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Impact of Body Mass Index on Asthma Exacerbations in Children and Adolescents

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ABSTRACT

Background: Asthma is a very common respiratory disease in childhood and adolescence, and the symptoms occur often enough to impair quality of life and resource utilization significantly. The increasing body mass index (BMI) is said to be a factor in an individual having more severe asthma or in poor control of asthma.

Objective: To know the relationship between BMI and asthma exacerbation among pediatric patients managed in a tertiary care hospital.

Methodology: A retrospective observational study was conducted at the Department of Paediatrics and Medicine of District Headquarter Hospital, Turbet, from January 2018 to December 2022. The study reviewed medical records of 220 children and adolescents (aged 5-18 years) with a confirmed diagnosis of asthma. Based on BMI, the participants were divided into underweight, normal weight, overweight and obese. Further data analysis was done using SPSS, and various tests, such as chi-square and multivariable logistic regression, were applied. Ethical approval was obtained from the ethical board of Mekran Medical College.

Results: The present study showed that moderate exacerbations were increased in the obese and overweight children with a p-value of 0.01. Their parameters of lung function were significantly lower FEV₁ and FEV₁/FVC ratio. These obese children also required higher medication use- inhaled corticosteroids (76.6%) and systemic corticosteroids (40%) than their normal-weight counterparts (p-value <0.05).

Conclusion: The role of BMI in the occurrence of exacerbations of asthma and control of asthma in children and adolescents is of tremendous importance. The findings of our study may affect pediatric asthma management dramatically. Obese and overweight children appear to have an increased rate of exacerbations and poorer lung function, whereas underweight children seem to have a tendency to undergo severe exacerbations. Such findings warrant immediate attention and the need for individualized asthma management options related to BMI.

Keywords: Respiratory Issues; Pediatric Asthma; Body Mass Index; Exacerbations

Introduction

Asthma, a prevalent chronic condition affecting children and adolescents worldwide, is characterized by recurrent attacks of wheezing, breathlessness, chest tightness, and cough due to airway inflammation and bronchial hyper-responsiveness.¹ Despite significant advancements in asthma management, the issue of exacerbation remains a major concern. These sudden worsening of symptoms can lead to emergency department visits, hospital admissions, substantial economic costs, and a diminished quality of life for the affected individuals.

The frequency and severity of asthma exacerbations depend on many factors, which include genetic predisposition, various environmental triggers, comorbid conditions, and so on. Recently, BMI has become an important factor in determining the severity and control of asthma. It is necessary to conduct some studies with these two conditions because of the increased direction of increased prevalence of childhood obesity as well as the increasing incidence of asthma in recent years. Most studies have suggested that overweight and/or obese asthmatic children have a higher frequency of exacerbations with severity both in frequency and severity compared to lean subjects, poor control of asthma, and a lesser response to standard treatment regimens, such as inhaled corticosteroids.²⁻⁴ Underweight children and adolescents with asthma face unique challenges. Malnutrition, impaired immune function with diminished muscle mass, affecting respiratory mechanics and lung function; enhanced susceptibility to infections, and a more severe disease course.^{5,6} In this way, BMI on both ends may influence asthma severity, though the underlying mechanisms and clinical implications could be vastly different. Efforts made over the past few years have increasingly reinforced the belief that BMI is associated with asthma; however, it appears increasingly complex, with their interplay being modified by multiple factors such as genetics, environmental exposures, nutritional patterns, the level of activity, and compliance to asthma management.

Understanding the interplay between asthma and obesity is crucial in the context of the increasing prevalence of these conditions in the pediatric population. This understanding can lead to developing more effective, targeted treatment strategies. This study aims to investigate the relationship between BMI and asthma exacerbation in children and adolescents at a tertiary care center. By examining clinical data, we seek to determine whether BMI is a significant predictor of asthma severity and identify potential risk factors for poor disease control. The findings from this study could inform intervention strategies that integrate asthma management and weight-related issues, thereby improving the health outcomes of this vulnerable group.

Objective

To know the relationship between BMI and asthma exacerbation among pediatric patients managed in a tertiary care hospital.

Methodology

The retrospective observational study was conducted at the Department of Paediatrics and Medicine of District Headquarter Hospital, Turbet, from January 2018 to December 2022. Medical records of patients aged from 5 to 18 years having confirmed asthma on basis of clinical history and spirometry findings were reviewed. Patients were included if they had at least one exacerbation of asthma documented and complete data of BMI were available. Patients with other chronic respiratory problems like cystic fibrosis and congenital lung anomalies as well as patients whose medical records were incomplete were excluded to ensure data integrity.

A total of 220 patients were included in this study and data encompassing demographic details, BMI classifications (underweight, normal weight, overweight, obese), asthma severity, frequency of exacerbations, lung function parameters (Forced Expiratory Volume in 1 second [FEV₁], and FEV₁/FVC ratio), and medication use, including inhaled corticosteroids and systemic steroids were collected. Statistical analysis was conducted using descriptive statistics to summarize baseline characteristics. For categorical variables, chi-square or Fisher's exact tests were applied, and t-tests for continuous variables based on data distribution. Multivariate logistic regression analysis assessed the independent association between BMI and asthma exacerbations while adjusting for potential confounders such as age, gender, and asthma severity. All data were added to SPSS for analysis and p-value of <0.05 was considered statistically significant.

The study was conducted using ethical guidelines and received approval (12-8/Med/17) from the review board (IRB) of Mekran Medical College. Patient confidentiality was strictly maintained through data anonymization, ensuring no personally identifiable information was disclosed.

Results

In the present study, a total of 220 children and adolescents aged 5 to 18 years with a confirmed diagnosis of asthma were included. The study population was categorized into four BMI groups, i.e. underweight, normal weight, overweight, and obese. Age differs significantly across groups ($p = 0.04$), with obese children being the oldest on average. Hospitalization rates also show a significant difference ($p = 0.01$), being highest in

Table 1. Baseline Demographic Characteristics of Study Participants

Characteristic	Under weight (n=45)	Normal Weight (n=90)	Over weight (n=55)	Obese (n=30)	p-value
Age (years, mean \pm SD)	9.8 \pm 2.1	10.5 \pm 2.4	11.2 \pm 2.3	11.8 \pm 2.5	0.04
Male (n, %)	25 (55.5%)	48 (53.3%)	27 (49.0%)	14 (46.6%)	0.63
Female (n, %)	20 (44.4%)	42 (46.6%)	28 (50.9%)	16 (53.3%)	0.63
Family history of asthma (n, %)	14 (31.1%)	40 (44.4%)	22 (40%)	15 (50%)	0.22
Hospitalization (n, %)	5 (11.5%)	11 (12.2%)	8 (14.5%)	7 (23.3%)	0.01

the obese group. However, gender distribution and family history of asthma do not vary significantly across BMI categories (Table 1).

Mild exacerbations are most common in normal-weight children, while moderate exacerbations are more frequent in overweight and obese groups (p -value = 0.01). Severe exacerbations are significantly higher in the underweight group (33.3%) compared to others (p -value = 0.03), suggesting a possible link between BMI and asthma severity (Table 2).

The present study showed that obese and overweight children have significantly lower FEV₁ (% predicted) (78 \pm 6; 88 \pm 6), FEV₁/FVC ratio (0.72 \pm 0.05; 0.76 \pm 0.06), and PEFR (% predicted) (80 \pm 6; 84 \pm 6) compared to normal-weight and underweight children (p < 0.05). This suggests that higher BMI is associated with poorer lung function (Table 3).

Results also showed that obese children have the highest use of inhaled corticosteroids (76.6%), systemic corticosteroids (40%), and long-acting beta-agonists (50%), with significant differences (p < 0.05). This suggests that higher BMI is associated with increased medication use, possibly due to poorer asthma control (Table 4).

Discussion

This study offers updated insights into the connection between asthma exacerbations in children and

adolescents in different age groups and their respective body mass index (BMI). By analyzing data from a tertiary care center, the study provides evidence on both ends of the underweight and obese BMI spectrum and how an individual's BMI level influences asthma severity, lung function, and medication use. Results showed that obese children showed more frequent, severe exacerbations, poorer lung function, and a need for higher corticosteroid doses compared to their underweight counterparts, who showed exacerbations of the severe type with alterations in respiratory function. These findings aligned with the previous studies and strongly advocated for BMI inclusion in developing personalized asthma management approaches.⁷⁻⁹ The present associations would help providers tailor interventions toward improving asthma control and overall health outcomes for this population.

Our current investigation reveals that children who are overweight or obese sustain a greater incidence of moderate exacerbations as opposed to those with normal weight, and there is a statistically significant disparity between these children (p =0.01). This finding supports earlier studies, such as Sharma et al. (2021), reporting that obesity increases the risk of asthma exacerbation and of attending the emergency room due to asthma exacerbation.¹⁰ Systemic inflammation, altered immune response, and mechanical effects of excessive weight on lung function are possible mediators of this association. In contrast, in the present study, children with low weight had a significantly higher prevalence of severe

Table 2. Frequency and Severity of Asthma Exacerbations

Exacerbation Severity	Under weight (n=45)	Normal Weight (n=90)	Over weight (n=55)	Obese (n=30)	p-value
Mild (n, %)	16 (35.5%)	40 (44.4%)	18 (32.7%)	8 (26.6%)	0.02
Moderate (n, %)	14 (31.1%)	30 (33.3%)	25 (45.4%)	14 (46.6%)	0.01
Severe (n, %)	15 (33.3%)	20 (22.2%)	12 (21.8%)	8 (26.6%)	0.03

Table 3. Lung Function Parameters by BMI Category

Parameter	Underweight (n=45)	Normal Weight (n=90)	Overweight (n=55)	Obese (n=30)	p-value
FEV ₁ (% predicted)	85 ± 5	88 ± 6	82 ± 7	78 ± 6	0.03
FEV ₁ /FVC Ratio	0.79 ± 0.05	0.81 ± 0.04	0.76 ± 0.06	0.72 ± 0.05	0.01
PEFR (% predicted)	87 ± 4	90 ± 5	84 ± 6	80 ± 6	0.02

exacerbations ($p=0.03$). These findings are in line with the findings of Lang et al. (2018), indicating that malnutrition and dysfunction in the immune system in underweight persons may increase the severity of the disease.¹¹

The present study also suggested that obese children presented the lowest FEV₁ and FEV₁/FVC ratio under obstructive airway pattern. The reduced FEV₁/FVC ratio among the obese (0.72 ± 0.05) was significantly lower than the normal-weight children (0.81 ± 0.04 , $p = 0.01$). Dixon et al. (2010) also presented the same findings, which stated that a strong relationship exists between obesity and decreased lung volumes and airway narrowing.¹² Their Peak Expiratory Flow Rate (PEFR) values were also reduced in overweight and obese children, indicating that increased adiposity adversely affects respiratory mechanics. Therefore, these findings further strengthen the hypothesis that obesity causes airway dysfunction by increasing airway resistance and reducing lung compliance.

The present study also suggests an increased requirement for asthma medication, including inhaled corticosteroids (76.6% in obese vs. 61.1% in normal-weight children, p -value = 0.04) and systemic corticosteroids (40% in obese vs. 22.2% in normal-weight children, p -value = 0.01), in overweight and obese children. This increased need for medication reflects a similar trend in a study by Boulet et al. (2019), who found that obese asthmatics required higher doses of corticosteroids for systemic inflammation and different drug metabolism.¹³ The increased use of long-acting beta-agonists (LABAs) and leukotriene receptor

antagonists (LTRAs) in the obese children in our study is indicative of worse control of asthma in this population, corroborating the data reported by Thompson et al. (2021) that overweight patients show poor response to standard asthma therapies.¹⁴

Several other investigations have examined the influence of BMI on the severity of asthma. Our findings corroborate the report by Peters et al. (2018) that concludes that obesity increases late and early asthma severity and frequency of exacerbations.¹⁵ Equally illustrative is the finding of the CAMP study that overweight and obese children exhibited poorer control over their asthma and higher medication use (Tantisira et al., 2003).¹⁶ However, while most studies emphasize obesity, our study emphasizes that underweight children also face unique obstacles that could include more intense exacerbations and possible nutritional insufficiencies impairing lung function. This deserves additional investigation, as it has been under-represented in the literature.

There are multiple pathways by which BMI affects asthma severity. Inflammation by obesity in a systemic manner, with cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF- α), may contribute to persistent airway inflammation.¹⁷ The increased weight exerts mechanical effects, which may reduce diaphragm movement or lower lung volumes and thus increase any symptoms of impaired ventilation. On the opposite side, underweight children may have limited muscle strength in respiration and deficiency of immune function, increasing their vulnerability to many infections and consequent severe exacerbations.

Table 4. Medication Use and Asthma Control by BMI

Medication Use	Under weight (n=45)	Normal Weight (n=90)	Over weight (n=55)	Obese (n=30)	p-value
Inhaled corticosteroids (n, %)	24 (53.3%)	55 (61.1%)	35 (63.6%)	23 (76.6%)	0.04
Systemic corticosteroids (n, %)	10 (22.2%)	20 (22.2%)	15 (27.2%)	12 (40%)	0.01
Long-acting beta-agonists (n, %)	12 (26.6%)	25 (27.7%)	20 (36.3%)	15 (50%)	0.02
Leukotriene receptor antagonists (n, %)	14 (31.1%)	30 (33.3%)	22 (40%)	16 (53.3%)	0.03

From an asthma management perspective, analyzing how any given anthropometric measure influences asthma control and treatment is important. Conversely, issues of weight management should be embedded in asthma care, with specific emphasis on interventions for obese and underweight children. Clinicians should facilitate clinical practice guidelines to consider treatment options tailored distinctly to a child's needs, including input regarding lifestyle, diet, and pharmacotherapy. More studies are warranted to assess the long-term effects of weight change on asthma and develop interventions to decrease asthma severity and concerns related to weight.

Conclusion

Our study highlights the significant role of BMI in determining asthma severity and control in children and adolescents. Children with obesity or overweight BMI are more likely to experience frequent exacerbations, reduced lung function, and increased medication use. Conversely, underweight children have a higher prevalence of severe exacerbations. These findings underscore the need to consider weight-related factors in personalized asthma management, with the aim of improving disease control and patient outcomes. Importantly, future research should focus on identifying the physiological and inflammatory mechanisms linking BMI and asthma, as this could lead to breakthrough interventions that cater to all weight classes in asthma care.

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