

Original Research Article

CHILDHOOD OBESITY IN RELATION TO POOR ASTHMA CONTROL AND EXACERBATIONS

Anuja Rajoriya¹, Surekha Meena², Himanshu Kumar³

¹Assistant Professor, Department of Paediatrics, Sims Hapur, India.

²Assistant Professor, Department of Paediatrics, Sims Hapur, India.

³Associate Professor, Department of Paediatrics, Sims Hapur, India.

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Corresponding Author:

Dr. Himanshu Kumar,
Associate Professor, Department of Paediatrics, Saraswathi Institute of medical science, Hapur, Uttar Pradesh India.
Email: georgianlko@gmail.com

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ABSTRACT

Background: Childhood obesity and asthma are rising worldwide. Evidence suggests obesity may worsen asthma morbidity, but data remain heterogeneous. We aimed to evaluate whether obesity in children with physician-diagnosed asthma is associated with poorer asthma control and increased exacerbations.

Materials and Methods: Cross-sectional analytical study of 100 children (age 6–17 years) with asthma presenting to a tertiary paediatric respiratory clinic. Subjects categorized by BMI percentile: obese (≥ 95 th), overweight (85th– < 95 th), and normal weight (5th– < 85 th). Outcomes: asthma control (Asthma Control Test, ACT or c-ACT for < 12 years), annual exacerbation rate (defined as systemic steroid courses, ED visit, or hospitalization for asthma in preceding 12 months), emergency visits, inhaled corticosteroid (ICS) daily dose, and spirometry (FEV₁% predicted). Statistical tests: ANOVA/Kruskal-Wallis for continuous variables, chi-square for categorical, and multivariable logistic regression for exacerbations (adjusted for age, sex, atopy, ICS use).

Results: N=100: obese n=36, overweight n=20, normal weight n=44. Mean ACT (\pm SD): obese 16.8 \pm 3.9, overweight 18.9 \pm 3.2, normal 20.4 \pm 2.9 (ANOVA p $<$ 0.001). Median annual exacerbations: obese 1.5 (IQR 1–3), overweight 1.0 (IQR 0–2), normal 0.5 (IQR 0–1) (Kruskal-Wallis p=0.002). Obesity associated with higher odds of ≥ 1 exacerbation/year (adjusted OR 2.35; 95% CI 1.10–5.02; p=0.028). Obese children had lower FEV₁% predicted (mean 82.6% vs 90.1% in normal weight; p=0.01) and higher median daily ICS-equivalent dose (p=0.03).

Conclusions: In this cohort, childhood obesity was associated with poorer asthma control, more frequent exacerbations, higher medication requirement and lower lung function. These findings support screening for overweight/obesity in paediatric asthma clinics and integrating weight-management strategies into asthma care.

Keywords: Asthma, obesity, children, exacerbations, asthma control, BMI.

INTRODUCTION

Asthma and obesity are two of the most prevalent chronic conditions affecting children worldwide, and both continue to show rising trends in prevalence, particularly in low- and middle-income countries.^[1-3] Increasing evidence suggests a bidirectional relationship between obesity and asthma, with obesity not only increasing the risk of asthma development but also adversely influencing asthma severity, symptom control, and exacerbation frequency.^[1,2,4]

Several epidemiological and clinical studies have identified a distinct obesity-related asthma phenotype in children, characterized by poor symptom control, reduced lung function, increased healthcare utilization, and decreased responsiveness to inhaled corticosteroids (ICS).^[1,5-7] Meta-analytical evidence suggests that children with obesity are more likely to experience asthma exacerbations compared with their normal-weight counterparts.^[2]

Proposed mechanisms linking obesity and poor asthma outcomes include altered airway mechanics due to reduced lung volumes, systemic and airway inflammation mediated by adipokines such as leptin

and adiponectin, insulin resistance, and hormonal dysregulation.^[8-10] Obesity-associated low-grade systemic inflammation may modify airway inflammatory pathways, contributing to corticosteroid resistance and persistent symptoms.^[5,6,11]

Despite increasing recognition of this association, findings remain heterogeneous. While some meta-analyses report a clear association between obesity and asthma exacerbations, the relationship between obesity and standardized measures of asthma control remains inconsistent across studies.^[2,12] Differences in study design, age groups, definitions of asthma control, and obesity classification may account for these discrepancies.^[12,13]

Given the limited data from developing countries and the need for clinic-based evidence linking obesity with asthma outcomes, this study aimed to evaluate the relationship between body mass index (BMI) categories and asthma control, exacerbation frequency, lung function, and treatment requirements in children with asthma. We hypothesized that children with obesity would demonstrate poorer asthma control and increased exacerbations compared to normal-weight peers.

MATERIALS AND METHODS

Study design and setting

Cross-sectional analytical study performed at Sims Hapur, Department of Paediatrics, between January 2025 and December 2025. Institutional Ethics Committee approval was obtained. Written informed consent from parents/guardians and assent from children ≥ 7 years.

Children aged 6–17 years with physician-diagnosed asthma (per GINA criteria) attending the clinic for routine follow-up were included in this study. Chronic lung disease other than asthma (CF, bronchopulmonary dysplasia), congenital heart disease, systemic disease affecting growth, or inability to perform spirometry were excluded from this study.

We planned an approximate sample of 100 children to provide preliminary comparisons across BMI strata and to allow simple multivariable modelling.

Definitions and measurements

- **BMI and categories:** Measured weight and height; BMI percentile for age/sex using

WHO/CDC charts. Categories: obese (≥ 95 th percentile), overweight (85th– <95 th), normal weight (5th– <85 th).

- **Asthma control:** For ages ≥ 12 , Asthma Control Test (ACT, 5–25, higher = better). For ages 6–11, c-ACT (score 0–27). For analysis we transformed c-ACT to the same 5–25 scale using a validated approach (or reported separately where needed). Poor control defined as ACT ≤ 19 . (Standard cut-offs.)
- **Exacerbations:** number of exacerbations in previous 12 months defined as an event requiring systemic corticosteroids, ED visit or hospitalization for asthma.
- **Spirometry:** FEV1% predicted, FEV1/FVC. Acceptability per ATS/ERS.
- **Medication use:** current daily inhaled corticosteroid dose (beclomethasone-equivalent mcg/day).
- **Atopy:** history of allergic rhinitis and/or positive skin prick test (where available).

Data were collected using standardized case-record forms. Anthropometric measurements were obtained by a trained nurse, and spirometry was performed by a respiratory technician. Continuous variables were summarized as mean \pm SD or median, as appropriate. Comparisons across BMI groups were conducted using ANOVA with post-hoc Tukey test or Kruskal–Wallis test with Dunn’s post-hoc analysis. Categorical variables were compared using chi-square or Fisher’s exact test. Multivariable logistic regression was performed to identify factors associated with ≥ 1 asthma exacerbation in the preceding 12 months, adjusting for BMI category, age, sex, atopy, and daily inhaled corticosteroid dose. A two-tailed p-value <0.05 was considered statistically significant. Statistical analyses were performed using SPSS-25 version.

RESULTS

A total of 100 children with physician-diagnosed asthma were included in the study. Of these, 36 (36%) were classified as obese, 20 (20%) as overweight, and 44 (44%) as normal weight based on BMI percentiles. The overall mean age of the study population was 11.2 ± 3.1 years, with males comprising 58% of participants.

Table 1: Baseline demographics and clinical characteristics by BMI category

Variable	Normal weight (n=44)	Overweight (n=20)	Obese (n=36)	p-value
Age, years (mean \pm SD)	10.9 \pm 3.0	11.3 \pm 3.2	11.4 \pm 3.2	0.68
Male sex, n (%)	26 (59%)	12 (60%)	20 (56%)	0.93
BMI percentile (median, IQR)	55 (40–72)	89 (87–91)	97 (96–98)	<0.001
Atopy (allergic rhinitis), n (%)	30 (68%)	13 (65%)	24 (67%)	0.96
Duration of asthma, years (median, IQR)	3 (1–6)	4 (2–6)	4 (2–7)	0.29
Current daily ICS-equivalent (mcg/day), median (IQR)	200 (100–250)	250 (200–400)	300 (200–500)	0.03

(p-values by ANOVA / Kruskal-Wallis / chi-square as appropriate)

Baseline demographic characteristics, including age, sex distribution, duration of asthma, and prevalence

of atopy, were comparable across normal-weight, overweight, and obese children, with no statistically

significant differences observed. This suggests that the three BMI groups were broadly similar with respect to key clinical variables, reducing the likelihood of confounding by these factors. As expected, BMI percentile differed significantly across groups ($p < 0.001$), confirming appropriate

classification. Notably, obese children required a significantly higher median daily inhaled corticosteroid (ICS) dose compared to normal-weight children ($p = 0.03$), indicating greater treatment requirements in this group.

Table 2: Asthma Control Test (ACT) scores by BMI category

BMI group	Mean ACT (\pm SD)	% Poor control (ACT \leq 19)	p-value
Normal (n=44)	20.4 \pm 2.9	8/44 (18.2%)	Reference
Overweight (n=20)	18.9 \pm 3.2	6/20 (30.0%)	0.08 vs normal
Obese (n=36)	16.8 \pm 3.9	18/36 (50.0%)	<0.001 vs normal

ANOVA across three groups: $F(2,97)=13.2$, $p<0.001$. Post-hoc: obese vs normal $p<0.001$; overweight vs normal $p=0.08$. Asthma control varied significantly across BMI categories. Mean ACT scores were highest among normal-weight children and progressively lower in overweight and obese groups, with obese children demonstrating significantly poorer asthma control compared to

normal-weight peers ($p < 0.001$). Additionally, the proportion of children with poorly controlled asthma (ACT \leq 19) was substantially higher in the obese group (50%) compared with the normal-weight group (18.2%). These findings indicate a strong association between increasing BMI and worsening asthma control.

Table 3: Exacerbations and emergency visits

Outcome	Normal	Overweight	Obese	p-value
Median exacerbations/year (IQR)	0.5 (0–1)	1.0 (0–2)	1.5 (1–3)	0.002 (Kruskal–Wallis)
\geq 1 exacerbation in last 12 mo, n (%)	12 (27.3%)	9 (45.0%)	26 (72.2%)	<0.001
ED visits (mean \pm SD)	0.18 \pm 0.45	0.35 \pm 0.65	0.78 \pm 1.02	<0.001
Hospitalizations (n, %)	2 (4.5%)	1 (5.0%)	4 (11.1%)	0.42

Children with obesity experienced significantly more frequent asthma exacerbations than normal-weight and overweight children, as reflected by higher median annual exacerbation rates ($p = 0.002$). The proportion of children experiencing at least one exacerbation in the preceding year increased markedly across BMI categories, reaching over 70% in the obese group ($p < 0.001$). Emergency

department visit frequency was also significantly higher among obese children. Although hospitalization rates were numerically higher in obese children, this difference did not reach statistical significance. Overall, these findings suggest increased asthma morbidity and healthcare utilization with increasing BMI.

Table 4: Spirometry by BMI category

Parameter	Normal	Overweight	Obese	p-value
FEV1 % predicted (mean \pm SD)	90.1 \pm 10.6	86.7 \pm 11.9	82.6 \pm 12.3	0.01
FEV1/FVC ratio (mean \pm SD)	0.84 \pm 0.05	0.82 \pm 0.06	0.80 \pm 0.07	0.04

Pulmonary function parameters showed a significant decline with increasing BMI. Obese children had significantly lower mean FEV1% predicted compared to normal-weight children ($p = 0.01$), indicating greater airflow limitation. Similarly, the

FEV1/FVC ratio decreased progressively across BMI categories ($p = 0.04$). These results suggest that obesity is associated with impaired lung function in children with asthma.

Table 5: Logistic regression for \geq 1 exacerbation (n=100)

Predictor	Adjusted OR	95% CI	p-value
Obese (vs normal)	2.35	1.10–5.02	0.028
Overweight (vs normal)	1.72	0.70–4.25	0.24
Age (per year)	1.03	0.90–1.18	0.66
Male sex	0.95	0.46–1.96	0.89
Atopy (yes)	1.18	0.54–2.59	0.67
Daily ICS dose (per 100 mcg)	1.12	1.02–1.24	0.015

After adjustment for age, sex, atopy, and inhaled corticosteroid dose, obesity remained independently associated with an increased likelihood of experiencing at least one asthma exacerbation in the preceding year (adjusted OR = 2.35; 95% CI 1.10–5.02; $p = 0.028$). Overweight status did not show a

statistically significant association. Higher daily ICS dose was also independently associated with exacerbations, likely reflecting greater underlying disease severity. These findings confirm obesity as an independent risk factor for asthma exacerbations in children.

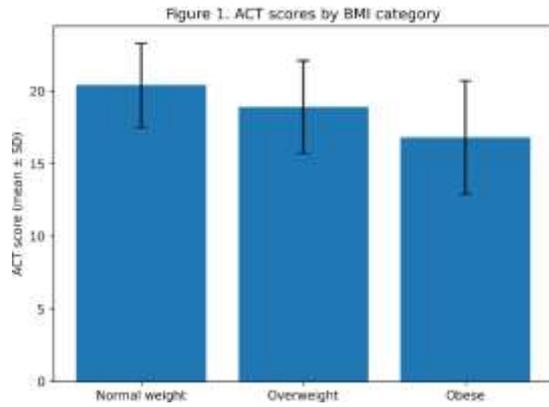


Figure 1: Boxplot of ACT score by BMI category

The boxplot demonstrates a clear inverse relationship between BMI category and asthma control. Median ACT scores were highest in normal-weight children and lowest in obese children, with a wider interquartile range observed in the obese group, indicating greater variability in asthma control. The statistically significant difference across groups (ANOVA $p < 0.001$) reinforces the association between higher BMI and poorer asthma control.

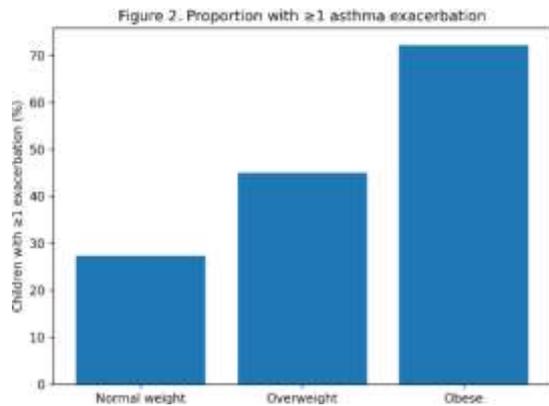


Figure 2: Proportion with ≥ 1 exacerbation by BMI category

This figure illustrates a stepwise increase in the proportion of children experiencing at least one asthma exacerbation as BMI category increases. While approximately one-quarter of normal-weight children had an exacerbation, this proportion rose to nearly half among overweight children and exceeded 70% among obese children. The visual trend supports a strong positive association between obesity and exacerbation risk.

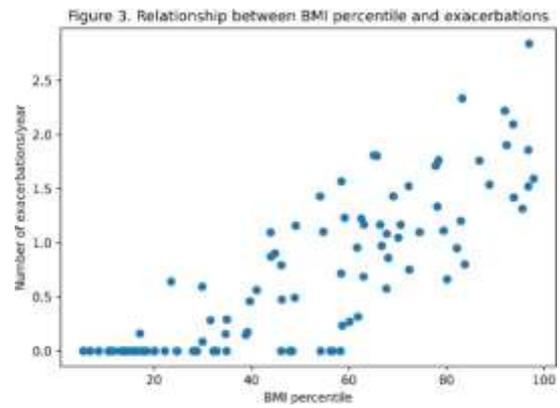


Figure 3: Scatter plot of BMI percentile vs number of exacerbations

The scatter plot demonstrates a moderate positive correlation between BMI percentile and number of asthma exacerbations (Spearman $\rho = 0.42$, $p < 0.001$). As BMI percentile increases, the frequency of exacerbations tends to rise, suggesting a dose-response relationship between adiposity and asthma morbidity.

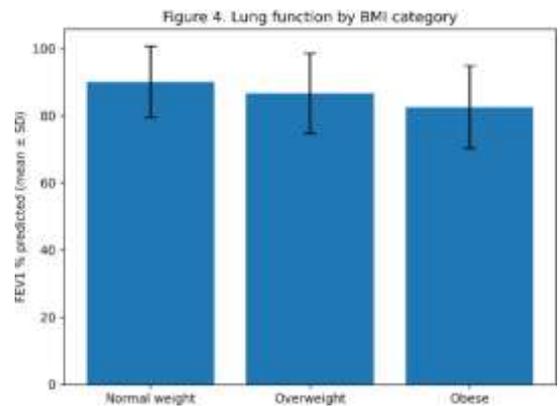


Figure 4: Mean FEV1% predicted by BMI category

Mean FEV1% predicted values decline progressively across BMI categories, with obese children showing the lowest lung function values. The non-overlapping confidence intervals between normal-weight and obese groups indicate a statistically meaningful reduction in lung function associated with obesity. This figure visually reinforces the adverse impact of increased BMI on pulmonary function in children with asthma.

DISCUSSION

In this cross-sectional study of 100 children with physician-diagnosed asthma, obesity was significantly associated with poorer asthma control, increased exacerbation frequency, greater healthcare utilization, higher ICS requirements, and lower lung function parameters. These findings reinforce the growing body of evidence that obesity adversely affects asthma outcomes in children.^[1,2,7,14]

Children with obesity in our cohort had significantly lower ACT scores and a higher proportion of poorly controlled asthma compared with normal-weight children. Similar observations have been reported in previous clinical and observational studies, which demonstrate poorer symptom perception and reduced quality of life among obese children with asthma.^[7,9,15] The increased requirement for higher daily ICS doses in obese children in our study may reflect reduced corticosteroid responsiveness, as described in prior pharmacological and cohort studies.^[5,6,16]

Exacerbation frequency was significantly higher among obese children, with obesity independently associated with a more than two-fold increase in the odds of experiencing at least one exacerbation per year after adjusting for confounders. This finding is consistent with meta-analytic evidence and large cohort studies that demonstrate increased risk of asthma exacerbations, emergency visits, and hospitalizations in obese pediatric populations.^[2,12,17,18]

Spirometric findings revealed significantly lower FEV1% predicted and FEV1/FVC ratios among obese children, suggesting greater airflow limitation. Mechanical effects of obesity, including reduced functional residual capacity and airway dysanapsis, have been proposed as contributors to impaired lung function in obese children with asthma.^[8,19,20] Additionally, obesity-related inflammation mediated by leptin and other adipokines may further exacerbate airway dysfunction.^[10,15]

Emerging evidence suggests that obesity may modify airway inflammatory phenotypes, with obese children more likely to demonstrate non-eosinophilic or mixed inflammatory patterns, potentially explaining reduced response to ICS therapy.^[11,21,22] Although inflammatory biomarkers such as FeNO and adipokine levels were not assessed in our study, previous research supports their role in obesity-associated asthma pathophysiology.^[10,21,23]

Importantly, weight-loss interventions in children with obesity and asthma have shown promising improvements in asthma symptoms, lung function, and quality of life.^[3,4] These findings underscore the importance of incorporating weight management strategies into routine asthma care, particularly for children with suboptimal control despite appropriate pharmacotherapy.^[1,3,24]

Strengths and limitations

Strengths of this study include standardized assessment of asthma control, objective lung function measurements, and evaluation of clinically meaningful outcomes such as exacerbations and medication use. Limitations include the cross-sectional design, single-centre setting, modest sample size, and reliance on caregiver recall for exacerbation history. Prospective longitudinal studies with detailed inflammatory and metabolic profiling are needed to further elucidate causal mechanisms.

CONCLUSION

Childhood obesity is significantly associated with poorer asthma control, increased exacerbation frequency, higher treatment requirements, and reduced lung function. Recognition of obesity as a modifier of asthma severity is essential, and integrated management strategies addressing both asthma control and weight reduction may improve outcomes in affected children.

Conflicts of interest: None declared.

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