

Evaluation Of Sims Score As A Marker Of Metabolic Syndrome In Children With Simple Obesity

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Abstract

Background: Childhood obesity is a serious global public health concern due to its prevalence in both industrialized and developing nations. A mathematical model for evaluating adult metabolic syndrome (MetS) was published by Soldatovic et al.

Objectives: To assess the siMS score as a metabolic syndrome screening tool in children and adolescents with simple obesity.

Methods: The goal of the current study was to compare the siMS score between those with and without metabolic syndrome in 50 obese children who were seen or admitted to the nutrition unit or outpatient nutrition clinic at Assiut University Children Hospital from January 1 through December 31, 2020.

Results: The prevalence of Mets among 50 studied cases with simple obesity was 48% with a male-to-female ratio of 1:1.4. The mean siMS score was significantly higher among Mets patients compared to patients without MetS (2.87 ± 0.29 versus 3.48 ± 0.52 , $P < 0.001$) in both studied groups respectively. Among MetS patients, a significant positive correlation was observed between the siMS score and triglyceride level ($r = 0.799$, $p < 0.001$). The predictive ability of siMS for prediction of MetS by using the ROC curve analysis revealed that at a cut-off value of 3.0, the areas under the ROC curves were 87.0% with a sensitivity of 87.5% and a specificity of 73.1%.

Conclusions: siMS was a good predictor for the development of MetS among pediatric patients with simple obesity.

Keywords: siMS score, childhood obesity, metabolic syndrome.

Background

The term "metabolic syndrome" (MetS) refers to a group of cardiovascular and metabolic risk factors that include central obesity, low HDL-C levels, hypertriglyceridemia, hypertension, and hyperglycemia. Childhood metabolic abnormalities persist throughout adulthood, predisposing these people to cardiovascular disease and type 2 diabetes (1).

There is no universal agreement regarding identifying metabolic syndrome in children and adolescents. It is clear that to prevent definitive lesions, each syndrome component must be recognized as soon as possible (2).

The National Cholesterol Education Program Adult Treatment Panel III (ATP III) (3) has modified its MetS criteria for children and adolescents to include the following: central obesity (waist circumference ≥ 90 th

percentile, high systolic or diastolic blood pressure ≥ 90 % for age, sex, and height, high triglycerides (TG ≥ 110 mg/dL or ≥ 1.24 mmol/L), low high-density lipoprotein (HDL ≤ 40 mg/dL or < 1.03 mmol/L), Known type 2 diabetes mellitus (T2DM) or high fasting blood glucose (FBG ≥ 100 mg/dL or ≥ 5.6 mmol/L). For individuals to be diagnosed with MetS, at least three MetS component abnormalities must exist (3).

A simple mathematical model for assessing MetS in adult "siMS" was first introduced by Soldatovic et al. (4). In 2017, Vukovic et al. (5) developed a pediatric variant from the original siMS score called PsiMS score (pediatric siMS score). The present study aimed to evaluate the role of the siMS score in the earlier detection of MetS among children with simple obesity.

Methods

The current study was a one-year prospective cohort study carried out from the beginning of January 2020 to the end of December 2020 at Assiut University Children Hospital (AUCH), Assiut, Egypt.

The primary goal was to evaluate the role of siMS score as a screening method of MetS in children with simple obesity "simple obesity defined as the BMI is $>95^{\text{th}}$ percentile" on 50 obese children (aged 7 – 17 years old, from both sexes) who attended or admitted to the Nutrition Unit or outpatient Nutrition clinic at AUCH during the period from.

Clinical trial number: NCT04680702

Children aged less than 7 years old, obese children with underlying endocrinal disorders like Cushing's syndrome and hypothyroidism, those with syndromic obesity like (Alstrom–Hallgren syndrome, Prader–Willi syndrome, Beckwith–Wiedeman syndrome, Bardet–Biedl syndrome), children or adolescent receiving medications that could affect lipid profile as (amiodarone, high dose thiazide diuretics, β -Blockers, loop diuretics, steroid hormones/anabolic steroids, sodium-glucose co-transporter 2 (SGLT2) inhibitors, immunosuppressants, antiviral therapy, centrally acting medications as anticonvulsants, additionally those who refused to participate in the current study were also excluded.

Every case in the study underwent a thorough history-taking process, anthropometric measurements calculated using WHO growth reference charts, and laboratory tests [fasting plasma glucose levels, lipid profile, including cholesterol, high-density lipoprotein (HDL) and triglyceride levels, and low-density lipoprotein (LDL) levels].

According to the International Diabetes Federation (IDF) definition, children under the age of 16 are diagnosed with MetS when they have abdominal obesity (waist circumference $\geq 90^{\text{th}}$ percentile for age, or adult cut-off if lower), together with two or more of the other components (5):

1. Triglycerides ≥ 1.7 mmol/l,
2. HDL cholesterol < 1.03 mmol/l,

3. Systolic BP ≥ 130 mmHg or diastolic BP ≥ 85 mmHg, and

4. Fasting glucose ≥ 5.6 mmol/l.

Adolescents older than 16 years old were diagnosed with MetS when two or more of the other components were present in addition to abdominal obesity (waist circumference ≥ 94 cm in males and ≥ 80 cm in females) (5):

1. Triglycerides ≥ 1.7 mmol/l,
2. HDL cholesterol < 1.03 mmol/l in males and < 1.29 in females,
3. Systolic BP ≥ 130 mmHg or diastolic BP ≥ 85 mmHg, and
4. Fasting glucose ≥ 5.6 mmol/l.

The study adhered to the guidelines set forth by Assiut University's Ethical Committee (IRB No.1710479). All participants or caregivers of children who participated in the study provided informed written consent.

Statistical Analysis

Data were gathered, edited, coded, and entered into the IBM SPSS (Statistical Package for Social Science, version 20). The qualitative data were presented as numbers (percentage), while quantitative data were presented as mean \pm standard deviation (SD) or median (range). The categorical data was compared using the Chi-square test or Fisher exact test when the expected frequency in any cell was less than 5. The Student t-test was used to compare quantitative data, and the Mann-Whitney U test was used to compare non-normally distributed data. The correlation between different variables was done using the Pearson correlation test. The optimal cut-off values for predicting metabolic syndrome were determined using Receiver Operating Characteristic Curve (ROC) analysis. P-value set significant at a level of 0.05.

Results

The mean age of the studied cases was 10.05 ± 2.01 years and ranged from 7 years up to 16 years old; more than half of the studied cases were ≥ 10 years old. Of the fifteen studied cases, 20 (40.0%) were male, and 30 (60.0%) were female. A positive family history of obesity was observed in ten cases (20.0%). The prevalence of Mets among the studied cases was 48% with a male-to-female ratio of

1:1.4. No significant difference was observed between patients with or without MetS regarding demographic data (age, sex, and family history of obesity).

The anthropometric measurements (MAC, waist, and hip circumference) and vital signs (systolic and diastolic blood pressure) show no significant difference between both studied groups ($P > 0.05$, for all).

For laboratory data, patients who developed MetS have significantly higher FBG levels ($P = 0.001$) and triglyceride levels ($P = 0.019$) compared to patients without MetS; meanwhile, other laboratory data show no significant difference between both studied groups ($P > 0.05$, for all), as shown in Table 1.

Table 1: Patient characteristics of the studied 50 obese pediatrics with or without MetS

Variable name	Total, n=50	No MS, n=26	MS, n=24	P value
Age (years)				
- Mean \pm SD	10.05 \pm 2.01	9.82 \pm 2.31	10.15 \pm 2.08	0.599
- Range	10 – 16.0	3.2 – 13.0	7.0 – 16.0	
- < 10 years	20 (40.0)	10 (38.5)	10 (41.7)	0.817
- \geq 10 years	30 (60.0)	16 (61.5)	14 (58.3)	
Sex, n (%)				
- Male	20 (40.0)	10 (38.5)	10 (41.7)	0.817
- Female	30 (60.0)	16 (61.5)	14 (58.3)	
Family history, n (%)				
- No	40 (80.0)	22 (84.6)	18 (75.0)	0.490
- Yes	10 (20.0)	4 (15.4)	6 (25.0)	
MAC (cm)				
- Mean \pm SD	28.84 \pm 2.88	28.50 \pm 2.63	29.21 \pm 3.15	0.391
- Range	22 – 36	22 – 34	24 – 36	
WC (cm)				
- Mean \pm SD	84.42 \pm 9.74	84.50 \pm 8.52	85.42 \pm 11.02	0.493
- Range	59 – 111	59 – 100	66 – 111	
Hip circumference (cm)				
- Mean \pm SD	98.68 \pm 11.41	96.08 \pm 9.29	101.50 \pm 12.94	0.093
- Range	74 – 135	74 – 112	78 – 135	
Systolic BP (mmHg)				
- Median (range)	110 (100 – 130)	110 (100 – 120)	110 (100 – 130)	0.850
Diastolic BP (mmHg)				
- Median (range)	70 (60 – 80)	70 (60 – 80)	70 (60 – 80)	0.769
Cholesterol (mmol/l)				
- Mean \pm SD	1.72 \pm 0.40	1.62 \pm 0.31	1.84 \pm 0.47	0.054
- Range	1.1 – 2.6	1.2 – 2.3	1.1 – 2.6	
HDL (mmol/l)				
- Mean \pm SD	0.48 \pm 0.10	0.50 \pm 0.11	0.46 \pm 0.09	0.153
- Range	0.3 – 0.8	0.3 – 0.8	0.3 – 0.6	
LDL (mmol/l)				
- Mean \pm SD	0.98 \pm 0.34	0.91 \pm 0.26	1.05 \pm 0.41	0.173
- Range	0.3 – 1.7	0.4 – 1.6	0.3 – 1.7	
FBG (mmol/l)				
- Mean \pm SD	5.08 \pm 0.65	4.80 \pm 0.42	5.38 \pm 0.73	0.001
- Range	4.1 – 6.1	4.1 – 5.5	4.1 – 6.1	
Triglyceride (mmol/l)				
- Mean \pm SD	1.39 \pm 1.25	1.25 \pm 1.50	1.54 \pm 0.89	0.019
- Range	0.38 – 8.5	0.47 – 8.5	0.38 – 84.2	

MAC; mid-arm circumference; WC: waist circumference; BP: blood pressure; HDL: high-density lipoprotein; LDL: low-density lipoprotein FBG: fasting blood glucose;

Quantitative data are presented as mean ± SD or median (range); qualitative data are presented as number (percentage). *Significance defined by p < 0.05.

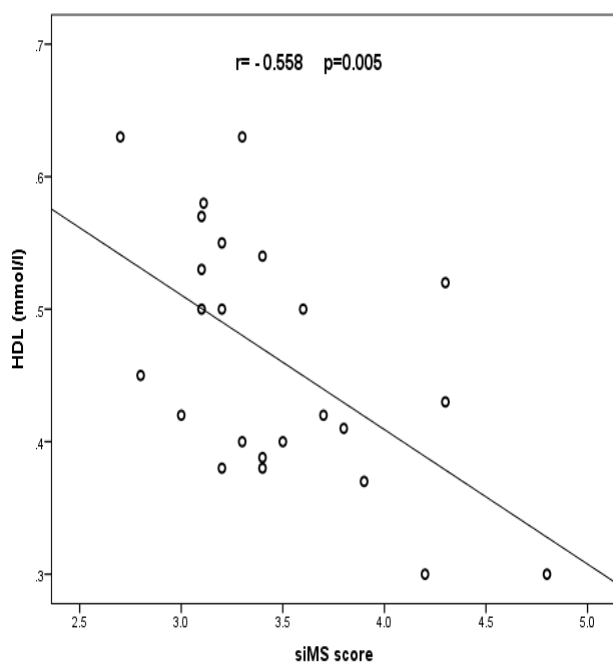
Table 2: shows that the mean siMS score was 3.16 ± 0.51, ranging from 2.4 to 4.8 among the studied participants. The mean siMS score was significantly higher among patients who developed MetS than those without MetS (2.87 ± 0.29 versus 3.48 ± 0.52, P<0.001) in both groups respectively.

Table 2 siMS between patients with and without MetS

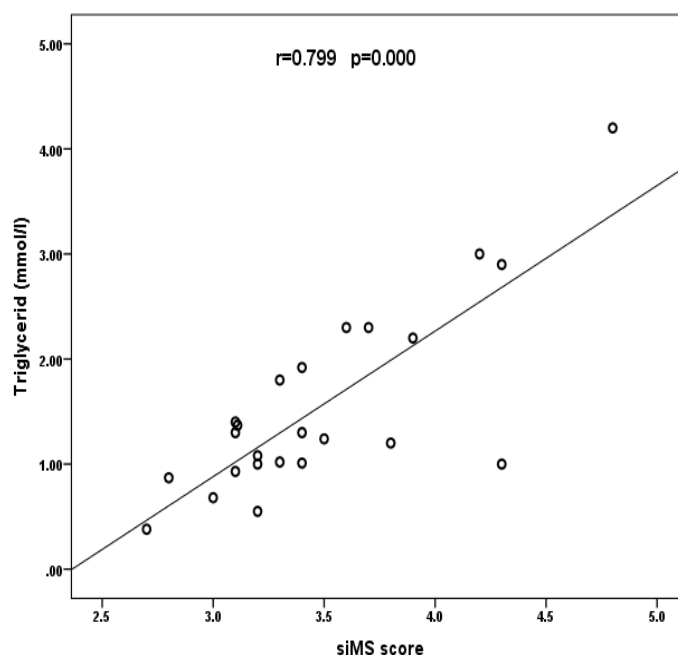
siMS score	Total, n=50	No MS, n=26	MS, n=24	P value
- Mean ± SD	3.16 ± 0.51	2.87 ± 0.29	3.48 ± 0.52	<0.001
- Range	2.4 – 4.8	2.4 – 3.5	2.7 – 4.8	

Quantitative data are presented as mean ± SD and range. *Significance defined by p < 0.05. Among patients with MetS, the siMS score shows a significant negative correlation with

HDL level (r= - 0.558, p=0.005) and a significant positive with triglyceride level (r= 0.799, p<0.001), Figure 1.



(A)



(B)

Figure 1: Scatter plot shows the correlation between A) siMS score and HDL level, B) siMS score and triglyceride level among patients with MetS

Table 3 and Figure 2 show the predictive ability of siMS for the prediction of MetS using the ROC curve analysis. At a cut-off value of 3.0, the areas under the ROC curves were 87.0% (95%CI: 0.773 – 0.968, P<0.001) with a sensitivity of 87.5% and a specificity of 73.1%.

Table 3: The best cut-off, sensitivity, and specificity for prediction of MetS disease by siMS score (n=50).

	Cut off	95%CI	Sensitivity	Specificity	AUC	P value
siMS	3.0	0.773 – 0.968	87.5%	73.1%	0.870	<0.001

AUC: Area under the curve; CI: confidence interval. *Significance defined by p < 0.05

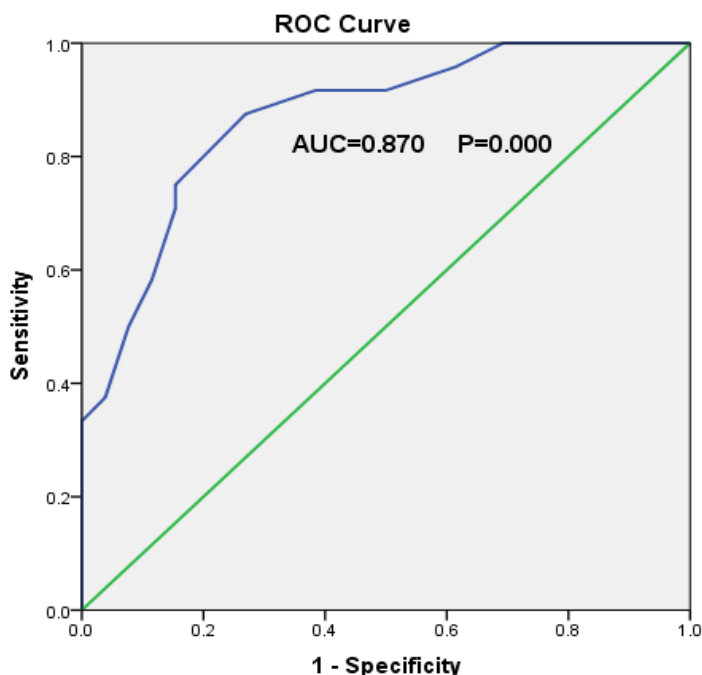


Figure 2: ROC curves for prediction of MetS among obese studied patients. siMS (blue) and reference line (green). AUC=0.870 (95%CI: 0.773 – 0.968), P value < 0.001

Discussion

Obesity in children has become more prevalent in most areas and countries (6). Childhood obesity is linked to increased risk factors and the prevalence of cardiovascular illnesses, coronary heart disease, hypertension, and diabetes in adulthood (7). Some obese children will develop metabolic syndrome (MetS), but who will be among them is unknown (8).

In the current study, the mean age of the studied cases was 10.05 ± 2.01 years and ranged from 7 years up to 16 years old; more than half of the studied cases were ≥ 10 years old. Slight female predominance was observed among the studied cases, as 40.0% were male, while 60.0% were females, with a male-to-female ratio of 1:1.5.

This finding comes in agreement with the previous study of Vukovic et al. on 153 obese children and adolescents; the mean age of the studied cases was 12.9 ± 3.2 and ranged from 4.9–18.9 years, 42.5% were males, and 57.5% were females (5).

This finding is also in line with the majority of other studies conducted in Egypt, which

showed a marked rise in female obesity rates compared to boys (9, 10). In contrast, Abou Ghazy et al. found that among 7 to 15-year-old Egyptian students living in Qalubia, obesity was higher in males than in girls (11). The varied age groups in the two studies could explain the disparities in results.

Twenty percent of people had a positive family history of obesity. This could be attributed to the family's unhealthy eating habits, which include overeating, consuming foods and beverages that are high in fat, salt, and sugar and low in fiber, eating less fresh fruits and vegetables, missing meals at the table, and participating in other family-oriented activities (12). This finding was further supported by Salem et al.'s Egyptian study, which found that obesity was considerably greater in children with a positive family history of obesity (27.3%) than in those with a negative family history (14.6%) (10).

The prevalence of MetS among the studied 50 obese children was 48%. The present finding was supported by many previous studies which reported that MetS is more

common among overweight and obese children. (13-24). MetS prevalence ranges from 10% (23) to 57.4% (17) in obese children and adolescents, and it increases with BMI (14, 16, 18, 23, 25, 26).

It is difficult to compare the prevalence of MetS in children across studies because of the numerous diverse criteria employed in its many classifications. Around 40 distinct criteria evaluate MS in children and adolescents (27, 28). According to some experts, the prevalence of MetS varies between 0 and 60% in the same cohort of children, depending on the diagnostic criteria used in research (29). The cause could be that there is no agreement in the research on cut-off points for particular components of MetS in children and adolescents (30).

No significant difference was observed between patients who developed or did not develop MetS regarding age, sex, and positive family history of obesity ($P>0.05$ for all). In line with our study, some authors did not observe an association between age and development of MetS (20, 22, 31, 32).

Although the association between MetS and ageing is well-established in adults, it is less evident in children (33). For example, Lee and colleagues discovered that children aged 10 to 18 had a lower prevalence of MetS (1.0%) than adults aged 19 to 25 (2.4%) (34). Others reported an inverse correlation (14, 35, 36). The inverse correlation in the younger group, according to Ramirez-Vélez et al., could be attributed to a higher prevalence of overweight in this group (14), as opposed to Asghari et al. asserted that it was caused by pubertal development (35). Overall, it seems that the development of pediatric MetS is more influenced by overweight and obesity than by age (33).

Also, no sex predilection was reported by previous studies (14, 22, 24, 34, 37-39). Other research, however, indicated that boys are more likely than girls to have MetS (15, 16, 20, 21, 23, 29, 40-43), also this finding is supported by two previous meta-analyses (44, 45).

The authors offer a possible explanation for this gender gap, which could be related to males having a higher prevalence of obesity

than females, as males often consume more energy due to self and family being perceived as underweight and underestimating their weight. Female teenagers, on the other hand, regulate their weight through nutrition and physical exercise as a result of self-perceived overweight (46). However, further studies are needed in this era.

In the current study, we observed that patients who developed MetS have higher fasting blood glucose levels (FBG) and triglyceride levels than patients without MetS. The majority of earlier investigations found that the most common risk factors for obese patients who had MetS were dyslipidemia (low HDL and/or high TG) (13, 15, 18, 20-23, 35, 39, 40, 42, 47). In contrast, the least frequent condition was high fasting glucose (13, 16, 19, 20, 38, 41, 48).

The present accessible definition of MetS in youth is dichotomous, resulting in information loss. Based on the International Diabetes Federation (IDF) MetS criteria for the adult population, a novel, readily available siMS score, a continuously calculable MetS score, was created (4). After that, Vukovic et al. (2017)(5) adapted the original siMS score to create the Pediatric siMS score (PsiMS), a continuous MetS score for use in obese children, and recently Huh et al. (2019) (49) proposed a clinically applicable relevant equation for constant metabolic syndrome risk monitoring in the Korean population. Our goal was to evaluate the role of the siMS score as a screening method of MetS in children and adolescents with simple obesity for earlier detection and, hence, better outcomes.

The mean siMS score was significantly higher among patients who developed MetS than those without MetS. Among patients with MetS, the siMS score showed a significant negative correlation with HDL level and a significant positive correlation with triglyceride level.

Also, the predictive ability of siMS for prediction of MetS by using the ROC curve analysis revealed that at a cut-off value of 3.0, the AUC was 87.0% (95%CI: 0.773 – 0.968, $P<0.001$) with a sensitivity of 87.5%, and a specificity of 73.1%, which meaning that

siMS was a good predictor for development of MetS among pediatric patients with simple obesity. However, further longitudinal prospective studies are needed to confirm the present finding. This will help in earlier diagnosis of MetS among pediatric patients, leading to better outcomes.

According to Vukovic et al. (2017)(5), PsiMS is a reliable and helpful test for diagnosing MetS in children and teenagers, consistent with the findings of the current investigation. Another pediatric study, "the CASPIAN-V study," compared it to other principal component analyses, confirmatory component analyses, and z-scores and discovered it was efficient in clinics and research programs (50).

A similar finding was reported by the recent comparative cross-sectional study of Khan et al. (2020)(51) on 232 subjects to evaluate the siMS score among patients with MetS and without MetS. The author reported that the

siMS score was higher in MetS cases (3.58 ± 0.725) than those without MetS (2.83 ± 0.727); the AUC for the siMS score for predicting MetS among the studied subjects was 0.866. Finally, the author concluded that the siMS score was better for diagnosing MetS.

In terms of the mathematical interpretation of the data from the many risk biomarkers included in the definition of MetS, the siMS score showed promise. Our study also demonstrated a significant area under the curve for diagnosing MetS. It proved that this mathematical scoring technique is substantially connected with several risk factors for developing MetS, such as low HDL and high triglyceride levels (AUC=87.0, $P < 0.001$).

Conclusions: The siMS scoring system is a quick, cost-effective, and readily available tool that may help predict MetS early among obese pediatric children and adolescents.

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