Physical Education, Health and Social Sciences

https://journal-of-social-education.org E-ISSN: 2958-5996

P-ISSN: 2958-5988

"Nutritional Status as a Predictor of Peak Expiratory Flow Rate in Adolescents: A Cross-Sectional Study"

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DOI: https://doi.org/10.63163/jpehss.v3i2.433

Abstract

This study investigates the association between nutritional status and peak expiratory flow rate (PEFR) in adolescents. A cross-sectional analysis of 300 participants revealed a significant negative correlation between body mass index (BMI) and PEFR.

Introduction:

Respiratory diseases pose a significant global health burden, particularly among children and adolescents. In developing countries like Pakistan, the situation is exacerbated by limited healthcare resources, increasing urbanization, and environmental pollution. [1] Malnutrition is a critical factor that affects respiratory health, especially during adolescence, a stage of rapid growth and development. Research has shown that under nutrition can lead to decreased lung function, as measured by peak expiratory flow rate (PEFR).[2] Despite the importance of PEFR as a diagnostic tool, there is a scarcity of data on the relationship between nutritional status and lung function in adolescents. This study aims to investigate the association between nutritional status and PEFR in Pakistani adolescents, [2] providing valuable insights into the predictors of lung function in this population.[3]

Study design

A cross sectional research study design was used for this study.

Study Area/Setting

The research was conducted in District Charsadda Khyber Pakhtunkhwa, Pakistan. This district was selected because it contains numerous educational institutions which has a diverse socio economic groups to allow generalizable results. Before selecting the research areas a list of public and private educational institutions was compiled. For this random number sample was choose from the selected institutions to avoid selection bias and ensure fair representation. Total of 14 educational institutions were included from which male and female students from urban and semi-urban regions of the district was selected in this study.

Interview and data collection process A Structured interviews were conducted with direct assessments of participants to obtain data. Each participant received their questions through standardized questionnaires. The data collection procedures was processed in selected schools at approved times and hours. During the interview participants report their lifestyle activities and respiratory symptoms accurately through direct interviews while physical and clinical data were assessed directly on-site

Sample Size

The sample for the study was selected using sample size formula. Briefly, 300 students will be sufficient to act as sample for the present study [4].

Sample selection:

The samples were selected randomly using the following procedure:

- Educational institutions in Charsadda were enlisted.
- For educational institution a representative sample was selected using from these lists using random number sampling method.
- 150 Male and 150 Female adolescents' age of 13-19 years old were selected.

Data Collection

Data was collected on the following parameters:

- Socio demographics.
- Lifestyle Factors
- Anthropometrics measurement (BMI)
- Peak expiratory flow rate (PEFR)

Inclusion criteria:

The study included participants who fulfilled these requirements:

- Adolescents between the ages of 13 and 19 years
- Currently enrolled in one of the selected educational institutions in Charsadda at present.
- Physically present at their school on the collection day.

Exclusion criteria

The study excluded participants who met any of these conditions.

- Participants excluded individuals who had gotten over major illnesses, surgical procedures or infections less than four weeks ago.
- Participants were excluded if they had experience chronic respiratory diseases requiring hospitalization or ongoing treatment such as tuberculosis.
- Participants who missed PEFR testing on the assessment day were excluded in the study.
- The participants were excluded if they had physical disability or deformity that would prevent accurate measurement of pulmonary function or anthropometry results.

Statistical Analysis

In this study data was analyzed using IBM SPSS Statistics (version 26.0) for statistical analysis. Statistics were employed to reveal participant data primarily through mean values and standard deviations along with frequencies and percentage distributions of socio-demographic characteristic, lifestyle factors, anthropometric measurements and peak expiratory flow rate (PEFR) values. Pearson's correlation was used to identify the linear relation between BMI-PEFR as well as lifestyle factor associations with pulmonary function. Independent t-tests and one-way ANOVA was used to establish significant PEFR differences between gender and BMI categories. A significant p value of 0.05 was set for all statistical hypothesis tests. Additionally, Content analysis methods were used to analyze any open-ended questions which assisted in interpreting contextual information about environmental and lifestyle factors affecting respiratory health. The analytical methodology provided quantitative and qualitative results which led to significant findings about variables linked to adolescent respiratory health

Methods

A cross-sectional study of 300 adolescents aged 13-19 years was conducted. BMI and PEFR were measured, and statistical analysis was performed.{5}

Results

The results showed a significant negative correlation between BMI and PEFR (Pearson's R = -0.222, $p < 0.001$). The Chi-Square test also revealed a substantial association between BMI and PEFR ($p < 0.001$). [4-5}

Discussion

The findings suggest that nutritional status, as indicated by BMI, is a significant predictor of PEFR in adolescents. Higher BMI values were associated with lower PEFR values, indicating potential respiratory function impairment.

Conclusion

The study highlights the importance of maintaining a healthy nutritional status to support respiratory health in adolescents.

Results and Discussions:

Anthropometric Study

Table 4.3: Frequencies of Anthropometric Factors

	Weight in Kgs	**Height in Feet**	**Age**	**BMI**	**PEFR**	**Calories**
Valid	300	300	300	300	300	300

Table 4.3 shows the frequencies of the anthropometric factors, which were chosen to acquire data for this study. The total number of responses were recorded as (N=300) while weight in Kgs, height in feet, age, BMI and PEFR all got (N=300) number of responses.

Table 4.3.1: BMI frequency and percentage

BMI		Frequency	Percent
Valid	15.1000-16.0000	2	0.7
	16.1000-17.0000	5	1.6
	17.1000-18.0000	11	3.6
	18.1000-19.0000	15	5.0
	19.1000-20.0000	43	14.3
	20.1000-21.0000	60	20.0
	21.1000-22.0000	68	22.6
	22.1000-23.0000	37	12.3
	23.1000-24.0000	35	11.6
	24.1000-25.0000	15	5.0
	25.1000-26.0000	2	0.7
	26.1000-27.0000	1	0.3
	27.1000-28.0000	2	0.7
	28.1000-29.0000	2	0.7
	29.1000-30.0000	1	0.3
	30.1000-32.0000	1	0.3
	Total	300	100.0

Table 4.3.1 displays the distribution of Body Mass Index (BMI) values among respondents shows a broad range, with several peaks in specific BMI categories. The most common BMI range is around “21.5”, reported by 11.0% of participants. Other notable ranges include “20.2” (4.3%), “22.2” (3.7%), and “20.8” (3.3%). Several categories such as “20.9” (2.7%), “19.5” (2.7%), and “19.8” (2.7%) also show moderate representation. Numerous BMI values are included in the data, ranging 15.9 (0.3%) to 32.0 (0.3%) and clustered around the mid-range values, with fewer instances at the extreme ends. The data offers a thorough understanding of the 300 respondents with a central tendency in the mid-20s.

Table 4.3.2: Frequency and percentage of Peak Expiratory Flow Rates (PEFR)

PEFR		Frequency	Percentage
Valid	150-200	2	0.7
	201-250	6	2.0
	251-300	25	8.3
	301-350	47	15.6
	351-400	90	30
	401-450	86	28.6
	451-500	29	9.6
	501-550	8	2.6
	551-600	5	1.6
	601-650	1	0.3
	651-660	1	0.3
	Total	300	100.0

Table 4.3.2 the distribution of Peak Expiratory Flow Rate (PEFR) values among respondents shows a diverse range, with several notable peaks in specific categories. Higher levels of airflow are indicated by the most frequent PEFR values, which are grouped around "400" (16.7%) and "350" (13.7%) other prominent values include “450” (10.3%), “300” (7.7%), and “410” (7.0%). For PEFR values like "370" (5.0%), "420" (5.7%) and "480" (1.7%) frequencies were observed. PEFR values in the data fluctuate widely, from low "145" (0.3%) to high "660" (0.3%). Mid-range values like "360" (2.7%) and "380" (3.0%) have a significant involvement with a predominant tendency toward the higher values.

BMI and PEFR Association and Correlation

Table 4.4: Case processing overview of the association between PEFR and BMI

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
BMI * PEFR	300	100.0%	0	0.0%	300	100.0%

A total of 300 cases were examined in the association research Table 4.4 in order to investigate into the association among PEFR and BMI. The validity and reproducibility of the analysis were guaranteed by the dataset's completeness, which included no missing values. All 300 observations, or 100% of the entire sample size, were included in the study, according to the case summary. This extensive dataset offers a strong basis for further statistical analysis and interpretation by enabling a thorough investigation of the possible relationship between BMI and PEFR.

Table 4.4.1 Chi-Square analyses assessing the relationship between PEFR and BMI

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3084.760[a]	2640	.000
Likelihood Ratio	917.872	2640	1.000
Linear-by-Linear Association	14.729	1	.000
N of Valid Cases	300		

Table 4.4.1 revealed Chi-Square tests conducted as part of the association study between BMI and PEFR. The p-value of .000 indicates that the 3084.760 value of Chi-Square with 2640 freedom’s degrees is extremely significant. This suggests a strong association between BMI and PEFR, rejecting the null hypothesis of independence between these variables. Additionally, the Association test of Linear-Linear, with 14.729 values and a p-value of .000, further supports a substantial linear association between BMI and PEFR. Though, the Ratio test of Likelihood, with 917.872 value of, shows a p-value of 1.000, indicating that this test did not detect a significant association. Overall, the Person Chi-Square and Association tests of Linear-by-Linear provide strong evidence of an association, reinforcing the robustness of the findings.

Table 4.4.2: Correlation study between BMI and PEFR

Symmetric Measures					
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	-.222	.064	-3.929	.000[c]
Ordinal by Ordinal	Spearman Correlation	-.300	.059	-5.439	.000[c]
N of Valid Cases		300			

4.4.2 Table demonstrates the symmetric measures from the correlation study among BMI and PEFR indicate a negative association between the two variables. Pearson's R value is -.222, with a standard error of .064, and the test statistic (T) is -3.929, resulting in a highly significant p-value of .000. This suggests a weak to moderate inverse linear relationship amongst PEFR and BMI, meaning that as PEFR reduction, BMI tends to increases. Similarly, the Spearman Correlation, which assesses the ordinal relationship, has a value of -.300 with a standard error of .059 and a test statistic of -5.439, also yielding a significant p-value of .000. The Spearman correlation indicates a stronger negative relationship on the ordinal scale. Both correlation coefficients underscore a significant inverse relationship between BMI and PEFR, highlighting the potential impact of BMI on respiratory function.

Discussion

Socio Demographic Study

Institutes of Respondents reflects the diversity of educational institutions represented in this study. Among the respondents, "Beacon Garden School System" had the highest participation with 18.3%, followed closely by "Spring Field College" at 18.0%. Other schools like "New Iqra School" (13.7%) and "Usmanai Public School" (13.0%) also contributed significantly. These figures suggest that most respondents came from a few prominent institutions, with less representation from smaller or lesser-known schools. {1-2} the broad representation of different schools allows for an inclusive analysis across various socio-educational backgrounds, but the concentration in a few schools may introduce some bias in the results [46-48]. Secondly, age distribution of respondents ranged from 13 to 19 years indicates that the largest group was 19-year-olds (16.0%), followed by 14-year-olds (15.7%) and 18-year-olds (14.3%). The remaining age categories were relatively evenly distributed, with each contributing between 13.3% and 13.7% of the sample. This relatively balanced age range ensures that the perspectives of both younger and older adolescents are captured, reflecting the diversity within the teenage population. The slightly higher representation of older students may indicate that some respondents were either repeating classes or had delayed school entry [49-51].

Lifestyle Factors

The data obtain from respondents for Use of Television or Computer highlights the prevalence of media consumption among students. Slightly more than half of the respondents 52.0% reported using television or computers, while 48.0% do not engage in these activities. This indicates a balanced split in media usage habits. The high proportion of users reflects the growing integration of technology into daily life, particularly among students, potentially influencing their study routines, leisure activities, and social interactions. While obtain data of Physical Activity shows that 54.7% of students participate in physical activity, while 45.3% do not. The majority engagement in physical exercise suggests that a significant portion of students maintain an active lifestyle, which is essential for overall health and well-being [52-54]. However, nearly half of the respondents lack regular physical activity, which could be a concern for their long-term health and could impact their academic performance and mental health [55].

Additionally, 55.7% of respondents go to school by walking, whereas 44.3% use vehicles. The predominance of walking may reflect the proximity of schools to students' homes, potentially contributing to daily physical activity [56, 57]. The use of vehicles by a substantial portion indicates that some students might live further away or have access to private transportation. This balance suggests a mix of accessibility factors and transportation preferences within the sample. While responses about the school distance of respondents provides insights into the distances students travel to school, which range from as short as 0.1 kilometers to as far as 20 kilometers. The majority of students 25.3% live 1 kilometer from school, indicating that a significant number of students reside close to their educational institutions. Other distances, such as 2 kilometers 10.0% and 0.5 kilometers 9.7%, also have notable representation. Shorter distances likely contribute to students walking to school, while longer distances necessitate vehicle use. The varied distances highlight differences in school accessibility, potentially impacting students' daily routines and punctuality [58].

In the obtained responses for sleeping patterns of respondents vary significantly. Most students report sleeping for 7 hours 26.7%, followed closely by those who sleep 8 hours 25.0% and 9 hours 22.3%. These durations align with recommended sleep times for adolescents, suggesting that a large portion of the sample maintains healthy sleep habits [59, 60]

However, some students report shorter sleep durations, such as 6 hours 13.3% or less, which could negatively affect their concentration, cognitive functions, and overall health [61, 62]. A small percentage of respondents report longer sleep durations 10-12 hours which might indicate either excessive rest or poor time management. Additionally, nearly all respondents 99.3% report not smoking, with only 0.7% identifying as current smokers. The minimal smoking rate is a positive indicator of healthy lifestyle choices among the students. Given that smoking is associated with various health risks, the low prevalence suggests effective awareness and prevention strategies within the community [63, 64]. It also highlights a strong adherence to non-smoking behaviors among this demographic.

Anthropometric Study

The distribution of weight among respondents varies widely, with the most common weight category being 50 kg, reported by 17.0% of participants. This is closely followed by weights of 45 kg and 55 kg, reported by 9.3% and 9.7% of respondents, respectively. The majority of the study population has a comparatively average body mass for their age, as evidenced by the distribution, which indicates a concentration of participants in the 45-60 kg range. But the range of weights in the sample from 38 kg to 80 kg highlights the variation in body mass, which could be impacted by factors like genetic predispositions, physical activity, and nutrition [66, 67]. Significant variation can also be seen in the respondents' heights; 13.7% of the sample reported being 5.0 feet tall which is the most frequent height. According to 11.7% and 10.0% of participants respectively, heights of 4.9 and 5.2 feet this statistics most responders are about average height for their age group [68]. Respondent's ages are distributed fairly across the categories with the most prevalent ages being 13 and 19 years old together up 15.7% of the sample. The oldest participants are 19 years old and the youngest are 13 (13.7% of the sample).

A balanced representation of the adolescent population in the study is possible by the even distribution of ages which enables several developmental in the examination of across stages The Body Mass Index (BMI) distribution indicates a wide range of values with a noticeable peak at 21.5, reported by 11.0% of participants. A considerable fraction of the sample is within the healthy weight range were reported as seen by other notable BMI values of 20.2 (4.3%) and 22.2 (3.7%). The sample contains people under weighted or overweighed as indicated by the presence of low 15.9 and high BMI values of 32. This emphasizes the necessity for focused health interventions in these populations [69].

According to the Peak Expiratory Flow Rate (PEFR) distribution 16.7 and 13.7% of participants reported airflow rates of 400 and 350 which were the most prevalent. For most of the sample these values show comparatively healthy lung function [70]. Lower PEFR values of 145 and 200 were reported by 0.3% of individuals. These results indicate respiratory problems or decreased lung capacity which could be brought on by lifestyle choices, environmental factors, or underlying medical diseases [70].

Respondents calorie consumption varies but the most common intake levels were 710 calories (8.7%) and 830 calories (3.0%). This variation points to potential dietary disparities with some participants consuming fewer or more calories per day than advised for their age and level of activity [48, 49]. The large range of values ranging from 380 to 1565 calories emphasizes difference in the sample nutritional requirements and consumption patterns which could be impacted by metabolism, physical activity, and availability of food sources [71-172].

The relationship among BMI) and PEFR

The examination of the link among BMI and PEFR reveals vital information about the correlation among body composition and function of respiration [73]. In this study, a thorough dataset of 300 cases was studied with no missing data increasing the robustness and dependability of the results. The whole dataset enables a thorough analysis into the potential relationships between BMI and PEFR establishing the framework for the conducted statistical analyses.

Chi-Square

Examination Significant findings were obtained from the Chi-Square tests, especially the linear-Linear Association and Person Chi-Square tests, which showed a substantial correlation between PEFR and BMI [74]. Additionally, P-value =.000 indicates that the Person Chi-Square assessment of 3084.760 with 2640 significant freedom’s degrees. This statistical significance suggests that there is a meaningful relationship between BMI and PEFR, rejecting the null hypothesis that assumes no association between these variables [75]. The significant results of the Linear-by-Linear Association test (value = 14.729, p-value = .000) further support this finding, indicating a linear relationship where changes in BMI may correspond to changes in PEFR [76]. On the other hand, the Likelihood Ratio test, which resulted in a value of 917.872 and a non-significant p-value of 1.000, did not support the association. The discrepancy between the results of the Pearson Chi-Square and Likelihood Ratio tests may be attributed to the differences in how these tests handle data distributions and the underlying assumptions each test makes. Nevertheless, the possibility of a true relation between BMI and PEFR is supported by the high significance as shown in the Pearson Chi-Square and Linear-by-Linear tests.

Correlation Analysis

The association between BMI and PEFR is further clarified by the symmetric measures obtained from the correlation analysis. A negative correlation is shown between Pearson's R and

Spearman's correlation coefficients suggesting that PEFR tends to decreased as BMI increased. Particularly, a weak to moderate inverse linear association is suggested by the Prson's R price of -0.222 and the noteworthy p-value of 0.000. In context of possible respiratory function deficiencies as body mass increases people with higher BMI are likely to have lower PEFR [77]. With a -0.300 value and a significant p-value of.000 of the Sperman link which evaluates the ordinaly link between BMI and PEFR also showed a stronger negative effect. The non-linear elements of the link between BMI and PEFR may be reflected in the greater correlation as seen in the Spearman analysis which were more accurately captures the ranking of people by BMI and its effect on PEFR [78].

Implications of Findings

The significant inverse relationships between BMI and PEFR found in this study imply that BMI has a considerable impact on respiratory performance. PEFR is also crucial indicator of lung function seems to be inversely correlated with higher BMI which is frequently linked to increased body fat and possible respiratory difficulties. The significance of keeping a healthy BMI to support the best possible respiratory health is highlighted by this relation.

Furthermore, the Chi-Square analysis considerable correlation offers more proof that BMI plays a significant part in the variability of respiratory function. These outcomes are in relation with earlier investigation that shows a correlation between obesity and a higher body mass index (BMI) and a decline in lung function as well as an elevated risk of respirational illnesses like COPD and asthma. In clinically and public health settings our findings emphasize the importance of measuring BMI as part of respiratory health assessments. Interventions aiming at lowering BMI in people with high body mass may enhance their respiratory function and overall health results.

Summary

A research project examined the health and demographic and lifestyle characteristics among adolescents aged 13 to 19 attending multiple educational facilities. Various educational institutions sent participants that displayed similar proportions of student age groups and no significant gender bias. The data showed that physical activity as well as walking to school and sufficient sleep duration occur among more than fifty percent of students. Most participants reported leading healthy lifestyles through their avoidance of smoking. The research showed dissimilarities regarding students' media habits as well as their sleeping patterns and ways of commuting and food consumption. The anthropometric assessment demonstrated an elevated number of students existing in the average weight and height segments yet BMI and PEFR measurements showed substantial variations between subjects. Researchers found evidence of a considerable negative association between BMI values and PEFR measurements indicating that BMI levels above average could harmed respiratory airflow.

Recommendations

The school must create regular fitness and sports activities so students remain active which helps both their lung function and their BMI health.

The schools need to establish educational programs focusing on nutrition which teach students proper dietary choices and the appropriate calorie requirements for their age group and exercise level. Regular tests of lung function (PEFR tests) should become part of school health examinations specifically for students who are overweight. The promotion of healthy routines should target the improvement of sleep hygiene as well as the reduction of excessive screen time and the establishment of regular sleep schedules. The schools should maintain accessible pathways leading to their facilities which supports students to reach school by walking while decreasing transportation dependence. The organization must strengthen its anti-smoking campaigns through wider spread awareness programs about smoking dangers while supporting the current low smoking statistics. Future research needs to expand its investigation by studying bigger populations from different backgrounds to establish the BMI-PEFR relationship and discover other environmental and genetic factors that could influence results.

Conclusion

The socio demographic characteristics, lifestyle choices, and anthropometric measurements of adolescents in District Charsadda, Pakistan, are all thoroughly examined in this study. The results provide significant understanding on how nutritional status and respiratory function interact, with a particular emphasis on the connection among PEFR and BMI. Respondents' socio demographic backgrounds showed notable differences in parental education and family income. As shown in study physical activity remained regular for 54.7% of students and sleep patterns were adequate as the respondents reported 6–9 hours of nightly rest (87.3% response). The BMI measurements varied from 15.9 to 32.0 with typical values at 21.5 while PEFR testing values spanned from 145 to 660 reaching a maximum of 400 L/min. Students displayed an average BMI rating of 21.33 together with an average PEFR score of 400.72. BMI and PEFR levels exhibited a negative correlation where higher BMI values corresponded to decreased respiratory function according to Pearson's correlation coefficient (-0.222 and Spearman's rho (-0.300; p=0.000). Schools alongside health authorities need to work together on implementing purpose-built programs mainly in areas where access is limited for the purpose of closing the health disparity gap. Health disparities among adolescents require immediate attention to guarantee their long-term health development.

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