DOI: 10.7860/JCDR/2026/79985.22730

Original Article

Paediatrics Section

Correlation Between Levels of Physical Activity and Pulmonary Functions in School-going Children of Ahmedabad, India: A Cross-sectional Study

HIMADRI KISHORKUMAR LAKHANI[1], PRASAD MULEY[2], BHAVANA GADHAVI[3]

ABSTRACT

Introduction: Physical activity is generally acknowledged as a determinant of overall health, but its physiological effects on the pulmonary system in healthy children and adolescents have not been thoroughly studied. It is proven that physical activity imposes a substantial load on the cardio-pulmonary system and promotes adaptive improvements in its efficiency. Hence, it can be assumed that physical activity may enhance pulmonary functions in younger populations too.

Aim: The present study aims to find out if any correlation persists between physical activity level and pulmonary function in school-going children and adolescents (8-14 years).

Materials and Methods: The present cross-sectional study was conducted on school-going children aged between 8 to 14 years from four different schools of Ahmedabad, India from August-2024 to November-2024. The Physical Activity Questionnaire for Children (PAQ-C) was filled out by children, and pulmonary function was measured through a standard digital spirometer. As the data were normally distributed (using Kolmogorov-Smirnov test), Pearson's correlation was used to analyse the correlation between PAQ-C and pulmonary functions {Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), Forced Expiratory Flow between 25% and 75% of Vital Capacity (FEF 25-75%), Peak Expiratory Flow Rate (PEFR), Slow Vital Capacity (SVC), Maximum Voluntary Ventilation (MVV)}. 75%, PEFR, SVC, MVV). Moreover, multiple regression for all pulmonary functions was done for various independent variables {physical Activity, age, gender, height, weight and Body Mass Index (BMI)}.

Results: Out of the total 534 children, 292 were boys and 242 were girls. Physical activity was reported by 34.08 (182), 35.5% (190), 26.4% (141), and 3.9% (21) of children with PAQ-C levels of 1-1.99, 2-2.99, 3-3.99, and 4-4.99, respectively. There was no statistical correlation found between physical activity levels and pulmonary function tests (Pearson's correlation test) in these children. Furthermore, when PAQ-C was used as the key independent variable and gender, age, height, weight, and BMI as covariates, the regression model was very stable for FVC, FEV1, SVC, and FEF at 25% to 75%. However, PAQ-C had no influence on Pulmonary Function Test (PFT) except for the small effect on PEFR.

Conclusion: The lack of a statistical relationship between physical activity levels and pulmonary function in school-aged children shows that, within this age range, pulmonary function may be more significantly influenced by growth and development variables like height, age and gender rather than physical activity.

Keywords: Paediatrics, Physical fitness, Respiratory function test, Spirometry

INTRODUCTION

According to the World Health Organisation (WHO), physical activity is a bodily movement produced by skeletal muscles that substantially elevates energy expenditure [1]. It will help with weight loss by reducing visceral fat and assist in the management of other metabolic disorders like hypertension [2] and Type 2 Diabetes Mellitus [3]. According to American College of Sports Medicine (ACSM), regular physical activity (for adults, 30 minutes, five times per week, and for children, 60 minutes daily) at moderate intensity reduces the rise of risk factors related to Non-Communicable Diseases [4].

Although physical activities have numerous beneficial effects, school children are not engaging in the recommended level of physical activity. In 2024, an updated study combining data from 146 countries showed that 80.3% children aged 13 to 15-year-old did not achieve the recommended level of physical activity (that is, fewer than 60 minutes of physical activity) [5]. Moreover, the rate of reduction in physical activities is seen to increase with age and is greater in girls than in boys [5]. According to recent evidence, post-Coronavirus Disease of 2019 (COVID) prevalence of sedentary behaviour has increased. Children were most affected, increasing their sedentary time by 159.5±142.6 min/day followed by adults (+126.9±42.2 min/day) and older adults (+46.9±22.0 min/day) [6].

These shocking numbers prove that people are getting directed towards a sedentary lifestyle. Avoiding physical activity has become a habit rather than a need, not only for adults but also for children. Sedentary behaviours have multifaceted adverse effects on the human body, including increased all-cause mortality, cardiovascular disease mortality, cancer risk, and risks of metabolic disorders such as diabetes mellitus, hypertension, and dyslipidaemia; musculoskeletal disorders such as arthralgia, osteoporosis, depression, as well as cognitive impairment [7].

Literature suggests that, in adults, cardiorespiratory functions are associated with being physically active [8,9]. Those individuals who remained active have better exercise tolerance and higher lung functions, especially FEV1 and FVC [8]. Moreover, physical activity will demand enhanced gas exchange, minute ventilation, pulmonary capacity, and many more changes in pulmonary function in adults, thus, improving lung volumes [9].

Even though there are several studies portraying improvement in pulmonary function for adults who have higher levels of physical activity [6,7]. But there is limited literature available to understand the impact of habitual physical activities on pulmonary function in school-going children and adolescents [10], and no literature for Ahmedabad city in particular. Furthermore, the physiological and anatomical factors like lung growth and respiratory mechanics are different in children then in adults. This may have varied impact of physical activities on lung parameters in children and adolescents. Moreover, other reasons generating the need to find a correlation between physical activity and pulmonary function in school-going children are increasing rates of childhood obesity [11], due to a sedentary lifestyle, which may lead to a drop in respiratory capacity amongst children.

Hence, the primary aim of the present study was to determine whether a correlation exists between levels of physical activity and pulmonary function in school-going children.

Study objectives:

- To record the pulmonary function by using a digital spirometer in school-going children;
- To identify the level of physical activity of school-going children by using PAQ-C {English and Gujarati};
- To establish a multiple regression model that predicts pulmonary function values based on level of Physical activity (PAQ-C), age, gender, height, weight, and BMI in school-going children.

MATERIALS AND METHODS

The present cross-sectional study was conducted among school-going children from August 2024 to November 2024. Five schools were approached from each of four different zones of Ahmedabad: north, south, east, and west. Finally, one school from each of the zones was selected using the chit method. School authorities were informed regarding the purpose of the study. After permission was attained from school authorities, children in classes 4 to 8 who satisfied the inclusion requirements were chosen using a simple random sampling technique (Random number table method). Ethical considerations were addressed by the institutional ethical committee of Apollo Institute of Physiotherapy, Ahmedabad, India. (EC-AIP/IEC/NS/2024-25/04).

Inclusion criteria: Normal school-going children (8-14 years) (children who did not have any behavioural, neurological, musculoskeletal, or systemic illness) of both genders were included.

Exclusion criteria: Participants were excluded from the study if they: (1) were not between eight and 14-year-old; (2) suffered from severe respiratory problems, chest abnormalities, neuromuscular conditions, previous chest operations, chronic productive cough, unmanageable wheezing or shortness of breath; (3) had history of prior asthma, reactive airway disease, or use of asthma medications beyond a single instance for symptom alleviation; (4) diagnosed with congenital heart disease diagnosis; (5) had prior hospitalisation due to respiratory issues; and (6) incapable of effective communication [12].

The present study was a time-bound study, and a total of 596 children from four schools of Ahmedabad, India were selected according to inclusion and exclusion criteria. They were explained the procedure, and informed consent was taken from parents and children. Out of 596, 547 children and parents consented to participate**.**

Study Procedure

Demographic Details (age, gender, height, and weight) were taken for the children willing to participate. Height was measured using stadiometer and weight was checked using standard digital weighing scale. BMI was calculated using these values. However, 13 children were not able to perform due to anxiety, unsatisfactory Pulmonary Function Test (PFT) readings (incomplete volume loops, poor start, premature termination, coughing or glottic closure, variable effort, etc.,) after multiple trials or voluntary withdrawal during testing. Finally, 534 children completed PAQ-C form filling and PFT testing.

To assess the Physical Activity of children, the Physical Activity Questionnaire for Children (PAQ-C) (link: https://www.prismsports.org/UserFiles/file/PAQ_manual_ScoringandPDF.pdf) was chosen. PAQ-C is a self-administered questionnaire having ten questions, (last question was skipped as it did not concern with physical activity) about physical activities performed by the child in the last week. Physical activities like skipping, sports, dance, cycling, swimming etc., which the child does, are to be selected from the first question in PAQ-C. It is a self-administered 7-day recall instrument for physical activity measurement on children aged 8-14 years (or grades 4 to 8). It provides a summary of the physical activity score derived from nine items, each scored on a 5-point scale. The result of the items is a value between 1 to 5; higher the value-greater is the level of physical activity performed by that child [13]. The reliability, content, and face validity of the PAQ-C are excellent, with an Intraclass Correlation Coefficient (ICC) of 0.96 (Cronbach's α=0.76) and 0.82 for the English and Gujarati languages, respectively [14,15]. PAQ-C was explained and distributed to children. Children were instructed to fill PAQ-C in their preferred language (Gujarati or English). If children had any queries while filling PAQ-C, they were asked to communicate openly with the researcher. Queries were addressed appropriately.

Whereas, pulmonary functions (FVC, FEV1, FEF 25%-75% of FVC, PEFR SVC, and MVV were measured by computer-based standard hand-held Spirometer 'SpiroTech (version-1.1.0.32)-Clarity'. After collecting PAQ-C from children, PFT was demonstrated with a standard digital Spirometer. Spirometry testing was done according to standard American Thoracic Society (ATS) guidelines [16].

The students were instructed to sit upright with their arms by their sides. For FVC recording, the child is supposed to use a nose-clip before blowing out quickly and forcefully into the mouthpiece, which is connected to a digital PFT, followed by deep and quick inspiration. For SVC measurement, the child is supposed to take deep inspiration and slow and complete expiration. For MVV documentation, the child is supposed to take as many breaths as possible in 15 seconds without getting fatigued [17].

The child performed the above-mentioned procedure three times. And the best result of the three reports was selected. Children were instructed that if during the procedure he/she felt tired, dizzy, anxious, or uneasy, they must inform immediately, and sufficient rest (>30 sec of rest) was given. Whenever, child was ready, the procedure was continued [17]. The data was recorded and statistically analysed and correlated.

STATISTICAL ANALYSIS

For the calculation of frequency, percentage, mean and Standard Deviation (SD) of all demographic details like age, height, weight, BMI and Pulmonary Functions (FVC, FEV1, FEF 25-75%, PEFR, SVC, MVV) was done through Excel software (Microsoft Office version 2021). To check for significance of difference between independent and dependent variables between girls and boys, independent t-test was used through Statistical Package for the Social Sciences (IBM-SPSS) (version 26). Mean and SD were also analysed for age ranges (8 to 10 years and 11 to 14 years) and also according to levels of physical activity (1.00-1.99, 2.00-2.99, 3.00-3.99, 4.00-4.99). The Kolmogorov-Smirnov test was used to check the normal distribution of the data. As the data were normally distributed, Pearson's correlation [18] was used to analyze the correlation between PAQ-C and Pulmonary Functions (FVC, FEV1, FEF 25-75%, PEFR, SVC, MVV). Multiple regression was done to understand impact of various independent variables like physical activity (PAQ-C), age, gender, height, weight and BMI on various PFT values (FVC, FEV1, FEF 25-75%, PEFR, SVC, MVV).

RESULTS

[Table/Fig-1] shows the demographic details of children stratified by gender. Significant difference was observed between girls and boys

Variables	Boys (n=292)		Girls (n=242)		Total (n=534)		t-value	p-value
	Mean±SD	Range (min-max)	Mean±SD	Range (min-max)	Mean±SD	Range (min-max)		
Age (years)	10.92±1.63	6 (8-14)	11.32±1.74	6 (8-14)	11.1±1.69	6 (8-14)	-2.68*	0.008*
Height (cm)	144.03±10.53	50 (119-169)	144.78±9.45	57 (119-176)	144.37±10.06	57 (119-176)	-0.86	0.393
Weight (kg)	36.96±11.92	60.85 (16-76.85)	37.43±10.33	58.7 (18.3-77)	37.17±11.23	61 (16-77)	-0.31	0.756
BMI (kg/m²)	17.5±4.02	24.23 (9.95-34.18)	17.66±3.81	20.91 (11.13-3.05)	17.5±3.93	24.23 (9.95-34.18)	-0.25	0.806
PAQ-C	2.77±0.86	3.12 (1-4.12)	2.12±0.76	3.51 (0.73-3.88)	2.47±0.88	3.56 (1-4.56)	9.18*	<0.001*
FVC (lit.)	1.92±0.49	3.16 (0.98-4.14)	1.81±0.44	3.15 (0.73-3.88)	1.87±0.47	3.41 (0.73-4.14)	2.60*	0.01*
FEV1(lit.)	1.76±0.42	1.94 (0.87-2.81)	1.73±0.71	2.76 (0.63-3.39)	1.74±0.57	2.76 (0.63-3.39)	2.08*	0.038*
FEF 25%-75% (lit/sec)	2.75±5.68	3.45 (0.92-4.37)	2.51±1.53	4.63 (0.58-5.21)	2.64±4.33	4.63 (0.58-5.21)	0.03	0.976
PEFR (lit/sec)	3.65±3.51	4.63 (1.38-6.01)	3.31±2.88	6.34 (0.97-7.31)	3.5±3.9	6.34 (0.97-7.31)	0.52	0.601
SVC (lit)	2.03±0.61	2.82 (0.54-3.36)	1.89±0.80	3.67 (0.76-4.43)	1.97±0.71	3.89 (0.54 -4.43)	3.76*	<0.001*
MVV (V)	59.47±19.17	97.09 (21.25-118.34)	57.83±16.83	104.47 (26.97-131.44)	58.72±18.14	110.19 (21.25-131.44)	0.90	0.368

[Table/Fig-1]: Gender-wise mean±SD, ranges and p-value of demographic details, PFT and physical activity (PAQ-C).
Statistical analysis-Independent Sample t-test, *-significant p-values.

for age, level of physical activity (PAQ-C), FVC, FEV1, and SVC. Other variables, such as height, weight, BMI, FEF 25%-75%, PEFR, and MVV, did not, however, differ significantly between boys and girls. Physical activity levels and pulmonary functions were higher in boys (292) than in girls (242), but still close to those of the total population (534) of children.

[Table/Fig-2] portrays baseline characteristics of children stratified by two age groups: 8-10 (n=201) and 11-14(n=333). It was observed that all the demographic values and PFT values were higher in older children compared to younger children. However, the mean and SD of PAQ-C is lower in the age group of 11-14 (2.41±0.91) years than their younger counterparts (2.58±0.82).

Variables	Age 8-10 years (n=201)	Age 11-14 years (n=333)	Total (n=534)
Age (years)	9.30±0.76	12.19±1.04	11.1±1.69
Height (cm)	136.93±7.82	144.78±8.46	144.37±10.06
Weight (kg)	30.93±8.18	40.94±11.13	37.17±11.23
BMI (kg/m²)	16.34±3.32	18.31±4.08	17.5±3.93
PAQ-C	2.58±0.82	2.41±0.91	2.47±0.88
FVC (lit.)	1.6±0.34	2.04±0.46	1.87±0.47
FEV1 (lit.)	1.53±0.74	1.87±0.39	1.74±0.57
FEF 25%-75% (lit/sec)	2.02±3.53	3.01±2.43	2.64±3.33
PEFR (lit/sec)	3.28±2.25	3.63±2.93	3.5±2.8
SVC (lit)	1.64±0.43	2.17±0.77	1.97±0.71
MVV (V)	50.15±12.74	63.87±16.83	58.72±18.96

[Table/Fig-2]: Age-wise demographic details and physical activity.

[Table/Fig-3] shows the number of participants in various intensities of Physical Activity (PAQ-C) with one being minimum and five being maximum in the last seven days. Out of 534, 190 children were having 2.00-2.99, followed by 182 with physical activity level between 1.00-1.99 and 141 children in level 3.00-3.99; lastly, only 21 children were having physical activity level between 4.00-4.99. It is clear from the results that the mean and SD of all the demographic and pulmonary function values were highest in children involved with maximum physical activity, except FEF 25-75% which is maximum in children with physical activity level between 3.00-3.99.

PAQ-C level	1.00-1.99	2.00-2.99	3.00-3.99	4.00-4.99
No of participants	182	190	141	21
Percentage	34.08%	35.5%	26.4%	3.9%
Age (years)	11.81±1.74	10.70±1.54	10.58±1.47	12.05±1.32
Height (cm)	147.02±10.23	141.92±9.55	142.68±8.61	154 ±10.9
Weight (kg)	38.18±11.77	35.12±9.5	36.70±10.75	48.38±13.95
BMI (wt/m²)	17.39±4.01	17.24±3.59	17.75±3.84	20.10±4.68
FVC (lit)	1.98±0.49	1.75±0.37	1.82±0.4	2.40±0.78
FEV1 (lit)	1.81±0.41	1.63±0.34	1.73±0.87	2.16±0.63
FEF 25-75% (lit/sec)	2.72±1.73	2.34±0.62	2.92±0.85	2.84±0.91
PEFR (lit/sec)	3.56±0.96	3.24±0.83	3.72±0.74	3.81±1.35
SVC (lit)	2.05±0.6	1.86 ±0.87	1.91±0.48	2.59±0.87
MVV (V)	61.38±18.38	57.20±17.56	55.33±14.98	72.30±25.78

[Table/Fig-3]: Mean and SD of PFT according to Physical activity intensity in children.

[Table/Fig-4] displays the correlation coefficient for the level of physical activity and pulmonary function values. There was no statistically significant correlation between physical activity level and pulmonary function values in school-going children.

PAQ-C	r value	p-value (significance)
FVC	0.004	0.92
FEV1	0.43	0.32
FEF 25%-75%	0.017	0.69
PEFR	0.01	0.98
SVC	0.038	0.38
MVV	-0.037	0.39

[Table/Fig-4]: Correlation between Physical Activity Level (PAQ-C) and PFT in children.
Statistical test: Pearson's Correlation.

[Table/Fig-5] displays the regression models, which show moderate to strong explanatory power for the majority of pulmonary function measures. The biggest proportion of variation explained was for FEV (R^2=0.566, SEE=0.267) and FVC (R^2=0.546, SEE=0.318), demonstrating good predictive accuracy. PEFR (R^2=0.375) and MVV

PFT variables	R^2	Adjusted R^2	F-value	SEE
FVC	0.546	0.541	105.83	0.318
FEV1	0.566	0.561	114.51	0.267
FEF 25%-75%	0.402	0.395	58.98	0.541
PEFR	0.375	0.368	52.71	0.749
SVC	0.480	0.474	81.07	0.419
MVV	0.350	0.342	47.19	14.85

[Table/Fig-5]: Model summary of multiple regression analyses for PFT parameters.
Statistical test-Linear regression

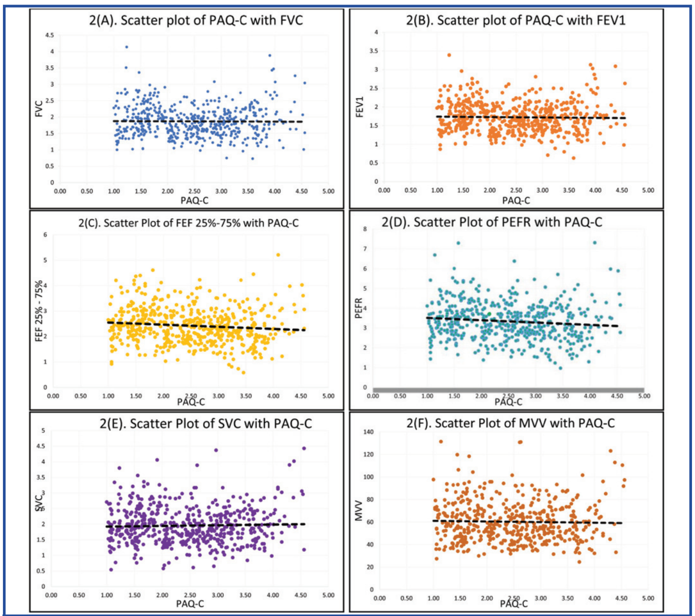
(R^2=0.350) revealed inferior model fits, with MVV also displaying the greatest prediction error (SEE=14.85), whilst SVC (R^2=0.480) and FEF25–75% (R^2=0.402) showed intermediate explanatory capacity. High F-values indicated that every model was statistically significant.

[Table/Fig-6] portrays regression analysis of PFT values for anthropometric (independent) covariates like gender, age, height, weight, and BMI. Anthropometric factors, specifically height, age, and gender, have the greatest influence on pulmonary function parameters. BMI consistently correlated negatively with lung function indices such as FVC, FEV, and SVC. PAQ-C did not significantly predict most outcomes, with the exception of PEFR, where a small negative association was found. Overall height and age were the strongest positive predictors across the models, while female gender and higher BMI were associated with reduced pulmonary function.

Dependent variables	Independent variables	B	SE	β	t-value	p-value
FVC	PAQC	0.002	0.017	0.004	0.121	0.904
	Gender	-0.135	0.030	-0.143	-4.498	<0.001*
	Age	0.040	0.011	0.142	3.501	0.001*
	Height	0.030	0.011	0.712	2.799	0.005*
	Weight	0.012	0.006	0.267	2.166	0.031*
	BMI	-0.053	0.023	-0.439	-2.263	0.024*
FEV1	PAQC	0.00	0.015	0.000	-0.003	0.998
	Gender	-0.102	0.025	-0.126	-4.041	<0.001*
	Age	0.044	0.009	0.182	4.588	<0.001*
	Height	0.029	0.009	0.798	3.207	0.001*
	Weight	0.008	0.005	0.206	1.714	0.087
	BMI	-0.051	0.020	-0.492	-2.592	0.010*
25%-75% of FEF	PAQC	-0.057	0.029	-0.072	-1.931	0.054
	Gender	-0.091	0.051	-0.065	-1.787	0.075
	Age	0.080	0.019	0.195	4.187	<0.001*
	Height	0.022	0.010	0.313	2.215	0.027*
	Weight	0.019	0.018	0.301	1.030	0.303
	BMI	-0.026	0.040	-0.148	-.663	0.508
PEFR	PAQC	-0.092	0.041	-0.086	-2.275	0.023*
	Gender	-0.158	0.070	-0.084	-2.246	0.025*
	Age	0.085	0.027	0.152	3.197	0.001*
	Height	0.022	0.014	0.231	1.593	0.112
	Weight	0.046	0.025	0.545	1.834	0.067
	BMI	-0.095	0.055	-0.390	-1.735	0.083
SVC	PAQC	0.001	0.023	0.002	0.053	0.958
	Gender	-0.212	0.039	-0.183	-5.382	<0.001*
	Age	0.033	0.015	0.097	2.223	0.027*
	Height	0.036	0.014	0.696	2.570	0.010*
	Weight	0.014	0.008	0.237	1.794	0.073
	BMI	-0.060	0.031	-0.404	-1.966	0.050*
MVV	PAQC	-0.404	0.805	-0.019	-0.502	0.616
	Gender	-2.693	1.396	-0.073	-1.929	0.054
	Age	1.557	0.527	0.144	2.955	0.003*
	Height	1.010	0.498	0.614	2.027	0.043*
	Weight	0.318	0.269	0.175	1.181	0.238
	BMI	-1.865	1.085	-0.395	-1.719	0.086

[Table/Fig-6]: Multiple linear regression analyses of PFT parameters with PAQC and covariates.
Statistical test: Linear regression Analysis of Variance-ANOVA, *-significant p-values.

[Table/Fig-7] portrays Scatter diagram for Physical Activity level (PAQ-C) and various pulmonary function values. It is visually clear that no correlation exists between pulmonary funcions and Physical activity levels.



[Table/Fig-7]: Scatter plot of physical activity levels and pulmonary functions in school going children.

DISCUSSION

Using correlation and multiple linear regression models, the current study investigated the association among children's pulmonary function measures, demographic characteristics, and physical activity. While physical activity, as shown by the PAQ-C score, demonstrated minimal predictive capacity and no statistically significant correlation with pulmonary functions, the study showed that age, height, and gender were the most reliable and significant variables.

Lung function parameters like FVC, FEV, and SVC were favourably correlated with age and height, which is in line with most research. These results are consistent with growth and development's known impact on lung capacity. An increase in height with age leads to children's growing thoracic dimensions, and muscular strength positively influences lung volumes and respiratory functions [19]. Likewise, gender disparities were noted, with female subjects exhibiting noticeably smaller lung capacities than male subjects. This discrepancy has been linked to changes in lung tissue growth, airway size, and hormonal impacts during the embryonic phases [20].

Additionally, the study found a persistently unfavorable correlation between BMI and lung function, specifically with regard to FVC, FEV, and SVC. Dixon AE et al., state that because excess body fat creates mechanical restrictions, a higher BMI has been associated with decreased lung capacities and greater airway resistance [21]. This implies that even in children, being overweight or obese may impair pulmonary mechanics.

Contrary to expectations, the PAQ-C's measure of physical activity did not significantly predict or affect the majority of lung function outcomes, with the exception of PEFR, where a slight inverse connection was discovered. There has been conflicting evidence in the past regarding this topic. While some studies have demonstrated that physical activity performed by children are not sufficient to change static lung volumes [22], others have pointed out that the benefits might be more noticeable in dynamic measures of airflow or exercise capacity than baseline pulmonary function if exercises were performed at moderate or intense intensity for at least 30 to 60 minutes per day [23]. Contrary to children, in adolescents, it is seen that Pulmonary functions have a moderate positive statistically significant correlation with levels of physical activity, probably due to their growth spurt, quick habituation to exercises, thus having greater average lung capacity [24].

It is proven, that there are benefits to lung indices when child engages in exercise which makes them "gets out of breath or sweat" [25]. On the contrary, such activities that are lung focused like aerobic exercises, dancing, cycling, running, yoga and pranayama, etc., are not preferred by children now-a-days as they refer screen-time over physical activity.

Children spend roughly six to seven hours a day in school, where they participate in Physical Education (PE) classes that expose them to activities like dancing, athletics, and mass physical therapy. The main goal of incorporating these exercises into the curriculum is to reap the many advantages that physical activity can offer. Furthermore, there would be clear differences in the kids' real involvement in PE programs. Activity levels can range from engaging in moderate-to-intense physical activity to engaging in entirely sedentary behaviour [26]. This is consistent with our findings that youngsters engaging in the maximum level of physical activity (between 4 to 4.99 on PAQ-C) had the highest PFT values. Furthermore, it is difficult to tailor such group activities according to the needs of individual children in school. Additionally, duration, intensity as well as frequency of these exercises may or may not be sufficient to bring permanent changes in the pulmonary system [27].

The model summaries indicated moderate to strong explanatory power for key pulmonary function parameters. FEV (0.566) and FVC (0.546) had the greatest R^2 values, indicating that gender, age, and height consistently explained a sizable amount of the variation in lung function. Lower explanatory capability was demonstrated by other outcomes, such as PEFR and MVV, which is in line with research showing that a broader range of factors, such as effort and ambient conditions, affect dynamic measures of airflow and exercise tolerance [28].

These results highlight how crucial it is to take anthropometric factors into account when evaluating children's lung function. Although physical activity is crucial for general health, factors like growth and body composition may have a greater direct impact on pulmonary function. Longitudinal designs and objective activity monitoring should be used in future studies to better understand causal linkages. Furthermore, given the increased prevalence of childhood overweight and obesity worldwide, further research is necessary to fully understand how obesity limits lung health.

In India, the total percentage of inactivity is as high as 21% as calculated by Gulati A et al., [29]. Furthermore, frequent exercise especially high-intensity exercise is crucial for improving lung function in children and adolescents. These findings highlight the necessity of focused public health initiatives to promote physical activity [30]. In addition the main reason for emphasizing improvement in pulmonary functions at a younger age is because of its impact in adulthood. If lung functions are poor during childhood, it will probably be reflected when the child grows [31]. This knowledge is enough to tailor the protocols of PE and exercises for children to enhance pulmonary functions in childhood itself, thus securing lung functions as ageing occurs [32].

Limitation(s)

The present cross-sectional study design and the study's dependence on self-reported measures may have contributed to the poor predictive value of physical activity in this investigation, since they may have failed to account for cumulative or long-term effects. Moreover, potential confounders like socioeconomic status, family environment, or dietary habits which may affect pulmonary functions and physical activity levels are not considered in the analysis. Furthermore, the study period (August-October 2024) includes seasonal variations that could affect both physical activity patterns and respiratory functions. Finally, Stratified sampling and blinding could be added to nullify any researcher bias.

CONCLUSION(S)

Age, height, and gender are key predictors of lung function in children, while higher BMI is associated with reduced pulmonary capacity. Physical activity showed minimal influence, suggesting that growth and body composition are more critical factors in respiratory health. Clinicians should consider these demographic and anthropometric variables when assessing lung function and designing interventions. Addressing obesity early may be essential for preserving lung health and improving overall well-being in paediatric populations. Maybe by directing proper and intense physical activity, we could bring improvement in all the pulmonary functions; however, the present level of physical activity is not sufficient to bring any significant changes in pulmonary capacity in school-going children.

REFERENCES

[1] WHO. Physical inactivity: A global public health problem. Geneva: World Health Organization; 2024.
[2] Shariful Islam M, Fardousi A, Sizear MI, Rabbani MG, Islam R, Saif-Ur-Rahman KM. Effect of leisure-time physical activity on blood pressure in people with hypertension: A systematic review and meta-analysis. Sci Rep. 2023;13(1):10639.
[3] Lao XQ, Deng HB, Liu X, Chan TC, Zhang Z, Chang LY, et al. Increased leisure-time physical activity associated with lower onset of diabetes in 44,828 adults with impaired fasting glucose: A population-based prospective cohort study. Br J Sports Med. 2019;53(14):895-900.
[4] ACSM's Guidelines for Exercise Testing and Prescription. 10th ed. China: Wolters Kluwer; 2025.
[5] Araujo RHO, Werneck AO, Martins CL, Barboza LL, Tassitano RM, Aguilar-Farias N, et al. Global prevalence and gender inequalities in at least 60 min of self-reported moderate-to-vigorous physical activity 1 or more days per week: An analysis with 707,616 adolescents. Journal of Sport and Health Science. 2024;13(5):709-16.
[6] Runacres A, Mackintosh KA, Knight RL, Sheeran L, Thatcher R, Shelley J, et al. Impact of the COVID-19 pandemic on sedentary time and behaviour in children and adults: A systematic review and meta-analysis. Int J Environ Res Public Health. 2021;18(21):11286.
[7] Park JH, Moon JH, Kim HJ, Kong MH, Oh YH. Sedentary lifestyle: Overview of updated evidence of potential health risks. Korean J Fam Med. 2020;41(6):365-73.
[8] Cheng YJ, Macera CA, Addy CL, Sy FS, Wieland D, Blair SN. Effects of physical activity on exercise tests and respiratory function. Br J Sports Med. 2003;37(6):521-28.
[9] Shephard RJ and Astrand PO. Endurance in Sports. 2nd ed. Oxford: Blackwell Science Ltd; 2000.
[10] Balbinot F, Claudino FCA, Lucas PK, Martins APD, Wendland EM, Gerbase MW. Does regular exercise impact the lung function of healthy children and adolescents? A systematic review and meta-analysis. Pediatric Exercise Science. 2022;*35*(3):186-94.
[11] Singh S, Awasthi S, Kapoor V, Mishra P. Childhood obesity in India: A two-decade meta-analysis of prevalence and socioeconomic correlates. Clin Epidemiol Glob Health. 2023;23:101390.
[12] Tsai MC, Jeng MJ, Chang HL, Tsao PC, Yang CF, Peng YY, et al. Spirometric reference equations for healthy children aged 6 to 11 years in Taiwan. J Chin Med Assoc. 2010;73(1):21-28.
[13] Benítez-Porres J, López-Fernández I, Raya JF, Álvarez Carnero S, Alvero-Cruz JR, Álvarez Carnero E. Reliability and validity of the PAQ-C questionnaire to assess physical activity in children. J Sch Health. 2016;86(9):677-85.
[14] Shah SS, Diwan SJ. Cross-cultural adaptation, translation, and psychometric properties of Gujarati version of physical activity questionnaire for older children. Physiother J Indian Assoc Physiother. 2020;14(2):64-69.
[15] Belim ZK, Sheth M, Sharma S. Reliability and validity of Gujarati version of physical activity questionnaire for children. Int J Phys Educ Sports Health. 2019;6(4):154-57.
[16] Graham BL, Steenbruggen I, Miller MR, Barjaktarevic IZ, Cooper BG, Hall GL, et al. Standardization of Spirometry 2019 Update. An Official American Thoracic Society and European Respiratory Society technical statement. Am J Respir Crit Care Med. 2019;200(8):e70-e88.

[17] Constant C, Sampaio I, Negreiro F, Aguiar P, Silva AM, Salgueiro M, et al. Respiratory disease screening in school-aged children using portable spirometry. J Pediatr (Rio J). 2011;87(2):123-30.
[18] Schober P, Boer C, Schwarte LA. Correlation coefficients: Appropriate use and interpretation. Anesth Analg. 2018;126(5):1763-68.
[19] Quanjer PH, Stanojevic S, Cole TJ, Baur X, Hall GL, Culver BH, et al. Multi-ethnic reference values for spirometry for the 3-95-yr age range: The global lung function 2012 equations. European Respiratory Journal. 2012;40(6):1324-43.
[20] Wanger J, Clausen JL, Coates A, Pedersen OF, Brusasco V, Burgos F, et al. Standardisation of the measurement of lung volumes. Eur Respir J. 2005;26(3): 511-22.
[21] Dixon AE, Peters U. The effect of obesity on lung function. Expert Rev Respir Med. 2018;12(9):755-67.
[22] Pazini F, Pietta-Dias C, Roncada C. Relationship between school children's levels of physical activity, anthropometric indices and pulmonary function. Rev Paul Pediatr. 2020;39:e2019189.
[23] Janssen I, Leblanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr Phys Act. 2010;7:40.
[24] Purnama TD, Sari DM, Sastradimadja SB, Arnengsih, Sungkar E, Shanti M. Correlation between level of physical activity, aerobic capacity and body mass index with vital lung capacity in adolescence. In Proceedings of the 11th National Congress and the 18th Annual Scientific Meeting of Indonesian Physical Medicine and Rehabilitation Association. 2019:115-118.
[25] Berntsen S, Wisløff T, Nafstad P, Nystad W. Lung function increases with increasing level of physical activity in school children. Pediatr Exerc Sci. 2008;20(4):402-10.
[26] Tanaka C, Tanaka M, Tanaka S. Objectively evaluated physical activity and sedentary time in primary school children by gender, grade and types of physical education lessons. BMC Public Health. 2018;18(1):948.
[27] Nourry C, Deruelle F, Guinhouya C, Baquet G, Fabre C, Bart F et al. High-intensity intermittent running training improves pulmonary function and alters exercise breathing pattern in children. European Journal of Applied Physiology. 2005;94(4):415-23.
[28] American Thoracic Society. Standardization of Spirometry, 1994 Update. American journal of respiratory and critical care medicine. 1995;152(3):1107-1136.
[29] Gulati A, Hochdorn A, Paramesh H, Paramesh EC, Chiffi D, Kumar M, et al. Physical activity patterns among school children in India. Indian J Pediatr. 2014;81(Suppl 1):47-54.
[30] Chen X, Ma J, Dong L, Chen Y, Chen K. The association between physical activity and lung function in adolescents: A cross-sectional NHANES study. Front Med (Lausanne). 2025;12:1538221.
[31] Hancox RJ, Rasmussen F. Does physical fitness enhance lung function in children and young adults? Eur Respir J. 2018;51(2):1701374.
[32] Pelkonen M, Notkola IL, Lakka T, Tukiainen HO, Kivinen P, Nissinen A. Delaying decline in pulmonary function with physical activity: A 25-year follow-up. Am J Respir Crit Care Med. 2003;168(4):494-99.

PARTICULARS OF CONTRIBUTORS:
1. PhD Scholar, Department of Physiotherapy, Faculty of Physiotherapy, Parul University, Vadodara, Gujarat, India.
2. Head, Department of Paediatrics, PIMSR, Parul University, Vadodara, Gujarat, India.
3. Head, Department of Physiotherapy, Parul Institute of Physiotherapy, Parul University,Vadodara, Gujarat, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Himadri Kishorkumar Lakhani,
B-14, Shilpgram Siddhi, Near Saurashtra Patel Samaj, New Nikol, Ahmedabad, Gujarat, India.
Email: himadriiphd@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Apr 22, 2025
- Manual Googling: Nov 17, 2025
- iThenticate Software: Nov 19, 2025 (8%)

ETYMOLOGY: Author Origin

EMENDATIONS: 8

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Apr 21, 2025**
Date of Peer Review: **Aug 27, 2025**
Date of Acceptance: **Nov 21, 2025**
Date of Publishing: **Apr 01, 2026**