*Brief Report*

# Prevalence of Metabolic Syndrome in Urban Colombian Adolescents Aged 10–16 Years Using Three Different Pediatric Definitions

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## Summary

**The aim of this study was to evaluate the metabolic syndrome (MetS) prevalence in adolescents using three different definitions for this age group. The evaluated sample consisted of 718 male and 743 female adolescents. Definitions by Cook *et al.*, de Ferranti *et al.* and International Diabetes Federation (IDF) for adolescents were used to estimate the prevalence of MetS. The prevalence of MetS was 8.5, 2.5 and 1.2% by de Ferranti *et al.*, Cook *et al.* and IDF definitions, respectively. High fasting glucose component had the lower prevalence whereas high triglycerides levels component was the most prevalent. In obese adolescents, the prevalence of MetS was higher. MetS classification in adolescents strongly depends on the definition chosen. Further research is required for the evaluation of the current definitions (multicentric studies), and for addition or design of new and useful criteria.**

**Key words: adolescents, metabolic syndrome, obesity, cardiovascular disease.**

## Introduction

There are several proposed definitions for metabolic syndrome (MetS) in adult stage (WHO, IDF, NCEP ATP-III, among the others), with different thresholds for its components [1, 2]. However, there are concerns regarding this approach because cardiovascular disease (CVD) is a multifactorial condition reflecting a pathologic process that could begin in childhood [3]. Currently, there is no gold standard definition for MetS in children and adolescents; however, the description of prevalence of MetS according to few proposed pediatric definitions is necessary in different populations around the world. The objective of this study was to assess the prevalence of MetS in adolescents aged 10–16 years from southwestern Colombia using three different definitions for this age group.

## Funding

This research was supported by the Colombian Department for Development of Science and Technology (COLCIENCIAS).

## Materials and Methods

*Subjects*

The sample ($n = 1.461$) consisted of 718 male and 743 female adolescents aged 10–16 years from a cross-sectional population survey, the *IFRECNTEC Study* (identification of risk factors for adult noncommunicable chronic disease in schooled population) [4]. Study information sheets were provided to participants and informed written consent was obtained from both the parent and the child. The study was reviewed and approved by the Universidad del Valle Ethics Committee.

*Metabolic syndrome*

MetS was estimated according to the definitions by Cook *et al.* [5], de Ferranti *et al.* [6] and IDF [7], which use age-adjusted cut-off points [8, 9]. These three definitions are described in Table 1.



doi:10.1093/tropej/fms054 Advance Access published on 26 October 2012

TABLE 1
*Proposed definitions for metabolic syndrome and its components in pediatric populations*

| Components | Cook *et al.* | de Ferranti *et al.* | IDF consensus |
|---|---|---|---|
| Abdominal obesity (waist circumference) | ≥90th percentile (age and sex specific)[a] | >75th percentile (age and sex specific)[a] | ≥ 90th percentile (age and sex specific)[a] |
| High fasting glucose levels | ≥110 mg/dl (6.1 mmol/l) | ≥110 mg/dl (6.1 mmol/l) | ≥100 mg/dl (5.6 mmol/l) |
| High triglyceride levels | ≥110 mg/dl (1.24 mmol/l) | ≥100 mg/dl (1.1 mmol/l) | ≥150 mg/dl (1.7 mmol/l) |
| Low HDL-C levels | ≤40 mg/dl (1.03 mmol/l) | <50 mg/dl (1.3 mmol/l) for <14 years old, <45 mg/dl (1.17 mmol/l) for >15 years old | <40 mg/dl (1.03 mmol/l) |
| High blood pressure | SBP and/or DBP ≥ 90th percentile (age, height and sex specific)[b] | SBP and/or DBP > 90th percentile (age, height and sex specific)[b] | SBP ≥ 130 or DBP ≥ 85 mmHg |
| MetS definition | Three or more of the previous criteria | Three or more of the previous criteria | Abdominal obesity and two or more of the previous criteria |

[a]According to IFRECNTEC percentile table [10].
[b]According to the National Heart, Lung and Blood Institute (NHLBI) percentile table [11].
SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; MetS, metabolic syndrome.

TABLE 2
*Description of the Colombian adolescents according to metabolic syndrome definitions*

| | *n* | %(CI95%) of subjects with metabolic syndrome | | |
|---|---|---|---|---|
| | | Cook *et al.* definition | de Ferranti *et al.* definition | IDF definition |
| Total | 1461 | 2.5 (1.7–3.3) | 8.5 (7.0–9.9) | 1.2 (0.6–1.7) |
| Gender | | | | |
| Male | 718 | 2.9 (1.6–4.1) | 7.9 (5.9–9.9) | 1.0 (0.3–1.7) |
| Female | 743 | 2.2 (1.1–3.1) | 9.0 (6.9–11) | 1.3 (0.5–2.2) |
| *P*-value | | 0.350 | 0.460 | 0.510 |
| Age | | | | |
| <12 years old | 317 | 2.2 (0.5–3.8) | 8.5 (5.0–11.6)[b] | 0.6 (0.0–1.5) |
| 12–15 years old | 713 | 3.4 (2.0–4.7)[a] | 11.2 (8.9–13.5)[a] | 1.8 (0.0–2.8)[a] |
| > 15 years old | 431 | 1.4 (0.2–2.5)[a] | 3.9 (2.1–5.8)[a,b] | 0.4 (0.0–1.1)[a] |
| *P*-value | | *0.034* | *<0.05* | *0.035* |
| Socioeconomic status | | | | |
| Low | 682 | 2.0 (0.9–3.2) | 8.0 (6.0–10.1) | 0.5 (0.0–1.1) |
| Middle | 407 | 2.9 (0.3–4.6) | 9.5 (6.7–12.4) | 2.0 (0.0–3.3) |
| High | 372 | 3.0 (1.2–4.7) | 8.1 (5.0–10.8) | 1.3 (0.0–2.5) |
| *P*-value | | 0.547 | 0.653 | 0.111 |
| Obesity (BMI percentile) | | | | |
| No (<95th) | 1358 | 1.2 (0.6–1.8) | 6.0 (4.7–7.2) | 0.3 (0.0–0.7) |
| Yes (≥95th) | 103 | 20.4 (12.6–28.2) | 41.7 (32.2–51.3) | 11.7 (5.4–17.9) |
| *P*-value | | *<0.001* | *<0.001* | *<0.001* |

[a,b]Significant difference between groups with same letter.
BMI, body mass index.

*Biochemical and clinical variables*

Blood was collected via venipuncture following an overnight fast. Fasting glucose, high-density lipoprotein cholesterol (HDL-C) and triglycerides were determined using commercial kits (Biosystems Inc., Spain) in an automatic Biosystems analyzer (Biosystems Inc., Spain). Waist circumference (WC) and blood pressure measurements were made by

Table 3
*Prevalence*[a] *of metabolic syndrome and its components by gender and obesity condition (n = 1461) in Colombian adolescents*

| | Total | Gender | | | Obesity | | |
|---|---|---|---|---|---|---|---|
| | | Male | Female | *P*-value | No | Yes | *P*-value |
| WC percentile | | | | | | | |
| >75th | 22.2 (20.0–24.3) | 21.7 (18.7–24.7) | 22.6 (19.6–25.6) | 0.684 | 16.5 (14.6–18.5) | 96.1 (92.4–99.9) | <0.001 |
| ≥90th | 8.8 (7.3–10.2) | 8.6 (6.6–10.7) | 8.9 (6.8–10.9) | 0.867 | 3.9 (2.9–4.9) | 72.8 (64.1–81.5) | <0.001 |
| High fasting glucose levels | | | | | | | |
| ≥5.6 mmol/l | 4.5 (3.4–5.5) | 6.0 (4.3–7.7) | 3.0 (1.7–4.2) | 0.006 | 4.4 (3.3–5.5) | 4.9 (0.7–9.0) | 0.836 |
| ≥6.1 mmol/l | 0.7 (0.3–1.1) | 0.8 (0.0–1.5) | 0.5 (0.0–1.1) | 0.494 | 0.7 (0.2–1.2) | 0.0 (0.0–0.0) | ____[b] |
| High triglyceride levels | | | | | | | |
| ≥1.1 mmol/l | 27.5 (25.2–29.8) | 23.1 (20–26.2) | 31.8 (28.4–35.1) | <0.001 | 26 (23.7–28.3) | 47.6 (37.9–57.3) | <0.001 |
| ≥1.24 mmol/l | 20.3 (18.3–22.4) | 17.5 (14.8–20.3) | 23.0 (20.0–26.0) | 0.010 | 19.2 (17.1–21.3) | 35.0 (25.7–44.2) | <0.001 |
| ≥1.7 mmol/l | 6.9 (5.6–8.2) | 4.9 (3.3–6.5) | 8.9 (6.8–10.9) | 0.003 | 6.1 (4.8–7.4) | 17.5 (10.1–24.9) | <0.001 |
| Low HDL-C levels | | | | | | | |
| ≤1.03 mg/dl | 29.6 (27.2–31.9) | 29.2 (25.9–32.6) | 29.8 (26.6–33.2) | 0.792 | 28.4 (26.0–30.8) | 44.7 (35.0–54.3) | 0.001 |
| <1.03 mg/dl | 26.8 (24.6–29.1) | 26.6 (23.4–29.8) | 27.1 (23.9–30.3) | 0.846 | 25.6 (23.3–28.0) | 45.7 (33.1–52.3) | <0.001 |
| Ferranti *et al.* cut points | 54.6 (52.0–57.1) | 55.3 (51.7–58.9) | 53.8 (50.2–57.4) | 0.576 | 53.4 (50.7–56.0) | 69.9 (61.0–78.8) | <0.001 |
| High blood pressure | | | | | | | |
| ≥90th | 8.6 (7.1–10) | 13.5 (11.0–16.0) | 3.8 (2.4–5.1) | <0.001 | 7.6 (6.2–9.1) | 20.4 (12.6–28.2) | <0.001 |
| >90th | 6.0 (4.7–7.2) | 8.4 (6.3–10.4) | 3.6 (2.3–5.0) | <0.001 | 5.1 (3.9–6.3) | 17.4 (1.0–2.5) | <0.001 |
| IDF cut points | 3.6 (2.6–3.5) | 5.6 (3.9–7.3) | 1.6 (0.7–2.5) | <0.001 | 2.9 (2.0–3.8) | 11.7 (5.4–17.9) | <0.001 |

[a]% (confidence interval 95%).
[b]Without report because no case was observed as glucose ≥110 mg/dl.
WC, waist circumference; HDL-C, high-density lipoprotein cholesterol.

trained investigators using standard techniques and instruments.

*Statistical analysis*

Analyses were performed in the total group and by gender, socioeconomic status, age groups and obesity status. Obesity condition and WC were evaluated using percentile data from a sub-analysis of *IFRECNTEC Study* [10] High Blood pressure component was estimated according to the National Heart, Lung and Blood Institute (NHLBI) percentile data [11]. The group differences were estimated by $\chi^2$. Statistics were computed using STATA 8.0.

## Results

Table 2 describes the study population in terms of demographic variables and prevalence of MetS. The highest prevalence was recorded using the de Ferranti *et al*. criteria, in particular, between 3.5 and 7 times the prevalence estimated by Cook *et al*. and IDF criteria. There were no differences in the prevalence of MetS when stratified by gender and socioeconomic status. In contrast, by age groups, there was a higher prevalence of MetS in the 12–15-years group, when compared with the group over 15 years. Using the definition of de Ferranti *et al*., even the group under 12 years presented higher prevalence of MetS than the older group. However these differences were not maintained after adjustment by obesity condition (data not shown). In obese adolescents, the prevalence of MetS ranged from 7-folds (de Ferranti *et al*.) to 39-folds (IDF) higher than that of non-obese subjects.

With the exception of the prevalence of subjects with glucose level $\geq$5.6 mmol/l, specific cut-off points for MetS components in IDF definition were those with lower prevalence (Table 3). WC >75th percentile (criteria of Ferranti *et al*.) and high levels of triglycerides and low HDL-C (Cook *et al*. and Ferranti *et al*. criteria) were the most prevalent components of MetS. Based on gender, in boys, the prevalence of high blood pressure (according to all three definitions) and fasting glucose levels $\geq$100 mg/dl (IDF definition) were significantly higher, whereas high triglycerides levels were more prevalent in girls. Moreover, obese adolescents had higher prevalence rates in all components by different cut-off points, except high fasting glucose (HFG).

## Discussion

On comparing our prevalence of MetS according to the definitions by Cook *et al*. and de Ferranti *et al*. with that in the original studies, our prevalence was lower than that reported in the study by Cook *et al*. (2.5% vs. 4.2%), and almost comparable with that presented in the study by de Ferranti *et al*. (8.5% vs. 9.2%). Two studies that used IDF definition in Asian populations reported higher prevalence than that found in our study (Liu *et al*.—3.0% [12] and Nguyen *et al*.—4.6% [13]), and high blood pressure was the most common component in both studies. Our results are in agreement with those reported by Cook *et al*. and de Ferranti *et al*. with regard to high levels of triglycerides and low HDL-C as the most prevalent MetS components, and all the above-mentioned studies with regard to HFG as the least prevalent.

As has been described in other studies [14, 15], obesity condition is an important determinant of MetS and its components. However, with regard to the HFG component, there was no difference based on obesity condition, and the prevalence of this component was low in obese adolescents. This observation is related to the finding of low prevalence of HFG in Italian obese adolescents reported by Grandone *et al*. [16]. In our adolescents group, it seems that HFG could be a late component in the MetS course.

To our knowledge, this study represents the first evaluation of MetS prevalence in a general population of Latin-American adolescents using three different definitions for this age group. However, previously, Rodríguez-Morán developed a research in Mexican children, comparing the cardiovascular markers and cardio-metabolic disease family history of subjects with MetS, according to four MetS definitions for adults. The authors included a suggested definition for adolescents based on family history, BMI, birth weight and biochemical components [17].

The information of the *IFRECNTEC* survey lacked data of pubertal changes and ethnicity, and therefore these variables were not in this analysis.

Primordial prevention of CVD should start in the pediatric years. Further research is required for the evaluation of the current definitions (multicentric studies), addition or design of new and useful criteria, and, importantly, analysis of the predictive capabilities of the pediatric MetS definitions for cardio-metabolic diseases during adult life periods.

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