RESEARCH ARTICLE

Comparative Spirometric Studies in Normal and Malnourished Children

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ABSTRACT

Background: Lung function tests are a measure of respiratory status. These tests are related to and hence affected by factors affecting growth and development in children.

Aims & Objective: The present study elucidates the effect of malnutrition on pulmonary functions in children.

Materials and methods: This was Cross-sectional study. Three hundred & fourteen randomly selected school children in the age group of 7 to 14 years were included in the study. The study groups were divided into three main categories: healthy normals; wasted; and wasted & stunted children. Pulmonary function tests were performed with computerised spirometer [Medspiror]. The data was analysed with the help of computer software SPSS 12.0 for Windows & Epi-info version 6.1.

Results: Wasted, wasted & stunted children showed lower lung volumes and flow rates than healthy normal children. Our observations suggest that different degrees of malnutrition have its effect on pulmonary function tests. The ratios between timed volume and vital capacities were in normal or above normal limit indicating no airflow limitation was produced by poor nutritional status.

Conclusion: The reduction in lung volumes and flow rates in wasted children is probably due to ventilatory muscle wasting. However, in wasted & stunted children along with muscular wasting diminished skeletal growth is a reason for decreased lung functions.

KEY WORDS: Malnutrition; Wasted; Wasted & Stunted; Lung Volume; Flow Rate

INTRODUCTION

Lung function tests measured by spirometry are an important measure in the assessment of childhood respiratory status in health and disease.[1]

Pulmonary function tests in healthy normal children are closely related to growth and development and are influenced by anthropometric environmental, genetic, ethnic, socio-economic and technological variations.[2,3] It has been observed that age, sex, body weight, height, BSA, race and smoking habits alter the value of pulmonary functions.[4] There is a decline in pulmonary functions as age increases[5] and it was also observed that weight gain shows a strong correlation with pulmonary function tests.[6,7]

Protein Energy Malnutrition [PEM] is common in most of underdeveloped countries and is the principal nutritional public health problem in the world. The body reserves of proteins and calories are markedly depleted in wasted [thin] children, so that there is a danger of development of severe PEM. The wasted and stunted [thin & short] children are suffering from acute malnutrition on a background of chronic malnutrition. Such children are not only small in stature but also have thin limbs. Stunting is a slowing of skeletal growth & stature defined by "waterlow"[8] as the result of a reduced rate of linear growth[9] weight loss is associated with wasting skeletal muscles & ventilatory muscles. . There is reduction in respiratory muscle strength and maximum voluntary ventilation [MVV] in malnourished children.[9]

Extensive evalution has been done worldwide to study the pulmonary function in adults but data on normal and malnourished children are scarce. No detailed study on lung function has been carried out in school children in this part of the country. So the present study was undertaken in malnourished school children from 7-14 years of age of both the sexes.

MATERIALS AND METHODS

Three hundred fourteen school children in the age group of 7-14 years were randomly selected from Reshamghar colony, Bakshi Nagar area of Jammu, India. There were 146 males & 168 females. Children having any type of respiratory as well as cardiac diseases, physically and mentally handicapped were excluded.

The age was recorded from the school register. The height [cm] body weight [kg] was measured by standard techniques & the body mass index was calculated. Anthropometric assessment of growth was done according to Waterlow classification considering height for age & weight for height.[10] This was followed by calculating expected heights and weights of children more than seven years of age based on sex using standard reference table according to NCHS.[11] W.H.O references[12] growth data was used as the reference standard for above classifications.

Pulmonary functions were measured with a computerised spirometer medspiror [Record & Medicare system Chandigarh]. It was performed during morning hours. The procedure of the respiratory function tests were carefully explained to each child and they were asked to make three efforts while sitting and the best of the three readings were considered in the study.

Parameters Studied

Lung Volumes: Forced vital capacity [FVC], Forced expiratory volume at 0.5 second [FEV0.5], Forced expiratory volume at 1 second [FEV1], Forced expiratory volume at 3 second [FEV3], ratios between forced expiratory volume in 0.5 to forced vital capacity [FEV0.5/FVC%] ratios between forced expiratory volume in 1 second to forced vital capacity and so on i.e FEV1/FVC% , FEV3/FVC% and maximum voluntary ventilation [MVV].

Flow Rates: Peak expiratory flow rate [PEFR], mean forced expiratory flow rate from 0.2 to 1.2 litres of volume change [FEF0.2—1.2], mean forced expiratory flow during the middle half of

FVC [FVC25-75%], Forced expiratory flow 25% FEF25%, FEF50% , FEF75%

Only two maneuvers i.e FVC & MVV accumulated all the necessary data. After all the test had been performed the computer stores and calculates all the necessary flow and volume data and plot them as parameters [using medspirar users manual RMS]

Statistical Analysis

The data analysed with the help of computer software SPSS 12.0 for windows & Epi-Info version 6.1. Mean & standard deviation were calculated for lung volumes and flows as well as anthropometric variables. One way ANOVA was applied to evaluate differences in means among three groups. Bonferroni 't' test was applied to assess intergroup comparison. A p-value of less than 0.05 was considered as statistical significant.

RESULTS

Among 314 children, 31.21% [n=98] were normal, wasted 33.75% [n=106] and wasted and stunted 35.03% [n=110].

Table-1: Intergroup Comparison in Age, Weight and Height among Three Groups Studied [n = 314]

Variable	Normal [Group I] [n = 98]	Wasted [Group II] [n = 106]	Wasted and Stunted [Group III] [n = 110]	'F' Test	Bonferroni 't' Test [Intergroup Comparison]
Age [in years]	9.63 ± 1.96	10.50 ± 2.38	10.89 ± 1.94	9.57 p = .0001	I vs II - 'S' I vs III - 'S' II vs III - 'NS'
Height [in cm]	134.04 ± 11.51	130.04 ± 17.02	120.06 ± 12.48	28.21 p = .0001	I vs II - 'NS' I vs III - 'S' II vs III - 'S'
Weight [in kg]	28.40 ± 7.11	22.23 ± 5.80	20.58 ± 5.1	47.58 p = .0001	I vs II - 'S' I vs III - 'S; II vs III - 'NS'

All values in mean ± SD 'S' = Significant 'NS' = Non-significant
Table shows mean ± SD and p-value of anthropometric measurement among three groups.

Table-2: Intergroup Comparison of Lung Volumes among Three Groups Studied [n = 314]

Variable	Normal [Group I] [n = 98]	Wasted [Group II] [n = 106]	Wasted and Stunted [Group III] [n = 110]	'F' Test	Bonferroni 't' Test [Intergroup Comparison]
FVC [L]	1.66 ± 0.54	1.48 ± 0.36	1.20 ± 0.38	29.75 (p = .0001)	I vs II - 'S' I vs III - 'S' II vs III - 'S'
$FEV_{.5}$ [L]	1.30 ± 0.31	1.07 ± 0.36	0.99 ± 0.29	25.18 (p = .0001)	I vs II - 'S' I vs III - 'S' II vs III - 'NS'
FEV_1 [L]	1.55 ± 0.36	1.34 ± 0.35	1.16 ± 0.36	28.90 (p = .0001)	I vs II - 'S' I vs III - 'S' II vs III - 'S'
FEV_3 [L]	1.65 ± 0.63	1.47 ± 0.34	1.21 ± 0.36	23.92 (p = .0001)	I vs II - 'S' I vs III - 'S' II vs III - 'S'
$FEV_{.5}$ / FVC %	79.78 ± 13.7	75.27 ± 19.1	80.65 ± 13.86	3.53 (p = 0.03)	I vs II - 'NS' I vs III - 'NS II vs III - 'S'
FEV_1 / FVC %	95.74 ± 8.9	93.10 ± 16.06	95.76 ± 8.03	1.83 (p = 0.16)	'NS'
FEV_3 / FVC %	99.33 ± 6.53	100.44 ± 0.36	100.33 ± 0.43	2.83 (p = 0.16)	'NS'
MVV [L/min]	63.82 ± 18.60	57.15 ± 15.6	53.03 ± 16.59	10.53 (p = .0001)	I vs II - 'S' I vs III - 'S' II vs III - 'NS'

All values in mean ± SD 'S' = Significant 'NS' = Non-significant

Table-3: Intergroup Comparison of Flow Rates among Three Groups Studied [n = 314]

Variable	Normal [Group I] [n = 98]	Wasted [Group II] [n = 106]	Wasted and Stunted [Group III] [n = 110]	'F' Test	Bonferroni 't' Test [Intergroup Comparison]
PEFR [L/sec]	3.75 ± 1.16	3.44 ± 1.25	3.08 ± 1.20	7.92 p = .0004	I vs II - 'NS' I vs III - 'S' II vs III - 'NS
$FEF_{.2-1.2}$ [L/sec]	2.63 ± 1.37	1.85 ± 1.43	1.68 ± 1.48	12.75 p = .0001	I vs II - 'S' I vs III - 'S II vs III - 'NS"
$FEF_{25\%}$ [L/sec]	3.56 ± 1.20	3.19 ± 1.37	2.97 ± 1.20	5.66 p = .003	I vs II - 'NS I vs III - 'S' II vs III - 'NS'
$FEF_{50\%}$ [L/sec]	2.80 ± 0.94	2.60 ± 0.97	2.46 ± 0.93	3.40 p = .034	I vs II - 'NS' I vs III - 'S' II vs III - 'NS'
$FEF_{25-75\%}$ [L/sec]	2.61 ± 0.94	2.37 ± 0.96	2.28 ± 0.88	3.33 p = .036	I vs II - 'NS' I vs III - 'S' II vs III - 'NS'
$FEF_{75\%}$ [L/sec]	1.65 ± 0.60	1.57 ± 0.72	1.54 ± 0.72	0.75 p = .46	'NS'

All values in mean ± SD 'S' = Significant 'NS' = Non-significant

Anthropometric Measurements: When comparison was made between different groups of malnourished children with normal wasted children were significantly lower in weight [P=0.0001]. Wasted & stunted children showed a clear cut lower value in height [P=0.0001] from wasted and normal children.

Lung Volumes: FVC – [P=0.0001] FEV1 [P=0.0001] & FEV3 [P=0.0001] were significantly lower in wasted [group-II], wasted & stunted[group-III] than normal children [group-I] respectively. $FEV_{0.5}$ showed statistically significance between normal & wasted i.e. it is lower in wasted children [group-II] but no significant difference between wasted [group-II] and wasted & stunted [group-III] children $FEV_{0.5}$/FVC% was significantly higher in wasted & stunted [group-III] than wasted [group-II] [P=0.03].

No significant difference was noticed in FEV1/FVC%, FEV3/FVC% between normal and different types of malnourished children. MVV were significantly lower and wasted [group-II], wasted & stunted [group-III] than normal children [group-I].

Table - 2 shows mean ± SD and p-value of lung volumes among three groups. The difference was found to be statistically significant for certain values *i.e.* FVC = 0.0001, $FEV_{.5}$ = 0.0001, FEV_1 = 0.0001 and MVV = 0.0001.

Flow Rates: Expiratory flow rate viz PEFR [P=0.0004], FEF25% [P=0.003], FEF50% [P=0.034] were significantly higher in normal [group-I] than wasted & stunted [group-III] children.

A reduction in $FEF_{0.2-1.2lt/sec}$. was observed in wasted [group-II], wasted & stunted [group-III] than normal children [group-I].

Table -3 shows mean ± SD and p-value of flow rates among three groups. The difference was found to be statistically significant for certain values

DISCUSSION

This study was undertaken to assess the pulmonary function tests of school going malnourished children and demonstrated that anthropometric, measurement, lung volumes and flow rates were significantly lower in malnourished children than normal healthy children. Malnutrition is a leading cause of impaired muscle contractility affecting both its strength and endurance.

Faridii et al [1995][13] studied the pulmonary function test in malnourished children and observrd that there was decrease in FVC FEV_1 in malnourished children as compared to normal healthy children.

Another recent observation by Nair et al [1999][9] in Indian undernourished children stated that respiratory function would be affected in the presence of malnutrition & reported reduced FVC, $FEV_{0.5}$, FEV_1, PEFR, MVV in malnourished children. They pointed out that PEFR & FEV_1 decreased proportionately as a result of poor endurance & strength of respiratory muscles.

On the basis of above conclusion, the present study can be evaluated. Our observation suggest that different degree of malnutrition have its effect on pulmonary function test. The reduction in lung volume and flow rates may be due to ventilatory muscle wasting. Another observation was that even though the study showed reduction in expiratory efforts which were not significant. It is suspected that muscular atrophy, especially the diaphragm in malnourished children may be the reason for decreased pulmonary function test. Along with the diaphragm the ventilatory muscles are also suspected of wasting. As stated above by Nair et al[9] the reduction in the vital capacities & MVV can be explained on the basis of decreased muscle strength & poor muscle endurance.

Another point of the study was that the ratios between timed volume and vital capacities were in normal or above normal limit. That indicates no airflow limitation was produced by poor nutritional status.

$FEF_{25-75\%}$ showed no significant change in wasted [group-II] and wasted & stunted [group-III] children as $FEF_{25-75\%}$ is relatively effort independent. It indicates the status of the small airways which reflects early airway obstruction.
So it is clear that no airway obstruction is seen in wasted [group-II] and wasted & stunted [group-III] children but it is supposed to be restrictive ventilatory impairments.

In case of wasted [group-II] only muscular wasting is a reason for decreased pulmonary functions but in wasted and stunted [group-III] along with muscular wasting linear growth also play a role in reduced lung functions. The ventilatory muscle wasting and decreased skeletal growth velocity may be the reason for lower pulmonary function in malnourished children than normal healthy children.

CONCLUSION

The reduction in lung volumes and flow rates in wasted children is probably due to ventilatory muscle wasting. However, in wasted & stunted children along with muscular wasting diminished skeletal growth is a reason for decreased lung functions.

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