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Interrelationship between body mass index and asthma in children suffering from asthma-analytical cross-sectional study

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Abstract. – OBJECTIVE: Bronchial asthma and obesity are correlated diseases that are highly prevalent among children. The effect of increased body mass index (BMI), aggravating asthma, is currently controversial in this group. The aim of this study is to determine the association between Body Mass Index and severity of asthma among obese children with asthma and normal-weight children with asthma in Riyadh, Saudi Arabia.

PATIENTS AND METHODS: Data from a cross-sectional analysis of 64 participants from Riyadh, Saudi Arabia, were analyzed. Symptoms were assessed through children's and caregivers' responses to a pretested questionnaire. Grouping of children into obese (18) and non-obese (46) was based on their body mass index (BMI) percentile. Association between obesity and final asthma score was estimated by chi-square test using SPSS software and p-value set at 0.005.

RESULTS: The mean age was 10.13 ± 2.54 years (ranged 5 to 14), and the majority, 46 (71.88%), were boys. Most of the participants, 46 (71.88%), were normal to underweight and 18 (28.13%) were overweight or obese. Most of the children, 35 (54.69%), complained of cough because of asthma sometimes. Out of 64 participants, 21 (32.81%) had uncontrolled asthma, and 43 (67.19%) had controlled asthma calculated using a questionnaire. Out of 46 non-obese children with asthma, 7 (15.22%) had uncontrolled asthma, and out of 18 obese children with asthma, 14 (77.78%) had uncontrolled asthma, and the difference in the proportion of Asthma severity was significant statistically across the groups (*p*-value <0.001).

CONCLUSIONS: Poor control of asthma symptoms was significantly higher in both obese and normal-weight children with asthma.

Key Words:
Asthma, Obesity, Child, Cough, Respiratory function tests.

Introduction

The pediatric population is most commonly diagnosed with asthma and obesity. The prevalence of these two chronic diseases has increased alarmingly since the last decades and has recently reached a plateau[1]. Worldwide, millions of people get affected with asthma, a chronic disorder. By 2025, the prevalence of asthma can increase by another 100 million to the present 300 million[2]. Both these two chronic disorders leave lifelong impacts on the health of children[3,4]. World Health Organization (WHO) considers obesity a worldwide epidemic due to an alarming increase in children from the past 20 years[5]. An increasing trend in the prevalence of obesity among children was seen from 0.7% in 1975 to 5.6% in 2016 in girls and from 0.9% in 1975 to 7.8% in 2016 in boys[6].

Globally 334,000,000 pediatric people worldwide have asthma, a common chronic disease. An increase in global prevalence from 11.1% to 11.6% in children aged 6-7 years and from 13.2% to 13.7% in children aged 13-14 years was reported by a time trends analysis from the International Study of Asthma and Allergies in Childhood (ISAAC) Phase. There were variations around the world[7]. The prevalence of childhood obesity and asthma is increasing likewise in Saudi Arabia. The increased prevalence of overweight, obesity and severe obesity in children and adolescents from 5 to 18 years of age is 23.1%, 9.3%, and 2%, respectively, and the prevalence of asthma among school children between the ages of 8 and 16 years is 23%. A sedentary lifestyle owing to the modernization of Saudi society, changes in dietary habits, and increasing exposure to environmental factors such as indoor allergens, dust, sand storms,

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and tobacco are the most important factors for the increased prevalence of obesity and asthma among children[8].

Like asthma, obesity, too, is considered a pro-inflammatory state. The possible mechanism for developing asthma in individuals with obesity is systemic inflammation created by the excess adipose tissue formed due to the pathophysiology of various conditions. However, asthma and obesity are linked in a multifactorial way. Changes in the mechanics of the airways, immune response, hormonal influences, and genetic-environmental factors are some of the different hypotheses to explain the pathogenesis behind this association[9]. Among obese, the lung gets affected both physiologically and mechanically by a decrease in lung and tidal volume and increased airway obstruction. In addition, adipose tissue-derived hormones and cytokines like leptin, adiponectin, tumor necrosis factor, and interleukins play an inflammatory role. Gastroesophageal reflux, sleep disorder, and metabolic syndrome are common triggers of asthma exacerbation and poor asthma control among obese[10].

There is very much convincing evidence that childhood obesity increases the risk of asthma or asthma-like symptoms. A previous age- and sex-matched case-control study by Nahhas et al[11] among 1,264 6- to 8-year-old schoolchildren with and without asthma in Madinah, Saudi Arabia, showed that BMI was associated with increased exacerbations of asthma in boys (odds ratio (OR) = 1.14, 95% confidence interval (CI), 1.08-1.20) and girls (OR = 1.37, 95% CI, 1.26-1.50). Another experimental study by Abd El-Kade et al[12] in 80 obese Saudi children with asthma (42 boys and 38 girls) with mean age 13.86± 3.21 reported that weight loss improved markers of systemic inflammation in obese Saudi children with asthma. There was a 17.5%, 15.5%, 22.4%, 14.1%, and 15.9% reduction in mean values of tumor necrosis factor-alpha (TNF-alpha), interleukin-6 (IL-6), interleukin-8 (IL-8), leptin and body mass index (BMI) respectively, and 38.7% increase in mean values of adiponectin in the training group after intervention.

Asthma and associated phenotypes need to be examined by repeating the above studies across different population groups. Childhood obesity mostly is originated during the preschool age, and it is credible to infer the association between obesity and asthma during this critical time window. However, no studies have evaluated the impact of obesity on children with asthma in Riyadh province. Hence this study aimed to determine the association between Body Mass Index and severity of asthma among obese children with asthma and normal-weight children with asthma in Riyadh, Saudi Arabia.

Aim

To determine the association between Body Mass Index and severity of asthma among obese children with asthma and normal-weight children with asthma in Riyadh, Saudi Arabia.

Methodology

Study design: The present study is an Analytical Cross-sectional study.

Study setting: This study was conducted in Riyadh, Saudi Arabia.

Source population: 5- 14 years old children of Riyadh, Saudi Arabia.

Study population: Obese children with asthma in the age group of 5-14 years visiting outpatient's children hospital. We have selected this age of children in the study because they can do Pulmonary Function Test to be sure about asthma diagnosis by documenting low FEV_1.

Study period: The total scheduled duration for this study will be around three months, including the data collection and processing from January 2021 to March 2021.

Sample size and Sampling technique: Stratified random sampling will be considered in this study, and a representative sample of Saudi schoolchildren in Riyadh was selected. The sample size was calculated from the formula n=Z2 P (1-P)/d2 where n is the sample size, Z is the statistic corresponding to the level of confidence, P is the expected prevalence of asthma (estimated as 4.05 % in Saudi Arabia [95 % confidence interval: 3.54-4.62%) and d is the proportion of sampling error. Hence, the sample size for asthmatic children was chosen as 64. Grouping of children into obese children with asthma (18) and non-obese children with asthma (46) was based on their body mass index (BMI) percentile since obesity is defined as a BMI more significant than the 95th percentile for age and gender. The BMI was calculated according to the formula: weight (kg)/ height^2 (m^2). As the overall prevalence of asthma in Saudi children ranges from 8% to 25%, there were fewer obese children with asthma.

Ethical consideration: This study was approved by King Fahad Medical City, Riyadh with IRB number 17-211E.

Inclusion criteria:

– Asthmatic outpatient's children from 5 years to 14 years.
– Children who can perform Pulmonary Function Test to be sure about asthma diagnosis

Exclusion criteria:

– Children with asthma who had received inhaled steroid treatment before will be excluded.
– Children who were diagnosed one month before.
– Children diagnosed with comorbidities and other genetic disorders.

Data Collection

Data was collected through the phone using a re-tested close-ended questionnaire. The questionnaire was prepared according to the Saudi Initiative for Asthma (SINA) guidelines, divided into two parts. The first part for the child and another for the caregiver containing information about how the asthma was today, did it affect daily activities or affecting sleep, and questions for the caregiver about the last four weekday and nighttime symptoms of asthma. In addition, age, height, weight were recorded. In addition, age, height, weight were recorded. A pulmonary function test (PFT) was performed for all children on the first visit. Forced expiratory flow in the first second (FEV_1), forced vital capacity (FVC), FEV_1/FVC, and peak expiratory flow (PEF) from the hospital records were noted to be sure about asthma diagnosis. Contact information was taken from the hospital records. The body mass index was calculated for all children with asthma. The children's measurements were divided into two groups. The first group included overweight children from 85th to 95th percentile and above; the other group included normal and low weight lower than 85th percentile.

Definitions

Obese: Body mass index (BMI) was calculated using the ratio of weight/height^2 (Kg/m^2) and classified according to the age- and sex-specific percentiles defined by the US Centers for Disease Control and Prevention (CDC), World Health Organization (WHO) and International Obesity Task Force (IOTF).

Asthma: Asthma was diagnosed based on a history of recurrent or chronic chest symptoms such as cough, wheezing, difficulty breathing, and chest tightness that demonstrated clinical reversibility with short-acting bronchodilator treatment in accordance with the guidelines of The Saudi initiative for Asthma and the Global Initiative for Asthma 2019.

This is the fourth version of the updated guidelines for the diagnosis and management of asthma, developed by the Saudi Initiative for Asthma (SINA) group, a subsidiary of the Saudi Thoracic Society. The main objective was to have guidelines that are up to date, simple to understand, and easy to use by healthcare workers dealing with asthma patients. The guidelines have focused more on personalized approaches reflecting a better understanding of disease heterogeneity with the integration of recommendations related to biological agents, evidence-based updates on treatment, and the role of immunotherapy in management which is based on the available evidence, local literature, and current national and regional levels[13].

Study variables: Asthma score was considered as the primary outcome variable. BMI was regarded as a primary explanatory variable.

Statistical Analysis

Descriptive analysis for gender, BMI, and response to the questionnaire was represented as frequency, and proportion and age were represented by mean and standard deviation. Association between BMI and asthma severity was checked using the chi-squared test, and IBM SPSS version 23 was used for statistical analysis. *p*-value was set at < 0.05 s.[14]

Result

All 64 subjects were finally analyzed.

Socio-Demographic and Anthropometric Characteristics

The mean age was 10.13 ± 2.54 (ranged 5 to 14) years in the study population. The majority, 46 (71.88%), were boys and the remaining 18 (28.13%) were girls. Most of the participants, 46 (71.88%), were normal to underweight and 18 (28.13%) were overweight or obese (Table I).

The Severity of Asthmatic Symptoms in Children

Among asthmatic symptoms, most children with asthma, 34 (53.13%), reported perfect asthma conditions today. While doing exercise, running, or playing a sport, 25 (39.06%) children reported a minor problem, and 23 (35.94%) children did not have any problem. Most of the children,

Table I. Summary of the demographic parameter in the study population (N = 64).

Parameter	Summary
Age (in years)	10.13 ± 2.54 (ranged 5 to 14)
Gender	
Male	46 (71.88%)
Female	18 (28.13%)
BMI (In Kg/M2)	
Normal or Underweight	46 (71.88%)
Overweight or Obese	18 (28.13%)

35 (54.69%), complained of cough because of asthma sometimes. Asthma causing nighttime wakeup was reported in very few children, and 3 (4.69%) children wake up most of the time, 29 (45.31%) wake up some times. The mean score from children was 9.11 ± 1.89 (ranged 5 to 12). Caregivers reported that during the last four weeks of time, longer duration of asthma symptoms reported as 20 (31.25%) children had a longer duration of asthma symptoms (4 to 10 days) and 5 (7.81%) had symptoms for (11 to 18 days). Wheezing because of asthma for 1-3 days was reported in 14 (21.88%) children followed by 4 to 10 days with 20.31 % of children. Most of 20 (31.25%) children wake up at night because of asthma for 1 to 3 days, followed by 13 (20.13%) with a duration of 4 to 10 days. The mean score from the caregiver was 12.09 ± 2.58 (ranged 7 to 15). Out of 64 participants, 21 (32.81%) had uncontrolled asthma (Table II).

Table II. Severity of asthmatic symptoms in the study population (N = 64).

Parameter	Summary
How is your asthma today?	
Very bad	1 (1.56%)
Bad	2 (3.13%)
Good	27 (42.19%)
Very good	34 (53.13%)
How much of a problem is your asthma when you run, exercise, or play sport?	
It is a big problem I cannot do what I want to do	4 (6.25%)
It is a problem, and I do not like it	12 (18.75%)
it is a bit problem, but it is okay	25 (39.06%)
it is not a problem	23 (35.94%)
Do you cough because of your asthma?	
Yes, all of the time	1 (1.56%)
Yes, most of the time	9 (14.06%)
Yes, some of the time	35 (54.69%)
No none of the time	19 (29.69%)
Do you wake up during the night because of your asthma?	
Yes, Most of the time	3 (4.69%)
Yes, some of the time	29 (45.31%)
No none of the time	32 (50.00%)
Chose the score from a child."	9.11 ± 1.89 (ranged 5 to 12)
During the last four weeks, how, many days did your child Asthma symptoms	
11 to 18 days	5 (7.81%)
4 to 10 days	20 (31.25%)
1 to 3 days	18 (28.13%)
Not at all	21 (32.81%)
Wheeze during the day because of asthma?	
11 to 18 days	8 (12.50%)
4 to 10 days	13 (20.31%)
1 to 3 days	14 (21.88%)
Not at all	29 (45.31%)
Wake up at night because of asthma	
11 to 18 days	4 (6.25%)
4 to 10 days	13 (20.31%)
1 to 3 days	20 (31.25%)
Not at all	27 (42.19%)
Score From Caregiver	12.09 ± 2.58 (ranged 7 to 15)
Final score	
Uncontrolled asthma	21 (32.81%)
Controlled asthma	43 (67.19%)

Comparison of BMI (in kg/m²) Between the Final Score

Out of 46 children of normal/underweight, 7 (15.22%) had uncontrolled asthma, and out of 18 overweight/obese children, 14 (77.78%) had uncontrolled asthma. The difference in the proportion of asthma severity was statistically significant across the groups *(p*-value <0.001) (Table III).

Discussion

This is the first study that investigated the association of increased BMI on asthma among children with asthma in Riyadh. The mean age was 10.13 ± 2.54 (ranged 5 to 14) years and the majority, 46 (71.88%), were boys. Most of the participants, 46 (71.88%), were normal to underweight and 18 (28.13%) were overweight or obese. Most of the children, 35 (54.69%), complained of cough because of asthma sometimes. Out of 64 participants, 21 (32.81%) children had uncontrolled asthma, and 43 (67.19%) had controlled asthma calculated using a questionnaire. Out of 46 children of normal/underweight, 7 (15.22%) children suffered from uncontrolled asthma, and out of 18 overweight/obese children, 14 (77.78%) suffered from uncontrolled asthma. The difference in the proportion of Asthma severity was significant statistically across the groups *(p*-value <0.001).

The mean age in the present study was 10.13 ± 2.54 (ranged 5 to 14) years. The majority, 46 (71.88%), were boys and the remaining 18 (28.13%) were girls**.** The findings were similar to a Cross-sectional study by Paciência et al[15], in Portugal, where the mean age of students was 9.0 years (8.0-9.0) and out of 845 participants, most of them, 429 were boys. Most children, 46 (71.88%), were normal to underweight, and 18 (28.13%) children were overweight or obese in the present study. This is in accordance with the data reported by Aliss et al[16], where obesity was highly prevalent in Saudi Arabia, and a prevalence of 23.1% and 9.3% of overweight and obesity was observed among Saudi children and adolescents. Increased trends in BMI of Saudi adolescents were published in three major Saudi national Cross-sectional[16].

In the present study, 7 (15.22%) children had uncontrolled asthma who were normal/underweight, and out of 18 overweight/obese children, 14 (77.78%) were diagnosed with uncontrolled asthma. The difference in the proportion of Asthma severity was statistically significant across the groups *(p*-value <0.001). This finding was in contrast to a retrospective study by De Vera et al[17], in Filipino children were 82.9% of the non-obese group and 86.8% of the overweight-obese group had a moderate-to-severe exacerbation, and there was no major significant difference in the severity of asthma exacerbations.

In the present study, we measured only BMI as an indicator of adiposity. Other studies like the nationwide Taiwan Children Health Study by Chen et al[18] compared various obesity measures like physical fitness levels, high sedentary time, intermediate factors, and pulmonary function in the pathway from central obesity to asthma. They suggested them as precipitating factors from central obesity to asthma. Another nationwide study by Musharrafieh et al[19] in Saudi Arabia among adolescents reported overweight/obese males were more likely to be asthmatics. In another previous study by Alhekail et al[8], in Saudi, increased BMI and asthma exacerbation did not have any association (p=0.84), and negative significance was noted with a duration of hospitalization (p=0.41), or frequency of hospitalization (p=0.89)

Inflammatory markers of asthma were not reported in the current study. In a cross-sectional study in Saudi by Al-Ayed et al[20], the median serum leptin concentrations in obese asthmatics were significantly higher than in non-obese asthmatics (p<.001). Uncontrolled asthmatics also had significantly higher leptin levels than controlled asthmatic children (p<.002). According to a systematic review by Sama et al[21], there is an increase in childhood obesity in Saudi Arabia

Table III. Comparison of BMI (in kg/m²) between final score (N = 64).

BMI (in kg/m²)	Final score		Chi-square	*p*-value
	Uncontrolled asthma	Controlled asthma		
Normal or underweight (N=46)	7 (15.22%)	39 (84.78%)	22.968	< 0.001
Overweight or obese (N=18)	14 (77.78%)	4 (22.22%)		

and suggested practitioners focus on increasing the obesity epidemic by early intervention to decrease the burden and adverse effects of childhood obesity in Saudi Arabia.

In the present study, most children, 35(54.69%), complained of cough because of asthma sometimes. Asthma causing nighttime wakeup was reported in very few children. Caregivers reported that during the last four weeks of time, 20 (31.25%) children had a longer duration of asthma symptoms (4 to 10 days), and 5 (7.81%) had symptoms for (11 to 18 days). Wheezing because of asthma for 4 to 10 days was reported in 13 (20.31 %) children. These findings from the questionnaire were almost similar to a two-stage cross-sectional survey by Abu-Shaheen et al[22], in Riyadh, where out of 600 respondents, 479 (79.8%) parents revealed the presence of asthma, dyspnea, or chest allergy in their children and were hospitalized previously for the asthmatic attack.

A specialized treatment plan is required that significantly improves asthma management for children with asthma as pediatric obese asthma is a clinically different asthma phenotype. The pathogenesis of obese children with asthma is completely different from obese adults and should not be extrapolated. The relationship between obesity and asthma is to be understood completely before planning treatment for asthma in obese children. Hence further studies are required to study the mechanism of asthma phenotypes being altered by increased BMI among children[23].

Novelties and Limitations

The study findings were based on colossal country-wide data and also the age range selected (5-14 years) as there is a dearth of data in this age group and the findings of the study contributed to evidence on the association of obesity and asthma among children with asthma. The children in these age groups can perform Pulmonary Function Test (PFT), and asthma can be diagnosed by documenting low FEV1 levels, degree, location, and reversibility of the lung compromised. Another strength in the present study is that both parents and children were surveyed about the asthma symptoms according to SINA guidelines to have a better understanding of the disease heterogeneity. Accurate methodology and advanced statistical approach were used to avoid errors, and the quality of the data was monitored in real-time throughout the study. These findings also direct for more comprehensive studies valuable in developing public health policy to prevent childhood obesity.

The sample size was very small, and hence the results cannot be generalized to the overall population of the specified group. The study was Cross-sectional in nature that hampers the temporal and causal relationship. Few important variables correlated with BMI like asthma, family history, laboratory tests, and medicines used have not been studied to exacerbate asthma symptoms. We recommend further multi-centric longitudinal studies to find the association between increased BMI and asthma.

Conclusions

The present study concluded that there is an association between increased BMI and aggravated asthma symptoms. The study identified novel characteristics and interactions between obesity and asthma. The results of this study have important implications for public health, which lead to developing preventive strategies for obese asthmatic children. Therapeutically, weight reduction and sports are essential interventions with clear clinical benefits. Pharmacotherapy is performed according to guidelines.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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