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Updates in Prevalence and Management of Metabolic Syndrome among Children in Saudi Arabia: A Systematic Review

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ABSTRACT

Metabolic syndrome (MetS), a set of cardiovascular risk factors, is one of the most prevalent metabolic abnormalities, which lead to many chronic conditions. This systematic review aims to detect the published literature on the prevalence of MetS among Saudi children. The Cochrane Library, Web of Science, Science Direct, EBSCO, and PubMed were all searched. Rayyan QCRI was used to screen study articles by title and abstract before full-text evaluation. Six studies were included, with a total of 1048 subjects. The prevalence of MetS among Saudi children ranged from 7% to 30%. The most commonly associated comorbidities with MetS were Type 2 diabetes mellitus (T2DM) and hypertension. According to this systematic analysis, the prevalence of MetS in various Saudi paediatric populations varied and ranged from 7% to 30%. A high prevalence of MetS was discovered in obese children, despite the fact that it was also seen in kids with normal BMI. The two related comorbidities that were most common were T2DM and hypertension. Obesity in children must be avoided in order to lower future MetS. In many different situations, screening for obesity and MetS should be a part of paediatric clinical care. By detecting the presence of MetS and taking action with specific lifestyle recommendations and regular follow-up to encourage adherence, it is anticipated that the long-term health of these children will be improved.

Keywords: *Metabolic syndrome, Obesity, Children, Saudi Arabia, Systematic review*

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INTRODUCTION

The m MetS is a set of linked risk factors with metabolic etiology that might result in atherosclerotic cardiovascular illnesses (Guembe *et al*., 2020). Increased triglycerides, a changed glucose metabolism, decreased HDL-C, increased blood pressure, and obesity is some of the typical risk factors (Saki *et al*., 2022). Insulin resistance was typically the outcome of dysregulated cellular metabolism (DeBoer, 2019). Numerous other conditions, including polycystic ovarian syndrome, hepatic steatosis, elevated uric acid levels, and obstructive sleep apnea, are also linked to MetS (Pan *et al*., 2022; Sangaraju *et al*., 2022).

MetS in children and adolescents can be diagnosed using a variety of techniques. The International Diabetes Federation (IDF) states that MetS is diagnosed in children between the ages of 10 and 16 who have central obesity (90th percentile or higher), triglycerides (TG) of 150 mg/dl or higher, HDL-C of 40 mg/dl or higher, systolic or diastolic blood pressure (BP), fasting plasma glucose (FG) of 100 mg/dl, or a history of type 2 diabetes (Aditama *et al*., 2021; Ying *et al*., 2022). According to WHO guidelines, MetS is diagnosed when three or more of the following characteristics are present: BMI > 95th percentile, hyperinsulinemia, impaired fasting glucose, or impaired glucose tolerance, BP > 95th percentile, TG > 105/136 mg/dL (1.2/1.5 mmol/L) for children > 10 years old, and HDL-C > 35 mg/dL (0.9 mmol/L) (Wu *et al*., 2022).

Significant changes in people's eating and lifestyle habits have occurred throughout the world as a result of global industrialization (Li *et al*., 2016). Increased sedentary behavior and physical inactivity were among these changes, along with increased consumption of sugary drinks and foods high in calories in densely populated areas (Ranasinghe *et al*., 2017). Because of this, type 2 diabetes mellitus (T2DM) and cardiovascular diseases (CVDs) have both steadily increased in prevalence worldwide, as has the prevalence of obesity (Ben Simon *et al*., 2022). Not just adults are affected by this phenomenon. A 10% global prevalence of obesity or overweight among school-aged children (aged 5–17) has been estimated (Elfaki *et al*., 2022).

Saudi Arabia is not exempt from the general rise in childhood obesity around the world. According to an analysis of 19,317

children and adolescents aged 5 to 18 (50.8% boys), the total prevalence of overweight, obesity, and severe obesity was, in fact, 23.1%, 9.3%, and 2%, respectively, in 2010 (Elfaki *et al*., 2022). According to statistics from 2014, the prevalence of overweight and obesity in Saudi boys (ages 6 to 13) was reported to be 7.3% and 17.4%, respectively, while it was 12.4% and 20.9%, in girls (Al-Enazy *et al*., 2014).

The prevalence of obesity and overweight in Saudi children aged 5 to 19 increased again in 2016 (17.4% and 35.6%, respectively), according to a World Health Organization (WHO) report (World Health Organization, 2014). According to a recent study conducted in the Riyadh region on 7930 children (aged 6–16 years), obesity and overweight were more common in boys than in girls, with rates of 12% and 18%, respectively (Al-Enazy *et al*., 2014).

Given the global rise in childhood obesity, it is important to find out if other cardiometabolic concerns, including MetS, are spreading. This is especially true for high-risk and understudied ethnic groups, such as young Arabs. This systematic review aims mainly to investigate the recently published literature on the prevalence and management of MetS among children in Saudi Arabia.

MATERIALS AND METHODS

This systematic review was carried out following established best practices (Preferred Reporting Items for Systematic Reviews and Meta-Analyses, PRISMA).

Study design

This was a systematic Review.

Study duration

From November to December 2022.

Study condition

This review evaluates recently published research on the incidence and treatment of MetS in Saudi Arabian children.

Search strategy

To locate the relevant articles, a thorough search of five major databases, including PubMed, Web of Science, Science Direct, EBSCO, and Cochrane Library, was carried out. Our search was restricted to English, and the unique requirements of each database were taken into consideration. Using the following keywords, which were converted into Mesh terms in PubMed, the appropriate studies were found; "Metabolic syndrome," "X syndrome," "Insulin resistance syndrome," "Children," "Pediatrics," "Adolescents," "Saudi Arabia," and "KSA." The necessary keywords were linked with the Boolean operators "OR" and "AND." The search yielded English-language publications with full text, freely accessible articles, and human trials.

Selection criteria

Inclusion criteria

The criteria used to determine which subjects should be added to the study were as follows; male or female patients who were checked for MetS diagnosis and within age limits (<20 years). Only the Saudi pediatric population was included.

Exclusion criteria

All other articles, ongoing investigations, and assessments of finished studies that did not concentrate on one of these subjects were ignored. Articles with adult populations were also excluded.

Data extraction

When examining the search strategy's results, we used Rayyan (QCRI) to check for duplicates (Ouzzani *et al*., 2016). The researchers narrowed the combined search results based on a set of inclusion/exclusion criteria to establish the relevancy of the titles and abstracts. The reviewers looked at the entire texts of the papers that met the criteria for inclusion. How to resolve conflicts was discussed by the authors. The approved study was added using a created data extraction form. The authors extracted data about the study titles, authors, study year, study designs, city, participant number, mean age, criteria of diagnosis, MetS prevalence, management, and main outcomes.

Strategy for data synthesis

To provide a qualitative overview of the included study aspects and outcomes, summary tables constructed from the data collected from the eligible studies were created. After data extraction for the systematic review, it was decided how to use the included study articles' data best. Studies that satisfied the full-text inclusion criteria were excluded if they did not give information on the prevalence and management of MetS among children in Saudi Arabia.

Risk of bias assessment

Using the ROBINS-I risk of bias assessment technique for non-randomized trials of interventions, the caliber of the included studies was assessed (Jüni *et al*., 2016). Confounding and participant selection for the study, classification of interventions, deviations from intended interventions, missing data, assessment of outcomes, and choice of the reported result were the seven areas covered.

RESULTS AND DISCUSSION

Search results

A total of 290 study articles resulted from the systematic search, and then 90 duplicates were removed. Title and abstract screening were conducted on 200 studies, and 122 studies were excluded. 78 reports were sought for retrieval, and only 9 articles were not retrieved. Finally, 69 studies were screened for full-text assessment; 42 were excluded for wrong study outcomes, 10 for unavailable data on MetS among children in Saudi Arabia, and 11 for the wrong population type. Six eligible study articles were included in this systematic review. **Figure 1** summarizes the process for choosing the studies.

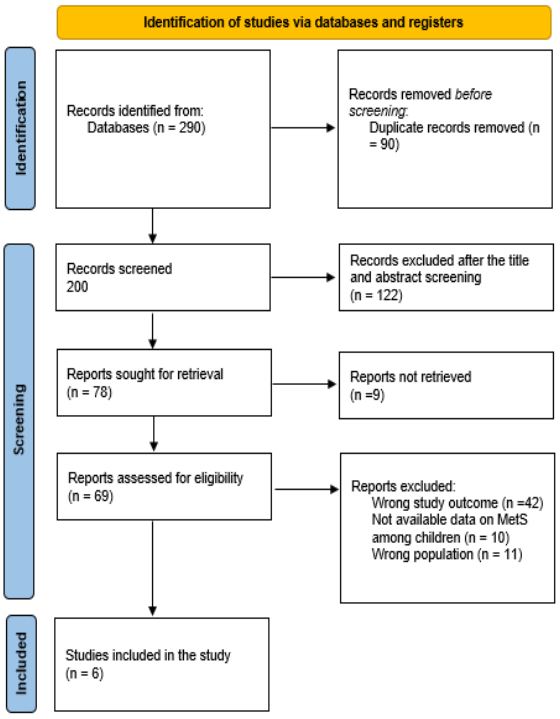

Figure 1. summarises the research selection method using a PRISMA flowchart.

Characteristics of the included studies

Table 1 includes the sociodemographic characteristics of the included participants; city, participants, mean age, gender, and criteria of MetS diagnosis. A total of six studies with 1048 subjects were included in this review. Three studies were conducted in Jeddah (Taha *et al*., 2009; Al-Agha *et al*., 2012; Alowfi *et al*., 2021), two in Riyadh (Aldhafiri *et al*., 2012; Al-Hussein *et al*., 2014), and one in Majmaah (Aldhafiri, 2020). Three studies used the National Cholesterol Education Expert Panel-Adult Treatment Panel (NCEP-ATP III) and WHO criteria for MetS diagnosis (Taha *et al*., 2009; Aldhafiri *et al*., 2012; Aldhafiri, 2020), two used the IDF (Al-Hussein *et al*., 2014; Alowfi *et al*., 2021), and one used criterion according to (de Ferranti *et al*., 2004)

Table 2 includes the features of the included studies; study designs, MetS prevalence, management, the main outcome, and risk of bias. Of the included studies, four studies were cross-sectional studies (Al-Agha *et al*., 2012; Al-Hussein *et al*., 2014; Aldhafiri, 2020; Alowfi *et al*., 2021), and two were cohort studies (Taha *et al*., 2009; Aldhafiri *et al*., 2012). The prevalence of MetS among Saudi children ranged from 7% (Alowfi *et al*., 2021) to 30% (Taha *et al*., 2009). The included studies reported that the high prevalence of MetS was found in obese children; however, it was also detected in children with normal BMI. The most common associated comorbidities were T2DM and hypertension.

Table 1. Sociodemographic characteristics of the included participants

Study	City	Participants (n)	Male (n)	Mean age	Criteria of MetS diagnosis
Taha *et al*., (2009)	Jeddah	57	33 (57.9%)	9.8 ± 3.5	NCEP-ATP III and WHO criteria
Al-Agha *et al*., (2012)	Jeddah	173	0	13.46 ± 3.22	According to de de Ferranti *et al*., (2004)
Aldhafiri *et al*., (2012)	Riyadh	56	34 (60.7)	13.4 ± 4.1	NCEP III
Alowfi *et al*., (2021)	Jeddah	172	0	12 to 19	IDF criteria
Al-Hussein *et al*., (2014)	Riyadh	518	268 (51.7)	6 to 17	IDF
Aldhafiri *et al*., (2020)	Majmaah	72	42 (58.3)	9.53±1.89	NCEP III

Table 2. Characteristics and outcomes of the included studies

Study	Study designs	MetS prevalence (%)	Management	Key findings	ROBIN-I
Taha *et al*., (2009)	Retrospective cohort	30	In Saudi children who are obese, hyperinsulinemia, dyslipidemia, hypertension, and impaired fasting glucose appear to be very common. Further studies are required to ascertain the efficacy of prevention and different pharmacological and lifestyle therapies in managing MetS in children.	In a population of obese Saudi youngsters, the MetS and its elements are highly prevalent. In our study, 30% of obese Saudi youngsters met the requirements for the MetS diagnosis by having three or more of the syndrome's components.	Moderate
Al-Agha *et al*., (2012)	Retrospective cross-sectional	14.29	They advocate for the promotion of family education seminars in Saudi Arabia, particularly to raise awareness of obesity and its comorbidities and to support a better diet that is high in fiber, low in sodium, simple carbs, and saturated fats.	The prevalence of obesity was rather high in our population, as was the prevalence of some of its related comorbidities, mainly T2DM and hypertension. We believe that an endemic of unhealthy indulgences is sweeping across children and adolescents within our populace and is responsible for the increasing blight that is MS and its components, which is mainly due to behavioral and environmental factors	Moderate

Aldhafiri, (2012)	Cohort study	7.1	NA	Although overweight and obesity may not be any more common than in the general Saudi teenage population, unhealthy body weight and over-fatness may be widespread in Saudi adolescent survivors of standard risk ALL.	Moderate
Alowfi *et al.*, (2021)	Cross-sectional	7	NA	MS is prevalent among overweight and obese female teenagers; however, it can also be found in people with a normal BMI or who are not obese. Additionally, compared to Makkah and Riyadh, the prevalence of overweight, obese, and MS patients is lower in this reference group; nevertheless, it varies greatly globally due to various diagnostic standards and cut-off points for MS.	Moderate
Al-Hussein *et al.*, (2014)	Cross-sectional	18	NA	Using the MetS diagnosis alone as a basis for prevention measures can backfire. BMI and waist circumference for age should be employed to determine cardiometabolic risk in children and adolescents.	Moderate
Aldhafiri, (2020)	Cross-sectional	16.7	To reduce the risk factors for this condition in the early stages of development, they stated that they should begin their research into identification, intervention, and prevention initiatives.	School-age children have a high frequency of MetS, and as they get older, the situation only gets more concerning.	Moderate

According to the authors' knowledge, this is the first comprehensive systematic review that identifies the prevalence and management trends of MetS among Saudi Arabian children and adolescents. Our study reported that the prevalence of MetS among Saudi children ranged from 7% (Alowfi *et al*., 2021) to 30% (Taha *et al*., 2009). This variance might be explained by the fact that children who are overweight or obese have a higher risk of developing MetS than children who are of normal weight (Al-Daghri, 2010).

The current findings are consistent with those of a previous review, which found that regardless of the specific diagnostic techniques, the prevalence of MetS in the pediatric population ranged from 1.2-22.6% (Tailor *et al*., 2010) to 0-19.2% (Friend *et al*., 2013). The prevalence of MetS is also significantly greater than the results of a meta-analysis conducted in Chinese children and adolescents, where it was discovered that 1.8% (IDF) and 2.6% (ATP III) had MetS (Ye *et al*., 2015).

There is agreement that (1) depending on the criteria used, the prevalence of MetS varies significantly (Wang *et al*., 2013). (2) that the prevalence of MetS differs depending on whether childhood or adolescent criteria are used, and (3) that the prevalence of childhood differs depending on which criteria are used (Carvalho *et al*., 2016). Because there were so few studies when diverse criteria were used on the same population, we were unable to add to the current understanding of how different definitions or cut-off values influenced prevalence. We were able to examine the prevalence of MetS in various groups using various criteria, and even though the median prevalence was frequently comparable **(Table 1)**, the range in prevalences differed significantly depending on the criteria utilized.

We found that the high prevalence of MetS was found in obese children; however, it was also detected in children with normal BMI. The most common associated comorbidities were T2DM and hypertension. Over the past few decades, obesity has become more common among Saudi children. A recent analysis of changes in Saudi children's nutritional health comparing growth data from all regions of the country from 1993 to 1994 to 2004 to 2005 revealed an increase in the prevalence of overweight and obesity over the previous 10 years (Albaker *et al*., 2022).

Because many people "lose" their MetS, the clinical significance of the condition in childhood and adolescence is still unknown. However, central obesity, which increases the risk of developing the condition at one age (Paiva *et al*., 2022), is a risk factor for the condition at 9 to 10 years of age. A deeper comprehension of the prevalence of the MetS and its underlying mechanism is necessary. It is still unclear how having diabetes or the MetS in the family relates to the prevalence of childhood MetS. To ascertain the clinical relevance of childhood MetS, more cross-sectional and longitudinal studies of children and adolescents are required, particularly in the United Kingdom, where prevalence among obese children has been described (Jakubiak *et al*., 2021) but not overall population prevalence.

There is a significant lack of reported management strategies for MetS among Saudi children. Further research and investigations to detect and suggest the efficacy of management plans are required. Given the close relationship between MetS and obesity, the majority of MetS interventions have been similar to those for pediatric obesity in general, i.e., they focus on changing unhealthy lifestyle factors that may have contributed to the metabolic issues in the first place. This includes eating habits that are high in saturated fat and carbohydrates (and, ultimately, calories in general) (Lee *et al*., 2016) as well as inadequate levels of physical activity (Sasayama *et al*., 2020). Thus, dietary changes increased physical activity, and a combination of the two have been the main areas of focus for interventions that have been evaluated for their effectiveness in lowering the proportion of children with MetS.

Thus, lowering the ratio of energy consumed to energy expended is the aim of these, primarily to lessen the degree of

central obesity that fuels metabolic abnormalities. Effective strategies have included attempts to examine adolescent motivation using methods like motivational interviewing, which involves evaluations of a patient's readiness to change on an individual basis (Bean *et al*., 2015).

The American Academy of Pediatrics, the American Heart Association, and the WHO have all recommended decreasing saturated fat intake in favor of unsaturated fat (like olive oil and other vegetable oils), increasing fruit and vegetable consumption, and lowering sugar intake for children and adolescents (World Health Organization, 2014).

In general, among MetS patients, efforts should be made to decrease the consumption of sugar-sweetened beverages, saturated fat, and calorie-dense food (such as fast food) and to increase consumption of oils and vegetables—probably through negotiating specific changes with teenagers and their families.

CONCLUSION

This systematic review reported that the prevalence of MetS was variable and ranged from 7% to 30% in different Saudi pediatric populations. Although it was also detected in children with normal BMI, a high prevalence of MetS was found in obese children. T2DM and hypertension were the most prevalent associated comorbidities. To reduce future MetS, childhood obesity must be prevented. Pediatric clinical care should include screening for obesity and MetS in a variety of contexts. The future health of these kids is likely to be improved by identifying the presence of MetS and intervening with specific lifestyle recommendations and frequent follow-up to encourage adherence.

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