



# Trends and Risk Factors of Metabolic Syndrome among Korean Adolescents, 2007 to 2018 (*Diabetes Metab J* 2021;45:880-9)

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We want to thank Dr. Dae Jung Kim for his interest in and critical comments on our recent paper, “Trends and risk factors of metabolic syndrome among Korean adolescents, 2007 to 2018” [1]. We also appreciate the opportunity to respond to Dr. Dae Jung Kim’s letter submitted to the *Diabetes and Metabolism Journal*.

The definition of metabolic syndrome in children and adolescents has not been standardized, with more than 40 classifications being used to date [2]. The most-used definitions in the current literature are the International Diabetes Federation (IDF) and the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) criteria modified by Cook; all are derived from the adult definition for pediatric use [3]. However, which criteria best predicts long-term morbidity has not yet been established [4]. The prevalence of metabolic syndrome in children is generally greater when evaluated using the modified NCEP-ATP III than with IDF criteria because the former adopted a lower threshold for hypertriglyceridemia (110 mg/dL vs. 150 mg/dL) and hypertension (90th percentile for age, sex, and height vs.  $\geq 130/85$  mg/dL). We used the IDF criteria instead of the modified NCEP-ATP III criteria in this study for several reasons. The hyperglycemia cutoff in the modified NCEP-ATP III criteria is 110 mg/dL, higher than the IDF criteria (100 mg/dL), which is widely accepted as a risk factor for type 2 diabetes mellitus in adults and children [5]. Also, the 110 mg/dL cutoff value for hypertriglyceridemia sug-

gested by the modified NCEP-ATP III criteria is relatively low considering the reference data for Korean children [6]. Also, central obesity, a principal pathophysiologic component in the concept of metabolic syndrome, is a prerequisite in the IDF criteria but not in the modified NCEP-ATP III criteria.

In this study, the prevalence of metabolic syndrome increased nonsignificantly from 1.7% to 2.2%, despite significant increases in central obesity (from 8.1% to 11.2%) and hyperglycemia (from 5.3% to 10.4%). The main reason for this is that hypo-high density lipoprotein (HDL)-cholesterolemia, which has the highest prevalence among the components of metabolic syndrome in Korean adolescents, has decreased enough to offset the increase in central obesity and hyperglycemia. The main reason for this phenomenon is that each component is given the same weight when defining metabolic syndrome, despite the general consensus of clinicians that hyperglycemia has a more significant impact on the development of diabetes mellitus and subsequent long-term morbidity.

A recent report offers a similar example of the prevalence of dyslipidemia in Korean adolescents over the past 12 years using the Korean National Health and Nutrition Examination Surveys dataset [7]. In that particular study, despite a remarkable increase of more than 1.5 times in the prevalence of hypercholesterolemia and hyper-low density lipoprotein-cholesterolemia, the overall prevalence of dyslipidemia showed a slight decrease due to the evident decline in hypo-HDL-cho-

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lesterolemia [7]. We believe that researchers and clinicians should recognize these limitations in the definition of metabolic syndrome and should pay attention to each component. We agree with Dr. Kim that comparing the number of metabolic abnormalities according to lifestyle factors might be an interesting strategy for addressing this. Still, we wanted to focus on specific metabolic derangements related to lifestyle factors in this study, after adjusting for the relevant covariates including socioeconomic status and total calorie intake. We also agree with Dr. Kim that further studies are needed that will focus on the interaction between lifestyle factors and socioeconomic status.

In this study, a decreasing rate of smoking among Korean adolescents over a span of 12 years was noted. In addition, controversial findings have shown that adolescent smokers have lower fasting blood sugar levels [1]. Although the data were not included in this study, smoking was not significantly associated with the overall odds of metabolic syndrome in our study population. Many toxic substances, including nicotine, heavy metals, and polycyclic hydrocarbons in tobacco smoke, are reported to have direct or indirect harmful effects on pancreatic  $\beta$ -cells [8]. However, previous epidemiological studies have shown conflicting and contradictory findings regarding the relationship between smoking and hyperglycemia. A recent study demonstrated that chronic smoking is associated with increased diabetes mellitus in Korean adults [9].

Several reports have suggested that smoking cessation leads to weight gain and subsequent increase in type 2 diabetes mellitus incidence, while smoking cessation still has an overall beneficial effect on reducing cardiovascular and all-cause mortality [10-12]. The impact of smoking on blood sugar control may vary depending on smoking duration. In addition, there is a possibility that the number of cigarettes smoked per day, weight control before and after smoking, and socioeconomic status may all be related to blood sugar control [13]. We want to point out that our study targeted an adolescent population with limited smoking duration and amount. Therefore, the impact of chronic smoking on blood sugar control could not be addressed in this study. Nevertheless, our findings suggest that smoking might not have contributed to the increase in hyperglycemia among Korean adolescents over the past 12 years.

We appreciate Dr. Kim highlighting the crucial impact of the COVID-19 pandemic on obesity among Korean adolescents. We have recently completed research on this topic using nationally representative data. In line with several global reports

[14], an increase in overweight and obesity prevalence in Korean youth was noted during the COVID-19 pandemic [15]. These findings suggest the need for intervention in modifiable lifestyle factors affecting childhood obesity, emphasizing the importance of youth education through schools and social networks with support from public health authorities.

## CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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