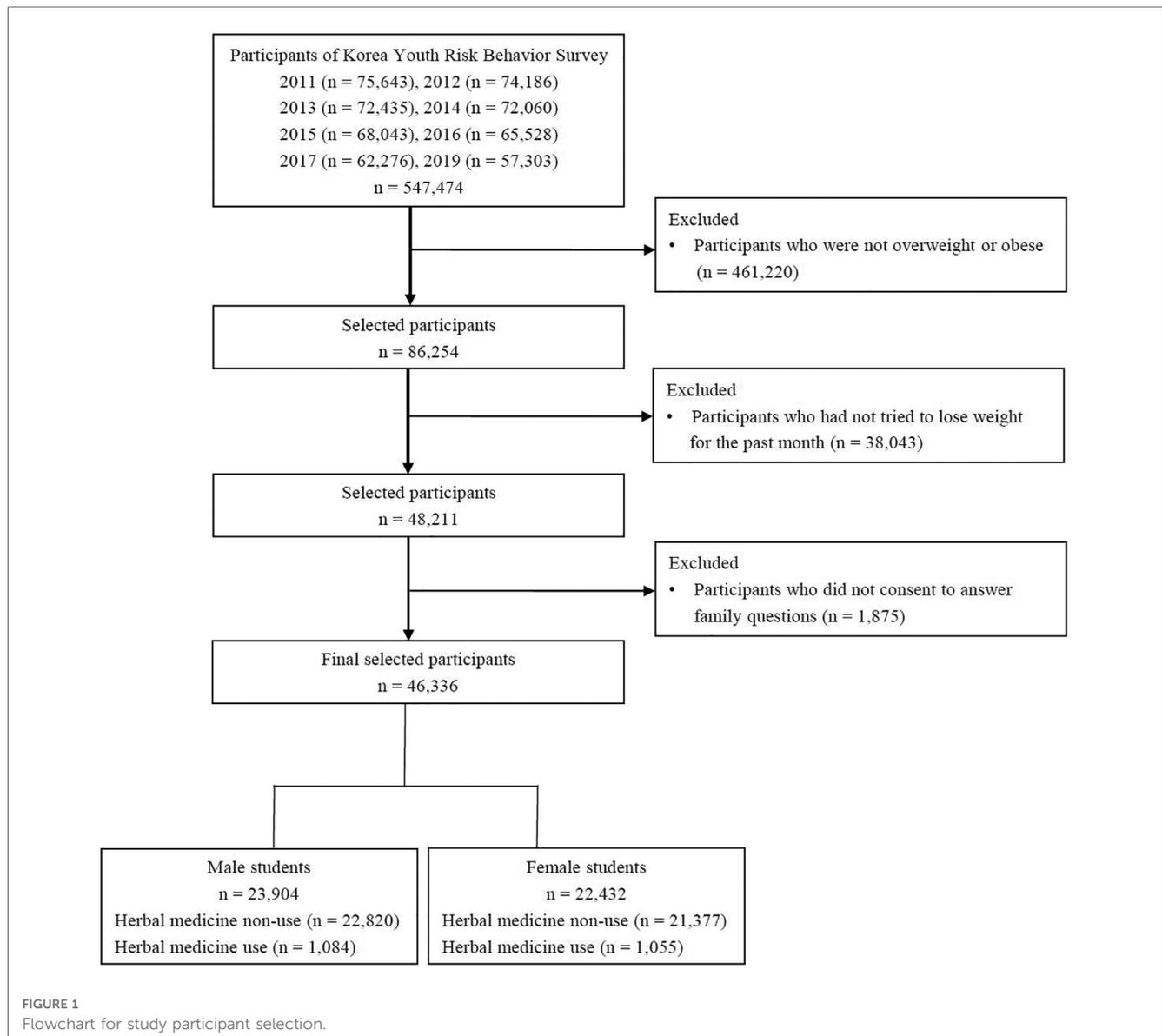
stress, suicidal ideation, and depressed mood), health behaviors (alcohol and tobacco use for the past 30 days, and physical activity), and disease (number of chronic allergic diseases, including asthma, allergic rhinitis, and atopic dermatitis).

2.3. Statistical analyses

Since the KYRBS used a complex, multistage stratified, cluster sampling design to represent the target population, certain groups of participants may be oversampled. Therefore, the sample weights were generated in the KYRBS to correct for unequal chances in participant selection due to the complex sampling design and to adjust for non-response and post-stratification. In all the statistical analyses, the sample weights were integrated and used so that the results were representative of Korean school adolescents. To take account of sex-specific differences in several

explanatory variables, including mental health and health behaviors, all statistical analyses were performed according to sex.

To compare general characteristics between the HM use and HM non-use groups, we used general linear model analyses for continuous variables and chi-squared tests with Rao-Scott correction for the categorical variables. The results are summarized as the mean ± standard error for the continuous variables and as the frequency (weighted column percentage) for the categorical variables. To investigate the association between HM use for weight loss and the individual variables of predisposing, enabling, and need factors, simple logistic regression analyses were performed for each sex. The results are indicated as crude odds ratios and 95% confidence intervals (CIs). To evaluate the association between HM use for weight loss and the combined variables of predisposing, enabling, and need factors, three multiple logistic regression models were constructed by sequentially adding the three factors conceptually classified in Andersen's model for each sex. Model 1 comprised

the combined variables of predisposing factors. Model 2 comprised the combined variables of predisposing and enabling factors. Model 3 comprised the combined variables of predisposing, enabling, and need factors. The results are reported as adjusted odds ratios (aORs) and 95% CIs. All statistical analyses were performed using complex samples procedure in IBM SPSS Statistics for Windows, version 28.0.0.0 (IBM Corp., Armonk, NY, USA). All statistical tests were applied with a significance level of 0.05 and a two-tailed test.

3. Results

A total of 46,336 overweight and obese adolescents (23,904 male and 22,432 female students) were included. Of them, 2,139 adolescents (1,084 male and 1,055 female students) reported using HM for weight loss. In both the male and female students, there were significant differences between the HM use and HM non-use groups in school grade, perceived household economic status, education level of their father and mother, perceived health status and stress, suicidal ideation, depressed mood, tobacco use, diagnoses of asthma, allergic rhinitis, and atopic dermatitis, and the number of chronic allergic diseases diagnosed. In the male students, significant differences between groups were observed in height, weight, perceived body image, fast food consumption, and nutrition education. In the female students, significant differences between groups were found in residential areas, BMI, sleep satisfaction, and alcohol use (**Table 1**).

For the male students, crude analyses showed that HM use for weight loss was significantly associated with school grade, region, perceived household economic status, father's and mother's education level, perceived health status, perceived body image, fast food consumption, nutrition education, perceived stress, suicidal ideation, depression, tobacco use, physical activity, and the number of chronic allergic diseases. However, after sequentially adjusting for predisposing, enabling, and need factors, only some of these variables were related to HM use. In model 1, which included the predisposing factors, there were significant associations of HM use with school grade and region. In model 2, which included predisposing and enabling factors, significant associations were found between HM use and school grade, perceived household economic status, and father's education level. In model 3, which included predisposing, enabling, and need factors, HM use was significantly associated with school grade, perceived household economic status, father's education level, perceived body image, perceived stress, suicidal ideation, depression, and the number of chronic allergic diseases. In the fully adjusted model 3, high school students were less likely to use HM compared to middle school students (aOR [95% CI], 0.62 [0.52–0.73]). Students who perceived their household economic status as middle/low were less likely to use HM compared with those who perceived their household economic status as high (middle, 0.76 [0.65–0.88]; low, 0.63 [0.5–0.78]). Students whose fathers had a college-level or higher degree were more likely to use HM than those whose fathers had a high school-level or lower degree [1.29 (1.07–1.56)]. Students

who perceived their body as being fat/very fat tended to use HM less than those who perceived their body as being very thin/thin/moderate [0.66 (0.5–0.88)]. Students under very high/high stress levels were more likely to use HM than those under low/no stress levels [1.3 (1.05–1.62)]. Students with suicidal ideation [1.23 (1.01–1.51)] and depressed mood [1.31 (1.1–1.57)] were more likely to use HM compared to those without. Students with two or three chronic allergic diseases tended to use HM more than those without [1.79 (1.36–2.36)] (**Figure 2**, **Table 2**).

For female students, crude analyses reported that HM use for weight loss was significantly associated with school grade, region, residential areas, perceived household economic status, father's and mother's education level, perceived health status, BMI, perceived stress, suicidal ideation, depressed mood, tobacco use, physical activity, and the number of chronic allergic diseases. After adjusting the same way as for the male students, only some of these variables were associated with HM use. In model 1, there were significant associations of HM use with school grade and region. In model 2, significant associations were observed between HM use and school grade, region, perceived academic record, perceived household economic status, and father's and mother's education level. In model 3, HM use was significantly associated with school grade, region, perceived academic record, perceived household economic status, father's and mother's education level, perceived health status, BMI, depression, and the number of chronic allergic diseases. In the fully adjusted model 3, high school students were less likely to use HM compared to middle school students [0.8 (0.68–0.94)]. Students living in Gwangju/Jeolla/Jeju tended to use HM less than those living in Seoul/Gyeonggi/Incheon [0.8 (0.65–0.99)]. Students with middle/low academic records were more likely to use HM compared with those with high records (middle, 1.28 [1.06–1.55]; low, 1.24 [1.03–1.48]). Students who perceived their household economic status as middle/low were less likely to use HM compared with those who perceived their household economic status as high (middle, 0.56 [0.48–0.66]; low, 0.63 [0.51–0.78]). Students whose parents had college-level or higher degrees were more likely to use HM than those whose parents had high school or lower degrees (father, 1.23 [1.03–1.48]; mother, 1.3 [1.1–1.54]). Students who perceived their health to be poor/very poor were more likely to use HM than those who perceived their health to be very good/good [1.33 (1.05–1.67)]. Obese students tended to use HM more than overweight students [1.5 (1.31–1.72)]. Students with depression were more likely to use HM than those without [1.25 (1.05–1.48)]. Students with one or two to three chronic allergic diseases were more likely to use HM compared to those without (one disease, 1.24 [1.06–1.45]; two to three diseases, 1.53 [1.15–2.03]) (**Figure 2**, **Table 3**).

Common to male and female students, the variables associated with HM use for weight loss were school grade, perceived household economic status, father's education level, depressed mood, and number of chronic allergic diseases in the fully adjusted model 3. Perceived body image, perceived stress, and suicidal ideation were related to HM use only in male students and region, perceived academic record, mother's education level,

TABLE 1 General characteristics of participants between herbal medicine use and non-use groups.
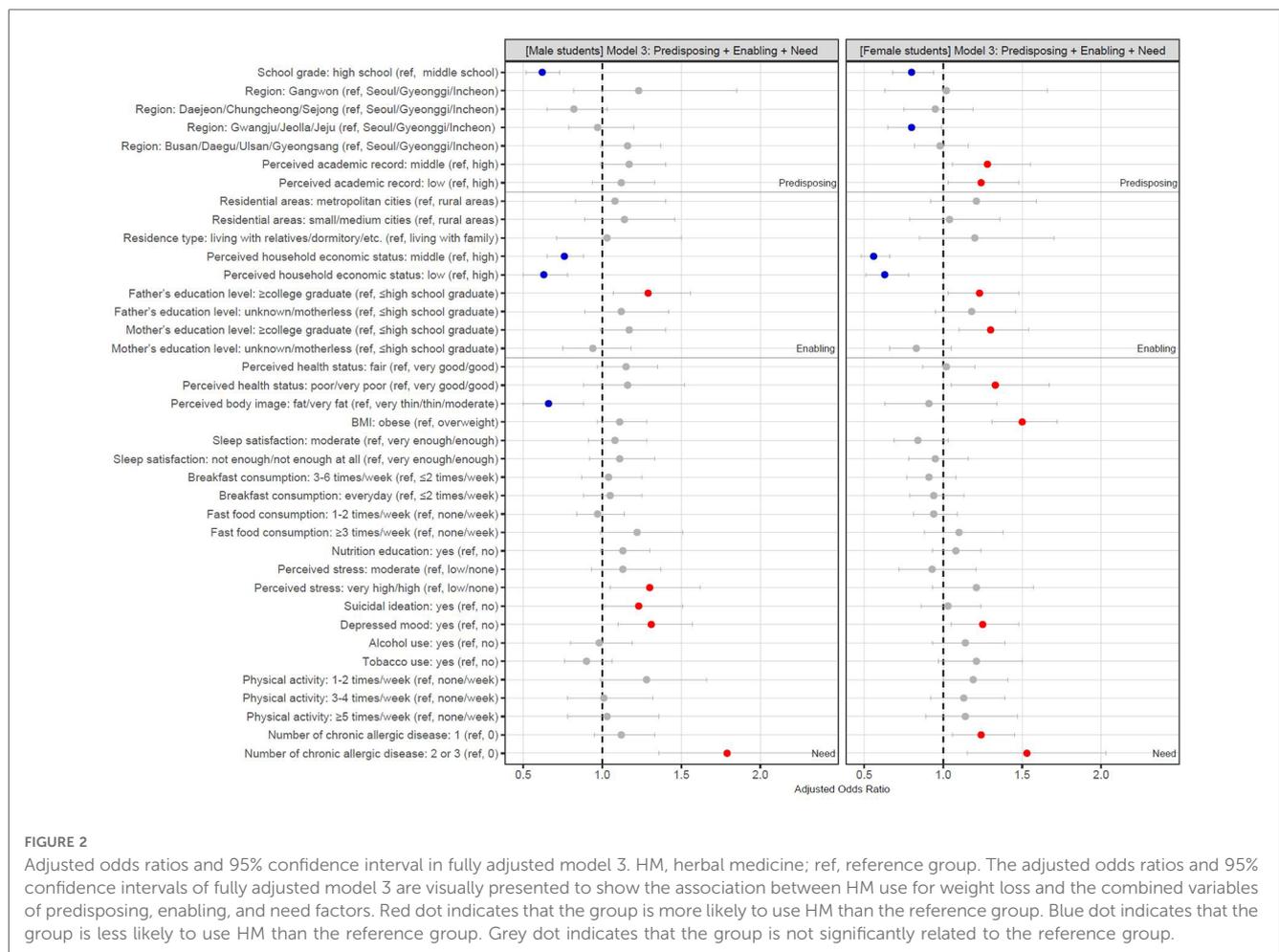
Variables	Male students				Female students			
	Herbal medicine				Herbal medicine			
	Total	Non-use	Use	P value	Total	Non-use	Use	P value
Number of participants	23,904	22,820	1,084	NA	22,432	21,377	1,055	NA
Predisposing factors								
School grade				<.001				.007
Middle school	12,149 (47.4)	11,476 (46.8)	673 (59.5)		11,379 (48.1)	10,810 (47.9)	569 (52.5)	
High school	11,755 (52.6)	11,344 (53.2)	411 (40.5)		11,053 (51.9)	10,567 (52.1)	486 (47.5)	
Region				.090				.094
Seoul/Gyeonggi/Incheon	9,339 (45.6)	8,917 (45.6)	422 (45.6)		8,815 (44.8)	8,363 (44.7)	452 (48.1)	
Gangwon	945 (3.3)	901 (3.3)	44 (3.9)		908 (3.6)	869 (3.6)	39 (3.5)	
Daejeon/Chungcheong/Sejong	3,195 (11.2)	3,071 (11.3)	124 (8.9)		3,014 (11.4)	2,882 (11.4)	132 (10.9)	
Gwangju/Jeolla/Jeju	3,603 (12.6)	3,449 (12.6)	154 (12)		3,607 (13.7)	3,466 (13.8)	141 (11.2)	
Busan/Daegu/Ulsan/Gyeongsang	6,822 (27.3)	6,482 (27.2)	340 (29.7)		6,088 (26.5)	5,797 (26.5)	291 (26.3)	
Perceived academic record				.366				.417
High	8,114 (33.5)	7,739 (33.5)	375 (34.5)		6,594 (29)	6,301 (29.1)	293 (27.2)	
Middle	6,668 (28)	6,351 (28)	317 (29.3)		6,197 (27.8)	5,895 (27.7)	302 (29.2)	
Low	9,122 (38.5)	8,730 (38.6)	392 (36.2)		9,641 (43.2)	9,181 (43.2)	460 (43.6)	
Enabling factors								
Residential areas				.287				.008
Rural areas	2,459 (6.9)	2,364 (7)	95 (5.8)		2,484 (7.5)	2,379 (7.6)	105 (6.2)	
Metropolitan cities	10,602 (43.7)	10,110 (43.7)	492 (43.6)		9,507 (42.2)	9,009 (42)	498 (46.7)	
Small/medium cities	10,843 (49.4)	10,346 (49.4)	497 (50.7)		10,441 (50.3)	9,989 (50.5)	452 (47.1)	
Residence type				.650				.558
Living with family	22,883 (96.1)	21,841 (96.1)	1,042 (96.4)		21,491 (96.5)	20,489 (96.5)	1,002 (96.1)	
Living with relatives/dormitory/etc.	1,021 (3.9)	979 (3.9)	42 (3.6)		941 (3.5)	888 (3.5)	53 (3.9)	
Perceived household economic status				<.001				<.001
High	9,344 (39.2)	8,806 (38.8)	538 (49.1)		6,243 (28.1)	5,830 (27.5)	413 (40.2)	
Middle	10,239 (42.6)	9,839 (42.8)	400 (37.8)		10,818 (47.9)	10,420 (48.4)	398 (37.3)	
Low	4,321 (18.2)	4,175 (18.4)	146 (13)		5,371 (24)	5,127 (24)	244 (22.6)	
Father's education level				<.001				<.001
≤high school graduate	8,232 (33.9)	7,938 (34.2)	294 (26.2)		9,064 (39.4)	8,708 (39.8)	356 (32.2)	
≥college graduate	10,544 (45.8)	9,972 (45.4)	572 (55.3)		8,495 (40.1)	8,011 (39.6)	484 (48.9)	
Unknown/fatherless	5,128 (20.3)	4,910 (20.4)	218 (18.5)		4,873 (20.5)	4,658 (20.6)	215 (18.8)	
Mother's education level				<.001				<.001
≤high school graduate	9,514 (40.1)	9,152 (40.5)	362 (33.6)		10,906 (48.5)	10,464 (48.9)	442 (41.6)	
≥college graduate	9,199 (39.6)	8,691 (39.1)	508 (48.5)		7,347 (34.2)	6,897 (33.7)	450 (44.5)	
Unknown/motherless	5,191 (20.3)	4,977 (20.4)	214 (17.9)		4,179 (17.2)	4,016 (17.4)	163 (14)	
Need Factors								
Height	170.19 ± 0.14	171.24 ± 0.07	169.14 ± 0.27	<.001	160.33 ± 0.1	160.47 ± 0.04	160.19 ± 0.19	.162
Weight	78.17 ± 0.18	79.23 ± 0.09	77.1 ± 0.34	<.001	65.5 ± 0.11	65.36 ± 0.05	65.65 ± 0.22	.205
Perceived health status				.011				<.001
Very good/good	16,861 (70.5)	16,132 (70.7)	729 (66.1)		13,795 (61.3)	13,188 (61.5)	607 (57.7)	
Fair	5,520 (23)	5,247 (22.8)	273 (26.1)		6,666 (29.8)	6,346 (29.8)	320 (29.8)	
Poor/very poor	1,523 (6.5)	1,441 (6.4)	82 (7.9)		1,971 (9)	1,843 (8.8)	128 (12.6)	
Perceived body image				.007				.961
Very thin/thin/moderate	1,092 (4.5)	1,018 (4.4)	74 (6.3)		727 (3.1)	692 (3.1)	35 (3.2)	
Fat/very fat	22,812 (95.5)	21,802 (95.6)	1,010 (93.7)		21,705 (96.9)	20,685 (96.9)	1,020 (96.8)	
BMI				.452				<.001
Overweight	10,978 (46.1)	10,505 (46.2)	473 (44.9)		12,715 (57)	12,210 (57.5)	505 (48.1)	
Obese	12,926 (53.9)	12,315 (53.8)	611 (55.1)		9,717 (43)	9,167 (42.5)	550 (51.9)	
Sleep satisfaction				.338				.022
Very enough/enough	8,311 (34.1)	7,953 (34.1)	358 (32.3)		4,793 (21.1)	4,569 (21.1)	224 (21.2)	
Moderate	7,950 (33.6)	7,600 (33.7)	350 (33.4)		7,226 (32)	6,914 (32.2)	312 (28.1)	
Not enough/not enough at all	7,643 (32.3)	7,267 (32.2)	376 (34.4)		10,413 (46.9)	9,894 (46.8)	519 (50.8)	
Breakfast consumption				.553				.324
≤2 times/week	6,742 (28.1)	6,450 (28.2)	292 (26.8)		6,850 (30.4)	6,505 (30.2)	345 (32.5)	
3–6 times/week	7,541 (31.5)	7,203 (31.6)	338 (31.2)		8,425 (37.7)	8,038 (37.8)	387 (36.1)	

(*continued*)

TABLE 1 Continued

Variables	Male students				Female students			
	Herbal medicine				Herbal medicine			
	Total	Non-use	Use	P value	Total	Non-use	Use	P value
Everyday	9,621 (40.4)	9,167 (40.3)	454 (42)		7,157 (31.9)	6,834 (31.9)	323 (31.3)	
Fast food consumption				.015				.124
None/week	7,464 (30.9)	7,130 (30.9)	334 (30.7)		7,353 (32.3)	7,014 (32.3)	339 (32.5)	
1–2 times/week	13,271 (55.9)	12,702 (56.1)	569 (53)		12,603 (56.6)	12,026 (56.7)	577 (54.4)	
≥3 times/week	3,169 (13.2)	2,988 (13.1)	181 (16.3)		2,476 (11.1)	2,337 (11)	139 (13)	
Soft drink consumption				.152				.620
None/week	5,008 (21)	4,794 (21.1)	214 (19.3)		7,193 (32.2)	6,876 (32.2)	317 (31.2)	
1–2 times/week	11,566 (48.5)	11,064 (48.6)	502 (47.6)		11,112 (49.6)	10,579 (49.6)	533 (49.4)	
≥3 times/week	7,330 (30.4)	6,962 (30.3)	368 (33.1)		4,127 (18.3)	3,922 (18.2)	205 (19.4)	
Vegetable consumption				.432				.957
≤2 times/week	3,379 (14.1)	3,227 (14.1)	152 (13.7)		4,051 (18.2)	3,867 (18.2)	184 (18)	
3–6 times/week	8,915 (37.3)	8,499 (37.2)	416 (39.3)		8,583 (38.4)	8,173 (38.3)	410 (38.8)	
Everyday	11,610 (48.6)	11,094 (48.7)	516 (47)		9,798 (43.4)	9,337 (43.4)	461 (43.2)	
Nutrition education				.001				.075
No	12,493 (53.5)	11,964 (53.8)	529 (48.4)		13,289 (60.3)	12,688 (60.4)	601 (57.4)	
Yes	11,411 (46.5)	10,856 (46.2)	555 (51.6)		9,143 (39.7)	8,689 (39.6)	454 (42.6)	
Perceived stress				<.001				<.001
Low/none	5,156 (21.2)	4,961 (21.4)	195 (17.2)		2,514 (11)	2,418 (11.1)	96 (9.8)	
Moderate	10,281 (43.1)	9,856 (43.3)	425 (39.8)		8,382 (37.7)	8,054 (38.1)	328 (30.3)	
Very high/high	8,467 (35.7)	8,003 (35.3)	464 (43)		11,536 (51.3)	10,905 (50.8)	631 (59.9)	
Suicidal ideation				<.001				<.001
No	20,927 (87.3)	20,049 (87.6)	878 (81.3)		17,688 (78.7)	16,919 (79)	769 (72.9)	
Yes	2,977 (12.7)	2,771 (12.4)	206 (18.7)		4,744 (21.3)	4,458 (21)	286 (27.1)	
Depressed mood				<.001				<.001
No	18,288 (76.1)	17,537 (76.5)	751 (68)		14,523 (64.8)	13,939 (65.2)	584 (55.5)	
Yes	5,616 (23.9)	5,283 (23.5)	333 (32)		7,909 (35.2)	7,438 (34.8)	471 (44.5)	
Alcohol use				.085				.033
No	19,101 (79.2)	18,212 (79.1)	889 (81.5)		18,971 (84.4)	18,114 (84.6)	857 (82)	
Yes	4,803 (20.8)	4,608 (20.9)	195 (18.5)		3,461 (15.6)	3,263 (15.4)	198 (18)	
Tobacco use				.013				.007
No	17,246 (71.3)	16,427 (71.2)	819 (75)		19,455 (86.8)	18,583 (86.9)	872 (83.9)	
Yes	6,658 (28.7)	6,393 (28.8)	265 (25)		2,977 (13.2)	2,794 (13.1)	183 (16.1)	
Physical activity				.053				.102
None/week	2,410 (10.4)	2,318 (10.5)	92 (8.9)		5,950 (27)	5,702 (27.2)	248 (23.5)	
1–2 times/week	8,791 (36.8)	8,357 (36.6)	434 (40.9)		9,703 (43.3)	9,240 (43.2)	463 (45.5)	
3–4 times/week	7,317 (30.6)	7,009 (30.7)	308 (29)		4,598 (20.1)	4,369 (20.1)	229 (20.9)	
≥5 times/week	5,386 (22.2)	5,136 (22.2)	250 (21.2)		2,181 (9.6)	2,066 (9.5)	115 (10.1)	
Asthma				<.001				<.001
No	23,153 (96.9)	22,122 (97)	1,031 (95)		21,929 (97.8)	20,921 (97.9)	1,008 (95.8)	
Yes	751 (3.1)	698 (3)	53 (5)		503 (2.2)	456 (2.1)	47 (4.2)	
Allergic rhinitis				<.001				<.001
No	19,631 (81.7)	18,784 (81.9)	847 (76.8)		18,231 (80.7)	17,429 (80.9)	802 (76)	
Yes	4,273 (18.3)	4,036 (18.1)	237 (23.2)		4,201 (19.3)	3,948 (19.1)	253 (24)	
Atopic dermatitis				.006				.001
No	22,241 (92.9)	21,253 (93)	988 (90.6)		20,305 (90.5)	19,383 (90.7)	922 (87.5)	
Yes	1,663 (7.1)	1,567 (7)	96 (9.4)		2,127 (9.5)	1,994 (9.3)	133 (12.5)	
Number of chronic allergic disease				<.001				<.001
0	18,223 (75.8)	17,441 (76.1)	782 (70.5)		16,651 (73.7)	15,949 (74.1)	702 (66.8)	
1	4,775 (20.3)	4,546 (20.2)	229 (22.4)		4,824 (22)	4,541 (21.8)	283 (26.7)	
2 or 3	906 (3.9)	833 (3.7)	73 (7)		957 (4.3)	887 (4.1)	70 (6.5)	

For continuous variables, values are presented as mean ± standard error and P values were obtained using general linear model analyses. For categorical variables, values are presented as unweighted frequency (weighted column proportion) and P values were obtained using chi-squared tests with Rao-Scott correction. Sample weights were integrated and used, in all analyses performed for male and female students, respectively.
BMI, body mass index; NA, not applicable.

FIGURE 2
Adjusted odds ratios and 95% confidence interval in fully adjusted model 3. HM, herbal medicine; ref, reference group. The adjusted odds ratios and 95% confidence intervals of fully adjusted model 3 are visually presented to show the association between HM use for weight loss and the combined variables of predisposing, enabling, and need factors. Red dot indicates that the group is more likely to use HM than the reference group. Blue dot indicates that the group is less likely to use HM than the reference group. Grey dot indicates that the group is not significantly related to the reference group.

perceived health status, and BMI were related to HM use only in female students.

4. Discussion

HM, a type of CIM, is actively used to treat obesity in adolescents worldwide since the currently available interventions have low compliance and lack long-term effects and safety data (1, 9, 10, 12). Studies on the usage, comparative effectiveness, and safety of HM have been conducted (12, 15). However, studies on the factors affecting HM use for weight loss in adolescents have not been conducted. This study investigated, for the first time, HM use for weight loss in overweight and obese adolescents and analyzed the predisposing, enabling, and need factors that affect HM use based on Andersen's behavior model using the KYRBS.

This study showed that after adjusting for all predisposing, enabling, and need factors, there was a significantly higher probability of HM use for weight loss in overweight and obese adolescents who were middle school students and who had higher perceived household economic status, father's education level, depressed mood, and two or more chronic allergic diseases

in both male and female students. Looking at the differences by sex, only male students showed significantly less HM use when the perceived body image was fat or very fat compared with very thin, thin, or moderate. Male adolescents with very high perceived stress or suicidal ideation had significantly more HM use. Female students with middle or low perceived academic records, college graduate or higher mother's education level, poor or very poor perceived health status, and an obese BMI had significantly more HM use.

A previous survey in Germany found that the use of HM among children and adolescents declined with the increase in age (24). The determinants of HM use were young age, poor health status, and a family with a high social class (24). Another study identified the factors that affected Korean medicine health care use by privately insured people and found that patients with more chronic diseases used Korean medicine services more (25). A study analyzing the factors that affected Korean medicine healthcare use for treating functional dyspepsia found that participants with private health insurance and who were frequently or constantly stressed used the Korean medicine healthcare system more (26). These studies have similar results to our study. However, a prior study identified factors related to HM use in children and adolescents regardless of disease (24). A

TABLE 2 Association of herbal medicine use with predisposing, enabling, and need factors in male students.

Variables	Crude Model		Model 1		Model 2		Model 3	
	cOR (95% CI)	P value	aOR (95% CI)	P value	aOR (95% CI)	P value	aOR (95% CI)	P value
Predisposing factors								
School grade								
Middle school	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
High school	0.6 (0.52–0.69)	<.001	0.6 (0.52–0.69)	<.001	0.62 (0.53–0.71)	<.001	0.62 (0.52–0.73)	<.001
Region								
Seoul/Gyeonggi/Incheon	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Gangwon	1.19 (0.82–1.73)	.371	1.18 (0.81–1.72)	.395	1.22 (0.82–1.8)	.327	1.23 (0.82–1.85)	.311
Daejeon/Chungcheong/Sejong	0.79 (0.63–0.99)	.042	0.79 (0.63–0.99)	.040	0.82 (0.65–1.04)	.097	0.82 (0.65–1.03)	.089
Gwangju/Jeolla/Jeju	0.95 (0.78–1.17)	.648	0.95 (0.78–1.17)	.649	0.96 (0.78–1.18)	.689	0.97 (0.79–1.2)	.799
Busan/Daegu/Ulsan/Gyeongsang	1.09 (0.94–1.28)	.264	1.09 (0.93–1.27)	.289	1.13 (0.96–1.32)	.131	1.16 (0.99–1.37)	.061
Perceived academic record								
High	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Middle	1.02 (0.86–1.2)	.858	1.06 (0.89–1.26)	.524	1.18 (0.99–1.4)	.065	1.17 (0.99–1.4)	.070
Low	0.91 (0.78–1.07)	.258	0.95 (0.81–1.12)	.563	1.15 (0.97–1.36)	.102	1.12 (0.94–1.33)	.210
Enabling factors								
Residential areas								
Rural areas	1 [Reference]		NA	NA	1 [Reference]		1 [Reference]	
Metropolitan cities	1.2 (0.94–1.53)	.140	NA	NA	1.1 (0.84–1.42)	.493	1.08 (0.83–1.4)	.577
Small/medium cities	1.23 (0.97–1.57)	.089	NA	NA	1.16 (0.91–1.49)	.237	1.14 (0.89–1.46)	.306
Residence type								
Living with family	1 [Reference]		NA	NA	1 [Reference]		1 [Reference]	
Living with relatives/dormitory/etc.	0.92 (0.64–1.32)	.652	NA	NA	1.13 (0.78–1.64)	.523	1.03 (0.71–1.5)	.869
Perceived household economic status								
High	1 [Reference]		NA	NA	1 [Reference]		1 [Reference]	
Middle	0.7 (0.6–0.81)	<.001	NA	NA	0.76 (0.66–0.89)	<.001	0.76 (0.65–0.88)	<.001
Low	0.56 (0.46–0.69)	<.001	NA	NA	0.67 (0.54–0.84)	<.001	0.63 (0.5–0.78)	<.001
Father's education level								
≤high school graduate	1 [Reference]		NA	NA	1 [Reference]		1 [Reference]	
≥college graduate	1.59 (1.35–1.87)	<.001	NA	NA	1.33 (1.1–1.6)	.003	1.29 (1.07–1.56)	.007
Unknown/fatherless	1.19 (0.97–1.45)	.092	NA	NA	1.13 (0.9–1.43)	.295	1.12 (0.89–1.42)	.315
Mother's education level								
≤high school graduate	1 [Reference]		NA	NA	1 [Reference]		1 [Reference]	
≥college graduate	1.49 (1.28–1.74)	<.001	NA	NA	1.18 (0.99–1.41)	.061	1.17 (0.99–1.4)	.073
Unknown/motherless	1.05 (0.87–1.28)	.595	NA	NA	0.91 (0.73–1.15)	.434	0.94 (0.75–1.18)	.583
Need Factors								
Perceived health status								
Very good/good	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Fair	1.22 (1.04–1.43)	.012	NA	NA	NA	NA	1.15 (0.97–1.35)	.103
Poor/very poor	1.3 (1.01–1.69)	.044	NA	NA	NA	NA	1.16 (0.88–1.52)	.288
Perceived body image								
Very thin/thin/moderate	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Fat/very fat	0.68 (0.52–0.9)	.007	NA	NA	NA	NA	0.66 (0.5–0.88)	.005
BMI								
Overweight	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Obese	1.05 (0.92–1.21)	.455	NA	NA	NA	NA	1.11 (0.97–1.28)	.132
Sleep satisfaction								
Very enough/enough	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Moderate	1.05 (0.89–1.24)	.573	NA	NA	NA	NA	1.08 (0.91–1.28)	.408
Not enough/not enough at all	1.13 (0.96–1.33)	.146	NA	NA	NA	NA	1.11 (0.92–1.33)	.265
Breakfast consumption								
≤2 times/week	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
3–6 times/week	1.04 (0.87–1.24)	.693	NA	NA	NA	NA	1.04 (0.87–1.25)	.647
Everyday	1.1 (0.93–1.3)	.291	NA	NA	NA	NA	1.05 (0.88–1.25)	.568

(*continued*)

TABLE 2 Continued

Variables	Crude Model		Model 1		Model 2		Model 3	
	cOR (95% CI)	*P* value	aOR (95% CI)	*P* value	aOR (95% CI)	*P* value	aOR (95% CI)	*P* value
Fast food consumption								
None/week	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
1–2 times/week	0.95 (0.82–1.11)	.510	NA	NA	NA	NA	0.97 (0.84–1.14)	.748
≥3 times/week	1.25 (1.02–1.54)	.033	NA	NA	NA	NA	1.22 (0.99–1.51)	.058
Nutrition education								
No	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Yes	1.24 (1.09–1.42)	.001					1.13 (0.99–1.3)	.075
Perceived stress								
Low/none	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Moderate	1.14 (0.94–1.38)	.170	NA	NA	NA	NA	1.13 (0.93–1.37)	.234
Very high/high	1.52 (1.26–1.83)	<.001	NA	NA	NA	NA	1.3 (1.05–1.62)	.016
Suicidal ideation								
No	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Yes	1.63 (1.38–1.93)	<.001	NA	NA	NA	NA	1.23 (1.01–1.51)	.040
Depressed mood								
No	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Yes	1.53 (1.33–1.77)	<.001	NA	NA	NA	NA	1.31 (1.1–1.57)	.003
Alcohol use								
No	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Yes	0.86 (0.72–1.02)	.087	NA	NA	NA	NA	0.98 (0.8–1.19)	.807
Tobacco use								
No	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Yes	0.82 (0.7–0.96)	.014	NA	NA	NA	NA	0.9 (0.76–1.06)	.211
Physical activity								
None/week	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
1–2 times/week	1.31 (1.02–1.68)	.032	NA	NA	NA	NA	1.28 (0.99–1.66)	.055
3–4 times/week	1.11 (0.86–1.44)	.438	NA	NA	NA	NA	1.01 (0.78–1.32)	.931
≥5 times/week	1.12 (0.86–1.47)	.405	NA	NA	NA	NA	1.03 (0.78–1.36)	.830
Number of chronic allergic disease								
0	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
1	1.2 (1.01–1.41)	.035	NA	NA	NA	NA	1.12 (0.95–1.33)	.186
2 or 3	2.03 (1.56–2.65)	<.001	NA	NA	NA	NA	1.79 (1.36–2.36)	<.001

Crude models of HM use were obtained using simple logistic regression analyses for the individual variable of predisposing, enabling, and need factors in male students. Model 1 of HM use was obtained using multiple regression analyses for predisposing factors. Model 2 of HM use was obtained using multiple regression analyses for predisposing and enabling factors. Model 3 of HM use was obtained using multiple regression analyses for predisposing, enabling, and need factors. Sample weights were integrated and used, in all analyses for male students.
aOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; cOR, crude odds ratio; NA, not applicable.

different study identified factors related to Korean medicine health care use, including HM, acupuncture, and moxibustion, in privately insured adults (25). The latter study also identified factors related to Korean medicine health care use in adult patients with functional dyspepsia (26). Our study was different because we limited the populations to overweight and obese adolescents that used HM for weight loss and analyzed the factors separately according to sex.

Based on modern medicine, HM can promote weight loss by reducing appetite, increasing lipid metabolism, inhibiting pancreatic lipase activity, promoting lipolysis, and preventing adipogenesis (14). While traditional medicine aims to balance the yin and yang by harmonizing the body, mind, and spirit (27), HM has multiple components and targets (28). Accordingly, various other systemic effects can be induced if a patient uses HM for weight loss. Several studies have reported that HM

relieves stress and treats anxiety, depression, and suicide ideation (29–31). In addition, the effects of HM on chronic allergic diseases have been reported by previous studies (32–34). Furthermore, it has been reported that HM remarkably increases the neuroprotective effect and cognition and learning abilities through the induction and secretion of nerve growth factor (35). HM use has been reported to reduce the risk of comorbidities (36), and patients use HM with the expectation of treating comorbidities (37). Therefore, adolescents with high perceived stress, depressed mood, a high number of chronic allergic diseases, and low academic performance might use HM not only for weight loss but also for its therapeutic effect on comorbidities.

Interestingly, male students whose perceived body image was fat or very fat used HM significantly less compared with students whose perceived body image was very thin, thin, or moderate. To interpret this result, we checked the use of weight loss behaviors

TABLE 3 Association of herbal medicine use with predisposing, enabling, and need factors in female students.

Variables	Crude Model		Model 1		Model 2		Model 3	
	cOR (95% CI)	*P* value	aOR (95% CI)	*P* value	aOR (95% CI)	*P* value	aOR (95% CI)	*P* value
Predisposing factors								
School grade								
Middle school	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
High school	0.83 (0.73–0.96)	.010	0.83 (0.72–0.95)	.008	0.84 (0.72–0.98)	.022	0.8 (0.68–0.94)	.007
Region								
Seoul/Gyeonggi/Incheon	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Gangwon	0.91 (0.58–1.43)	.670	0.9 (0.57–1.43)	.656	1.03 (0.63–1.67)	.916	1.02 (0.63–1.66)	.922
Daejeon/Chungcheong/Sejong	0.89 (0.71–1.11)	.299	0.89 (0.71–1.11)	.290	0.95 (0.76–1.2)	.662	0.95 (0.75–1.19)	.645
Gwangju/Jeolla/Jeju	0.75 (0.61–0.93)	.007	0.75 (0.61–0.93)	.007	0.8 (0.65–0.98)	.035	0.8 (0.65–0.99)	.040
Busan/Daegu/Ulsan/Gyeongsang	0.92 (0.78–1.09)	.346	0.92 (0.78–1.1)	.358	0.95 (0.8–1.13)	.553	0.98 (0.82–1.16)	.775
Perceived academic record								
High	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Middle	1.13 (0.94–1.35)	.198	1.14 (0.95–1.37)	.154	1.32 (1.09–1.58)	.004	1.28 (1.06–1.55)	.009
Low	1.08 (0.92–1.28)	.361	1.09 (0.93–1.29)	.296	1.36 (1.14–1.62)	<.001	1.24 (1.03–1.48)	.020
Enabling factors								
Residential areas								
Rural areas	1 [Reference]		NA	NA	1 [Reference]		1 [Reference]	
Metropolitan cities	1.37 (1.06–1.76)	.015	NA	NA	1.2 (0.91–1.58)	.194	1.21 (0.92–1.59)	.177
Small/medium cities	1.15 (0.89–1.48)	.298	NA	NA	1.04 (0.8–1.36)	.770	1.04 (0.79–1.36)	.780
Residence type								
Living with family	1 [Reference]		NA	NA	1 [Reference]		1 [Reference]	
Living with relatives/dormitory/etc.	1.1 (0.79–1.54)	.567	NA	NA	1.25 (0.89–1.77)	.204	1.2 (0.85–1.7)	.300
Perceived household economic status								
High	1 [Reference]		NA	NA	1 [Reference]		1 [Reference]	
Middle	0.53 (0.45–0.62)	<.001	NA	NA	0.55 (0.47–0.65)	<.001	0.56 (0.48–0.66)	<.001
Low	0.64 (0.54–0.77)	<.001	NA	NA	0.71 (0.58–0.87)	<.001	0.63 (0.51–0.78)	<.001
Father's education level								
≤high school graduate	1 [Reference]		NA	NA	1 [Reference]		1 [Reference]	
≥college graduate	1.52 (1.3–1.79)	<.001	NA	NA	1.21 (1.01–1.45)	.041	1.23 (1.03–1.48)	.023
Unknown/fatherless	1.13 (0.93–1.36)	.226	NA	NA	1.16 (0.93–1.44)	.180	1.18 (0.95–1.46)	.135
Mother's education level								
≤high school graduate	1 [Reference]		NA	NA	1 [Reference]		1 [Reference]	
≥college graduate	1.55 (1.33–1.8)	<.001	NA	NA	1.31 (1.11–1.55)	.002	1.3 (1.1–1.54)	.002
Unknown/motherless	0.94 (0.77–1.16)	.582	NA	NA	0.84 (0.66–1.06)	.136	0.83 (0.66–1.05)	.122
Need Factors								
Perceived health status								
Very good/good	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Fair	1.07 (0.91–1.24)	.423	NA	NA	NA	NA	1.02 (0.87–1.2)	.791
Poor/very poor	1.53 (1.23–1.9)	<.001	NA	NA	NA	NA	1.33 (1.05–1.67)	.016
Perceived body image								
Very thin/thin/moderate	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Fat/very fat	0.99 (0.69–1.43)	.961	NA	NA	NA	NA	0.91 (0.63–1.34)	.642
BMI								
Overweight	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Obese	1.46 (1.28–1.67)	<.001	NA	NA	NA	NA	1.5 (1.31–1.72)	<.001
Sleep satisfaction								
Very enough/enough	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Moderate	0.87 (0.72–1.06)	.156	NA	NA	NA	NA	0.84 (0.69–1.03)	.095
Not enough/not enough at all	1.08 (0.91–1.29)	.389	NA	NA	NA	NA	0.95 (0.78–1.16)	.590
Breakfast consumption								
≤2 times/week	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
3–6 times/week	0.89 (0.75–1.05)	.156	NA	NA	NA	NA	0.91 (0.77–1.08)	.292
Everyday	0.91 (0.77–1.08)	.289	NA	NA	NA	NA	0.94 (0.79–1.13)	.525

(*continued*)

TABLE 3 Continued

Variables	Crude Model		Model 1		Model 2		Model 3	
	cOR (95% CI)	*P* value	aOR (95% CI)	*P* value	aOR (95% CI)	*P* value	aOR (95% CI)	*P* value
Fast food consumption								
None/week	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
1–2 times/week	0.95 (0.82–1.11)	.535	NA	NA	NA	NA	0.94 (0.81–1.09)	.394
≥3 times/week	1.18 (0.94–1.48)	.153	NA	NA	NA	NA	1.1 (0.88–1.38)	.410
Nutrition education								
No	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Yes	1.13 (0.99–1.3)	.082					1.08 (0.93–1.24)	.314
Perceived stress								
Low/none	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Moderate	0.9 (0.7–1.16)	.407	NA	NA	NA	NA	0.93 (0.72–1.21)	.584
Very high/high	1.33 (1.05–1.69)	.019	NA	NA	NA	NA	1.21 (0.93–1.57)	.157
Suicidal ideation								
No	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Yes	1.4 (1.2–1.63)	<.001	NA	NA	NA	NA	1.03 (0.86–1.24)	.749
Depressed mood								
No	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Yes	1.5 (1.31–1.72)	<.001	NA	NA	NA	NA	1.25 (1.05–1.48)	.010
Alcohol use								
No	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Yes	1.2 (1–1.44)	.053	NA	NA	NA	NA	1.14 (0.93–1.39)	.203
Tobacco use								
No	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
Yes	1.28 (1.04–1.56)	.017	NA	NA	NA	NA	1.21 (0.97–1.5)	.086
Physical activity								
None/week	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
1–2 times/week	1.22 (1.03–1.45)	.022	NA	NA	NA	NA	1.19 (1–1.41)	.051
3–4 times/week	1.2 (0.98–1.47)	.074	NA	NA	NA	NA	1.13 (0.92–1.39)	.251
≥5 times/week	1.23 (0.97–1.57)	.094	NA	NA	NA	NA	1.14 (0.89–1.47)	.299
Number of chronic allergic disease								
0	1 [Reference]		NA	NA	NA	NA	1 [Reference]	
1	1.36 (1.16–1.58)	<.001	NA	NA	NA	NA	1.24 (1.06–1.45)	.006
2 or 3	1.75 (1.33–2.3)	<.001	NA	NA	NA	NA	1.53 (1.15–2.03)	.003

Crude models of HM use were obtained using simple logistic regression analyses for the individual variable of predisposing, enabling, and need factors in male students. Model 1 of HM use was obtained using multiple regression analyses for predisposing factors. Model 2 of HM use was obtained using multiple regression analyses for predisposing and enabling factors. Model 3 of HM use was obtained using multiple regression analyses for predisposing, enabling, and need factors. Sample weights were integrated and used, in all analyses for female students.
aOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; cOR, crude odds ratio; NA, not applicable.

other than HM and the status of perceived body image in the HM use and HM non-use groups. As a result, overweight and obese adolescents whose perceived body image was very thin, thin, or moderate significantly used other weight loss methods, including regular exercise, fasting for at least 24 h, prescription weight loss medication, laxatives or diuretics, monotrophic diet, and vomiting after eating than those whose perceived body image was fat or very fat (**Supplementary Meterial S1**).

When analyzing HM use according to BMI, obese females used significantly more HM for weight loss than overweight females. To interpret this result, we checked the use of weight loss behaviors other than HM according to the status of BMI in both groups. As a result, obese adolescents tended to use weight loss methods more than overweight adolescents, except for regular exercise (in male students) and vomiting after eating (in female students); however, statistical significance could not be confirmed in some

cases (**Supplementary Meterial S2**). Judging from these results, HM use differs according to the perceived body image and BMI classification, which seems not to be specific to HM use, but to other weight loss methods. Therefore, future studies should analyze the factors that affect weight loss efforts in overweight and obese adolescents. These studies will help provide data for effective weight loss practices in adolescents and related policy establishments.

While the KYRBS used for analysis did not address the effectiveness and safety of HM, previous studies have shown that HM can be more effective than placebo and lifestyle management in treating childhood obesity, with a low risk of serious adverse events (15). However, it is important to note that these studies have high risks of performance bias and unclear risks of selection and detection bias. Additionally, some patients taking HM have reported adverse events such as digestive and

skin disorders, with a reported incidence of 6.6% (38). Therefore, it is crucial to conduct well-designed prospective clinical studies to further investigate the effectiveness and safety of HM for weight loss.

This study has the following limitations. First, KYRBS is a self-reported online survey conducted to identify the statuses and trends of adolescent health behaviors. In the case of HM use for weight loss, it is possible that adolescents responded by including over-the-counter herbal drugs and herbal health functional foods as well as HM prescriptions from Korean medicine clinics or hospitals. Differences according to these could not be confirmed due to the nature of the questionnaires since they were not developed for research purposes. Second, because KYRBS data are based on students' self-reports, responses may have been under or over-reported, especially height and weight. It has been reported that height is over-reported and weight is under-reported in the KYRBS (39). Therefore, it is possible that the definition of overweight and obesity based on the BMI percentiles in this study may not accurately represent overweight and obesity in adolescents. Finally, since this study is a cross-sectional analysis, the causal relationship of HM use for weight loss cannot be confirmed.

Nevertheless, this is the first study to identify the factors affecting HM use for weight loss in overweight and obese adolescents. In addition, the representativeness of the data was secured by using a large national representative database of Korean school adolescents. Furthermore, because of sex differences in obesity prevalence, treatment, and perception (40), we analyzed the data by sex. These results can be used to establish methods to promote HM use in clinical settings and can provide ideas for future research. Our study found that the use of HM for weight loss in adolescents was more prevalent among parents with higher education levels. This result is consistent with previous studies that show a positive association between education level and the use of CIM (41, 42), It has also been reported that providing more information on CIM promotes its use (43). Based on these findings, clinicians can promote the use of CIM, including HM, in clinical settings by providing sufficient information on the effectiveness and safety of HM for weight loss. This information can include evidence from previous studies, as well as potential risks and benefits. By doing so, clinicians can encourage informed decision-making and promote the use of HM in a safe and effective manner. In addition, given the high socioeconomic burden caused by obesity in adolescents, this study can be used as the bases for policymakers to strengthen the health insurance coverage extension for weight loss interventions.

Data availability statement

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

Ethics statement

Since the KYRBS did not collect any identifiable information about human participants and was publicly accessible, it was not considered human subject research. The Korea Institute of Oriental Medicine review board approved this study as an exemption from review (I-2206/006-003).

Author contributions

Conceptualization, BL: Methodology, MHY and BL: Formal analysis, MHY: Writing (original draft preparation), MHY and BL: Writing (review and editing), MHY and BL: Funding acquisition, BL. All authors contributed to the article and approved the submitted version.

Funding

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fped.2023.1166786/full#supplementary-material.

References

1. Nicolucci A, Maffeis C. The adolescent with obesity: what perspectives for treatment? *Ital J Pediatr.* (2022) 48(1):9. doi: 10.1186/s13052-022-01205-w

2. Di Cesare M, Sorić M, Bovet P, Miranda JJ, Bhutta Z, Stevens GA, et al. The epidemiological burden of obesity in childhood: a worldwide epidemic requiring urgent action. *BMC Med.* (2019) 17(1):212. doi: 10.1186/s12916-019-1449-8

3. Simmonds M, Llewellyn A, Owen CG, Woolacott N. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. *Obes Rev.* (2016) 17 (2):95–107. doi: 10.1111/obr.12334

4. Kang S, Kim S, Lee J. Prevalence rates and risk factors of overweight and obesity in children and adolescents: using Korean national health and nutrition examination survey 2005 data. *Epidemiol Health.* (2008) 30(2):188–97. doi: 10.4178/kje.2008.30.2.188

5. Salam RA, Padhani ZA, Das JK, Shaikh AY, Hoodbhoy Z, Jeelani SM, et al. Effects of lifestyle modification interventions to prevent and manage child and adolescent obesity: a systematic review and meta-analysis. *Nutrients.* (2020) 12(8):2208. doi: 10.3390/nu12082208

6. O'Connor EA, Evans CV, Burda BU, Walsh ES, Eder M, Lozano P. Screening for obesity and intervention for weight management in children and adolescents: evidence report and systematic review for the US preventive services task force. *Jama.* (2017) 317(23):2427–44. doi: 10.1001/jama.2017.0332

7. Reinehr T, Widhalm K, l'Allemand D, Wiegand S, Wabitsch M, Holl RW. Two-year follow-up in 21,784 overweight children and adolescents with lifestyle intervention. *Obesity (Silver Spring).* (2009) 17(6):1196–9. doi: 10.1038/oby.2009.17

8. Knop C, Singer V, Uysal Y, Schaefer A, Wolters B, Reinehr T. Extremely obese children respond better than extremely obese adolescents to lifestyle interventions. *Pediatr Obes.* (2015) 10(1):7–14. doi: 10.1111/j.2047-6310.2013.00212.x

9. Kelly AS, Auerbach P, Barrientos-Perez M, Gies I, Hale PM, Marcus C, et al. A randomized, controlled trial of liraglutide for adolescents with obesity. *N Engl J Med.* (2020) 382(22):2117–28. doi: 10.1056/NEJMoa1916038

10. Inge TH, Courcoulas AP, Jenkins TM, Michalsky MP, Helmrath MA, Brandt ML, et al. Weight loss and health Status 3 years after bariatric surgery in adolescents. *N Engl J Med.* (2016) 374(2):113–23. doi: 10.1056/NEJMoa1506699

11. Barnes PM, Bloom B, Nahin RL. Complementary and alternative medicine use among adults and children: United States, 2007. *Natl Health Stat Report.* (200812):1–23. doi: 10.1037/e623942009-001

12. Eldalo AS, Alotaibi MN, Alenazi TO, Albogami HA, Mohamed KM. Use of herbal medicines in the treatment of obesity in taif, Saudi Arabia. *Saudi J Med Med Sci.* (2017) 5(2):149–54. doi: 10.4103/1658-631X.204862

13. Welz AN, Emberger-Klein A, Menrad K. Why people use herbal medicine: insights from a focus-group study in Germany. *BMC Complement Altern Med.* (2018) 18(1):92. doi: 10.1186/s12906-018-2160-6

14. Kazemipoor M, Cordell GA, Sarker MMR, Radzi C, Hajifaraji M, En Kiat P. Alternative treatments for weight loss: safety/risks and effectiveness of anti-obesity medicinal plants. *Int J Food Prop.* (2015) 18(9):1942–63. doi: 10.1080/10942912.2014.933350

15. Lee B, Kwon CY. Comparative effectiveness of east Asian traditional medicine for childhood simple obesity: a systematic review and network meta-analysis. *Int J Environ Res Public Health.* (2022) 19(20):12994. doi: 10.3390/ijerph192012994

16. Garrison LP Jr., Neumann PJ, Erickson P, Marshall D, Mullins CD. Using real-world data for coverage and payment decisions: the ISPOR real-world data task force report. *Value Health.* (2007) 10(5):326–35. doi: 10.1111/j.1524-4733.2007.00186.x

17. Kim Y, Choi S, Chun C, Park S, Khang Y-H, Oh K. Data resource profile: the Korea youth risk behavior web-based survey (KYRBS). *Int J Epidemiol.* (2016) 45 (4):1076-e. doi: 10.1093/ije/dyw070

18. Andersen RM. Revisiting the behavioral model and access to medical care: does it matter? *J Health Soc Behav.* (1995) 36(1):1–10. doi: 10.2307/2137284

19. Babitsch B, Gohl D, Von Lengerke T. Re-revisiting Andersen's behavioral model of health services use: a systematic review of studies from 1998 to 2011. *GMS Psycho Soc Med.* (2012) 9:1–15. doi: 10.3205/psm000089

20. Andersen R, Newman JF. Societal and individual determinants of medical care utilization in the United States. *Milbank Mem Fund Q Health Soc.* (1973) 51 (1):95–124. doi: 10.2307/3349613

21. Aday LA, Andersen R. A framework for the study of access to medical care. *Health Serv Res.* (1974) 9(3):208.

22. Wan TT, Yates AS. Prediction of dental services utilization: a multivariate approach. *Inquiry.* (1975) 12(2):143–56.

23. Chern J-Y, Wan TT, Begun JW. A structural equation modeling approach to examining the predictive power of determinants of individuals' health expenditures. *J Med Syst.* (2002) 26:323–36. doi: 10.1023/A:1015868720789

24. Du Y, Wolf IK, Zhuang W, Bodemann S, Knöss W, Knopf H. Use of herbal medicinal products among children and adolescents in Germany. *BMC Complement Altern Med.* (2014) 14:218. doi: 10.1186/1472-6882-14-218

25. Jung B, Kim J, Ha IH, Lee J. Factors affecting utilisation of traditional Korean medical services by privately insured persons: a retrospective study using Korean health panel survey (KHPS). *BMJ Open.* (2020) 10(1):e033159. doi: 10.1136/bmjopen-2019-033159

26. Lee B, Yang C, Yim MH. Factors affecting Korean medicine health care use for functional dyspepsia: analysis of the Korea health panel survey 2017. *Healthcare.* (2022) 10(7):1192. doi: 10.3390/healthcare10071192

27. Marshall AC. Traditional Chinese Medicine and Clinical Pharmacology. In: Hock F, Gralinski M, editors. *Drug Discovery and Evaluation: Methods in Clinical Pharmacology.* Cham: Springer (2020). doi: 10.1007/978-3-319-68864-0_60

28. Wang Y, Fan X, Qu H, Gao X, Cheng Y. Strategies and techniques for multi-component drug design from medicinal herbs and traditional Chinese medicine. *Curr Top Med Chem.* (2012) 12(12):1356–62. doi: 10.2174/156802612801319034

29. Li DY. Curative effect analysis of 86 cases of depression with suicidal ideation treated by traditional Chinese medicine guipi decoction combined with cognitive therapy. *J Guiyang College Tradit Chin Med.* (2011) 33(2):44–5.

30. Qu W, Liu S, Zhang W, Zhu H, Tao Q, Wang H, et al. Impact of traditional Chinese medicine treatment on chronic unpredictable mild stress-induced depression-like behaviors: intestinal microbiota and gut microbiome function. *Food Funct.* (2019) 10(9):5886–97. doi: 10.1039/C9FO00399A

31. Lopresti AL, Smith SJ, Malvi H, Kodgule R. An investigation into the stress-relieving and pharmacological actions of an ashwagandha (Withania somnifera) extract: a randomized, double-blind, placebo-controlled study. *Medicine.* (2019) 98 (37):e17186. doi: 10.1097/MD.0000000000017186

32. Cai X, Sun X, Liu L, Zhou Y, Hong S, Wang J, et al. Efficacy and safety of Chinese herbal medicine for atopic dermatitis: evidence from eight high-quality randomized placebo-controlled trials. *Front Pharmacol.* (2022) 13:927304. doi: 10.3389/fphar.2022.927304

33. Zheng Z, Sun Z, Zhou X, Zhou Z. Efficacy of Chinese herbal medicine in treatment of allergic rhinitis in children: a meta-analysis of 19 randomized controlled trials. *J Int Med Res.* (2018) 46(10):4006–18. doi: 10.1177/0300060518786905

34. Lo PC, Lin SK, Lai JN. Long-term use of Chinese herbal medicine therapy reduced the risk of asthma hospitalization in school-age children: a nationwide population-based cohort study in Taiwan. *J Tradit Complement Med.* (2020) 10 (2):141–9. doi: 10.1016/j.jtcme.2019.04.005

35. Moon E, Her Y, Lee JB, Park JH, Lee EH, Kim SH, et al. The multi-herbal medicine gongjin-dan enhances memory and learning tasks via NGF regulation. *Neurosci Lett.* (2009) 466(3):114–9. doi: 10.1016/j.neulet.2009.09.033

36. Yan B, Jiang Z, Yuan J, Li M, Zeng J, Tang J, et al. Effects and safety of herbal medicines among community-dwelling residents during COVID-19 pandemic: a large prospective, randomized controlled trial (RCT). *Phytomedicine.* (2021) 85:153403. doi: 10.1016/j.phymed.2020.153403

37. Lee H, Kim B, Yun Y. Utilization of Korean medicine among children with cerebral palsy-qualitative study by grounded theory. *J Soc Prev Korean Med.* (2019) 23(2):25–42. doi: 10.25153/spkom.2019.23.2.003

38. Jang S, Kim KH, Sun SH, Go HY, Lee EK, Jang BH, et al. Characteristics of herbal medicine users and adverse events experienced in South Korea: a survey study. *Evid Based Complement Alternat Med.* (2017) 2017:4089019. doi: 10.1155/2017/4089019

39. Bae J, Joung H, Kim JY, Kwon KN, Kim Y, Park SW. Validity of self-reported height, weight, and body mass index of the Korea youth risk behavior web-based survey questionnaire. *J Prev Med Public Health.* (2010) 43(5):396–402. doi: 10.3961/jpmph.2010.43.5.396

40. Cooper AJ, Gupta SR, Moustafa AF, Chao AM. Sex/gender differences in obesity prevalence, comorbidities, and treatment. *Curr Obes Rep.* (2021) 10(4):458–66. doi: 10.1007/s13679-021-00453-x

41. Klafke N, Eliott JA, Wittert GA, Olver IN. Prevalence and predictors of complementary and alternative medicine (CAM) use by men in Australian cancer outpatient services. *Ann Oncol.* (2012) 23(6):1571–8. doi: 10.1093/annonc/mdr521

42. Jang A, Kang DH, Kim DU. Complementary and alternative medicine use and its association with emotional Status and quality of life in patients with a solid tumor: a cross-sectional study. *J Altern Complement Med.* (2017) 23(5):362–9. doi: 10.1089/acm.2016.0289

43. Huebner J, Ebel M, Muenstedt K, Micke O, Prott FJ, Muecke R, et al. A lecture program on complementary and alternative medicine for cancer patients–evaluation of the pilot phase. *J Cancer Educ.* (2015) 30(2):340–3. doi: 10.1007/s13187-014-0706-y