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Review

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Secular Trends in Pediatric Overweight and Obesity in Korea

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Over the previous decades, the prevalence of pediatric obesity has been increased in Korea as well as worldwide. Pediatric obesity is associated with comorbidities in childhood and adulthood. We reviewed the prevalence of pediatric obesity using data from the National School Health Examination (NSHE) and the Korea National Health and Nutrition Examination Survey (KNHANES). Obesity was defined as a body mass index (BMI) ≥25 kg/m^2; BMI ≥95th percentile for the corresponding sex and age in the 2007 growth charts for the NSHE; or BMI ≥95th percentile for the corresponding sex and age in the 2017 growth charts for the KNHANES. There was a slight discrepancy in the prevalence of obesity depending on the data source. The prevalence of obesity increased from 8.7% in 2007 to 15.0% in 2017 in the NSHE (in children aged 6–18 years) and from 8.6% in 2001 to 9.8% in 2017 in the KNHANES (in children aged 2–18 years). The increase in the prevalence of obesity was higher in boys and high school students. Accurate epidemiologic data analyzed using the new 2017 growth charts are essential in developing strategies for controlling obesity. Efforts to collect more reliable nationally representative data, including longitudinal studies, are warranted.

Key words: Pediatric obesity, Prevalence, Child, Adolescent, Korea

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INTRODUCTION

The prevalence of pediatric obesity has increased worldwide over several decades.[1] Pediatric obesity is a public concern because it is associated with comorbidities, such as type 2 diabetes mellitus (T2DM), dyslipidemia, hypertension, non-alcoholic fatty liver disease, obstructive sleep apnea, polycystic ovary syndrome, and psychiatric problems in childhood.[2-6] Obesity is also linked to increased health-related expenditure.[7] Furthermore, children who are overweight or obese have a higher risk for obesity and related disorders in adulthood.[8-10] High body mass index (BMI), including overweight and obesity, makes a significant contribution to disability-adjusted life-years in adults.[11]

An increasing prevalence of pediatric obesity has been reported in many countries. In the United States, the prevalence of obesity and extreme obesity has markedly increased over the recent several decades.[12,13] The prevalence of obesity and extreme obesity among children aged 2–19 years in the United States increased from 10.0% and 2.6% in 1988–1994 to 17.2% and 6.0% in 2013–2014, respectively. In China, the prevalence of obesity has increased sharply over the last 30 years.[14] In Korea, several studies on the prevalence of pediatric obesity have been reported.[15] Oh et al.[16] reported that the prevalence of obesity in children increased from 5.8% in 1998 to 9.7% in 2005. However, Nam et al.[17] showed that the prevalence of overweight and obesity among children and adolescents between 2001 and 2014 had plateaued. Prevalence studies on pediatric obesity using the new 2017 growth charts are not available. In this review, we discuss the up-to-date epidemiologic data on overweight and obesity among Korean children and adolescents.

SECULAR TRENDS OF OVERWEIGHT AND OBESITY

Nationally representative data from Korean children and adolescents have been collected through the National School Health Examination (NSHE) and the Korea National Health and Nutrition Examination Survey (KNHANES). Both collection tools have strengths and weaknesses. For NSHE, a sufficient number of participants were enrolled every year. However, there were limitations, such as measurement errors and exclusion of children and adolescents not attending school. On the other hand, the use of trained personnel to perform anthropometric measures in KNHANES makes it reliable. However, due to the relatively small numbers of young participants, the prevalence of overweight and obesity might significantly vary by years.

The NSHE aims to generate baseline data related to health issues of students in elementary, middle, and high schools. The students are assessed annually under the supervision of the Ministry of Education.[18] A two-stage, stratified, cluster sampling method was used in the NSHE to select a representative sample of students in Korea. Recently, more than 80,000 students aged 6 to 18 years participated in the NSHE. The NSHE data was analyzed using the 2007 growth charts, which defined overweight as BMI ≥ 85th percentile and < 95th percentile for the corresponding sex and age, and obesity was defined as BMI ≥ 95th percentile for the corresponding sex and age or BMI ≥ 25 kg/m^2.[19] The prevalence of overweight and obesity increased from 15.3% to 23.7% over the last 10 years (Table 1, Fig. 1). The increasing tendency was observed in both boys and girls (Fig. 2). When stratified by sex and schools, boys and high school students showed a more significant increase in the prevalence of overweight and obesity between 2007 and 2017 (Fig. 3). There was an unexpected increase in the prevalence of overweight and obesity between 2008 and 2009, which was attributed to the application of a more appropriate sampling strategy in 2009. New 2017 growth charts were published in 2018, necessitating a reanalysis using the newly released growth charts.[20] The 2017 growth charts for BMI were adjusted to lower 95th percentile line, because the previous version had a higher BMI percentile values in boys. In addition, the definition of obesity was changed to BMI ≥ 95th percentile for the corresponding sex and age in the 2017 growth charts.

The prevalence of overweight and obesity among children and adolescents can be also obtained from the KNHANES data. The KNHANES is a cross-sectional survey that is conducted annually by the Korea Centers for Disease Control and Prevention and the Ministry of Health and Welfare.[21] It collects nationally representative data from a multi-stage, clustered, probability design. Recently,

Table 1. Prevalence of overweight and obesity in Korean children and adolescents

Year	NSHE (6–18 yr)							KNHANES (2–18 yr)						
	n	Obesity (%)			Overweight (%)			n	Obesity (%)			Overweight (%)		
		Boy	Girl	Total	Boy	Girl	Total		Boy	Girl	Total	Boy	Girl	Total
2001								2,982	9.9	7.1	8.6	10.1	8.4	9.3
2005								1,922	9.6	8.6	9.1	8.8	9.0	8.9
2007	112,401	10.7	6.6	8.7	5.4	7.9	6.6	1,118	11.6	8.1	10.0	10.1	9.3	9.7
2008	122,289	10.4	6.3	8.4	5.4	7.8	6.6	2,325	10.9	7.9	9.5	11.5	8.9	10.3
2009	194,817	13.2	8.8	11.1	7.2	9.6	8.3	2,395	9.9	7.2	8.6	10.0	9.9	9.9
2010	188,352	13.9	9.1	11.7	6.7	9.3	7.9	1,984	12.1	8.2	10.3	9.3	8.7	9.0
2011	181,350	13.7	9.4	11.6	6.8	9.5	8.1	1,716	10.7	9.5	10.1	7.9	9.5	8.6
2012	87,253	14.0	11.2	12.6	5.9	8.8	7.3	1,530	9.3	8.1	8.7	9.9	8.6	9.3
2013	84,480	14.9	10.5	12.8	6.8	10.8	8.7	1,688	9.7	7.5	8.6	11.7	7.2	9.5
2014	82,581	15.1	10.5	12.9	6.6	9.8	8.1	1,390	10.6	8.0	9.4	8.6	10.1	9.3
2015	84,815	15.5	11.0	13.4	6.9	9.9	8.4	1,282	10.2	9.7	9.9	9.5	7.9	8.8
2016	82,883	17.1	11.2	14.3	7.2	9.7	8.4	1,570	10.9	9.5	10.2	8.2	7.1	7.7
2017	80,460	17.7	12.0	15.0	7.3	10.2	8.7	1,441	9.6	10.3	9.8	8.5	9.2	8.8

Diagnostic criteria for overweight and obesity were based on the 2007 growth charts[19] for the NSHE and the 2017 growth charts[20] for the KNHANES.
NSHE, National School Health Examination; KNHANES, Korea National Health and Nutrition Examination Survey.

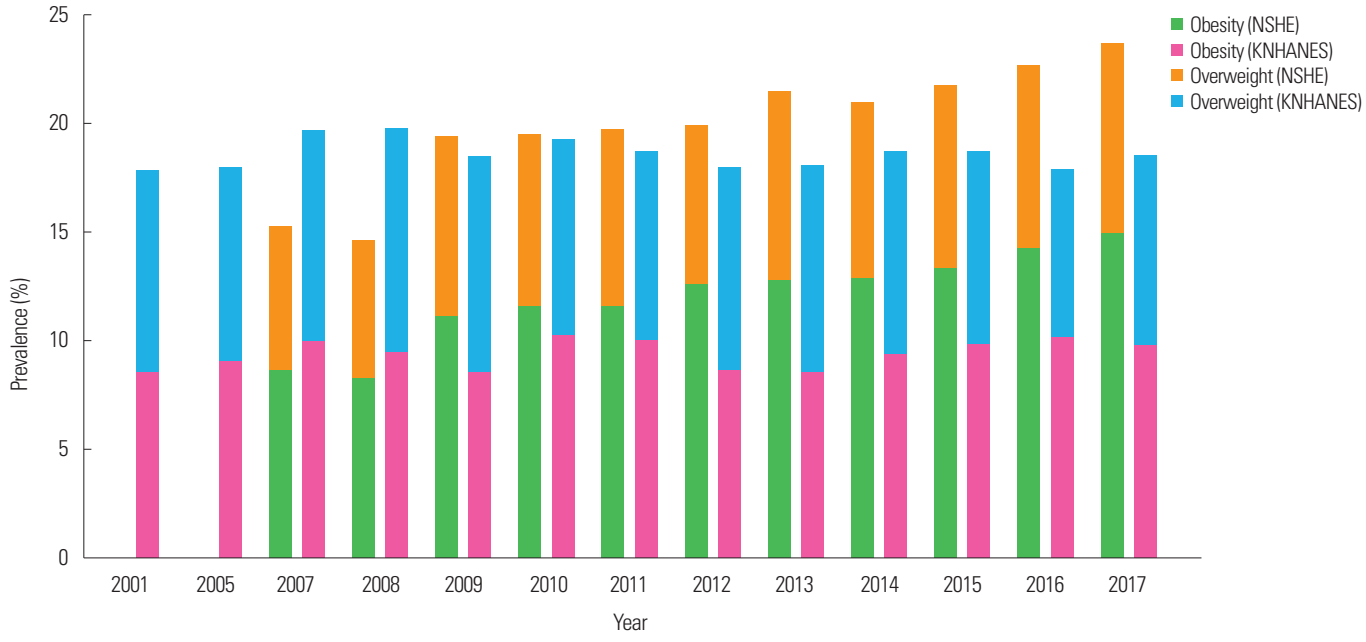

Figure 1. Prevalence of overweight and obesity among Korean children and adolescents. NSHE: children aged 6–18 years, KNHANES: children aged 2–18 years. NSHE, National School Health Examination; KNHANES, Korea National Health and Nutrition Examination Survey.

Figure 2. Prevalence of overweight (A) and obesity (B) by sex and year among Korean children and adolescents. NSHE: children aged 6–18 years, KNHANES: children aged 2–18 years. NSHE, National School Health Examination; KNHANES, Korea National Health and Nutrition Examination Survey.

data on overweight and obesity based on the 2017 growth charts was provided.[20,22] The prevalence of overweight and obesity among children and adolescents aged 2 to 18 years in the KNHANES slightly increased from 17.9% in 2001 to 18.6% in 2017 (Table 1, Fig. 1). In boys, the prevalence of obesity was unchanged, although overweight slightly decreased. In girls, the prevalence of both overweight and obesity increased (Fig. 2). Interestingly, the prevalence of extreme obesity, which was BMI ≥ 120% of the 95th percentile, significantly increased from 1.2% to 2.1% between 2001 and 2013–2014 (P=0.010).[17]

In Korea, the prevalence of obesity has increased over time. However, the prevalence differs based on the data source and

Figure 3. Secular changes in the prevalence of overweight and obesity from the National School Health Examination between 2007 and 2017 by sex and schools.

growth chart references for BMI. The collection of nationally representative data and the application of new growth charts are warranted for the generation of more accurate epidemiological data.

CHARACTERISTICS OF OBESITY IN KOREAN CHILDREN AND ADOLESCENTS

A recent report from the NSHE and the Korean Youth Health Risk Behavior On-line Survey revealed increased consumption of junk food, frequent skipping of breakfast among middle and high school students, increased sedentary time, and decreased consumption of vegetables over the last 5 years.[23] According to the KNHANES, total caloric intake and fat intake increased between 2007 and 2015 in children and adolescents.[24] Approximately 10% of middle and high school students performed vigorous physical activity for more than 30 minutes 5 days per week, and almost half of high school students slept less than 6 hours per day. According to the KNHANES, the daily time spent in moderate-to-vigorous physical activity has not changed between 2007 and 2015 among those aged 10–18 years.[24] Low socioeconomic status was associated with obesity in children and adolescents using the KNHANES data.[25] These are well-known risk factors for developing overweight and obesity in children and adolescents.[26-29] Interestingly, these behavioral characteristics were more common among high school students, which is in line with the rapidly increased prevalence of obesity in the same population group.

OBESITY-RELATED COMORBIDITIES

Obesity is associated with dyslipidemia, hypertension, non-alcoholic fatty liver disease, T2DM, and metabolic syndrome. Many studies link pediatric obesity and these diseases in the Korean population. Lim et al.[30] reported that obese children and adolescents had higher rates of metabolic syndrome, and higher levels of blood pressure, fasting plasma glucose, triglycerides, and low-density lipoprotein cholesterol and they had lower high-density lipoprotein cholesterol than normal-weight counterparts. The prevalence of metabolic syndrome in Korean children and adolescents increased from 4.0% in 1998 to 7.8% in 2007, in conjunction with an increased prevalence of obesity over this time period.[31] Seo and Kim[32] showed that the BMI z-score was a reliable marker for detecting metabolic syndrome. In another study, children and adolescents with obesity had elevated levels of glycated hemoglobin.[33] Elevated alanine aminotransferase, a marker for non-alcoholic fatty liver disease, was associated with obesity.[34] Children and adolescents with obesity had a higher prevalence of elevated blood pressure and hypertension.[24] However, most studies were cross-sectional and used the KNHANES data. Longitudinal follow-up cohort studies are scarce in Korea.

CONCLUSION

Pediatric obesity is associated with many comorbidities in childhood and adulthood. In Korea, the prevalence of obesity has increased over time, although there is a slight discrepancy based on data source and the reference on BMI. Accurate epidemiologic data analyzed using the new 2017 growth charts are essential in developing strategies for controlling obesity. Efforts to collect more reliable nationally representative data, including longitudinal studies, are warranted.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Study concept and design: JHK; acquisition of data: all authors; analysis and interpretation of data: JHK; drafting of the manuscript: JHK; critical revision of the manuscript: all authors; statistical analysis: JHK; administrative, technical, or material support: all authors; and study supervision: JHK.

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