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# The Effect of Body Mass Index on Spirometric Parameters in Children with Asthma

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## ABSTRACT

**Aim:** Asthma and obesity represent one of the most crucial public and health problems of modern society that frequently begin in childhood and have some mutual elements of risk. Abdominal distribution of connective tissue is important determinant which brings to decrease of lungs function. Multiple influence of overweight on function of the lungs would clearly manifest over reduction of forced expiratory volume in the first second (FEV1) and forced vital capacity (FVC). **Method:** Examining was conducted at Pediatric Clinic of University Clinical Hospital Tuzla during the year 2013/2014. Research included 60 children with diagnosed asthma who were in relation to BMI were divided in 3 groups. The first group was children with BMI ranging from 5 to 85 percentile, the second were children with 85 to 95 percentile and the third was 95 percentile. By prospective study, compared identical pulmonary variable for all three age group of asthma patients were analyzed, the children with normal body mass a well as the overweight and the obese. **Results:** At the beginning of testing, the frequency of normal spirometric findings was significantly lower in the obese group in comparison with other two observed groups (p<0,05). The only cases of mixed and restrictive disorder of ventilation were registered in the obese group of tested at the beginning of the examined (p<r0,001). **Conclusion:** When being compared the values of spirometric parameters before and after the research, the only significant difference was in the obese group, the values after tests were significantly higher, with the exception of relation FEV1/FVC, that had the same distribution of values before and after research. However, the group with normal body mass and overweight, had all the spirometric parameters with equal distribution before and after research (p>0,05 for all measurements).
**Key words: asthma, obesity, children, spirometry.**

## 1. INTRODUCTION

Asthma and obesity represent one of the most crucial public and health problems of modern society that frequently begin in childhood and have some mutual elements of risk. Allergic disease and asthma became the commonest chronic disease in children in developed countries, with a set trend of constant prevalence growth in the last few decades. At the same time, the number of obese children and adults is getting the scale of pandemic worldwide. Early childhood is a dynamic period for growth and development of disease. To use an example, inadequate feeding during childhood, the period with the fastest growth in life, could cause lifelong consequences and affect the future quality of life in children.

The research in our area showed a surplus of 1/5 students from elementary and secodary schools had eccesive weight (1). The higher stage of overweight affects the respiratory function in many ways. It is known that changes of lungs function depend on size and specific distribution of connective tissue. Abdominal distribution of connective tissue is important determinant which brings to decrease of lungs function. Amassing of connective tissue in abdominal cavity increases intraabdominal pressure (2). The increase of intraabdominal pressure in visceral overweight rises diaphragm up which causes the compression of

thoracic cavity. In consequence, there is a compression of lung parenchyma with reduced ability to spread lung during inspiration especially in basal parts. Excessive accumulation of connective tissue in abdominal cavity pushes diaphragm to thoracic cavity, reduces excursions of thorax and ventilation of lower parts of lungs, the consequence of it is compression atelectasis and aggravated discharge elimination. Obesity causes changes in respiratory mechanism, decrease of endurance and strength of respiratory muscles, and limitations in lungs functional test (3).

The main effect of overweight on decreased lungs function is decrease of lungs compliance, that is the result of mechanical influence of overweight onto the walls of thorax and front abdominal wall rarely on the lungs themselves. Multiple influence of overweight on function of the lungs would clearly manifest over reduction of forced expiratory volume in the first second (FEV1) and forced vital capacity (FVC) with protection of their normal relation then with increase of residual volume (RV). In mild and moderate overweight VC and TLC are usually at normal span but in morbid obesity they can be reduced to 20-30% in comparison with normal BMI and has important influence on all lung volume, the biggest effects are on FRC and ERV. Overweight and asthma, their relation represents one of the biggest challenges. By a majority of epidemiological research papers is shown connection between overweight and asthma (4-7). Overweight is linked with increase of come down with asthma, poor response to adequate antiasthmatic therapy and poor asthma control. The connection of obesity and asthma could be partially explained by influence of asthma on obesity. Asthma initiated by effort could cause avoiding physical activity that could increase gaining weight, and finally being overweight. Therefore, asthma and obesity could make worse each other (8). Several studies indicate that losing weight can have influence on clinical course of asthma (8-10).

## 2. EXAMINEES AND METHODS

### 2.1. Examinees

Examining was conducted at Pediatric Clinic of University Clinical Hospital Tuzla during the year 2013/2014. Research included 60 children with diagnosed asthma according to criteria of Global Strategy for Asthma Management and Prevention (11) of both sexes age 5-15 years who were in relation to BMI were divided in 3 groups. The first group was children with BMI ranging from 5 to 85 percentile( normal weight), the second were children with 85 to 95 percentile (overweight) and the third was 95 percentile (obese).

### 2.2. Methods of work

By prospective study, compared identical pulmonary variable for all three age group of asthma patients were analyzed, the children with normal body mass a well as the overweight and the obese. The medical findings of spirometry were done on Jaeger-Master Screen version 4.3. The followed pulmonary parameters were expiratory forced volume in the first second (FEV1), forced vital capacity (FVC), relation of exhaled quality of the air in the first second with complete quality of air that could be exhaled (FEV1/FVC), the maximum speed of exhale (peak expiratory flow PEF), forced expiratory flow in 25% FVC (FEF25), forced expiratory flow in 50% FVC (FEF50) and forced expiratory flow in 75% FVC (FEF75).

Obese children were referred to endocrinologist for designing a proper diet. Clinical and spirometric reevaluation was performed every three months during the research.

### 2.3. Statistical data processing

All data were analyzed by GraphPad Prim version 7 (San Diego, California, USA) and SPSS version 10 for Windows. The analysis were covering frequency of spirometric abnormalities (obstructive, restrictive and mixed disorder of ventilation), among the groups and inside the same group in the time. Among the parameters of spirometric testing, analyzed were: FEV1, FVC, FEV1/FVC, PEF, FEF25, FEF50, and FEF75.

## 3. RESULTS

At the beginning of testing, the frequency of normal spirometric findings was significantly lower in the obese group in comparison with other two observed groups ($p<0,05$). Normal findings were equally distributed between the groups with normal and overweight fed ($p>0,05$). The only cases of mixed and restrictive disorder of ventilation were registered in the obese group of tested at the beginning of the examined ($p<0,001$).

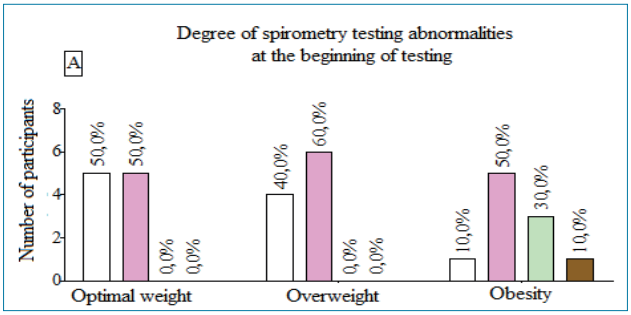


Figure 1. The degree of disorder in spirometric medical findings at the beginning of testing

At the beginning as well as the end of test, FEV1 group with normal body mass was significantly higher in connection with the obese group ($p<0,01$ and $p<0,05$ receptively). FEV1 was equally distributed between the groups with normal body mass and overweight ($p<0,05$). In the end of test it was significantly higher in normal body mass ($p>0,05$). FEV1 was significantly higher in the group with overweight fed in connection with obese group ($p<0,05$), in the end this difference was not significant ($p>0,05$).

At the beginning of tests, FVC group with obesity was significantly lower than the overweight and normal body mass ($p<0,01$). However, at the end of tests, this difference was not significant ($p>0,05$).

At the same time, at the beginning as well as at the end of tests FVC had equal distribution between the groups with normal body mass and overweight ($p>0,05$ for both measurements).

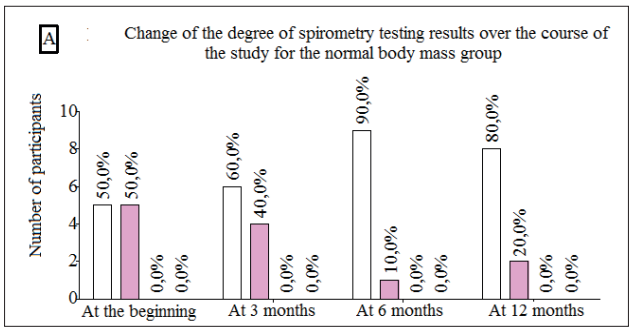


Figure 2. The change of an abnormalities degree of spirometric finding during the tests in the group with normal body mass

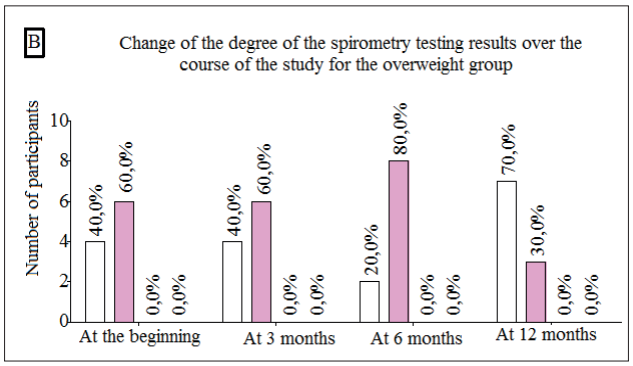


Figure 3. The change of a abnormalities degree of spirometric finding during the tests in the group with the overweight fed

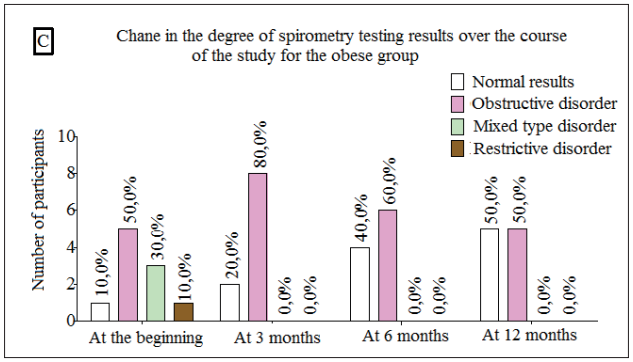


Figure 4. The change of an abnirmalitiese degree of spirometric finding during tests in the group with the obese

Tiffenau index had equal distribution among the observed groups at the beginning of research (p>0,05 for all measurements)The only difference was at the end of tests between the groups with obesity and normal body mass (p<0,05), the obese had significantly lower values.

At the beginning as well the end of research, PEF groups with normal body mass were significantly higher in relation with the obese (p<0,01 for both measurements). In the end of research it was significantly higher in connection with the overweight body mass (p<0,01). FEF25 groups with normal body mass was significantly higher in relation to the obese group (p<0,01) at the beginning but not the end of the research (p>0,05). Among other observed groups, equal distribution of FEF25 was registered at the beginning and the end of research (p>0,05 for all measurements). At the beginning as well as the end of research, the only significant difference of FEF50 was between the groups with normal body mass and obesity. The obese group had significantly lower values of this parameter (p<0,05 for both measurements). Similar to FEF50, the only significant difference of FEF75 was between the groups with normal body mass and obesity, the obese group had significantly lower value of this parameter at the beginning as well as the end of research (p<0,05 for both measurements).

Comparative analysis of a degree of spirometric abnormalities at the beginning, 3 months after the beginning, 6 months after the beginning and 12 months after the beginning in a group normally fed (A), overweight (B) and obese (C).

In comparison with the beginning of tests and 3 months later, normal findings of spirometry was more frequent after 6 and 12 months in groups with overweight fed and obese (p<0,05 for both measurements).

When being compared the values of spirometric parameters before and after the research, the only significant difference was in the obese group, the values after tests were significantly higher, with the exception of relation FEV1/FVC, that had the same distribution of values before and after research. However, the group with normal body mass and overweight, had all the spirometric parameters with equal distribution before and after research (p>0,05 for all measurements)

## 4. DISCUSSION

Positive correlation of higher BMI and asthma was observed long time ago, as well as connection of obesity with lung function imbalance. At the beginning of research, the frequency of normal spirometric finding was significantly lower in the group of obese in comparison with two other observed groups. However, normal finding was equally distributed between normal and overweight groups. After the beginning of research, 3 and 6 months later, the obstructive imbalance of ventilation was significantly rarer in the group with normal fed in comparison with the overweight and obese, there was no significant difference between the last two. After 12 months from the beginning of tests, the obstructive imbalance of ventilation was equally distributed between the observed groups, but the restrictive and mixed imbalance of ventilation were not registered.

Numerous studies showed changes in lung function occurring in the obese (12). The effect of obesity on lung function is reflected onto the reduction of functional residual capacity (FRC), research showed reversed relation between BMI and FRC (13, 14).

Spirometric variables in adults as forced expiratory volume during the first second (FEV1) and forced vital capacity (FVC), have the tendency of decrease due to accumulation and pressure of connective tissue on the thorax and subdiaphragmatic that is limiting distention of lungs (15, 16). Obesity could cause decrease of lung compliance, lung volume, changes of peripheral upper respiratory tract which could have some influence on blood volume in lungs and ventilatory – perfusive connection. Furthermore, obesity could also cause the first restrictions of air flow, with decreased forced expiratory volume during the first second (FEV1) and forced vital capacity (FVC). However, that decrease is usually symmetrical and FEV1/FVC connection is unchanged. Some

authors even found restrictive obstruction of lung parameters in the obese respondents with increased FEV1/FVC connection (17). Such changes in lung physiology could cause perfunctory breathing in obese patients, and decreased lung volume. This decrease is connected with decrease of peripheral upper respiratory tract measure, that could cause changes in function of smooth muscle of bronchi and potentially could increase obstruction and bronchial hyperactivity (BHR).

In our observed groups at the beginning of tests, FVC of the group with obesity was significantly lower in relation to the groups being overweight and with normal body mass index. However, at the end of tests, this difference was not significant. Simultaneously, at the beginning as well the end of tests FVC had equal distribution between the groups with normal body mass and overweight. At the beginning as well as the end of tests, FEV1 groups with normal body mass was significantly higher in connection with obese group. At the beginning of tests, FEV1 was equally distributed between the groups with normal body mass and overweight, while at the end of tests it was significantly higher in a group with normal body mass. On the other hand, at the beginning of tests FEV1 was significantly higher in the overweight group in relation to obese group, in the end of tests this difference was not significant. When compared the values of spirometric parameters before and after tests in each observed group, the only significant difference was in the obese group. The values of the same after tests were significantly higher, with the exception of FEV1/FVC relation, that had equal distribution of values before and after the research.

In literature there were many contradictory findings of spirometric variables followed in children. In Turner and coworkers Study which comprised 693 children were compared. In obese children FVC was higher in relation to children who were not obese and overweight. The relation of %FEV1/FVC was decreased (18). The same was shown in Tantisira and cow. study, the increase of BMI decreases the relation of FEF1/FVC (19). Tiffenau index had equal distribution between observed groups at the beginning of research, the only observed difference at the end of tests was between the obese and normal body mass groups. The obese had significantly lower values. At the beginning as well as in the end of research, PEF of the group with normal BMI was significantly higher in relation to the obese group. However, at the end of research it was significantly higher in relation to the overweight group.

The Study Chow and coworkers showed positive correlation with BMI, the relation FEV1/FVC showed inversive correlation in obese non-asthmatic children, that correlation was not registered in children who became ill with asthma . The reduction of BMI caused improvement of morning PEF values in obese children with asthma. There was no statistically significant difference in FEF25, FEF50, FEF75 among the children with asthma having normal body mass index and the obese (20). In our research FEF25 groups with normal BMI was significantly higher in relation to the obese group at the beginning of the research, but not at the end of the research. The obese group had significantly lower values of FEF50 and FEF75 in relation to normally fed. In relation to the beginning of the tests and 3 months later, normal findings of spirometric tests was significantly more frequent after 6 and 12 months in overweight and obese groups.

A clear approach in treatment and proper evaluation of increased body mass index and asthma, will not only have positive repercussions on more adequate and better concept in treatment of asthma, but it will also have positive effects on comorbid diseases.

The effects of obesity could be caused by the change of function in respiratory tract, due to the fact that obesity and overweight are correlated with the increase of bronchial hyperactivity in children with asthma and those with no asthma. The combined effect of increased bronchial sensitivity and inflammatory in the obese persons could be the start for asthma attack. Understanding the relations between obesity and asthma in children can be an important step for understanding etiology of asthma in childhood.

This research has proved that overweight and obese children with diagnosed asthma had serious degree of spirometric imbalance. The medium value of lung volume in analyzed overweight and obese children was at the lowest level in correlation to children with normal body mass index, which negatively influenced the seriousness of clinical picture and number of exacerbation in the followed and analyzed group.

## 5. CONCLUSION

When being compared the values of spirometric parameters before and after the research, the only significant difference was in the obese group, the values after tests were significantly higher, with the exception of relation FEV1/FVC, that had the same distribution of values before and after research. However, the group with normal body mass and overweight, had all the spirometric parameters with equal distribution before and after research ($p>0,05$ for all measurements).

• Conflict of interest: None declared.

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