Diagnostic Methods of Metabolic Syndrome in Children

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Abstract- We aimed to define Metabolic Syndrome (METs) from different viewpoints to determine the most appropriate method that could be used for early METs’ diagnosis in general population and treat them immediately. This study was an analytic cross-sectional study which was conducted on 725, twelve year-old-girls and boys from Rasht city in Iran. METs was defined based on 7 different methods. Data were reported by descriptive statistics (number, percent, mean, and standard deviation) and analyzed by Cohen's kappa coefficient correlation and chi-square in SPSS version 19. The highest and lowest percentages of METs were obtained by DE Ferranti (17.5%) and viner et al., (0.8%) methods, respectively. Results showed that viner et al., had the highest degree of agreement with NCEP ATPIII and the lowest with DE Ferranti. Furthermore, De Ferranti showed the highest degree of agreement with NHANESIII and the lowest with Viner et al., According to results, the identification of the cut off points of obesity could help to promote public health care.

Keywords: Metabolic syndrome; Obesity; Child

Introduction

Metabolic syndrome (METs) has different complications such as cardiovascular diseases and diabetes type 2 (1,2). These complications commonly occur by the insulin resistance caused by increasing central obesity or general obesity and overweight (3). So, early diagnosis of metabolic syndrome in children is important.

Recently, the prevalence of obesity has an increasing trend in childhood and adolescent and this issue is one of the most harbinger of health in the world (4).

There are different physical characteristics in children and adults. For example, the United States national cholesterol education designed a method for METs in adults. This method defined METs based on waist circumference(WC) >102 centimeter in males and >88 cm in females (5). These numbers could not be used for children because of their different growth speed in different ages, and this leads to introduce many different methods for diagnosis of METs in pediatrics.

Cook et al., used WC ≥90th percentile for children and did not categorize HDL based on age (6). NCEP used cook method and selected WC >90th percentile instead of ≥90th percentile (7).

Moreover, modified NCEP ATP3 has been proposed new guideline based on abdominal obesity in boys and girls which indicated abdominal obesity ≥90 cm in men and ≥80 cm in females and triglyceride ≥150 mg/dl, HDL ≤40 and 50 in males and females respectively, and Systolic BP ≥130 mmHg or diastolic BP ≥85 mmHg (8).

Subsequently, De Ferranti (9), IDF (10), NHANES (11), and Viner (12) determined METs based on WC, TG, FBS, blood pressure, and HDL.

As it was informed, there is no uniform definition for METs. In this study, we aimed to define METs from different viewpoints to determine the most appropriate method that could be used for early METs diagnosis in general population and treat them immediately.

Materials and Methods

This study was an analytic cross-sectional study which was conducted on 725, twelve year-old-girls and boys from Rasht city in Iran. Data were collected by a checklist consisting of demographic characteristics, past
Diagnostic method of METs

medical history in students, clinical examination including the measurement of height (based on centimeter), weight (based on kilogram), body mass index (BMI, based on percentile), WC and laboratory tests (FBS, BS, Cholesterol, TG, LDL, and HDL) by venous sampling in fasting state of 10 hours.

Investigators used similar calibrated tools in all centers. Height and weight were measured by Seca stadiometer and scale, respectively. BMI was calculated by dividing weight (kg) to height (m²). According to BMI, participants were divided into normal (5-85th percentile), overweight (85-95th percentile) and obese groups (≥ 95th percentile).

Ethical approval was obtained from Ethics committee of Guilan University of Medical Sciences and informed consent letters were obtained from parents. All participants were referred to the referral lab in Rasht. The lab had quality accreditation of laboratory department of Ministry of health.

METs was defined based on different methods as shown in table 1.

| Table 1. METs diagnostic methods |
|----------------------------------|
| 1) Cook et al                     |
| 3 or more criteria               |
| 1. FBS≥110                       |
| 2. WC≥90th percentile            |
| 3. TG≥110 mg/dl                  |
| 4. HDL≤40                        |
| 5. BP≥90th percentile            |
| 2) De Ferranti                   |
| 3 or more criteria               |
| 1. FBS≥110                       |
| 2. WC>75th percentile            |
| 3. TG≥100                        |
| 4. HDL≤50                        |
| 5. BP>90th percentile            |
| 3) IDF                           |
| Central obesity + 2 other criteria |
| 1. WC≥75th percentile            |
| 2. TG≥150                        |
| 3. HDL≤40                        |
| 4. SBP>130 or DBP≥85             |
| 5. FBS≥100                       |
| 4) NHANES III                    |
| 3 or more criteria               |
| 1. Abdominal obesity (abdominal obesity≥ 90 cm in men and ≥ 80 cm in females) |
| 2. TG≥150 mg/dl                  |
| 3. HDL≤40 in male HLD≤50 in female | |
| 4. SBP>130 mmHg or DBP≥85 mmHg   |
| 5. FBS≥110                       |
| 5) Modified NCEPATP III          |
| 3 from 5 criteria                |
| 1. WC≥90th percentile            |
| 2. SBP or DBP>90th percentile     |
| 3. TG≥100                        |
| 4. HDL≤40                        |
| 5. FBS≥110 mg/dL                 |
| 6) NCEP APPIII                   |
| More than 3 criteria             |
| 1. HDL≥50 in female              |
| 2. SBP or DBP>90th percentile     |
| 3. WC≥95th percentile            |
| 4. LDL≤20 or HDL≤35 mg/dL        |
| 7) viner et al                   |
| 3 or more criteria               |
| 1. BMI≥95th percentile           |
| 2. SBP>95th percentile           |
| 3. TG≥150 mg/dL or HDL≤35 mg/dL  |
| 4. Impaired Fasting Glucose      |
| FBS≥110 mg/dL                   |

Data were reported by descriptive statistics (number, percent, mean, and standard deviation) and analyzed by Cohen’s kappa coefficient correlation and chi-square in SPSS version 19.

Results

In this study, 725 students included 247 (34.1 %) female and 478 (65%) male. Results showed that 85.1% were normal weight, 4.83% overweight, and 10.7% obese.

The highest and lowest percentages of METs were obtained by DE Ferranti (17.5%) and viner et al (0.8%) methods, respectively (Table 2).

Result showed that viner et al., had the highest degree
of agreement with NCEP ATPIII and the lowest with De Ferranti. Furthermore, De Ferranti showed the highest degree of agreement with NHANESIII and the lowest with Viner et al., (Table 3).

There was a significant relation between the prevalence of METs and obesity by all methods (P<0.0001). Although, NHANES III and De Ferranti methods mentioned higher prevalence of METs in obese and overweight adolescents (Table 4).

| Method        | 95% upper confidence interval | 95% lower confidence interval | Count | Percent |
|---------------|-----------------------------|-----------------------------|-------|---------|
|                |                             |                            |       |         |
| Viner et al.   |                             |                            |       |         |
| Without metabolic syndrome | 99.2% | 98.3% | 719      |
| With metabolic syndrome | 0.8% | 0.3% | 6        |
| Total          | 100.0%                      | -                           | 725    |
| Without metabolic syndrome | 95.7% | 94.1% | 694      |
| IDF           |                             |                            |       |         |
| Without metabolic syndrome | 4.3% | 3.0% | 31       |
| With metabolic syndrome | -  | - | 725      |
| Total          | 100.0%                      | -                           | 725    |
| Cook et al.    |                             |                            |       |         |
| Without metabolic syndrome | 6.9% | 5.2% | 50       |
| With metabolic syndrome | -  | - | 725      |
| Total          | 100.0%                      | -                           | 725    |
| de Ferranti    |                             |                            |       |         |
| Without metabolic syndrome | 82.5% | 79.6% | 598      |
| With metabolic syndrome | 17.5% | 14.9% | 127      |
| Total          | 100.0%                      | -                           | 725    |
| NHANESIII      |                             |                            |       |         |
| Without metabolic syndrome | 14.8% | 12.3% | 107      |
| With metabolic syndrome | -  | - | 725      |
| Total          | 100.0%                      | -                           | 725    |
| Modified NCEP ATPIII |                             |                            |       |         |
| Without metabolic syndrome | 8.0% | 6.2% | 58       |
| With metabolic syndrome | -  | - | 725      |
| Total          | 100.0%                      | -                           | 725    |
| NCEP ATPIII    |                             |                            |       |         |
| Without metabolic syndrome | 2.1% | 1.2% | 15       |
| With metabolic syndrome | -  | - | 725      |
| Total          | 100.0%                      | -                           | 725    |
### Table 3. Degree of agreement between different methods

| Method          | Viner Et al | IDF | Cook et al | DE Ferranti | NHANESIII | Modified NCEP ATP II | NCEP ATP II |
|-----------------|-------------|-----|------------|-------------|-----------|----------------------|------------|
| Kappa           | 0.218       | 0.379 | 0.492      | 0.599       | 0.898     | 0.585                | 0.733      |
| Agreement       | 86%         | 84%  | 91%        | 90%         | 97%       | 96%                  | 95%        |

### Table 4. Comparing Body mass index in different methods for metabolic syndrome diagnosis

| Method          | Body mass index |
|-----------------|-----------------|
|                 | Normal weight (5th-85th percentile) | Over Weight (85th percentile) | Obesity (≥ 95th percentile) |
|                 | Count | Column N | Count | Column N | Count | Column N | P     |
| Without metabolic syndrome | 617   | 100.0%    | 73    | 100.0%   | 29    | 82.9%    | 0.0001 |
| With metabolic syndrome |       |           |       |          |       |          |       |
| Total           | 617   | 100.0%    | 73    | 100.0%   | 35    | 100.0%   |       |
| Without metabolic syndrome | 613   | 99.4%     | 58    | 75.9%    | 23    | 65.7%    | 0.0001 |

### Diagnostic method of METs

- **Viner et al.**
- **IDF**
- **Cook et al.**
- **DE Ferranti**
- **NHANESIII**
- **Modified NCEP ATP II**
- **NCEP ATP II**

**Table 3. Degree of agreement between different methods**

- **Kappa** and **Agreement** values are provided for each method.

**Table 4. Comparing Body mass index in different methods for metabolic syndrome diagnosis**

- **Count** and **Column %** values are given for each category.

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Continuance of Table 4

|                          | With metabolic syndrome | Total | Without metabolic syndrome | Total | Without metabolic syndrome | Total | Significance |
|--------------------------|-------------------------|-------|----------------------------|-------|---------------------------|-------|--------------|
| NHANESIII                |                         |       |                            |       |                           |       |              |
| With metabolic syndrome  | 59                      | 9.6%  | 48                         | 65.8% | 20                        | 57.1% |              |
| Total                    | 617                     | 100.0%| 73                         | 100.0%| 35                        | 100.0%|              |
| Without metabolic syndrome|                         | 571   | 92.5%                      | 42.5% | 16                        | 45.7% | 0.0001       |
| NHANESIII                |                         |       |                            |       |                           |       |              |
| Modified NCEP ATPIII     |                         |       |                            |       |                           |       |              |
| With metabolic syndrome  | 46                      | 7.5%  | 42                         | 57.5% | 19                        | 54.3% |              |
| Total                    | 617                     | 100.0%| 73                         | 100.0%| 35                        | 100.0%|              |
| Without metabolic syndrome|                         | 595   | 96.4%                      | 68.5% | 22                        | 62.9% | 0.0001       |
| NCEP ATPIII              |                         |       |                            |       |                           |       |              |
| With metabolic syndrome  | 22                      | 3.6%  | 23                         | 31.5% | 13                        | 37.1% |              |
| Total                    | 617                     | 100.0%| 73                         | 100.0%| 35                        | 100.0%|              |
| Without metabolic syndrome|                         | 617   | 100.0%                     | 89.0% | 28                        | 80.0% | 0.0001       |
| Total                    | 617                     | 100.0%| 73                         | 100.0%| 35                        | 100.0%|              |

Discussion

Atherosclerosis and coronary heart diseases in adulthood are common and lethal. This process begins early in childhood (13). The presence of identifiable risk factors such as obesity, hypertension, and diabetes mellitus can accelerate this process (14, 15). So, trying to detect risk factors of Atherosclerosis in primary school children is important (16). In this study, the prevalence of obesity and overweight was almost 15%. In our country such as other countries, prevalence of obesity in children was increased and more effort should be done on the reduction of BMI and obesity (17-19). BMI does not measure body fat directly, but can be considered as an alternative way to show obesity (20).

Waist circumference is used as a common parameter for diagnosing METsand this shows its importance. It is believed that WC and not BMI could relate with obesity induced complications. Furthermore, Dysrated et al., mentioned a high negative correlation between WC and cardiorespiratory 95 fitness in men (r= -0.68) and a moderate correlation in women (21).

American diabetes association (ADA) recently suggested that control and screening of possible risk factors that starts in childhood can help to identify and decrease risks of heart diseases. So, it seems that not only measuring BMI, but also WC can help clinicians for early detection of diseases (22). The prevalence of METs in adolescents is very different which differs between 0.2-9.5 percent in USA and 1.4- 4.1 in Europe (based on IDF, WHO, and NCEP ATPIII) (23).

However, Ghaemi et al., reported METs prevalence 20% in Iran. In their study, participants had 2 criteria such as high TG, low HDL, hypertension or abnormal glucose tolerance test in addition to obesity (24). These results showed an increased prevalence of METs in comparison to other previous Iranian researches (25-26).

Although, in this study De Ferranti method determined the highest frequency of METs (17.5%), 9.4% of them had normal weight and this might be related to the increased WC.

To the best of our knowledge, there was a significant prevalence of METs based on BMI by all methods. According to these results, although, increased METs prevalence can be expected consequent to increased BMI, this study showed that METs in none-obese children may also be occurred and recommended that all none-obese children with high blood sugar or increased waist circumference without other components should be checked for METs.

So, for early diagnosis of METs, it seems that regular checkups for blood pressure, blood glucose and lipids in pediatric field could be helpful.

According to results, the identification of the cut off points of obesity could help to promote public health care.

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Acknowledgments

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