

## Association between Asthma and Body Mass Index in Children

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### ABSTRACT

Obesity has been reported to be associated with an increase in asthma in children. If there is any association, it could be attributed to an effect of obesity on lung volume and thus airway's obstruction.

Data from 2413 children aged 7–12 years in Isfahan were analyzed. The subjects were included in this study if data were available for: height, weight, age, lung volume, and any measure of asthma, including history of diagnosed asthma, wheeze, chronic cough, and medication as obtained by questionnaire. Body mass index (BMI) percentiles, divided into quintiles per year age, were used as a measure of standardized weight.

After adjusting for, sex, age, smoking and family history, BMI was a significant risk factor for wheeze ever ( $p = 0.000$ ) and asthma ever ( $p = 0.000$ ), diagnosed asthma ( $P=0.000$ ) and current asthma ( $p = 0.000$ ). There was no significant correlation between BMI and obstructive spirometry. Increased BMI was significantly associated with an increased airway resistance.

Despite the fact that higher BMI is a risk factor for, wheeze ever, wheeze and dyspnea in the last 12 months, and diagnosed asthma, higher BMI is not a risk factor for obstructive pattern in pulmonary function test.

**Keywords:** Asthma; Body Mass Index; Children; Iran; Obesity

### INTRODUCTION

In the past two decades there has been a significant increase in the prevalence of asthma, atopy, and obesity in children worldwide.<sup>1</sup> It is possible that these events are linked.<sup>2-4</sup>

In children, most cross sectional studies of large random population samples have shown that excess body weight is associated with a higher rate of both symptoms and diagnosed asthma.<sup>2,3</sup> However, in Taiwanese teenagers obesity was associated with an increase in airway hyper responsiveness, atopy, and atopic symptoms in girls but not boys.<sup>3</sup> This suggests that the association between asthma and excess body weight may differ between adults and children and between boys and girls.

A more recent study could not disclose any

significant correlation between asthma as defined by bronchial hyper-responsiveness and obesity, and stressed that the reported associations might be due to miss-interpretation of noisy breathing in overweight subjects in questionnaire based studies.<sup>4,5</sup>

In this article we have performed a cross sectional study in a large population of Iranian children. The purpose was to determine if increased body weight, as measured by body mass index, was associated with a higher prevalence of asthma symptoms or obstructive pattern in spirometry. Possible differences between boys and girls with regard to the mentioned association are also evaluated.

### MATERIALS AND METHODS

During the years between 1998 and 2000, two epidemiologic studies were conducted to determine the Prevalence of asthma in primary school and junior high school children in Isfahan.<sup>6,7</sup> Children aged 6 to 14 years were enrolled in the study. A modified ISAAC questionnaire enhanced with, pulmonary

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function tests (PFT) was used for the purpose. Details of the populations, response rates, and non-responders have been published elsewhere.<sup>6,7</sup> Data from the mentioned studies was used to evaluate possible associations between asthma symptoms and BMI quantiles. In this study only those children; for whom height, weight, age, and pulmonary function had been measured were included. Information on symptoms, family history, and diagnoses was collected by a parent completed questionnaire.<sup>8</sup> In this study asthma-ever is defined as any history of wheezy breathing associated with dyspnea, current asthma is a history of at least one attack of wheezy breathing and dyspnea during the last 12 months, diagnosed asthma is the same as asthma ever plus a doctor diagnosis of asthma. All of the mentioned conditions were confirmed in medical interview performed during the pulmonary function testing sessions.

Obstructive pattern in spirometry was rather loosely defined as a finding of FEV<sub>1</sub>/FVC of less than 75% and/or FEF<sub>25-75</sub> of less than 70% of predicted value. Air-way resistances in excess of 150% of normal values were categorized as abnormal.

Lung function was recorded using Master Lab. Body (Erich Jägers Germany). Forced expiratory maneuvers were repeated until two measurements of forced expiratory volume in 1 second (FEV<sub>1</sub>) within 100 ml were obtained. The largest FEV<sub>1</sub> was used in the analyses. Children were tested after withholding  $\beta$  agonist for at least 6 hours. Percentage predicted FEV<sub>1</sub>, forced vital capacity (FVC), and PEFR were calculated.<sup>9</sup>

Air-ways resistance was measured using the same device at the same session.

Normal values for the measured values were derived from published local equations.<sup>10</sup>

To simplify analysis of the data; the recorded spirometric values, were categorized into normal and abnormal values, based on the criteria described above.

BMI was calculated by dividing weight in kg, by the square of the height in meters {(weight in kg / (height m)<sup>2</sup>},<sup>11</sup> There is no standard definition for obesity with regard to weight distribution in children, so we used BMI quantiles; per sex per age as a measure of standardized weight.<sup>11,12</sup> We present results as BMI percentiles corrected for age and sex. BMI percentiles divided into quintiles were used to assess the relationship between standardized weight, symptoms, and lung function. This kind of subdivision of BMI in children has been previously published for Isfahanian pediatric populations and seems to be a suitable model for our study<sup>(13)</sup>. To avoid the effects of malnutrition and/or chronic illnesses a few pupils with BMI<5<sup>th</sup> percentile were excluded from the analysis.

The included quantiles are as follows:

- 1- BMI= 6- 25<sup>th</sup> percentile
- 2- BMI =26-50 percentile
- 3- BMI =51-85 percentile
- 4- BMI =86-95 percentile
- 5- BMI>95 percentile

The statistical package for the social sciences (SPSS, version 10. Chicago, IL), was used for data analysis. To compensate for multiple comparisons; for all analyses p values of <0.01 were regarded as significant. Pearson's chi square (X<sup>2</sup>) statistic and Kruskal-Wallis test were used to determine the significance of differences in prevalence between different BMI groups.

**Table 1. Distribution of the frequency of asthma, or asthma related symptoms as compared with kruskal-wallis test in children with various body mass index (BMI) quintiles.**

Topics	BMI-Q1 No=550*		BMI- Q2 N=605*		BMI- Q3 N=579*		BMI- Q4 N=513*		BMI- Q5 N=166*		P ‡ total	P § boy	P § girl
	No†	%	No†	%	No†	%	No†	%	No†	%			
Family History of Asthma	16	2.9	14	2.3	12	2.1	8	1.5	5	3	.000	.000	.000
Wheeze Ever	192	35.2	123	20.6	101	17.9	120	23.7	59	36.4	.000	.000	.000
Asthma Ever	66	12.6	88	14.5	108	18.6	106	20.7	49	29.6	.000	.02	.000
Diagnosed Asthma	64	21.4	35	12.8	30	12	23	8.2	10	9	.000	.012	.000
Current Asthma	66	12	88	14.5	108	18.7	106	20.8	49	29.6	.000	.000	.09

= total number in each quintile (Q)

†= number of affected children

‡=significance of difference between quintiles for the whole group

§= significance of difference between quintiles for the boys

§= significance of difference between quintiles for the girls

**Table 2. Distribution of abnormal spirometric parameters in various quintiles as compared with crusal-valis test.**

Topics	BMI-Q1		BMI- Q2		BMI- Q3		BMI- Q4		BMI-Q5		P ‡ total	P § boy	P ξ girl
	No†	%	No†	%	No†	%	No†	%	No†	%			
FVC	55	9.9	28	4.7	47	8.1	32	6.0	9	4.8	0.08	0.06	.2
FEV1	51	9.5	28	4.7	38	6.7	29	5.7	7	4.2	.17	.09	.1
FEV1/FVC	4	1.3	8	1.73	18	3.8	6	1.8	0	0	.04	.05	.041
FEF <sub>25-75</sub>	72	13.1	61	10	47	8.1	46	9	21	12.6	.04	.013	.035
TLC	89	39.2	29	23.9	10	23.2	5	27.7	3	75	.008	.2	.007
RV	103	45.3	50	41.3	19	44.1	10	55.5	3	75	.000	.000	.09
Airway's Resistance	105	47.5	54	44.3	20	48.5	11	67.3	4	100	.000	.000	.001

Missing values are more frequent for TLC, RV and airway's resistance

†= number of affected children

‡=significance of difference between quintiles for the whole group

§= significance of difference between quintiles for the boys

ξ= significance of difference between quintiles for the girls

## RESULTS

Complete data were available for 2413 children. The proportion of participants in each group, classified according to quartiles of BMI percentile, is shown in table 1. The basis of this classification is justified by previous studies in Iran.<sup>13</sup>

As shown in tables 1 and 2, higher BMI was associated with a: higher prevalence of wheeze ever, diagnosed asthma, current asthma, reduced total lung capacity (TLC) and. An increased residual volume (RV) were observed only in those pupils with the highest BMI patterns.

In differential analyses of data from girls and boys, a higher BMI was significantly associated with a higher prevalence of, wheeze in the last 12 months, wheeze ever, dyspnea and wheeze ever, in both girls and boys.

## DISCUSSION

Despite the recent findings confirming the fact that obesity, by it self might be considered as an inflammatory condition,<sup>14</sup> and the generally approved fact that asthma is an inflammatory process,<sup>15</sup> associations between the two conditions are not well understood.<sup>16</sup>

Although BMI may not be the best measure of obesity in children, it is widely used and we do not have a more convenient alternative definition.<sup>11</sup>

This study confirms the findings of previous studies that a higher BMI is associated with a higher prevalence of wheezy breathing and usual asthma symptoms in children. However, there was no association between higher BMI and the presence of

airways obstruction as diagnosed by obstructive pattern in spirometry.

The only statistically significant association was between increased BMI and excessive airways resistance.

Significance of the later finding is questionable, since obesity may increase the airways resistance, especially in the upper airways in the absence of asthma.<sup>17</sup>

The findings suggest that a higher BMI in children is associated with a higher prevalence of symptoms that are often attributed to asthma, but not with a higher prevalence of asthma.

The association between a higher BMI and symptoms of wheeze and cough in children has been observed in previous studies.<sup>18,19</sup> However, wheeze and cough are non-specific symptoms which may be attributed to a number of different causes, including asthma. To confirm a diagnosis of asthma in children presenting with a history of wheeze or cough, it would usually be necessary to find evidence of variable airway obstruction. In our population the increased prevalence of wheeze associated with increased BMI was not associated with any higher prevalence of airway obstruction. This suggests that the excess symptoms among overweight children may be due to causes other than asthma. Increased BMI is associated with an increase in the occurrence of both gastro-esophageal reflux<sup>20</sup> and sleep apnoea,<sup>21</sup> and both of these conditions may mimic the symptoms of wheeze or cough without changes in lung function or airway responsiveness.<sup>22</sup> The same argument can be applied to the association between diagnosed asthma and obesity; simply the physicians might have interpreted the mentioned wheeze as asthma.

Alternatively, increased BMI may be associated with a number of changes to the mechanical function of the lungs and airways that could lead to symptoms of wheeze and cough.<sup>23</sup> Other studies have shown that a higher BMI is associated with a higher rate of wheeze with exercise.<sup>24</sup> In this study we did not collect information that would allow us to differentiate between wheeze at rest and wheeze with exertion, so we could not determine the extent to which the excess wheezing in our overweight subjects was due to wheeze during exercise. Exertional wheeze in overweight subjects may be due to an increase in the work of breathing, with upper airway collapse or changes in lung mechanics increasing the load on the upper airway. Other studies have shown an increase in airway resistance in obese subjects<sup>23</sup> and wheeze may be due to changes in airway caliber, collapsibility, or inability to overcome airway hysteresis.

Although others have shown previously that FVC is reduced in obese adults,<sup>19</sup> we did not find a significant reduction in FVC in children in the highest BMI quintile. However when we measured total lung capacity, a slight reduction of TLC was noted in obese children. It is necessary to provide more observations with regard to lung volumes in asthmatic children either obese or thin.

Although inhaled corticosteroid medication can normalize lung function and airway responsiveness<sup>25</sup> it is unlikely that the use of such medication could account for the absence of any association between a higher BMI and increased airway obstruction or airway hyper responsiveness since only a few children were taking such a treatment during the study period. Furthermore, it is unlikely that symptoms would persist during inhaled corticosteroid medication treatment if airway hyper responsiveness or airway obstruction had been normalized.

A previous study found that increased BMI was associated with a higher prevalence of atopy and symptoms of wheeze in girls but not in boys; however such a difference could not be shown in our study.<sup>3</sup>

Our study has significant clinical implications. Previous studies have shown higher rates of diagnosed asthma in obese children.<sup>24,26,27</sup> However, without evidence of airway obstruction or airway responsiveness, it is unlikely that these children truly have asthma. It is important to elucidate the true etiology of symptoms in overweight children. Increasing symptoms with higher weight may be the result of being unfit, worsening asthma, gastroesophageal reflux, or sleep disordered breathing. The treatment options for these etiologies vary markedly.

Some may require inhaled or even oral corticosteroids which, if used indiscriminately, may exacerbate the weight problem. Others may be more likely to benefit from a weight loss program, H<sub>2</sub> blockers, or even nasal continuous positive airway pressure.

It is unlikely that a higher BMI is a risk factor for asthma or airway hyper responsiveness in children and it is likely that the prevalence of asthma in obese children is the same as in the rest of the population. Obesity and asthma are both significant health problems and must be addressed in both children and adults to optimize lung function and quality of life.

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