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THE EFFECT OF BODY WEIGHT ON PEAK EXPIRATORY FLOW RATE (PEFR) AMONGTHE ADOLESCENT RURAL SCHOOL CHILDREN, AN OBSERVATIONAL STUDY

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ABSTRACT

Background: The increasing prevalence of childhood obesity in developing countries is a growing public health concern. Obesity has been linked to pulmonary dysfunction, including reduced peak expiratory flow rate (PEFR). This study aimed to investigate the effect of body weight on PEFR among rural adolescent school children. **Methods:** A cross-sectional observational study was conducted in schools located in and around Nagamangala Taluk, with a study duration of 18 months. The sample size was determined using a formula based on the prevalence of obesity in school-going children. Anthropometric measurements, including height, weight, waist circumference (WC), and waist-to-height ratio (WHtR), were recorded. PEFR was measured using a peak flow meter. Statistical analysis, including correlation coefficient, t-test, and linear regression analysis, was performed using SPSS version 26. **Results:** The study included 573 rural adolescent school children, with a majority aged between 13 and 15 years and a higher proportion of female participants. The prevalence of overweight based on WHtR was 29.7%. There was no significant difference in mean age between overweight and normal WHtR groups. However, a higher prevalence of overweight was observed among boys compared to girls. Higher consumption of sweets, soft drinks, and fast food was significantly associated with overweight, while a higher frequency of exercise showed an inverse association. Longer duration of TV viewing was also associated with overweight. Overweight children had a significantly higher mean BMI and lower mean PEFR compared to children with a normal WHtR. There was a significant inverse correlation between PEFR and both BMI and WHtR. **Conclusion:** The present study observed a significant inverse correlation between PEFR and both BMI and WHtR. The study findings support the negative impact of excess body weight on lung function, as evidenced by reduced PEFR among overweight rural adolescent school children. The results emphasize the need for interventions to address childhood obesity and promote healthy lifestyle behaviors. Awareness among healthcare professionals, parents, and educators is crucial for early detection and management of pulmonary dysfunction associated with excess body weight in children.

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INTRODUCTION

The definitions of overweight and obesity include abnormal or excessive fat accumulation that could harm one's health. Since 1980, the global rate of obesity has nearly doubled. [1] Obesity is a condition with well-defined pathologic and pathophysiologic consequences, growing incidence and prevalence, significant costs, and poor outcomes [2]. Despite a chronically high burden of undernutrition, Indo-Asian countries are currently facing the unusual challenge of a rapid growth in childhood obesity. [3] Obesity and undernutrition coexist, showing a "double burden of the disease." [4] The aforementioned research all point to the seriousness of obesity and its financial impact on both developed and developing nations.

Obesity and various systemic illnesses have been linked by clinical, laboratory, and epidemiological data. Several investigations have shown a connection between pulmonary dysfunction and excessive body weight. Obesity is associated with a number of breathing issues, including obstructive sleep apnea, obesity hypoventilation syndrome, and asthma. [5, 6] A peak expiratory flow metre, a tiny hand-held instrument used to track a person's capacity to breathe out air, measures a person's greatest speed of expiration, or peak expiratory flow rate (PEFR). It has been demonstrated that it can predict early deterioration of the patient's condition before they really occurred [7]. It monitors the airflow through the bronchi and hence represents the severity of outflow obstruction. For the purpose of diagnosing and treating respiratory illnesses, PEFR is widely recognised as the objective measure of ventilatory capacity. Many studies have demonstrated a substantial correlation between obesity and PEFR as

well as a considerable reduction in PEFR in obese people [8–10]. Researchers discovered that, out of all the pulmonary function indicators, fat buildup along the chest wall has the greatest impact on the PEFR. The relationship between visceral adiposity and pulmonary function indices was shown to be negative, indicating that visceral fat deposition has a detrimental impact on pulmonary activity [11]. In a systematic review, Tenorio et al. discovered that there is evidence of a link between children and adolescents with obesity and lower spirometric values of forced vital capacity and forced expiratory volume [12]. Aiming to determine if increased body weight in these rural teenage school children will impair their pulmonary function, we designed this study to screen for pulmonary function in school-going children who attend both government and private schools.
Source of Data: The data for this study will be collected from school children in rural areas. Permission will be obtained from the principals of selected high schools and the Block Education Officer of Nagamangala Taluk, Mandya District.

MATERIALS AND METHODS

The study population consists of school-going adolescent children of rural areas .Its a cross-sectional observational study.The study was done in schools located in and around Nagamangala Taluk which was chosen as the sampling area. Three out of the six blocks in Nagamangala Taluk was randomly selected namely Bellur ,Devalapura and Kadabahally.All students meeting the inclusion criteria from the selected blocks was considered until the desired sample size was reached.

Sample Size Calculation: The sample size was calculated using the following formula: n = (Zα/2)^2 * (PQ) / E^2 Where: n = sample size Zα/2 = Z value at 5% error (1.96) P = prevalence of obesity in school-going children (taken as 15.2% based on previous studies) Q = 100 - P E = allowable error (taken as 20% of P) By substituting the values into the formula, the sample size was determined.

Study Duration: The study was conducted over a period of eighteen months, from February 2021 to August 2022.

Inclusion Criteria: Children in the age group of 10 to 18 years who are studying in the selected schools was included in the study.

Exclusion Criteria: Children with the following conditions was excluded from the study:

1. Acute/chronic respiratory infections.
2. Any morbidity under treatment.
3. Congenital and acquired syndromes.

Methodology

Before commencing the study, approval from the institutional ethical committee was obtained. Consent was obtained from parents and school authorities before starting the study. The demographic data and relevant history wasrecorded in a proforma. Age was determined based on the completed years as per the school records. The children were clinically assessed.

The following anthropometric measurements was taken:

- ***Height:*** Measured in centimeters without footwear, with the children standing erect, looking forward, feet closed, and back of the head and body touching the stadiometer.
- ***Weight:*** Measured in kilograms using a standard electronic weighing machine. Weight was measured without footwear and with light clothes.
- ***Waist circumference (WC):*** Measured using a standard tape measure at the midpoint between the lower margin of the last palpable rib and the upper level of the iliac crest.
- ***Waist-to-height ratio (WHtR):*** Calculated as waist circumference divided by height, both measured in the same units. A cutoff value of 0.5 was used to classify children into two groups: a. Group A: Children with WHtR less than 0.5 b. Group B: Children with WHtR greater than or equal to 0.5

Peak expiratory flow rate (PEFR) was measured using a peak flow meter. The children were instructed to take a deep breath and blow into the peak flow meter as hard and fast as possible. The procedure was repeated three times, and the highest value was recorded as the observed PEFR.

Statistical Analysis

Statistical analysis was performed using SPSS (Statistical Package for Social Science) version 26. The analysis includes Karl Pearson's correlation coefficient, student t-test, and linear regression analysis. Linear regression analysis was used to derive a prediction equation for PEFR using age, weight, height, and WHtR as independent variables. The mean values of PEFR for Group A and Group B was obtained and compared using statistical analysis. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The study investigate the relationship between body weight and PEFR in rural adolescent school children. PEFR is a measure of lung function, and the study examined how it varied based on body weight and other factors. The study included a total of 573 rural adolescent school children. The distribution of the study groups by age showed that the majority of the participants were between 13 and 15 years old, accounting for over half of the total group. The distribution of the study groups by gender revealed that 62.1% of the participants were female, while 37.9% were male. The participants were categorized into two groups based on their waist to height ratio (WHtR). Group A consisted of children with a WHtR below 0.5, while Group B included children with a WHtR greater than or equal to 0.5. The results indicated that 29.7% of the participants were classified as overweight based on their WHtR. When comparing the mean age between the two groups, it was found that overweight adolescent children had a slightly higher mean age of 13.63 years compared to 12.87 years in children with a normal WHtR. However, this difference was not statistically significant ($p = 0.44$). The comparison of gender distribution between the two groups showed that 47.9% of adolescent boys were overweight, while only 18.5% of adolescent girls were overweight. This difference was statistically significant ($p < 0.01$), indicating a higher prevalence of overweight among boys.
The study also examined the association between dietary factors and overweight. No significant association was found between type of diet (non-vegetarian vs. vegetarian) and overweight ($p = 0.539$). However, a significant association was observed between higher consumption of sweets, soft drinks, and fast foods with the presence of overweight among adolescent children ($p < 0.01$).

Furthermore, the study investigated the relationship between physical activity and overweight. It was found that there was a significant inverse association between higher frequency of exercise and the presence of overweight among adolescent children ($p < 0.01$). The duration of TV viewing was also assessed, and it was observed that adolescents who watched TV for longer durations had a higher prevalence of overweight ($p < 0.01$). Mean BMI (Body Mass Index) was significantly higher among overweight adolescent children compared to those with a normal WHtR (19.65 vs. 16.91 Kg/m^2; $p < 0.01$). Additionally, mean PEFR (Peak Expiratory Flow Rate) was significantly lower among overweight adolescent children compared to those with a normal WHtR (211.88 vs. 249.82; $p < 0.01$). This indicates that excess body weight is associated with reduced lung function. Lastly, a significant inverse correlation was found between PEFR and both BMI and WHtR ($p < 0.01$). This suggests that as BMI and WHtR increase, PEFR decreases, indicating a negative impact of excess body weight on lung function.

Table 1. Distribution of variables

Variables	Group	N	p-value
Age (yrs)	A	403	0.44
	B	170	
Gender			
Female	A	290	
	B	66	
Male	A	113	
	B	104	
Waist to height ratio (WHtR)			
Group A (<0.5)		403	
Group B (>=0.5)		170	
Type of diet			0.539
Non-Veg	A	296	
	B	120	
Veg	A	107	
	B	50	
Sweet consumption			<0.01
1-2/week	A	87	
	B	0	
2-3/week	A	252	
	B	105	
2-3/month	A	64	
	B	44	
3-4/month	A	0	
	B	21	
Soft drink consumption			<0.01
1-2/week	A	87	
	B	0	
2-3/week	A	252	
	B	105	
2-3/month	A	64	
	B	44	
3-4/month	A	0	
	B	21	
Fast food consumption			<0.01
1-2/week	A	87	
	B	0	
2-3/week	A	231	
	B	105	
2-3/month	A	85	
	B	44	
3-4/month	A	0	
	B	21	
Exercise history			<0.01
<1 hour/day	A	211	
	B	65	
1-2 hours/day	A	170	
	B	105	
2-3 hours/day	A	22	
	B	0	
TV viewing			<0.01
<1 hour/day	A	295	
	B	132	
1-2 hours/day	A	87	
	B	17	
>2 hours/day	A	21	
	B	21	
BMI (Kg/m2)	A	403	<0.01
	B	170	
PEFR	A	403	<0.01
	B	170	
PEFR and Waist to Height Ratio			<0.01
PEFR and Body Mass Index			<0.01
PEFR comparison at various ages			<0.01

DISCUSSION

The present study aimed to investigate the potential association between increased body weight and pulmonary function among rural adolescent school children. Childhood obesity has emerged as a significant public health issue in developing countries, with potential socioeconomic and health burdens. Several studies have already established the association between excess body weight and pulmonary dysfunction, including breathing problems like obstructive sleep apnea, obesity hypoventilation syndrome, and asthma [15].

Table 2. Mean PEFR comparison among study groups at various ages

Age (yrs)	Group A		Group B	
	Mean	SD	Mean	SD
10	215.16	29.84	179.55	83.02
11	249.82	56.66	193.40	14.30
12	250.30	46.39	205.00	52.76
13	252.50	28.24	211.88	67.17
14	255.00	30.37	226.00	64.64
15	259.52	29.47	230.00	77.83
16	260.00	25.94	240.00	61.22
17	270.00	31.13	249.82	63.27
18	280.00	10.38	270.00	10.38
p- value	<0.01			

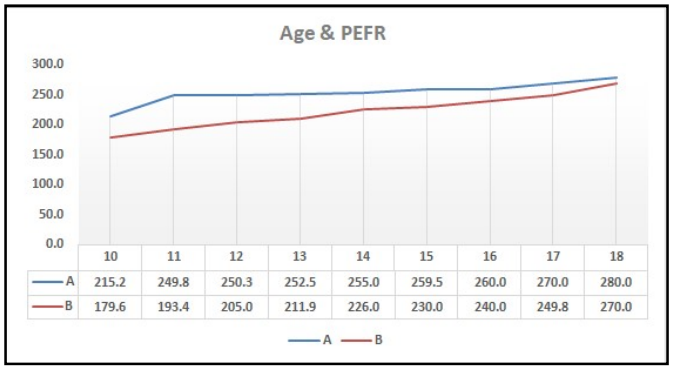

Figure 1. Mean PEFR was significantly lower among overweight adolescent children at all ages (p<0.01)

The study included 573 school-going adolescent children from rural areas, and their pulmonary function was assessed using Peak Expiratory Flow Rate (PEFR), a widely accepted indicator of ventilatory capacity. The children were classified into two groups based on their waist-to-height ratio (WHtR), with a cutoff of 0.5. Group A consisted of children with WHtR less than 0.5, while Group B included children with WHtR greater than or equal to 0.5. The prevalence of overweight among the studied adolescent children was found to be 29.7%. Notably, the prevalence differed significantly between genders, with 47.9% of adolescent boys classified as overweight compared to 18.5% of adolescent girls. This finding aligns with previous studies that have reported varying prevalence rates of overweight and obesity among adolescents, influenced by factors such as age, sex, definitions used, and study methodologies [16].

The study also examined the relationship between overweight and various lifestyle factors. Significant associations were observed between higher consumption of sweets, soft drinks, fast food, and overweight among adolescent children. Conversely, a higher frequency of exercise demonstrated a significant inverse association with overweight. These findings reinforce the importance of dietary choices and physical activity in preventing and managing overweight and obesity in this population. Other studies have similarly highlighted the impact of sedentary behaviors, such as excessive television viewing and computer usage, on the prevalence of overweight and obesity [17]. Regarding pulmonary function, the mean PEFR was found to be significantly lower among overweight adolescent children. This inverse correlation was observed across all age groups. Previous studies have also reported a negative association between body mass index (BMI) and lung function measures [18]. The reasons for this association include altered respiratory muscle activity due to adiposity, changes in airway caliber, increased airway resistance, and remodeling of respiratory passages due to circulating inflammatory mediators. Additional large-scale research is needed to further elucidate the precise relationship between body weight and PEFR.

CONCLUSION

In conclusion, this study adds to the growing body of evidence linking overweight and obesity to pulmonary dysfunction among rural adolescent school children. The findings underscore the need for targeted interventions to address the rising prevalence of childhood obesity in developing countries. Promoting healthy dietary habits, regular physical activity, and reducing sedentary behaviors are crucial strategies to mitigate the socioeconomic and health burdens associated with childhood obesity. Furthermore, efforts should be made to raise awareness among healthcare professionals, parents, and educators about the potential respiratory consequences of excess body weight in children, facilitating early detection and appropriate management of pulmonary dysfunction.

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