Incidence and trend of a metabolic syndrome phenotype among Tehranian adolescents; Finding from TLGS 1998-2001 to 2003-2006

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**Objective:** To assess the incidence and trend of the metabolic syndrome (MetS) phenotype in adolescents of Tehran Lipid and Glucose Study (TLGS) during 3.6 years of follow up.

**Study 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 MetS in baseline and after 3.6 years was: ATP III 7.4 and 6.7%, IDF 3.5 and 8.0%, AHA 4.1 and 9.4%, and NHANES 13.6 and 13.4%, respectively. Incidence rates included: ATP III 5.2% (95% CI 3-6), IDF 6.8% (95% CI 5-8), AHA: 8.3% (95% CI 6-10), and NHANES 8.8% (95% CI 6-10).

**Conclusion:** Prevalence of MetS is increasing in Tehranian adolescences.

The metabolic syndrome (MetS), defined as a groups of risk factors, including obesity, impaired glucose metabolism, dyslipidemia, and hypertension, is associated with an 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 the MetS prevalence in adolescents of Tehran Lipid and Glucose Study (TLGS) after 3.6 years of follow up.

**RESEARCH DESIGN AND METHODS**

**Dataset and subjects:** This study was conducted within the framework of the TLGS, a prospective study performed in a representative 15005 individuals aged 3-85 years, residents of one district of Tehran (4). Adolescents aged 10–19 y 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 re-assessed 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 body mass index (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 MetS by the Third Report of the National Cholesterol Education Program (Adult Treatment Panel III [ATP III]) (6), International Diabetes Federation (IDF) (7), American Heart Association (AHA) (8), and the National Health and Nutrition Examination Survey (NHANES) (9) were used.

**RESULTS**

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

High fasting triglyceride and low HDL cholesterol were the most prevalent components according to ATP criteria (38.4% and 41.6%, respectively), whereas high FBS was the least common (1%). Lowering FBS 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 (WC) cut point from 90th percentile to 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 MetS incidence (positive versus negative) was significant (likelihood ratio: $\chi^2=70.64$, P=0.0001). When BMI and WC were put in logistic regression, we found strong association of these variables with MetS incidence. Overweight adolescents were 5.69 times as likely to develop MetS (95% CI 2.31-13.96). Subjects with WC more than 90th percentile for age and sex had 2.24 times more change to develop MetS (95% CI: 1.01-4.97). On logistic regression no significant association was seen between FBS, TG, HDL-C, blood pressure and age, with MetS incidence.

CONCLUSIONS

Findings from this study show that prevalence of MetS in Tehranian adolescents has changed at follow up according to all definitions except for NHANES definition. The MetS phenotype was most common in overweight adolescents, with a prevalence of 57.9%, compared with 29.2% of at risk for overweight and only 2.4% of normal weight. The difference in MetS among overweight subjects was noticeable and shows the importance of overweight on prevalence of MetS. In addition, adolescents who were overweight were 5.69 times as likely to develop MetS. This can indicate that MetS is greatly confined to overweight adolescents.

The most common metabolic risks in our subjects were high triglyceride and low HDL-C levels. These findings are in accordance with several previous studies conducted among children and adults in our area (10). The high prevalence of the MetS 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-C levels, increase triglyceride levels, and impede with metabolism of fatty acids; Kelishad 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 MetS 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 MetS 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 MetS from that of a single entity causally associated with insulin resistance to one in which the syndrome depicts several distinct but inter-correlated entities (12). Nevertheless, when we lowered FBS 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 Duncan study (15). These results call into question of the utility of the FBS cut points in pediatric definitions of MetS.

Our findings show that prevalence and incidence of MetS, as a major risk factor for chronic diseases, is high in Tehranian adolescents. Prevalence and incidence of MetS 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.

Authors Contributions: M.A. Afkhami and M. Rashidi analysed data and wrote the manuscript. S. Zahedi-Asl, N. Saadati, M. Atifah and F. Hosseinpanah contributed in implementation and analysis of data. F. Azizi designed, supervised and analysed study and wrote the manuscript.

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Competing interest: None

REFERENCES


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### Table 1- Baseline and follow up prevalence, incidence and instability of metabolic syndrome in adolescents: Tehran Lipid and Glucose Study

<table>
<thead>
<tr>
<th>Definition</th>
<th>Prevalence (Baseline)*</th>
<th>Instability**</th>
<th>Incidence***</th>
<th>Follow-up prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Baseline overweight</td>
<td>Total</td>
<td>Baseline overweight</td>
</tr>
<tr>
<td>Pediatric AHA</td>
<td>4.1 (2.8-5)*</td>
<td>34.2 (19-49)</td>
<td>2.6 (1.5-3)</td>
<td>15.8 (4-27)</td>
</tr>
<tr>
<td>Pediatric ATP III</td>
<td>7.4 (5.7-9)</td>
<td>57.9 (42-73)</td>
<td>5.6 (4-7)</td>
<td>36.8 (21-52)</td>
</tr>
<tr>
<td>Pediatric NHANES III</td>
<td>13.6 (11-15)</td>
<td>63.2 (47-78)</td>
<td>7.8 (6-9)</td>
<td>31.6 (16-46)</td>
</tr>
<tr>
<td>Pediatric IDF</td>
<td>3.5 (2.3-4.7)</td>
<td>34.2 (19-49)</td>
<td>2 (1-2)</td>
<td>21.1 (8-34)</td>
</tr>
</tbody>
</table>

* Numbers in parenthesis denote confidence interval

** Instability was defined as the percentage of baseline MetS-positive adolescents who were MetS-negative at follow-up.

*** Incidence was defined as the proportion of new cases from those adolescents who had been MetS-negative at baseline