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Research Article

Study Time after School and Habitual Eating Are Associated with Risk for Obesity among Overweight Korean Children: A Prospective Study

Eun Young Lee[a] Borami Kang[a] Yeoree Yang[a] Hae Kyung Yang[a] Hun-Sung Kim[a, b] Sun-Young Lim[b] Jin-Hee Lee[b] Seong-Su Lee[c] Byung-Kyu Suh[d] Kun-Ho Yoon[a, b]

[a]Division of Endocrinology and Metabolism, Department of Internal Medicine, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, South Korea; [b]Institute of Catholic Ubiquitous Health Care, The Catholic University of Korea, Seoul, South Korea; [c]Division of Endocrinology and Metabolism, Department of Internal Medicine, Bucheon St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, South Korea; [d]Department of Pediatrics, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, South Korea

Keywords
Childhood · Eating behavior · Obesity · Overweight · Sedentary time

Abstract
Objective: To investigate behavioral factors that contribute to the development of obesity among overweight children. ***Methods:*** Among a community sample of 884 children aged 9–13 years, 833 children completed a baseline and 1-year follow-up examination that included anthropometrics, physical fitness, and behavioral factors. ***Results:*** During the follow-up period, BMI for most children with normal weight or obesity did not change. However, among overweight children (n = 100), about one-third developed obesity (n = 26), while the others were categorized as normal weight (n = 32) or overweight (n = 42) after 1 year. Characteristics of overweight children at baseline and follow-up were analyzed. Those who developed obesity showed a notable increase in blood pressure as well as in BMI, waist circumference, and body fat over 1 year. At baseline, this group spent more time studying after school compared to overweight children who did not develop obesity, while there were no differences in time spent viewing television or engaging in vigorous physical activity. Eating outside the home, fast food consumption, and habitual eating in the absence of hunger were more common at baseline in those who did versus those who did not develop obesity. After adjusting for age,

Kun-Ho Yoon, MD, PhD
Division of Endocrinology and Metabolism, Department of Internal Medicine
Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea
222 Banpo-daero, Seocho-gu, 06591 Seoul, South Korea
yoonk@catholic.ac.kr

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sex, and BMI, spending more time studying after school and habitual eating without hunger were associated with the development of obesity. ***Conclusion:*** Among Korean overweight children, study time after school and habitual eating without hunger were associated with an increased risk for development of obesity.

Introduction

Childhood obesity is an increasingly important public health issue. The prevalence of obesity among children and adolescents has steadily increased over the last few decades [1]. This phenomenon is not limited to Western countries, but is also observed in the Asian population [2]. In 2013, the prevalence of childhood obesity was greater than 10% in developing countries and even higher (>20%) in developed countries [1]. In addition, the combined prevalence of overweight and obesity among children has increased by 47.1% from 1980 to 2013 [1].

There are serious health implications associated with childhood obesity, which can contribute to cardiovascular and metabolic abnormalities during early childhood or puberty [3–7]. More than 50% of children with obesity have at least one cardiometabolic risk factor [4]. Dyslipidemia, abnormal glucose regulation, and increased fasting insulin levels often accompany childhood obesity [4, 5], which is also closely associated with future cardiovascular and metabolic diseases. Elevated blood pressure in children with obesity can put them at 30–40% greater risk for future stroke and ischemic heart disease [5]. Previous studies have demonstrated a relative risk of 1.5–5.1 for cardiometabolic diseases such as diabetes, hypertension, stroke, and ischemic heart disease in children with obesity [6]. Furthermore, childhood obesity is associated with increased premature adult mortality, with a relative risk of 1.4–2.9 compared to children without obesity [6, 7].

For these reasons, earlier management of childhood obesity is critical. Given its increasing prevalence, methods of prevention and intervention in overweight children who are at high risk for obesity are needed. There are few studies evaluating predictors of obesity in overweight children; thus, we investigated behavioral factors that contributed to the development of obesity among overweight children over 1 year.

Material and Methods

Study Population and Physical Examination

A total of 884 children aged 9–13 years were recruited from five elementary and middle schools in Chung-Ju city. This cohort is part of an ongoing prospective community-based study that began in 2014. At the first follow-up examination in 2015, 833 children completed the anthropometric measures, physical fitness testing, and questionnaires. Body weight and composition (fat and muscle) were measured using bioimpedance analysis (IOI 353; Jawon Medical, Seoul, South Korea). This analysis was performed in the morning, after an overnight fast, with children wearing light clothing and no accessories. Waist circumference was measured within 0.1 cm using a plastic tapeline. BMI (kg/m^2) was used to define overweight (≥85th percentile), obese (≥95th percentile or 25 kg/m^2), and normal weight (<85th percentile). We used the Korean Centers for Disease Control and Prevention (KCDC) standard growth charts as an indicator for age- and sex-specific percentiles for BMI [8]. Height was measured within 0.1 cm using BIKI 200 (Jawon Medical, Seoul, South Korea). Physical fitness was measured by four domains: cardiopulmonary endurance, flexibility, muscle strength, and agility. Cardiopulmonary endurance was measured by running for 15~20 m. Flexibility, muscle strength, and agility were evaluated by trunk flection, grip strength, and standing long jump test, respectively. All tests were performed at least twice, and the total of all scores were recorded, based on the standards proposed by the Ministry of Education, Science and Technology of South Korea in 2009 [9]. The study protocol was approved by the Ethics Committee of Seoul St. Mary's Hospital (KIRB-00465–005).

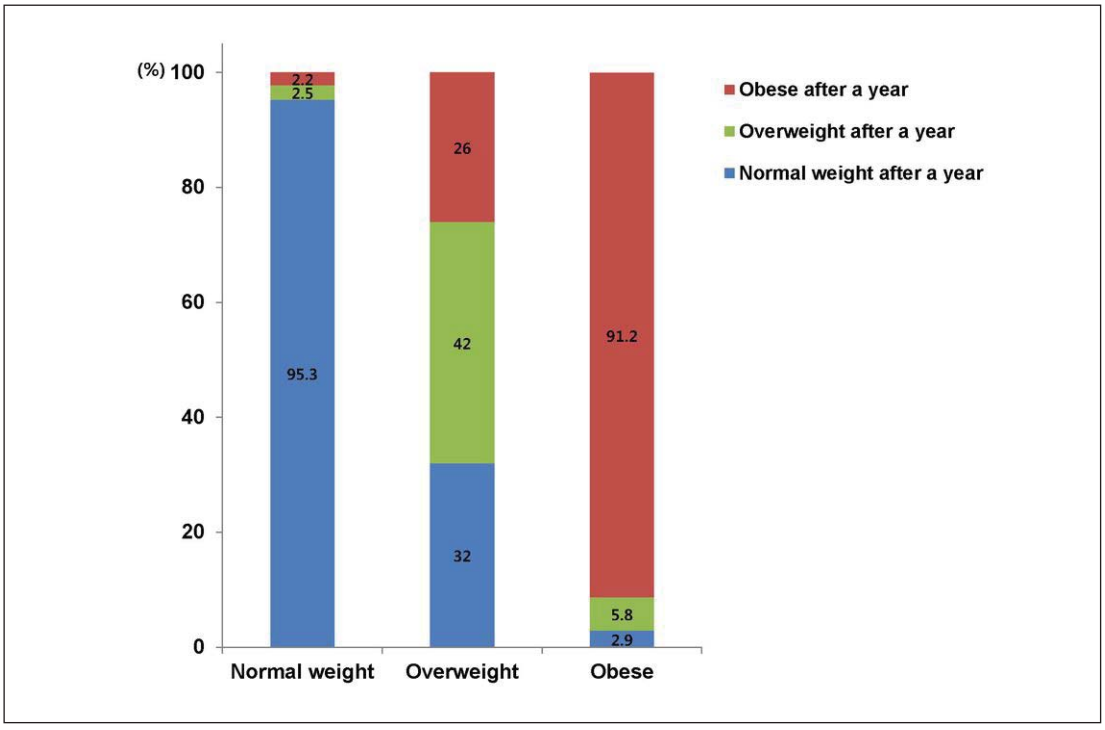

Fig. 1. Changes in BMI categories among 833 children during 1 year of follow-up.

Questionnaire of Behavioral Factors

Behavioral and emotional characteristics were assessed using self-reported questionnaires that targeted areas such as physical activity, sleep, eating frequency, and eating behavior. The physical activity questionnaire investigated the frequency of vigorous physical activity, type and duration of exercise outside of gym class, amount of TV watching or computer use, and preference for physical activity. To evaluate eating patterns, children were asked how often they ate 12 specific foods, such as fruit, vegetables, milk, soda, bread, candy, or fast food. Eating behavior was evaluated by 16 questions including eating speed, number and regularity of meal times, and frequency of eating outside the home, night snacking, impulsive eating, and eating in the absence of hunger. These questionnaires were modified from the questionnaire suggested by the Youth Health Behavior Survey and the Children and Adolescent Obesity of South Korea [10].

Statistical Analysis

Data are presented as mean ± standard deviation (SD) or n (%). Analysis of variance (ANOVA) and post hoc analysis were performed to compare groups according to the weight category. Categorical variables were analyzed using the Mantel-Haenszel χ^2 or McNemar test. Univariate regression analysis was used to evaluate associations between obesity and behavioral or emotional factors. Multi-nominal logistic regression analysis was performed to control for potential confounders. All statistical analyses were performed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA). A p value of <0.05 was considered to be statistically significant.

Results

Baseline Characteristics of Study Population

At baseline, 12.1% (boys 11.3%; girls 14.8%) and 16.4% (boys 17.8%; girls 11.7%) of children were overweight and obese, respectively. The prevalence of overweight decreased to 7.8% (p = 0.029) after 1 year of follow-up, while the prevalence of obesity increased to

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Table 1. Baseline characteristics of overweight children by BMI categories after 1 year*

	Normal weight (n = 32)	Overweight (n = 42)	Obese (n = 26)	p value#
Age, years	10.9 ± 1.6	9.9 ± 1.2[a]	11.0 ± 1.4[b]	0.003
Female sex (%)	8(25.0)	16(38.1)	3(11.5)	0.315
SBP, mm Hg	123.7 ± 13.5	118.2 ± 10.6	116.1 ± 11.6[a]	0.039
DBP, mm Hg	75.3 ± 10.5	76.0 ± 8.7	72.5 ± 10.3	0.335
Height, cm	152.1 ± 12.5	143.3 ± 8.8[a]	152.0 ± 10.7[b]	<0.001
Weight, kg	53.4 ± 11.7	46.0 ± 7.7[a]	55.0 ± 9.5[b]	<0.001
WC, cm	75.1 ± 7.5	73.3 ± 6.6	78.3 ± 5.4[b]	0.011
BMI, kg/m^2	22.7 ± 1.6	22.2 ± 1.3	23.6 ± 1.2[a]	<0.001
BMI percentile	87.7 ± 2.6	89.3 ± 2.4[a]	90.1 ± 2.6[a]	<0.001
Body fat, %	22.9 ± 3.1	22.8 ± 3.3	23.4 ± 2.7	0.696
Fat mass, kg	12.4 ± 3.3	10.5 ± 2.6[a]	12.9 ± 2.7[b]	0.002
Muscle mass, kg	38.1 ± 8.2	32.8 ± 5.3[a]	39.0 ± 6.8[b]	<0.001
Physical fitness				
Cardiopulmonary endurance	6.8 ± 3.6	7.5 ± 3.2	6.6 ± 2.8	0.516
Flexibility	8.9 ± 6.1	7.3 ± 5.9	8.2 ± 5.8	0.523
Muscle strength	8.3 ± 3.0	7.9 ± 2.8	9.0 ± 2.8	0.314
Agility	7.7 ± 3.7	7.8 ± 3.4	7.9 ± 3.1	0.957
Total score	36.7 ± 8.6	35.2 ± 10.5	35.8 ± 10.2	0.814

DBP = Diastolic blood pressure; SBP = systolic blood pressure; WC = waist circumference.
*Data were shown as mean ± SD or number (%).
#P value is for ANOVA analysis among three groups.
[a]Indicates a significant difference between obese and normal weight.
[b]Indicates a significant difference between obese and overweight.

Table 2. Difference in blood pressure and anthropometrics over one year in overweight children according to BMI categories after 1 year*

	Normal weight (n = 32)	Overweight (n = 46)	Obese (n = 26)	p value#
Δ SBP, mm Hg	–6.9 ± 15.9	0.1 ± 11.2	3.3 ± 13.3a	0.014
Δ DBP, mm Hg	–1.5 ± 13.1	1.6 ± 9.6	4.2 ± 13.7	0.201
Δ Height, cm	6.4 ± 3.1	6.0 ± 1.6	6.0 ± 2.1	0.678
Δ Weight, kg	1.7 ± 3.9	5.6 ± 1.8a	9.7 ± 2.4a,b	<0.001
Δ WC, cm	0.8 ± 5.0	4.0 ± 6.1a	6.1 ± 4.3a	0.001
Δ BMI, kg/m^2	–1.1 ± 1.2	0.8 ± 0.8a	2.1 ± 0.8a,b	<0.001
Δ BMI percentile	–12.4 ± 10.4	–0.4 ± 3.2a	3.5 ± 2.2a,b	<0.001
Δ Body fat, %	–2.1 ± 3.2	1.5 ± 2.0a	3.6 ± 1.9a,b	<0.001
Δ Fat mass, kg	–0.7 ± 2.2	2.1 ± 1.2a	4.7 ± 1.7a,b	<0.001
Δ Muscle mass, kg	2.4 ± 2.3	3.2 ± 1.3a	4.5 ± 1.4a,b	<0.001
Δ Muscle mass – Δ fat mass, kg	3.1 ± 2.5	1.2 ± 1.8a	–0.1 ± 2.0a,b	<0.001

DBP = Diastolic blood pressure; SBP = systolic blood pressure; WC = waist circumference; Δ = values 1 year after minus values at baseline.
*Data are shown as mean ± SD.
#P value is for ANOVA analysis among three groups.
[a]Indicates a significant difference between obese and normal weight.
[b]Indicates a significant difference between obese and overweight.

19.7% ($p < 0.001$). Obesity significantly increased in boys (22.0%, $p < 0.001$), but not in girls (11.7%, $p = 1.000$) after 1 year. Most children with normal weight (95.3%) or obesity (91.2%) at baseline remained in the same BMI categories during follow-up (fig. 1). However, among children who were overweight at baseline (n = 100), 32 were normal-weight, 42 were overweight, and 26 were obese 1 year later.

We categorized overweight children at baseline into 3 groups according to BMI categories after 1 year of follow-up. Baseline BMI was higher in children whose BMI category changed to obesity, compared to those whose BMI category changed to normal weight (table 1). Although baseline systolic blood pressure (SBP) was low in children whose BMI category changed to obesity after 1 year (table 1), it significantly increased during follow-up, while it decreased in children whose BMI category changed to normal weight (table 2). There was no significant difference in physical fitness levels at baseline according to BMI categories after 1 year.

Anthropometric Changes over 1 Year and Baseline Behavioral Characteristics According to BMI Categories

During the follow-up period, weight gain was more prominent in children who developed obesity compared to others. Likewise, there was a greater increase in anthropometrics, such as waist circumference, BMI, and body fat percentage in overweight children who developed obesity compared to those who did not (table 3). Although there were no significant differences in vigorous physical activity or TV viewing, children who developed obesity during follow-up spent greater amounts of time studying after school compared to those without obesity (p for trend = 0.046; table 3). They also reported worse eating habits, such as fast food or fatty food consumption and eating outside the home, compared to those who did not develop obesity ($p = 0.028$ and $p = 0.002$, respectively). Soda intake and breakfast consumption tended to increase in children with obesity, but not significantly ($p = 0.116$ and $p = 0.103$, respectively). Children with obesity were more often noted to eat habitually in the absence of hunger compared to those without obesity ($p = 0.002$), and tended to eat impulsively or under stress, but not significantly ($p = 0.071$).

Multinominal Regression Analysis for Developing Obesity after 1 Year

On regression analysis, children with normal weight after 1 year were used as a reference group, and their baseline characteristics were compared to those of children who remained overweight and to those of children who developed obesity after 1 year. As shown in table 4, after adjusting for age and sex, greater time spent in after-school study was significantly associated with development of obesity after 1 year (odds ratio (OR), 6.39 (95% confidence interval (CI) 1.08–37.72); $p = 0.041$). This relationship remained significant even after adjusting for BMI (OR, 13.30 (95% CI, 1.76–100.27); $p = 0.012$). Habitual eating without hunger also showed an independent association with development of obesity after adjusting for age, sex, and BMI (OR, 13.76 (95% CI, 1.29–147.14); $p = 0.030$). Although frequent eating of fast food or fatty food and breakfast were associated with developing obesity after 1 year, these relationships were not significant after adjusting for other confounders.

Discussion

In the present study, we observed that most children with normal weight or obesity at baseline remained in the same BMI categories during 1 year of follow-up. However, overweight children were more likely to change their BMI category compared to those with normal weight or obesity. About one-third of overweight children developed obesity after 1

Table 3. Baseline behavioral and emotional characteristics of overweight children by BMI categories after 1 year*

	Normal weight (n = 30)	Overweight (n = 40)	Obese (n = 23)	p value
Lifestyle				
Vigorous physical activity				
<1 h	21 (70.0)	23 (57.5)	12 (57.1)	0.472
1~2 h	4 (13.3)	13 (32.5)	5 (23.8)	
≥2 h	5 (16.7)	4 (10.0)	4 (19.0)	
Exercise out of gym class				
No	9 (30.0)	11 (27.5)	8 (34.8)	0.740
Yes	21 (70.0)	29 (72.5)	15 (25.2)	
Study after school				
<1 h	10 (34.5)	9 (22.5)	3 (13.0)	0.046
1~3 h	14 (48.3)	21 (52.5)	12 (52.2)	
≥3 h	5 (17.2)	10 (25.0)	8 (34.8)	
TV viewing				
<1 h	21 (72.4)	19 (47.5)	11 (47.8)	0.181
1~3 h	7 (24.1)	15 (37.5)	12 (52.2)	
≥3 h	1 (3.4)	6 (15.0)	0 (0)	
Sleep time				
<7 h	2 (7.1)	1 (2.5)	0 (0)	0.287
7~8 h	17 (60.7)	25 (62.5)	11 (57.9)	
≥9 h	9 (32.1)	14 (35.0)	8 (42.1)	
Food frequency				
Fruit				
≤6	20 (71.4)	28 (73.7)	16 (69.6)	0.900
Daily	8 (28.6)	10 (26.3)	7 (30.4)	
Vegetable				
≤2	6 (20.7)	6 (15.8)	2 (9.1)	0.365
3~6	13 (44.8)	18 (47.4)	11 (50.0)	
Daily	10 (34.5)	14 (36.8)	9 (40.9)	
Soda				
≤2	24 (82.8)	29 (74.4)	16 (69.6)	0.116
3~4	5 (17.2)	6 (15.4)	4 (17.4)	
≥5	0 (0)	4 (10.3)	3 (13.0)	
Candy or sweetener				
≤2	22 (75.9)	27 (67.5)	16 (69.6)	0.253
3~4	6 (20.7)	10 (25.0)	3 (13.0)	
≥5	1 (3.4)	3 (7.5)	4 (17.4)	
Fast or fatty food				
<1	16 (55.2)	13 (32.5)	6 (26.1)	0.028
≥1	13 (44.8)	27 (67.5)	17 (73.9)	

Table 3 continued on next page

year while the other two-thirds did not. Greater time spent in after-school study and habitual eating in the absence of hunger were significantly associated with an increased risk of developing obesity among overweight children.

Recently, many studies have highlighted the negative impact of sedentary time on health, independent of physical activity [11–13]. We observed an association between obesity and sedentary time which was measured as time spent in after-school study, while most previous studies have investigated time spent viewing TV, playing video games, or using the computer [14, 15]. This may have two implications. First, this may reflect a particular social norm in Korea; namely, an excessive passion (especially among parents) for education requiring

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Table 3. Continued

	Normal weight (n = 30)	Overweight (n = 40)	Obese (n = 23)	p value
Eating behavior				
Breakfast				
≤2	6 (20.7)	7 (17.5)	2 (8.7)	0.103
3~5	9 (31.0)	3 (7.5)	5 (21.7)	
≥6	14 (48.3)	30 (75.0)	16 (69.6)	
Regular meal				
No	8 (27.6)	8 (20.5)	5 (21.7)	0.596
Yes	21 (72.4)	31 (79.5)	18 (78.3)	
Eating slowly				
No	10 (35.7)	17 (42.5)	9 (39.1)	0.780
Yes	18 (64.3)	23 (57.5)	14 (60.9)	
Frequent or night snack				
No	19 (65.5)	21 (52.5)	18 (78.3)	0.425
Yes	10 (34.5)	19 (47.5)	5 (21.7)	
Eating outside the home				
No	29 (100)	33 (82.5)	16 (69.6)	0.002
Yes	0 (0)	7 (17.5)	7 (30.4)	
Habitual eating without hunger				
No	28 (9.6)	34 (85.0)	17 (73.9)	0.020
Yes	1 (3.4)	6 (15.0)	6 (26.1)	
Eating under stress				
No	27 (93.1)	37 (92.5)	18 (78.3)	0.104
Yes	2 (6.9)	3 (7.5)	5 (21.7)	
Impulsive eating				
No	28 (96.6)	38 (95.0)	19 (82.6)	0.071
Yes	1 (3.4)	2 (5.0)	4 (17.4)	

*Data are shown as number (%). Lifestyle is expressed as mean time spent per day. Food and breakfast frequency are expressed as times per week.

children and adolescents to engage in extracurricular study. A previous study reported that after-school institutional study is routine among Korean children and adolescents [16]. Interestingly, we observed that children spending more time studying spent significantly less time watching TV or using the computer (data not shown). This suggests that sedentary time measured by study time after school could be an important factor for evaluating obesity risk, at least in South Korea. Secondly, a more important aspect is that children and adolescents are prone to eat snacks or fast food during extracurricular study time, which could contribute to obesity. Our observation that children with obesity frequently eat fast food and/or drink soda supports this hypothesis. We also found a positive association between study time after school and frequency of fast food or soda consumption (data not shown). Therefore, it may be prudent to encourage children with obesity to reduce snacks, fast food, or soda to lose weight, rather than to decrease study time. Several studies have shown an association between obesity and memory and attention deficit [17–19], both of which might affect study time. However, we could not explore this association because cognitive function scores were not available.

Eating behaviors have been extensively studied in childhood obesity. The number, regularity, and duration of meals are generally suggested as factors in obesity-related eating behaviors [20]. However, we did not observe any differences in these eating behaviors between children who did and those who did not develop obesity. Only habitual eating in the

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Table 4. Multi-nominal logistic regression analysis*

	Age and sex adjusted				Age, sex, and BMI adjusted			
	overweight		obese		overweight		obese	
	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Study after school								
<1 h	1 (reference)		1 (reference)		1 (reference)		1 (reference)	
1~3 h	1.56 (0.46–5.24)	0.477	2.87 (0.624–13.22)	0.176	1.59 (0.44–5.72)	0.482	3.71 (0.64–21.62)	0.145
≥3 h	4.14 (0.86–19.90)	0.076	6.39 (1.08–137.72)	0.041	5.10 (0.99–26.40)	0.052	13.30 (1.76–100.27)	0.012
Fast or fatty food								
<1	1 (reference)		1 (reference)		1 (reference)		1 (reference)	
≥1	2.86 (1.00–8.15)	0.049	3.76 (1.13–12.56)	0.031	2.73 (0.92–8.14)	0.071	3.32 (0.90–12.28)	0.072
Breakfast								
≤2	1 (reference)		1 (reference)		1 (reference)		1 (reference)	
3~5	0.49 (0.08–3.04)	0.443	2.06 (0.27–15.60)	0.486	0.66 (0.10–4.40)	0.663	2.56 (0.26–25.09)	0.419
≥6	2.25 (0.59–8.65)	0.236	3.97 (0.66–23.76)	0.131	2.33 (0.56–9.67)	0.244	3.90 (0.55–27.74)	0.174
Habitual eating without hunger								
No	1 (reference)		1 (reference)		1 (reference)		1 (reference)	
Yes	5.49 (0.59–51.52)	0.136	8.59 (0.93–78.93)	0.057	5.52 (0.58–52.95	0.139	13.76 (1.28–147.14)	0.030

*Study after school is expressed as mean time spent per day. Food and breakfast frequency are expressed as number of times per week.

absence of hunger was significantly associated with obesity after adjusting for confounders. Additionally, eating under stress and impulsive eating tended to be greater among children with obesity. This suggests that dietary habits driven by psychological aspects may be more important than the number, regularity, or duration of meals. Consistent with our results, girls eating without hunger were reported to have a 4.6 times greater risk of being overweight [21]. This type of eating behavior in response to presence of food or an emotional state is defined as disinhibited eating, which leads to weight gain and binge eating in adults [22, 23]. To prevent obesity, the regulation of disinhibited eating, particularly during childhood and adolescence, may be necessary. For example, one randomized trial reported that training in food cue responsivity and appetite awareness were effective for reducing eating in the absence of hunger in children [24].

The generalizability of our study may be limited because of the short follow-up period and relatively small number of participants. Lack of laboratory data such as glucose or lipid profile is another limitation. Sedentary time and physical activity data collected from questionnaires are subject to recall bias. However, the prospective study design is a major strength of this study. In addition, we focused on overweight children who are at high risk for obesity, and discovered that their weight was more prone to change compared to children with obesity. Furthermore, we tracked not only BMI changes but also body composition, including fat and muscle mass.

Conclusion

In the present study, we identified several important behavioral factors that are associated with the development of obesity in overweight Korean children, including increased time spent in after-school study and habitual eating in the absence of hunger. However, these risk factors should be interpreted in the context of potentially different social norms. Further studies in varied social environments are needed to further investigate factors contributing to childhood obesity.

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Disclosure Statement

All authors declare that there are no conflicts of interest.

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