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Association of Body Mass Index with Asthma Severity and Pulmonary Function among Asthmatic Children

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Abstract

Background

Asthma is a chronic inflammatory disease in respiratory system and obesity is another inflammatory disease of which incidence rate is increasing. Although, many studies have been conducted on severity of asthma and its relationship with obesity, but different results have been obtained. This study aimed to determine a relationship between BMI with asthma severity and pulmonary function in Kurdistan province, Iran.

Materials and Methods: In this cross sectional study 90 asthmatic patients referred to tertiary referral hospital in Kurdistan, North West of Iran, were selected by simple random method. Body mass index (BMI) was calculated by dividing weight by height. Pulmonary Function Test (PFT) and *bronchial-stimulation-test* were used for confirmation and investigation of asthma severity. Data were analyzed using SPSS-15 and Chi-square and spearman correlation coefficient tests.

Results: Relationship between BMI and severity of asthma (mild, medium and severe) was evaluated, there was a weak and positive relationship between them ($P<0.05$, $r=0.23$). There was a significant difference between spirometry indices in different levels of BMI variable ($P<0.05$). There was no significant relation between Forced expiratory volume in 1st second/Forced Vital Capacity (FEV1/FVC) and waist size ($P>0.05$), but there was a significant and inverse correlation between waist size and other parameters such as (FEV1, FVC and forced expiratory flow [FEF_{25-75}]) ($P<0.05$). Furthermore, there was a significant and inverse correlation between spirometry indices and Waist-Hip ratio ($P<0.05$).

Conclusion

It seems that attention to BMI in people with pulmonary diseases including asthma can help improve clinical and physiological conditions of the person.

Key Words: Asthma, Body mass index, Children, Pulmonary function.

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1- INTRODUCTION

Asthma is a chronic inflammatory disease in respiratory system which includes a broad scope of the young to middle-aged population. Inflammation and spasm of the flat muscles of the airways cause excessive narrowing of air ways and symptoms such as coughing, stiffness of chest and wheezing in patients with asthma (1-3). Although phenomenon of local inflammation in asthma has been proved, there is limited evidence that justifies involvement of systemic inflammation in asthma (4, 5). It is estimated that about 300 million persons in the world suffer from asthma. In recent decade, its incidence has increased all over the world in children and adults and probably 100 million persons will be added to the people with asthma by 2025 (6). According to the reports, 1 out of 250 persons dies due to asthma in the world (7). In a study, incidence rate of asthma has been reported 2.3% in Kurdistan and based on this study, incidence rate of asthma in Kurdistan province, Iran is almost similar to other findings inside the country while the incidence rate has been lower than the studies conducted in other countries (8).

Several studies showed that obesity is another inflammatory disease of which incidence rate in Iran and the world is increasing (9, 10). In a study in Tehran, it was shown that 40% of the adults had overweight and 21.1% of them were obese (11). Extensive studies have been conducted on severity of asthma and its relationship with other parameters such as pulmonary function and obesity, and different results have been obtained (8, 12-15). Recently, findings obtained from a study on children showed that children with mild asthma (mild and medium) who were obese at the beginning of adulthood had more obstruction of airway than those who were not obese (13). In another study, results showed that overweight ($25 > BMI > 29.9$) or obesity ($BMI \geq 30$) make asthma susceptibility severer or uncontrollable (16). Findings of another study show that weight loss also can lead to clinical and physiological improvements in cases of asthma (17, 18). Also, on the contrary, some results have been reported which have shown the opposite findings. In the study which was conducted based on the spirometry findings, there was no relationship between BMI (as an index for obesity) and severity of asthma (19); however the mechanisms underlying the association between obesity and asthma are incompletely understood (20, 21). In some studies, it was suggested that overweight and obesity may change asthma severity with increase in systemic or air-way inflammation (22, 23). Other results suggested that overweight and obesity may change asthma severity directly or by causing physiological disorder by reducing air caliber (such as increase in response of airways) (12, 24).

Since results obtained from studies about asthma, pulmonary function and obesity are not equal and there are significant differences between them; more studies in this field become more important and finding logical relationship between these parameters can help improve life of patients with asthma and airway obstruction diseases.

This study aimed to determine a relationship between BMI with asthma severity and pulmonary function in children of Kurdistan Province- Iran.

2- MATERIALS AND METHODS

2-1. Study design and population

This cross-sectional study was performed during January 2015 to January 2016 and its sample size included 90 patients with asthma referring to tertiary referral hospital in Kurdistan province-Iran. The selection method was simple random method. The patients having filled the informed consent were included in the study.

2-2. Measuring tools

Height (m^2) of all studied people was calculated by the researcher in the same place in hospital with standard wall-mounted stadiometer and also, their weight (kg) was measured with calibrated electronic scales (Seca- Germany).

Body mass index (BMI) was calculated by dividing weight by height ($BMI = \frac{Weight(kg)}{Height(m)^2}$)(25).

Classification of samples according to BMI was as follow; Less than the 5th percentile: Underweight; 5th percentile to less than the 85th percentile: Healthy; 85th to less than the 95th percentile: Overweight and equal to or greater than the 95th percentile: Obese (25). Other physical parameters of the people were calculated.
Pulmonary Function Test (PFT) and bronchial-stimulation-test are used for confirmation and investigation of asthma severity by the allergist and clinical immunologist. Spirometry means measurement of the airflow and capacity of lung through Forced Vital Capacity (FVC) and also, measurement of airflow obstruction. Disorder of pulmonary function in asthmatic people is as follow:

- **A.** Airflow obstruction and reduction of Forced expiratory volume in 1st second (FEV1) and FEV1/FVC ratio of below 80%.
- **B.** Pulmonary dilution in response to beta agonists (increase of FEV1 by about 12% or more or FEV1 by more than 200 cc).
- **C.** FEV1 with rate of 15% above.
- **D.** Maximum flow difference from the morning to the evening by 20% above.

Pulmonary function tests were performed in all people (with spiro lab III- Italy); and forced expiratory volume in one second (FEV), forced vital capacity (FVC), FEV_1/FVC ratio and the forced expiratory flow (FEF_{25-75}) were measured between 25 and 75 seconds.

2-3. Classification of asthma severity

- **A.** Mild intermittent: there were attacks of below or equal to twice a week every day or less than two nights per month and FEV1>= 80% and changes of PEF <20%.
- **B.** Mild persistent: there were attacks more than twice a week but less than once a day or more than two nights in a month and FEV1>= 80% and changes of PEF: 20 -30%.
- **C.** Moderate persistent: daily symptoms and more than one night per week, expected FEV1:60-80% and changes of PEF>30%.
- **D.** Sever persistent: persistent symptoms and repetitive nightly attacks and limitation of physical activity, FEV1<=60% and changes of PEF>30 % (26).

2-4. Ethical considerations

The aim of the study was described for parents with details. Ethical consideration were as follow: not mention the child name, not to do additional tests or collecting blood, and eventually voluntarily participation in this study. Finally, after completing the form by parents, the samples were included to the study.

2-5. Statistical analysis

Data were analyzed using SPSS-15 and Chi-square and spearman correlation coefficient tests. P-value less than 0.05 were considered significant.

3- RESULTS

A total of 90 subjects were included in the analysis. Demographic, clinical and physiologic characteristics are as follow: female constituted 47% and male

constituted 53% of the study population. Severity of asthma was evaluated and the results showed that 39.3% of subjects had mild asthma, 33.7% moderate and 27% severe. In order to obtain BMI, weight and length of subjects was measured and finally divided into 4 major groups: (33.3% were healthy, 25.8% were obese, 24.7% were overweight and 11.2% were in group underweight).

In waist grouping, most of subjects were in group L (Low 49.4%), then H (High 30.3%), VH (Very High 14.6%) and VL (Very Low 5.6%). Finally, we measured waist-hip ratio and results were as follow: 30.3% G (Good), 21.3% EXT (Extreme), 19.9% H (High, 15.7% A (Average) and 15.7% EXC (Excellent).

To examine the relationship between BMI and the severity of asthma symptoms Chi-square test would be used. In case of relation (if there is relation), the intensity and direction of the relationship would be determined using spearman correlation coefficient. Considering P- <0.05 obtained from **Table.1**, independency of two variables (BMI and Asthma severity) can be rejected. So, it can be deduced that there is a significant relationship between BMI and asthma severity.

Spearman correlation coefficient is used to find the intensity and direction of the relationship (**Table.2**). As given in **Table.2**, spearman correlation coefficient (0.238) indicated a positive correlation.

To examine the relationship between spirometric indices and BMI in patients with asthma, the Kruskal Wallis test was used (Because variable data of spirometry did not follow normal distribution). In this test, the difference of spirometric indices in different levels of BMI was examined and results are given in **Table.3**.

According to results obtained from Kruskal Wallis test, it can be deduced that there is a significant difference between spirometric indices in different levels of BMI variable (P<0.05), max rank observed in level underweight in FEV1, FVC and FEF25-75 variables and min rank was in level obese. In FEV1/FVC ratio, max rank was in level underweight and min rank was in level overweight (**Table.3**).

In **Table.4**, the relationship between spirometric indices and waist size was analyzed with spearman correlation coefficients test. Results showed that there is significant relationship between spirometric indices (except for FEV1/FVC) and waist size (P<0.05). Coefficients between two variables were strong and inverse, which means increase in one variable, decreases the other one. But when the FEV1 / FVC ratio to be considered, there is no significant relationship between two variables (P>0.05).

Like the previous case, in **Table.5**, relationship between spirometry indices and waist-Hip ratio was analyzed with spearman correlation coefficients test (considering that the data did not follow normal distribution).

Results showed that there is a significant relationship between spirometry indices and waist-hip ratio (P<0.05). The coefficients between two variables were average and inverse, which means increase in one variable, decreases the other one.

Table-1: The Relationship between BMI and Asthma Severity

	Kendall's tau-c	P-value
Spearman's rho	0.250	0.024

Table-2: The Correlations between BMI and Asthma Severity

	Correlation Coefficient	P-value	N
Spearman's rho	0.238 *	0.024	90

Table-3: The Relationship between BMI and spirometry indices in Patients with Asthma

Spirometry test	Grouping Variable: BMI group	Mean Rank	Chi-square (Kruskal -Wallis Test)	P- value
FEV_1	Healthy	55.74	45.030	0.001
	Underweight	75.15		
	Obese	17.26		
	Overweight	46.7		
FVC	Healthy	56.09	43.79	0.001
	Underweight	75.05		
	Obese	18.09		
	Overweight	44.67		
FEV_1/FVC	Healthy	54.61	25.008	0.001
	Underweight	69.6		
	Obese	27.39		
	Overweight	41.02		
FEF_{25-75}	Healthy	55.61	41.24	0.001
	Underweight	76		
	Obese	19.67		
	Overweight	43.5		

Table-4: The Relationship between Spirometry Indices and Waist Size in Asthmatic Patients

	Variable	Correlation Coefficient	P-value	Number
Spearman's rho	FEV1	-0.755	0.001	90
	FVC	-0.755	0.001	90
	FEV_1/FVC	-0.085	0.428	90
	FEF_{25-75}	-0.735	0.001	90

Table- 5: The Relationship between Spirometry Indices and Waist-Hip Ratio

	Variable	Correlation Coefficient	P-value	Number
Spearman's rho	FEV1	-0564	0.001	90
	FVC	-0.58	0.001	90
	FEV_1/FVC	-0.437	0.001	90
	FEF_{25-75}	-0.566	0.001	90

4- DISCUSSION

The percentages of asthma severity (mild, moderate, and severe) in patients included in this study were almost equal (close together), but patients with mild asthma had more percentage (39.3%). Between BMI groups (healthy, obese, underweight and overweight), the healthy group contained most of the subjects (33.3%) and the lowest subjects were in the underweight group (11.2%). According to results of this study, there was a

relationship between BMI and asthma severity and it means that asthma severity has increased significantly in people with overweight of (25<BMI<29.9), and obese people (BMI ≥ 30), and positive relationship was observed. Similarly in a study, findings show that weight gain makes asthma symptoms severer among the people who have severe asthma or cannot control their asthma (27). In another study, results showed that weight loss improved asthma control and also, pulmonary function (13). Another considerable point which clarifies relationship between these two factors is the presence of different reports which indicate that low weight is also, accompanied by reduction of respiratory function and emergence of asthma (28, 29). Although, many results confirm the relationship between these two parameters (14, 28, 30), but there are other studies which haven't reported significant relationship between BMI and severity of asthma symptoms (19).

In the study which was conducted by Lavoie et al., no significant relationship was obtained between asthma severity and BMI, but according to their findings, increase in BMI leads to difficulty of disease control (9). The study which was conducted similarly to the present study in Kurdistan province shows that there was no significant relationship between the asthma and BMI (8). Difference of results, can be due to the fact that the questionnaire has been used in the previous study and the study has been conducted based on the personal information of the participant in the research, but in our study, diagnosis has been done based on clinical measurements of the patients. According to the reports, relationship between increase of BMI and increase of asthma severity in women is higher than that in men (31). The reason for effect of increase in overweight on severity of asthma symptoms is not absolutely clear, but according to the reports, diameter and size of the airways may be reduced in the bodies with overweight or obesity by creating inflammation in respiratory or systemic airways (32) and asthma severity risk and physiological deficiencies intensify airway hyper–responsiveness (14, 24, 33, 34). In addition, reduction of pulmonary function or change in immunological balance including pre-inflammatory cytokines beside diet, gastroesophageal reflux, mechanical effects of obesity, atopic and hormonal effects have been introduced as potential mechanisms through which obesity can lead to asthma in adults (35).

In the next part of the study, relationship between spirometry indices and BMI, waist and waist/hip ratio has been investigated on which basis each of the parameters FEV_1, FVC and FEF_{25-75} in people with different BMIs has changed considerably. In other words, with increase in weight, pulmonary function has changed a lot. According to the reports, with increase in BMI rate, FEV_1, FVC and FEF_{25-75} have decreased (14).

But the important point is that according to findings of the present study, FEV_1/FVC ratio hasn’t changed a lot while according to Strunk et al., increase in BMI has relationship with decrease in FEV_1 and FEV1/FVC ratio (13). However, there are other studies which confirmed Strunk et al. research (36, 37).

In addition, it was specified in a study that there is considerable decrease in FEV_1 and FVC for every 0.05 unit of increase in waist-hip ratio and these findings are in line with results of our study. Scientific evidence shows that obese body reduces vital capacity and in this regard, it has a significant role in narrowing of airways and inefficiency of elasticity of the diaphragm (38). Such structural changes lead to drop of FEF_{25-75} and FVC. On the other hand, Central Adiposity dependency has been reported in adults with decrease

in volume of lungs and severity of asthma symptoms (38, 39).

4-1. Limitations of the study

The child's habit and socio- cultural context that can influence the pain experience of children and was not controllable in the present study.

5. CONCLUSION

Considering what was obtained in this study, it seems that attention to BMI in people with pulmonary diseases including asthma can help improve clinical and physiological conditions of the person. Considering that excessive decrease or increase of BMI can be effective in severity of asthma. Therefore, it is recommended that a range of BMI be introduced in the future studies in which people with asthma can gain better condition in terms of severity of asthma symptoms.

6- CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

7- AKNOWLAGEMENT

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