

Prevalence of the Metabolic Syndrome Among U.S. Adolescents Using the Definition From the International Diabetes Federation

EARL S. FORD, MD, MPH
CHAOYANG LI, MD, PHD
GUIXIANG ZHAO, MD, PHD

WILLIAM S. PEARSON, PHD
ALI H. MOKDAD, PHD

OBJECTIVE — Our objective was to estimate the prevalence of the metabolic syndrome using the 2007 pediatric International Diabetes Federation (IDF) definition among adolescents in the U.S.

RESEARCH DESIGN AND METHODS — We used data from 2,014 participants aged 12–17 years of the National Health and Nutrition Examination Survey 1999–2004.

RESULTS — The prevalence of the metabolic syndrome for the period 1999–2004 was ~4.5% (~1.1 million adolescents aged 12–17 years in 2006). It increased with age, was higher among males (6.7%) than females (2.1%) ($P = 0.006$), and was highest among Mexican-American adolescents (7.1%). The prevalence of the metabolic syndrome was relatively stable across the 6-year period: 4.5% for 1999–2000, 4.4–4.5% for 2001–2002, and 3.7–3.9% for 2003–2004 (P for linear trend >0.050).

CONCLUSIONS — Our results provide the first estimates of the prevalence of the metabolic syndrome using the pediatric IDF definition among adolescents in the U.S.

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Prospective and cross-sectional studies in children have linked the metabolic syndrome, or clusters of factors considered to be part of it, to diabetes (1), cardiovascular disease (2), intima-media thickness (3), increased carotid artery stiffness (4), and hepatosteatosis (5). Until recently, no standard definition of the metabolic syndrome for use in pediatric populations was available. Consequently, researchers have used a plethora of definitions (6). In 2007, the International Diabetes Federation (IDF) presented a definition for use in children and adolescents, thus becoming the first major organization to do so (7). Because no estimates of the prevalence of the meta-

bolic syndrome using the pediatric IDF definition exist, we analyzed data from a national sample of children and adolescents from the U.S. to estimate the prevalence of the syndrome and to examine demographic variation in its prevalence.

RESEARCH DESIGN AND METHODS

— We used data from the National Health and Nutrition Examination Survey 1999–2004 that included a representative sample of the civilian, non-institutionalized U.S. population selected using a multistage, stratified sampling design. Details about the survey may be found elsewhere (8). Our analytic sample included participants aged 12–17 years.

According to the IDF definition, an individual aged 10–15 years has the metabolic syndrome if he or she has central adiposity (≥ 90 th waist circumference percentile or adult threshold if lower) plus at least two of the following criteria (1): 1) triglycerides ≥ 150 mg/dl (1.7 mmol/l), 2) HDL cholesterol < 40 mg/dl (1.03 mmol/l), 3) systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg, 4) fasting plasma glucose ≥ 100 mg/dl (5.6 mmol/l) or previously diagnosed type 2 diabetes.

For participants aged 12–15 years, we defined abdominal obesity using the 90th percentiles for the waist circumference for whites because the adult definition recommends applying white thresholds to African Americans and applying South Asian thresholds, which are smaller than those for whites, to ethnic South and Central Americans. Because the thresholds for Mexican Americans exceeded those for whites, we applied white thresholds to Mexican-American youth (9). For males aged 14 and 15 years, we used adult thresholds of 90 cm for Mexican Americans and other Hispanics and 94 cm for whites, African Americans, and others because these thresholds were smaller than the 90th percentiles. For females of all ages, we used the adult threshold of 80 cm because it was smaller than the 90th percentiles. For those aged ≥ 16 years, the adult IDF definition of the metabolic syndrome was applied (10). In addition, we estimated the prevalence of the metabolic syndrome and abdominal obesity using waist circumference thresholds (sex- and age-specific 90th percentiles) derived from National Health and Nutrition Examination Survey 1999–2004 data when these thresholds were smaller than adult thresholds.

Because concentrations of plasma glucose and serum triglycerides were measured using reference analytic methods only for the participants who attended the morning examination, we limited the analyses to males and non-pregnant females aged 12–17 years who attended the morning medical examina-

From the Division of Adult and Community Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia.

Address correspondence and reprint requests to Earl Ford, MD, MPH, Centers for Disease Control and Prevention, 4770 Buford Highway, MS K66, Atlanta, GA 30341. E-mail: eford@cdc.gov.

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Abbreviations: IDF, International Diabetes Federation.

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Table 1—Unadjusted prevalence of the metabolic syndrome and its components based on pediatric criteria from the IDF among U.S. adolescents aged 12–17 years, National Health and Nutrition Examination Survey 1999–2004

	Sample size (n)	Metabolic syndrome 1*	Metabolic syndrome 2†	Abdominal obesity 1‡	Abdominal obesity 2§	Hypertriglyceridemia	Low HDL cholesterol	High blood pressure	Hyperglycemia
Total participants	2,014	4.5 ± 0.6	4.4 ± 0.6	28.6 ± 1.4	27.3 ± 1.3	8.9 ± 1.0	22.6 ± 1.4	3.5 ± 0.6	10.6 ± 1.2
Age (years)									
12	709	1.2 ± 0.3	1.0 ± 0.3	24.0 ± 2.4	20.7 ± 2.2	8.9 ± 1.5	12.9 ± 2.2	1.2	10.1 ± 1.8
14	622	5.2 ± 1.0	5.1 ± 1.0	26.1 ± 2.3	25.6 ± 2.3	10.0 ± 1.6	18.6 ± 2.0	4.9 ± 1.2	14.2 ± 2.5
16–17	683	7.1 ± 1.3	7.1 ± 1.3	35.5 ± 2.2	35.5 ± 2.2	7.9 ± 1.4	36.1 ± 2.3	4.6 ± 1.0	7.9 ± 1.3
P for linear trend		<0.001	<0.001	0.001	<0.001	0.635	<0.001	0.005	0.327
Sex									
Male	1,058	6.7 ± 1.3	6.6 ± 1.3	21.0 ± 1.7	18.5 ± 1.5	10.5 ± 1.6	23.4 ± 1.9	5.6 ± 0.9	15.3 ± 1.9
Female	956	2.1 ± 0.6	2.1 ± 0.6	36.5 ± 2.2	36.5 ± 2.2	7.3 ± 1.3	21.8 ± 2.1	1.3	5.8 ± 1.0
P χ^2		0.006	0.008	<0.001	<0.001	0.131	0.566	<0.001	<0.001
Ethnicity									
White	537	4.5 ± 0.8	4.5 ± 0.8	27.2 ± 2.1	25.9 ± 1.9	10.5 ± 1.5	25.1 ± 2.0	3.4 ± 0.8	11.6 ± 1.9
African American	637	3.0 ± 0.7	2.7 ± 0.7	29.3 ± 2.0	27.4 ± 1.9	3.6 ± 0.8	14.4 ± 1.9	5.0 ± 0.9	7.2 ± 1.1
Mexican American	700	7.1 ± 1.0	6.6 ± 1.1	34.5 ± 1.9	33.2 ± 1.9	10.8 ± 1.1	21.5 ± 1.6	2.5 ± 0.6	14.3 ± 1.8
P χ^2		0.007	0.012	0.063	0.043	<0.001	<0.001	0.040	0.003

Data are % ± SEM unless otherwise indicated. *Metabolic syndrome defined using thresholds for waist circumference based on 90th percentiles from NHANES III 1988–1994 data. †Metabolic syndrome defined using thresholds for waist circumference based on 90th percentiles from NHANES 1999–2004 data. ‡Abdominal obesity defined using thresholds for waist circumference based on 90th percentiles from NHANES III 1988–1994 data. §Metabolic syndrome defined using thresholds for waist circumference based on 90th percentiles from NHANES 1999–2004 data. ||Does not meet standard of statistical reliability and precision (relative SEM >30%). NHANES, National Health and Nutrition Examination Survey.

tion and who had fasted for ≥8 h. Because of limited sample size for the racial or ethnic groups designated as “other race—including multi-racial” and “other Hispanic,” no results were reported separately for these subgroups. SUDAAN was used for the analyses to account for the complex sampling design.

RESULTS— Attending the morning examination were 2,126 participants aged 12–17 years. After excluding participants with missing values for the variables included in our analyses, our analytic sample comprised 2,014 participants.

The prevalence of the metabolic syndrome for the period 1999–2004 was ~4.5% (Table 1). It increased with age, was higher among males than females, and varied by ethnicity. Monthly postcensal data for the resident population show that there were 25,487,535 males and females aged 12–17 years in the U.S. during November 2006. Thus, ~1.1 million young adults aged 12–17 years had the metabolic syndrome according to IDF criteria. The prevalence of the metabolic syndrome was relatively stable across the 6-year period: 4.5% for 1999–2000, 4.4–4.5% for 2001–2002, and 3.7–3.9% for 2003–2004 (P for linear trend >0.050).

CONCLUSIONS— Our estimated prevalence of the metabolic syndrome of ~4.5% is at the low end of the range of

previous estimates (4.2 to ~50%) from pediatric studies conducted in the U.S. (11–21). The new IDF pediatric definition now provides a standard that will facilitate comparisons of study results including prevalence estimates across studies. Because few researchers used identical pediatric definitions, markedly different prevalence estimates ranging from 0 to 59% around the world populate the literature (13,22–24).

Like its adult counterpart, the pediatric definition emphasizes the central role of obesity. However, ethnic-specific percentiles for the distributions of waist circumference in children and adolescents remain relatively rare. Percentiles for U.S. children and adolescents were derived from national data at a time when the prevalence of obesity was already rising and thus may not represent optimal percentiles. In contrast to many researchers who adapted adult cut points for high blood pressure and concentrations of triglycerides, the IDF retained the adult cut points of its adult definition. These decisions help to explain why the prevalence in our study was not higher. Furthermore, the use of adult cut points possibly raises the risk level for cardiometabolic disease among those identified as having the metabolic syndrome.

More needs to be learned about the possible health consequences of having the metabolic syndrome in childhood or

adolescence. However, emerging evidence suggests that children who have the metabolic syndrome increase their risk of developing adverse events later in life (1,2).

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