ORIGINAL RESEARCH

Spirometric impairments in undernourished children - A study in a tertiary care hospital

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ABSTRACT

Background: Malnutrition has profound effects on various aspects of child health, including respiratory function. This study investigates spirometric impairments in undernourished children, aiming to understand the impact of nutritional status on pulmonary function. **Material and methods:** The study included 1021q undernourished children, categorized into three groups based on Waterlow criteria: Normal (n= 51), Wasted (n= 30), and Stunted & Wasted (n= 21). Spirometric parameters, including Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1), Peak Expiratory Flow Rate (PEFR), FEV1/FVC ratio, and Maximum Voluntary Ventilation (MVV), were measured for each participant. **Statistical Analysis:** Mean values and standard deviations were calculated for each spirometric variable in each group. The differences between groups were analyzed using ANNOVA, with significance levels indicated by p-values. **Results:** the pulmonary functions (FVC, FEV1, PEFR, FEV1/FVC ratio, MVV) show significant variations among the Normal, Wasted, and Stunted & Wasted groups. **Conclusion:** This study provides evidence of spirometric impairments in undernourished children, emphasizing the importance of nutritional interventions to support optimal respiratory health. Understanding these associations contributes to a comprehensive approach in addressing the health challenges faced by undernourished pediatric populations.

Keywords: Spirometric impairments, undernutrition, wasted & stunted.

INTRODUCTION

Millions of children worldwide suffer from undernutrition, which is especially problematic in areas with little resources. Undernutrition has repercussions that go beyond the outward manifestations of malnourishment, affecting multiple physiological systems, including respiratory function.[1] Spirometry is a commonly used pulmonary function test that measures the volume and flow of air during inhalation and exhalation. It is an essential tool for evaluating respiratory function. Comprehending the spirometric abnormalities in malnourished children is essential to deciphering the complex relationships between nutritional status and respiratory health during the formative years of childhood.[2]

Stunting (low height for age), wasting (low weight for height), underweight (low weight for age), and micronutrient deficiencies are the four types of undernutrition.[3]

Although there is evidence linking undernutrition to respiratory health, little is known about the precise spirometric abnormalities associated with undernutrition in children, especially those in the school-age range (5–12 years).[4] Spirometric parameter research can shed light on the functional effects of undernutrition on the respiratory system, as this age range is crucial for respiratory development.[5]

The present investigation was conducted to study effect of undernutrition on lung volumes and flow rates in healthy normal, waisted and wasted and stunted school going children in the age group of five to twelve years.

MATERIAL AND METHODS

Study Setting

The current prospective study on spirometric impairments in undernourished children was carried out in the Postgraduate Department of Physiology at

Government Medical College, Jammu.A total of 102 school children (55 males, 47 females) within the age range of 5 to 12 years participated in the study, which spanned over a one-year period between May 2015 and April 2016. Ethical clearance for the study was obtained from the Institutional Ethics Committee of GMC Jammu (vide approval number IEC/2015/150 dated 21/05/2015), and written informed consent was procured from the parents and guardians of the children.

Exclusion Criteria

- Children with physical or mental handicaps were excluded from the study.
- Individuals with pre-existing respiratory or other chronic diseases were not included in the study.

Demographic and Anthropometric Measurements

Demographic details, including height, weight, and age, were recorded for each participant to characterize the study population.

Spirometric Testing

Spirometric tests were conducted using a DT Spiro spirometer manufactured by Maestros Medline Systems Limited, Himachal Pradesh. The following parameters were measured: Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), Peak Expiratory Flow Rate (PEFR), and Maximum Voluntary Ventilation (MVV).

Data Collection

Three readings of each spirometric parameter were taken at the same time of day, with participants in a sitting position. The best of the three readings was considered for analysis. The focus of the study was on two main parameters: FVC and MVV. The DT Spiro device was employed to collect and store all relevant flows and volumes data.

Familiarization and Demonstration

Prior to the actual recording of spirometric data, participants were familiarized with the apparatus. Ademonstration was provided to instruct them on how to perform the various tests accurately.

Procedure

A clean mouthpiece, disinfected with potassium permanganate, was attached to a breathing tube and placed in the subjects' mouths. Participants were instructed to clip their nostrils with their thumb and index finger or to use a nose clip during the spirometric tests.

Data Analysis

All recorded data, including FVC and MVV, were subjected to analysis using appropriate statistical methods to identify and quantify any spirometric impairments associated with undernutrition in the studied population.

The methodology employed in this study adheres to ethical standards, ensures participant safety, and aims to provide valuable insights into the spirometric implications of undernutrition in school children aged 5 to 12 years.

Categorization of participants was done into three groups based on the Water low criteria

1. **Normal**
- Height/Age:>90%
- Weight/Height:>80%

2. **Wasted**
- Height/Age:>90%
- Weight/Height:<80%

3. **Stunted and Wasted(or WASTED & STUNTED)**
- Height/Age:<90%
- Weight/Height:<80%

Statistical analysis

Data was reported as means and standard deviation (SD) for normally distributed variables, median and interquartile range(IQR) for abnormally distributed variables, or as a percentage for discrete variables. According to the variable type and distribution, variables were compared using ANOVA or the Kruskal–Wallis test as appropriate. The analysis was done using the SPSS software (version 20). latest version.

RESULTS

Table 1: Comparison of mean values for FVC, FEV1, FEV1/FVC ratio, PEFR AND MVV of children

Variable	Normal (51)	Wasted (30)	Stunted And Wasted(21)	P value	Significance
FVC(L)	1.71+/=0.58	1.55+/=0.68	1.25+/=0.34	0.012	HS
FEV1(L)	1.41+/=0.51	1.27+/=0.40	0.81+/=0.35	0.000	HS
PEFR(L/Sec)	3.10+/=1.71	2.82+/=1.48	2.00+/=0.94	0.023	S
FEV1/FVC(%)	0.83+/=0.21	0.85+/=0.19	0.67+/=0.26	0.011	HS
MVV(L/mi n)	49.60+/=28.01	54.22+/=25.20	42.60+/=26,.67	0.322	NS

Above table is presenting data related to pulmonary function tests for three different groups: Normal, Wasted, and Stunted & Wasted.

DISCUSSION

Under-nutrition is defined as failure to consume adequate energy, protein and micronutrients to meet the basic requirements for body maintenance, growth and development. A sign nutritional deprivation is failure in growth and development. is necessary. Of

the various anthropometric indices that can be used to assess child growth status, height-for-age portrays performance in terms of linear growth and essentially measures long-term growth faltering; weight-for-height reflects body proportion, or the harmony of growth, and is particularly sensitive to acute growth disturbances; and weight-for-age represents a convenient synthesis of both linear growth and body proportion.[6]

This study demonstrated that body mass index was significantly (p=0.00) more in normal (Group I) children as compared to wasted (Group II) and wasted & stunted children (Group III). The difference is probably due to the differences in the body composition of normal and underweight children. Body mass mainly consists of fat mass and lean mass (fat free mass). Reduced body mass is suggestive of either reduced fat mass or reduced fat free mass or both.

In the present study, the mean values of FVC in Group I, Group II, Group III were 1.71L, 1.55L & 1.25L respectively. The values showed gradual fall from normal (Group I) children to wasted (Group II) and wasted & stunted children (Group III) and the fall was found to be statistically highly significant (p=0.012).

Joshi AR et al[8] observed in their study that adiposity had a significant positive correlation with dynamic lung function. They elaborated that lower body fat in underweight as compared to normal weight may be responsible for the lower dynamic lung functions among the underweight. This may be explained by the fact that sympathetic activity is influenced by adiposity & increased adiposity is accompanied by sympathetic overactivity. It is thus possible that low body fat percentage may be associated with lower sympathetic activity such that it increases the bronchial tone resulting in lower air flow.

Kaur R et al[9] elucidated the effect of malnutrition on lung volumes of 208 children of both sexes in the age group of 7-14 years of age. There were 110 wasted and stunted children according to water low classification considering height for age and weight for height. FVC was significantly reduced in wasted and stunted children as compared to normal children.The study attributed reduction in lung volumes in wasted and stunted children due to muscular wasting & decreased skeletal growth.

Forced expiratory volume in half second $FEV_{0.5}$: The mean values of $FEV_{0.5}$in Group I, Group II and Group III were 1.29L, 1.08L and 0.75L respectively. The values showed gradual fall from normal to the wasted and wasted and stunted and the fall was found to be statistically highly significant.

Kaur et al[9] also observed $FEV_{0.5}$ to be significantly reduced in wasted and stunted children as compared to normal children.

Forced expiratory volume in one second (FEV1) and three seconds (FEV3): In the present study, mean value for FEV1of children was observed to be less in wasted & stunted children (Group III) (0.81L) as compared to wasted (Group II) (1.27L) and Group I (normal) (1.41L). The difference among three groups was found to be statistically highly significant (p=0.00). Similarly, mean value for FEV3 was observed to be less in wasted and stunted children (0.81L), as compared to wasted (1.15L) and normal (1.21L) children. This gradual difference was found to be statistically significant (p=0.49).

FEV1provides an indication of expiratory power and overall resistance to air movements in the lungs. Normally, 80% of vital capacity can be expelled in 1 second, but in children it is significantly higher than that of adults. FEV1remains the single most validated and clinically useful test of ventilator function for assessment and management of airflow limitation. FEV1is a more reliable indicator in distinguishing between obstructive and restrictive lung diseases.[10]

In the present study, the mean values of PEFR in L/sec were 3.10, 2.82 and 2.00 in Group I,II and III respectively. There was a gradual fall in the values from Group I to Group III. The difference was found to be statistically highly significant in Group 1 versus Group II.

Zverea Y[11] studied prediction equation of PEFR in stunted children and observed lower PEFR than their counterparts with normal height for age. This observation is similar to the one found in present study.

From the present study, it is evident that the mean values of various pulmonary function tests showed decrease in Group Il (wasted) and Group (wasted and stunted) as compared to Group I(normal). The above findings suggest that undernutrition results in reduction in lung volume and flow rate due to ventilatory muscle wasting and there was significant reduction in diaphragm weight which was affected proportionately in the same way as the other skeletal muscles.

CONCLUSION

There is decrease in lung function tests among wasted as well as stunted children due to under-nutrition, which results in reduction in lung volume due to ventilator muscle was ting and there is significant reduction in diaphragm weight which is proportionately in the same way as the other skeletal muscles. The ventilator muscle wasting and decreased skeletal growth velocity may be the reason for lower pulmonary functions in undernourished children when compared to healthy ones. The alteration in muscle mass influences both strength and endurance and reduced vital capacity and expiratory muscle strength.

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