The Egyptian Journal of Hospital Medicine (January 2025) Vol. 98, Page 389- 395

Assessment of Relation between Obesity and Asthma Severity in Children with Bronchial Asthma

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ABSTRACT

Background: Asthma has a high prevalence worldwide among children. However, with comorbidity such as obesity the symptoms and signs of asthma could be exaggerated.

Objective: This work aimed to assess the possible relation between obesity and the incidence of asthma among children, and to decrease the burden of childhood asthma by evaluating the associated risk factors for asthma and obesity.

Subjects and methods: This descriptive cross-sectional study included a total of 80 obese and non-obese children with bronchial asthma, attending Pediatric Outpatient Clinic, Suez Canal University Hospitals. The children's ages ranged from two to twelve.

Results: There were high statistical differences between the obese and non-obese groups regarding weight, mid-arm circumference and BMI. There were statistical differences between the two groups regarding severity of the attacks and the frequency of hospitalization per year (P value <0.001<0.001, 0.001, respectively). There were statistical differences between the two groups regarding the frequency of the day and night symptoms of asthma.

Conclusions: Obesity significantly correlates with asthma incidence, asthma severity, day and night symptoms, and hospitalization frequency. Obesity in asthmatic children is linked to more severe exacerbation and hospitalizations.

Keywords: Obesity, Asthma Severity, Bronchial Asthma, Children

INTRODUCTION

One of the most significant challenges in modern public health is the obesity epidemic. According to the World Health Organization, over three hundred and forty million children and adolescents (those aged five to eighteen) were overweight or obese in 2016. In 2020, that number dropped to 39 million. The World Health Organization (WHO) reports that the prevalence of obesity has tripled since 1975, but that certain countries have seen a slowdown in this trend over the last decade [(1)]. The combined prevalence of overweight and obesity in children in Europe aged 2–7 was 17.9% (95% CI: 15.8–20.0) from 2006–2016, with 5.3% of those children being obese (95% CI: 4.5–6.1). Among people of this age, the epidemic of overweight and obesity is at its worst [(2)].

In contrast, asthma is the most common long-term illness in children; among children aged 6-7 years old, 11% have wheezed in the past year, and among adolescents aged 13–14 years old, 13% have done so. Consequently, a large percentage of youngsters will likely experience a combination of these two frequent disorders. Both the positive and negative aspects of the correlation between obesity and asthma can be explained by imaginable physiological and pathological processes. Children with asthma are at increased risk of becoming overweight due to their reduced physical activity and the use of medications that enhance hunger and weight [(3)].

Worldwide, the prevalence of both obesity (affecting 42% of adults and 18% of children) and asthma (affecting 8% of adults and children) has been steadily rising over the past few decades. Asthma affects 11% of adults who are overweight, 14.6% of women who are overweight, and 15.7% of children who are overweight [(3-4)].

Atopy and obesity are two of the many overlapping clinical characteristics that make up the disease known as asthma, which further complicates matters. Asthma and obesity both have their own complicated effects on the immune system. Finally, there is strong evidence that obesity and asthma could have the same pathophysiology. Firstly, it is a well-known fact that compared to individuals of healthy weight, children and adults who are obese are more likely to suffer from asthma [(5)]. Second, being overweight increases, the likelihood of a child developing asthma, and around a quarter of newly diagnosed instances of pediatric asthma are directly linked to obesity [6]. And lastly, some children with obese asthmatic who lose weight report better control of their asthma symptoms [(6)].

And lastly, there is evidence that being overweight raises the risk of acquiring asthma and makes the condition worse for people already suffering from it. Furthermore, there appears to be a reciprocal association between the two diseases, since asthma may serve as a predictor of obesity [(7)].

Overweight and obesity are associated with an increased risk of asthma, according to a large body of research (both retrospective and prospective) [(8)]. Studies have shown that children whose body mass index (BMI) remained in the upper quintile or higher during the 14-year follow-up were more likely to develop asthma, and that children whose BMI remained in the third quintile or lower during the last year had a lower risk of

Received: 15/08/2024
Accepted: 15/10/2024

persistent wheezing. But a large-scale investigation including 16 European cohorts indicated that asthma was the culprit in raising the incidence of obesity (hazard ratio (HR) 1.87 (95% CI 1.32; 2.64) [9].

And just as asthma is an "umbrella" diagnosis that encompasses a wide range of mechanistic endotypes and clinical phenotypes, there are likely to be multiple altered molecular pathways behind clinical heterogeneity in obese asthma. Although atopy is frequently seen in inflammatory diseases and pediatric asthma, it is not necessarily present in childhood obesity-related asthma [10-11]. We aimed to assess the possible relation between obesity and the incidence of asthma among children.

SUBJECTS AND METHODS

This cross-sectional study included a total of 80 children with bronchial asthma, attending Pediatric Outpatient Clinic, Suez Canal University Hospitals.

Inclusion Criteria:

1- Asthmatic children, both genders, aged 2-12 years who were presented with recurrent paroxysmal attacks of cough, dyspnea, and wheezing relieved spontaneously or with bronchodilators.
2- Children who had been on systemic corticosteroid medication for at least three months.

Exclusion Criteria:

1. Suspicion of suffering from any chronic respiratory diseases other than bronchial asthma.

All patients were subjected to:

A. Medical history: data were collected from the parents and comprised inquiries regarding atopy in the family, early delivery, exposure to secondhand smoke at home, substances consumed, length of episodes, symptoms during the day and night, severity of asthma, and frequency of hospitalizations [12].

B. Physical examination: measurements of BMI, arm and abdominal circumference. The standard method for determining BMI involves dividing the weight in kilograms by the square of the height in meters. Using the international standards for BMI, researchers measured overweight and obesity by sex from 2 to 18 years old. A BMI of 25 kg/m² was considered overweight, while a BMI of 30 kg/m² was considered obese by the age of 18 [13].

Ethical approval:

This study was ethically approved by the Ethics Committee of the Suez Canal Faculty of Medicine. Written informed consent of all the participants' parents was obtained. The study protocol conformed to the Helsinki Declaration, the ethical norm of the World Medical Association for human testing.

Statistical analysis:

The data was analyzed using SPSS version 26. We reported absolute frequencies for categorical variables and utilized chi-square and Fisher exact tests for comparisons as needed. The chi-squared trend test was used to compare the ordinal data between the two groups. Depending on the type of data, quantitative variables were defined using either the means and standard deviations or the median and interquartile range. A Mann Whitney test and an independent sample t test were used to compare the quantitative data of one group to another.

RESULTS

We enrolled eighty children with bronchial asthma in this study to assess the relation between obesity and asthma severity in children with bronchial asthma. The study population was allocated into two groups, **obese group (N=40)**: included children with bronchial asthma and high BMI, and **non-obese group (N=40):** included children with bronchial asthma and normal BMI.

Baseline characteristics of the research groups are displayed in Table 1. No statistically significant differences were found between the groups when stratified by gender, age, residence, or family history of allergies or smoking.

Table (1): Description of the study groups

Clinical characteristics		Obese group (n=40)	Non-obese group (n=40)	p-value
Age (years)		6.48 ± 2.48	6.93 ± 1.82	0.512
Gender	Male	22 (55%)	24 (50%)	0.714
	Female	.1 (45%)	20 (50%)	
Residency	Urban	23 (57.5%)	2. (52.5%)	0.802
	Rural	.7 (42.5%)	19 (47.5%)	
Family Smoking	Positive	22 (55%)	2. (52.5%)	0.911
	Negative	.1 (45%)	19 (47.5%)	
Family History of Allergies	Positive	26 (65%)	25 (62.5%)	0.620
	Negative	14 (35%)	15 (37.5%)	

The study showed that more boys (52.5%) had asthma than girls in childhood. Most of the study group population was living in urban areas (55%). Families of children with asthma are more likely to smoke than families of children without asthma; nonetheless, there was no statistically significant difference between the two groups.

Table 2 displays the comparative distributions of anthropometric measures among the study groups. Regarding weight, waist, mid-arm, and BMI, statistical analysis showed that the non-obese group was significantly different from the obese group.

Table (2): Anthropometric measures of the study population

Anthropometric measures		Obese group (n=40)	Non-obese group (n=40)	p-Value
Weight (Kg)	mean ± SD	41.12 ± 10.02	32.47 ± 9.66	**0.001**
	median (range)	41.45 (23 - 55.1)	32.6 (18.8 – 54.1)	
Mid-arm circumference (cm)	mean ± SD	24.21 ± 4.87	13.77 ± 2.11	**<0.001**
	median (range)	23.1 (.9 – 29)	13 (10– 16)	
Abdominal circumference (cm)	mean ± SD	92.67 ± 11.71	39.06 ± 14.59	**<0.001**
	median (range)	91 (79 – 118)	35 (22 – 53)	
BMI (kg/m^2)	mean ± SD	35.84 ± 3.79	20.60 ± 1.68	**<0.001**
	median (range)	33.77 (29.9 – 36.5)	20.2 (17.6 – 23.6)	

The study groups' clinical characteristics are displayed in Table 3. The two groups differed statistically in terms of the number of hospitalizations each year and the severity of the attacks (P values <0.001, <0.001, 0.001, respectively).

Table (3): Clinical characteristics of the study population

Clinical characteristics		Obese group (n=40)	Non-obese group (n=40)	p-value
Severity of asthma	intermittent	2 (5%)	16 (40%)	**<0.001**
	Mild persistent	6 (15%)	12 (30%)	
	Moderate persistent	10 (25%)	9 (22.5%)	
	Severe persistent	22 (55%)	3 (7.5%)	
Frequency of hospitalization	mean ± SD	6..2 ± 2.03	3.48 ± 1.75	**0.001**
	median (range)	5 (2 – 9)	3 (1 – 7)	

The range of frequency of hospitalization among obese group was 5 times/year however, the range of frequency of hospitalization among non- obese group was 3 times/year. The frequency of hospitalization had significantly higher association with severe type of asthma (p<0.001) in obese group.

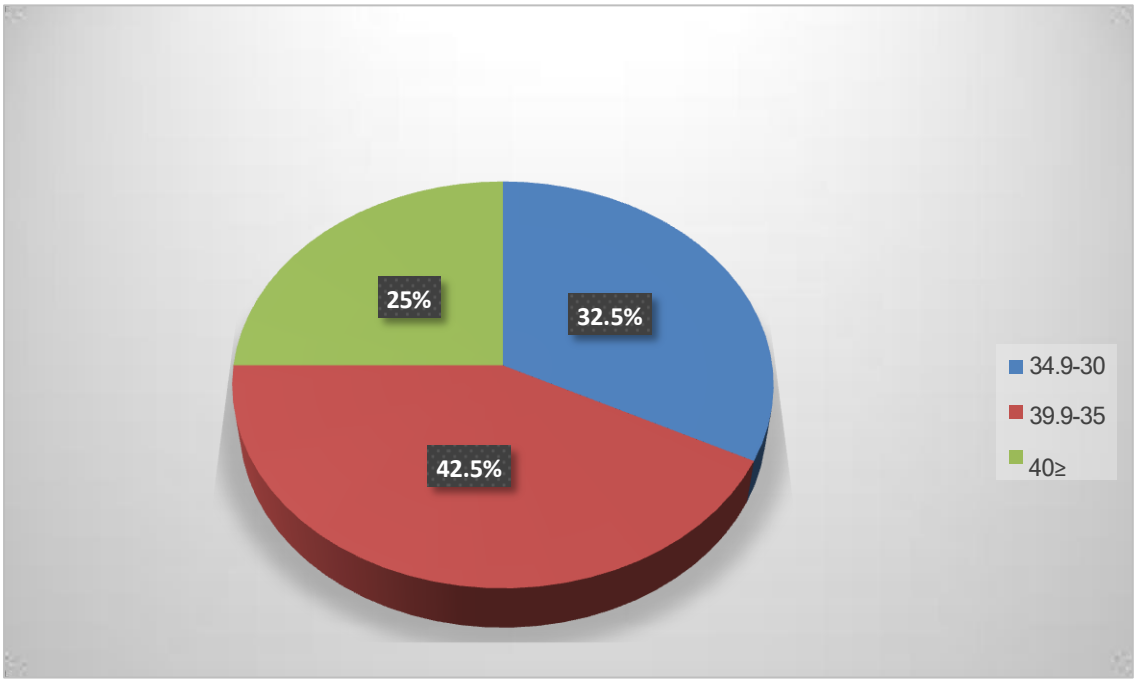

Figure (1): Distribution of obese group according to BMI:

Obese children with BMI 30-34.9 kg/m^2 represented 32.5% of total obese asthmatic children. Obese children with BMI 35-39.9 kg/m^2 represented 42.5% of total obese asthmatic children while obese children with BMI>40 kg/m^2 represented 25% of total obese asthmatic children.

Table 4 shows the distribution of severity of asthma according to the BMI in the obese group. When comparing the groups based on asthma severity, no substantial difference was found (P value= 0.072).

Table (4): Distribution of severity of asthma according to the BMI in the obese group

		BMI			Total	P value
		30-34.9	35-39.9	≥40		
Severity of asthma	Intermittent	2 (100%)	0 (0%)	0 (0%)	2 (100%)	0.072
	Mild persistent	3 (50%)	2 (33.3%)	1 (16.7%)	6 (100%)	
	Moderate persistent	2 (20%)	4 (40%)	4 (40%)	10 (100%)	
	Severe persistent	5 (22.7%)	7 (31.8%)	10 (45.5%)	22 (100%)	

The study revealed that mild persistent cases were 15% of obese group and 30% of non-obese group, moderate persistent cases were 25% of obese group and 22.5% of non-obese group, while the intermittent asthma cases were 5% of obese group and 40% of non-obese group, severe persistent asthma cases were 55% of obese group and 7.5% of non-obese group.

Day and night symptoms were reported by the study population at varying frequencies, as shown in Table 5. When comparing the prevalence of daytime and nighttime asthma symptoms, a statistically significant difference was found between the obese and non-obese groups.

Table (5): frequency of day and night symptoms among the study population

variable	Frequency	Obese group (n=40)	Non-obese group (n=40)	p-value
Day symptoms	≤ 2 days/week	2 (5%)	18 (45%)	**0.001**
	> 2 days/week	6 (15%)	10 (25%)	
	Daily	10 (25%)	11 (27.5%)	
	Throughout the day	22 (55%)	1 (2.5%)	
Night symptoms	≤ 2 times/month	.4 (25%)	16 (40%)	**0.001**
	3-4 times/month	12 (30%)	12 (30%)	
	> 1 days/week	10 (25%)	9 (22.5%)	
	Daily	8 (20%)	3 (7.5%)	

Asthmatic children with day symptoms throughout the day were 55% of obese group and 2.5% of non-obese group while the asthmatic children with night symptoms daily were 20% of obese group and 7.5% of non- obese group.

Table 6 shows logistic regression analysis to assess the predictors of the severity of asthma among asthmatic children.

Table (6): Logistic regression analysis of the severity of asthma

Predictors	Unstandardized Coefficients		OR	95% CI	P value
	B	Std. Error			
(Constant)	-18.233	5.141	**0.001**		
Age	0.084	0.152	1.088	(0.780 – 1.519)	0.712
Gender	0.097	0.147	1.017	(0.709 – 1.408)	0.321
BMI	0.024	0.009	1.062	(1.039 – 1.086)	**<0.001***
Obese vs non-obese group	6.622	3.112	20.210	(1.758 – 50.140)	**0.021***
*** Statistical significance (P < 0.05)**					

A positive correlation between age and asthma severity was found, however it was not statistically significant (OR=1.088, P value =0.712). As for gender and asthma severity, there was a weak but positive correlation (OR=1.017, P value =0.321). The severity of asthma was positively associated with BMI (OR=1.062, P value <0.001).

To determine what factors, influence the severity of asthma in children, the researchers used multivariate linear regression analysis, as shown in Table 7.

Table (7): Linear regression analysis of the frequency of hospitalization

Predictors	**Unstandardized Coefficients**		**β**	**95% CI**	**P value**
	B	**Std. Error**			
(Constant)	-3.471	1.302	0.058		
Age	0.211	0.092	0.846	0.636 – 1.830	0.452
Gender	0.308	0.122	0.661	0.451 – 1.645	0.213
BMI	0.022	0.009	0.380	0.011 – 0.749	**<0.001***
Obese vs non-obese group	1.401	0.207	0.895	0.536 – 2.326	**0.001***
ANOVA <0.001, R^2 =0.358 *** Statistical significance at P <0.05**					

The analysis showed that there was an insignificant positive association between the age and the frequency of hospitalization (β =0.846, P value =0.452). However, BMI showed significant positive association with the frequency of hospitalization (β =0.38, P value <0.001).

DISCUSSION

A cross-sectional study was conducted with 80 children diagnosed with bronchial asthma at the outpatient clinic of Suez Canal University Hospital. The primary goal of the study was to examine the relationship between obesity and the severity of asthma in these children. To achieve the study's objectives, children with bronchial asthma and high BMI were categorized into two groups: one group consisted of obese children (N=40), while the other group comprised children with normal weight (N=40).

Researchers discovered a statistically significant difference in the occurrence of daytime and overnight asthma attacks between the obese and non-obese participants. Daytime symptoms were experienced by 55% of the obese children and 2.5% of the non-obese children with asthma, while nighttime symptoms were experienced by 20% of the obese children and 7.5% of the non-obese children daily**.**

The study found a significant correlation between asthma severity and BMI. Specifically, 15% of the obese children and 30% of the non-obese children had mild persistent asthma, 25% of the obese children and 22.5% of the non-obese children had moderate persistent asthma, 5% of the obese children and 40% of the non-obese children had intermittent asthma, and 55% of the obese children and 7.5% of the non-obese children had severe persistent asthma.

Quinto *et al.* [14] found a statistically significant difference in the distribution of β-agonist units and oral corticosteroids based on BMI, which aligns with our findings. When compared to children of normal weight, those who were overweight were 15% more likely to receive a β-agonist unit. Additionally, obese children had a 17% higher probability of receiving a β-agonist unit compared to their normal-weight counterparts.

In a 2017 study of 360 African American children, **Loman *et al.*** [15] examined various clinical predictors of asthma severity and found that overweight or normal-weight females had milder asthma than obese females. However, the severity of asthma in the obese group did not differ significantly from the lean group, as noted by **Desai *et al.*** [2]**.** Similarly, in a 2019 study conducted by **Sharif-Askari *et al.*** [16]**,** there were notable disparities in the obese group when their BMI was considered.

Several theories have been proposed to explain this connection. First, the inflammatory hypothesis suggests that pro-inflammatory mediators, such as adipokines, leptin, interleukin-6 (IL-6), tumor necrosis factor-alpha, and interferon-gamma, are released into the bloodstream when tissues experience hypoxia due to the increase in adipose tissue. These mediators affect the Th2/Th1 cell ratio and contribute to lung function decline [17-18]. Another possible explanation is that excess fat has a mechanical effect on the lungs. Obese individuals have reduced pulmonary compliance, which causes them to feel more breathless than they actually are and may lead them to use more medication for their asthma.

Asthma affected 52.5% more males than females in this study. Whether gender influences the onset of asthma in children remains a topic of mixed results in the literature. In a prospective birth cohort that followed 4,452 children for 11 years, wheezing was 38% more common in males than in females [19]. Another birth cohort study of 4,393 children followed for 14 years

found that boys between the ages of two and three had a 1.6-fold greater chance of developing asthma later in life, whereas girls did not have such an effect (hazard ratio, 0.8) [(20)]. This suggests a possible role for sex hormones in gender differences in asthma progression.

Most of the study population lived in urban areas (55%). Similar results were found in the **Abdou** [(21)] study in 2013. Other studies indicate that children living in urban areas are more likely to develop both obesity and asthma [(22)]. Furthermore, children from urban minority groups with asthma are more likely to engage in reduced physical activity, contributing to obesity [(23)]. Higher levels of nitrogen dioxide (NO^2) exposure in inner-city schools may exacerbate asthma symptoms in obese children [(24)]. Additionally, research has linked childhood obesity to asthma onset and severity [(25)].

This study also found that smoking was common among both obese and non-obese households with children suffering from asthma. However, there was no significant difference in smoking rates between the two groups. Smoking worsens asthma symptoms and increases the likelihood of developing the condition [(26-27)].

Researchers have explored the use of mid-upper arm circumference (MUAC) as a potential screening tool for childhood obesity. Several studies have shown a strong correlation between MUAC and adiposity indices, suggesting that MUAC can accurately identify obesity in children aged 9 to 11 [(28)]. MUAC has also been shown to be a reliable surrogate for identifying overweight and obesity in children from North India [(29)] and Pakistan [(30)].

Hospitalization frequency was significantly and positively correlated with BMI in this study (β=0.38, P<0.001). Overweight children were more likely to require hospitalization, with an annual total of five visits for obese patients compared to three for non-obese children (p=0.001). In the obese group, there was a strong correlation between severe asthma and the frequency of hospitalizations (p<0.001).

In 2016, a meta-analysis revealed that overweight children were somewhat more likely to experience asthma attacks that required hospitalization (OR=1.17, 95% CI: 1.03-1.34; I^2=54.7%) [(31)]. Similarly, **Okubo *et al.*** [(32)] found that obese children had significantly longer hospital stays, and a much higher 30-day readmission rate compared to children of normal weight.

Obesity is significantly associated with the use of either non-invasive or invasive mechanical ventilation among hospitalized children with acute asthma exacerbations, according to nationwide studies in the USA (OR=1.59; 95% CI, 1.28-1.99) [(33)]. Additionally, **Gross *et al.*** [(34)] found that overweight or obese children were more likely to be admitted to the PICU.

CONCLUSION

Obesity significantly correlates with asthma incidence, asthma severity, day and night symptoms, and hospitalization frequency. Obesity in asthmatic children is linked to more severe exacerbation and hospitalizations.

No funding.
No conflict of interest.

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