Incidence and Trend of a Metabolic Syndrome Phenotype Among Tehranian Adolescents

Findings from the Tehran Lipid and Glucose Study, 1998–2001 to 2003–2006

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OBJECTIVE — To assess the incidence and trend of the metabolic syndrome phenotype in adolescents from the Tehran Lipid and Glucose Study during 3.6 years of follow-up.

RESEARCH DESIGN AND METHODS — A total of 932 adolescents, aged 10–19 years, who had complete data and returned for reassessment 3.6 years later were investigated.

RESULTS — Prevalence of metabolic syndrome at baseline and after 3.6 years was 7.4 and 6.7%, respectively, based on the Adult Treatment Panel (ATP) III definitions; 3.5 and 8.0%, respectively, based on the International Diabetes Federation (IDF) definitions; 4.1 and 9.4%, respectively, based on the American Heart Association (AHA) definitions; and 13.6 and 13.4%, respectively, based on the National Health and Nutrition Examination Survey (NHANES) definitions. Incidence rates were 5.2% (95% CI 3–6) based on ATP III, 6.8% (5–8) based on IDF, 8.3% (6–10) based on AHA, and 8.8% (6–10) based on NHANES definitions.

CONCLUSIONS — Incidence of metabolic syndrome is high in Tehranian adolescents.

Diabetes Care **33:2110–2112, 2010**

The metabolic syndrome, defined as a group of risk factors, including obesity, impaired glucose metabolism, dyslipidemia, and hypertension, is associated with a heightened risk for developing cardiovascular diseases and type 2 diabetes and an enhanced mortality from all causes (1–3). The aim of this study was to assess incidence and trend of metabolic syndrome prevalence in adolescents of the Tehran Lipid and Glucose Study (TLGS) after 3.6 years of follow-up.

RESEARCH DESIGN AND METHODS

— This study was conducted within the framework of the TLGS, a prospective study performed in a representative 15,005 individuals aged 3–85 years and residents of one district of Tehran (4). Adolescents, aged 10–19 years, who had complete data and returned for reassessment 3.6 years later were included in this study. Subjects who were pregnant or who were taking medications that affect serum lipids, blood pressure, and carbohydrate metabolism were excluded in the study. The final sample consisted of 932 adolescents, who were first assessed in 1999–2001 and reassessed in 2003–2005.

Details of the TLGS protocol and all laboratory procedures were published elsewhere (4). Overweight was defined as at or above the 95th percentile of BMI for age. At risk for overweight was defined as at or above the 85th percentile but less than the 95th percentile of BMI for age (5).

In this study, pediatric definitions of metabolic syndrome by the Third Report of the National Cholesterol Education Program (Adult Treatment Panel III [ATP III]) (6), the International Diabetes Federation (IDF) (7), the American Heart Association (AHA) (8), and the National Health and Nutrition Examination Survey (NHANES) (9) were used.

RESULTS

— A total of 932 adolescents (530 [56.9%] girls and 402 [43.1%] boys), mean age 14.38 ± 2.85 years, were studied. Prevalence of metabolic syndrome according to the ATP III at baseline was 7.4% (95% CI 5.7–9) and after 3.6 years of follow-up was 6.7% (5–8) (Table 1). There was a significant association between metabolic syndrome prevalence (according to ATP III criteria) and BMI, as 57.9% of overweight adolescents had the metabolic syndrome compared with 29.2% of adolescents at risk for overweight and 2.4% of adolescents with normal weight ($P < 0.0001$).

High fasting triglycerides and low HDL cholesterol were the most prevalent components according to ATP III criteria (38.4 and 41.6%, respectively), whereas high fasting blood glucose (FBG) was the least common (1%). Lowering the FBG cut point from 110 to 100 mg/dl increased the percentage of subjects who met this standard from 1 to 7.6%, and lowering waist circumference cut point from the 90th percentile to the 75th percentile for sex and age increased the proportion of subjects who met this standard from 10.3 to 27.3%.

The logistic regression of metabolic risks on metabolic syndrome incidence (positive versus negative) was significant (likelihood ratio $\chi^2 = 70.64$, $P = 0.0001$). When BMI and waist circumference were put in logistic regression, we found strong a association of

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Received 7 January 2010 and accepted 25 May 2010. Published ahead of print at http://care.diabetesjournals.org on 2 June 2010. DOI: 10.2337/dc09-0023.

Table 1—*Baseline and follow-up prevalence, incidence, and instability of metabolic syndrome in adolescents: the TLGS*

	Prevalence (95% CI) (baseline)		Instability (95% CI)*		Incidence (95% CI)†		Follow-up prevalence (95% CI)	
Definition	Total	Baseline overweight	Total	Baseline overweight	Total	Baseline overweight	Total	Baseline overweight
Pediatric AHA	4.1 (2.8–5)	34.2 (19–49)	2.6 (1.5–3)	15.8 (4–27)	8.3 (6–10)	48 (53–96)	9.4 (7–11)	50 (34–65)
Pediatric ATP III	7.4 (5.7–9)	57.9 (42–73)	5.6 (4–7)	36.8 (21–52)	5.2 (3–6)	44 (19–68)	6.7 (5–8)	32 (16–46)
Pediatric NHANES III	13.6 (11–15)	63.2 (47–78)	7.8 (6–9)	31.6 (16–46)	8.8 (6–10)	50 (19–68)	13.4 (11–15)	50 (34–65)
Pediatric IDF	3.5 (2.3–4.7)	34.2 (19–49)	2 (1–2)	21.1 (8–34)	6.8 (5–8)	36 (31–80)	8 (6–9)	37 (21–52)

*Instability was defined as the percentage of baseline metabolic syndrome–positive adolescents who were metabolic syndrome–negative at follow-up. †Incidence was defined as the proportion of new cases from those adolescents who had been metabolic syndrome–negative at baseline.

these variables with metabolic syndrome incidence. Overweight adolescents were 5.69 times as likely to develop metabolic syndrome (95% CI 2.31–13.96). Subjects with waist circumference more than the 90th percentile for age and sex had 2.24 times more chance to develop metabolic syndrome (95% CI 1.01–4.97). On logistic regression, no significant association was seen between FBG, triglycerides, HDL cholesterol, blood pressure, and age with metabolic syndrome incidence.

CONCLUSIONS — Findings from this study show that prevalence of metabolic syndrome in Tehranian adolescents has changed at follow-up, according to all definitions except for the NHANES definition.

The metabolic syndrome phenotype was most common in overweight adolescents, with a prevalence of 57.9% compared with 29.2% of adolescents at risk for overweight and only 2.4% of normal weight. The difference in metabolic syndrome among overweight subjects was noticeable and shows the importance of overweight on the prevalence of metabolic syndrome. In addition, adolescents who were overweight were 5.69 times as likely to develop metabolic syndrome. This can indicate that metabolic syndrome is greatly confined to overweight adolescents.

The most common metabolic risks in our subjects were high triglyceride and low HDL cholesterol levels. These findings are in accordance with several previous studies conducted among children and adults in our area (10). The high prevalence of the metabolic syndrome and high triglyceride levels in Iran and other Asian countries (10,11) strengthens the hypothetical ethnic predisposition toward this type of dyslipidemia among Asians (12). Diets with high *trans*-unsaturated fat could lower HDL cholesterol levels, increase triglyceride levels, and impede metabolism of fatty acids. Kelishadi et al. (13) indicated that the poor quality of the consumed fat, being rich in saturated and *trans*-fatty acids, correlated with the high prevalence of dyslipidemia among adolescents in Iran. In addition, they found that the risk of the metabolic syndrome among children and adolescents rose with the consumption of solid hydrogenated fat and white-flour bread (14). These findings potentiate the speculation that some food habits may play a role in metabolic syndrome development.

The high glucose level was the least common metabolic risk according to ATP III criteria. This finding supports a change in the thought of the metabolic syndrome from that of a single entity causally associated with insulin resistance to one in which the syndrome depicts several distinct but intercorrelated entities (12). Nevertheless, when we lowered FBG cut point from 110 to 100 mg/dl, the proportion of subjects who met this amount increased to 7.6%. This shift has also been reported in the Duncan Study (15). These results call into question of the utility of the FBG cut points in pediatric definitions of metabolic syndrome.

Our findings show that prevalence and incidence of metabolic syndrome, as a major risk factor for chronic diseases, is high in Tehranian adolescents. Prevalence and incidence of metabolic syndrome increased with the severity of obesity and reached to nearly 60% in overweight adolescents. We conclude that health professionals and policy makers should concentrate on primary prevention of childhood obesity and the metabolic syndrome, especially in developing countries in nutrition transition, which are facing an epidemic of chronic diseases in the near future.

Acknowledgments— This study was supported by the Endocrine Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University.

No potential conflicts of interest relevant to this article were reported.

M.A.A. and M.R. analyzed data and wrote the manuscript. S.Z.-A., N.S., M.A., and F.H. contributed to implementation and analysis of data. F.A. designed, supervised, and analyzed study and wrote the manuscript.

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