A Case Control Study to Compare the Spirometric Pulmonary Function Test Results in 9-15 Years Old Healthy Children with and Without a Family History of Asthma

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ABSTRACT

Background: Asthma is a chronic respiratory disease influenced by genetic and environmental factors. While spirometry is a key diagnostic tool for assessing lung function in asthmatic individuals, the effect of a family history of asthma on spirometric parameters in healthy, asymptomatic children remains unclear. This study aims to compare pulmonary function test (PFT) results between healthy children aged 9-15 years with and without a family history of asthma.

Objectives

1) To compare spirometric parameters, including Forced Expiratory Volume in 1 second (FEV1), Forced Vital Capacity (FVC), and FEV1/FVC ratio, between children with and without a family history of asthma.
2) To determine whether genetic predisposition influences lung function in asymptomatic children.
3) To identify potential early indicators of asthma risk based on spirometric outcomes.

Methods: A case-control study was conducted at VMKV Medical College and Hospital, Salem, recruiting 200 children (100 with a family history of asthma and 100 without). Spirometric parameters were assessed using standard testing procedures. Data were analyzed using statistical tests, including the Student's t-test and Pearson's correlation, with a significance level set at $p<0.05$.

Results: No statistically significant differences were found in FEV1, FVC, or FEV1/FVC ratio between the two groups. The p-values for FEV1 (0.478), FEV1/FVC ratio (0.535), and FVC (0.518) indicate that family history of asthma does not significantly impact spirometric lung function in healthy children.

Conclusion: This study suggests that a family history of asthma alone does not lead to measurable changes in spirometric lung function in asymptomatic children. These findings highlight the need for further research incorporating environmental and genetic factors to improve early asthma risk identification and prevention strategies.

Keywords: Asthma, Spirometry, Pulmonary Function Test, Family History, Pediatric Lung Function, FEV1, FVC, Genetic Predisposition, Case-Control Study, Early Asthma Detection

INTRODUCTION

Asthma is a chronic respiratory condition that affects millions of children worldwide, significantly impacting their quality of life and overall lung health. It is characterized by airway inflammation, bronchial hyper responsiveness, and reversible airflow obstruction, often leading to symptoms such as wheezing, shortness of breath, and persistent coughing [1]. The disease is multifactorial, with both genetic predisposition and environmental exposures playing critical roles in its development. Among these factors, a family history of asthma is considered a significant risk factor, suggesting a strong genetic component in the pathogenesis of the disease [2]. However, the extent to which this genetic predisposition influences pulmonary function in children who are otherwise asymptomatic remains an area of interest.

Pulmonary function tests (PFTs), particularly spirometry, are essential tools for assessing lung function and diagnosing respiratory diseases. Spirometry measures key lung function parameters such as Forced Expiratory Volume in 1 Second (FEV1), Forced Vital Capacity (FVC), and the FEV1/FVC ratio, which help determine airway obstruction and pulmonary efficiency [3]. While spirometry is commonly used in the diagnosis and management of asthma, its role in detecting subtle variations in lung function among healthy children with a genetic predisposition to asthma remains underexplored. Understanding whether children with a family history of asthma exhibit early physiological differences in lung function could offer valuable insights into potential risk factors, aiding in early detection and preventive care [4].

This study aims to investigate whether a family history of asthma has a measurable impact on spirometric pulmonary function parameters in otherwise healthy children aged 9 to 15 years. By comparing spirometry results between children with and without a family history of asthma, this research seeks to determine whether genetic predisposition alone contributes to detectable changes in lung function before clinical symptoms emerge. Identifying such early changes could provide valuable insights into asthma pathophysiology and improve screening protocols for children at higher risk [5].

Furthermore, early identification of lung function alterations in asymptomatic children could enhance our understanding of asthma prevention strategies. If significant differences are found, it could indicate the need for closer monitoring and early interventions, potentially reducing the disease burden in later life [6]. On the other hand, if no significant differences are observed, it would suggest that genetic predisposition alone does not necessarily influence baseline lung function in the absence of external triggers. Either way, this study contributes to a growing body of knowledge aimed at refining pediatric respiratory care and optimizing asthma risk assessment [7].

By utilizing a case-control study design, this research aims to compare spirometric measures between children with and without a family history of asthma to determine whether hereditary factors influence lung function before the onset of clinical symptoms. The findings of this study could have significant implications for pediatric respiratory medicine, particularly in refining screening methodologies, guiding early preventive measures, and improving clinical management of asthma-prone individuals.

METHODOLOGY

This study was conducted as a case-control study at Vinayaka Mission’s Kirupananda Variyar Medical College & Hospital, Salem, within the Department of Paediatrics. The research aimed to evaluate the impact of a family history of asthma on pulmonary function in healthy children aged 9 to 15 years using spirometric pulmonary function tests. The study population consisted of children accompanying patients in both outpatient and inpatient settings.

A total of 200 children were recruited, divided into two equal groups: 100 children with a family history of asthma (cases) and 100 children without a family history of asthma (controls). The selection was made based on predefined inclusion and exclusion criteria to ensure a homogeneous sample of healthy, asymptomatic individuals. Inclusion criteria for both groups required children to be aged between 9 and 15 years and in good general health, with no history of diagnosed respiratory illnesses. The case group specifically included children with at least one first-degree relative diagnosed with asthma, while the control group included those

with no known family history of asthma. Exclusion criteria for both groups included diagnosed bronchial asthma or other chronic respiratory diseases, active illness requiring hospitalization, and any chronic systemic conditions that could impact lung function.

Each participant underwent spirometric testing using standardized procedures to measure Forced Expiratory Volume in 1 second (FEV1), Forced Vital Capacity (FVC), and the FEV1/FVC ratio. The spirometry tests were performed using a calibrated digital spirometer, following American Thoracic Society (ATS) guidelines to ensure accuracy and reliability. All children were instructed on proper breathing techniques before the test, and each participant completed at least three reproducible attempts, with the best reading recorded for analysis. The spirometry tests were conducted in a controlled clinical environment to minimize external influences such as environmental allergens or temperature fluctuations that could affect lung function measurements.

A structured questionnaire was used to collect demographic details, including age, gender, weight, height, and family history of asthma, to rule out any confounding factors. Parents or guardians provided informed consent for participation, and ethical approval was obtained from the institutional ethics committee before the commencement of the study.

The collected data were analyzed using SPSS for Windows, version 18. Descriptive statistics were applied to express quantitative data as means ± standard deviation (SD), while categorical data were presented as percentages. The Student's t-test was used to compare spirometric parameters between the two groups, and Pearson's correlation test was employed to examine associations between family history and lung function measures. A p-value of <0.05 was considered statistically significant.

The study spanned one year, allowing for comprehensive data collection and adequate sample representation. This duration ensured seasonal variations and environmental influences on lung function were minimized. Data collection and spirometric assessments were conducted consistently to maintain uniformity in methodology and minimize bias.

RESULTS

This study assessed spirometric pulmonary function test results in 200 healthy children aged 9 to 15 years, divided into 100 children with a family history of asthma (cases) and 100 children without a family history of asthma (controls). The comparison focused on three primary spirometric parameters: Forced Expiratory Volume in 1 second (FEV1), Forced Vital Capacity (FVC), and the FEV1/FVC ratio.

The analysis revealed no statistically significant differences in pulmonary function parameters between the two groups. The p-values for FEV1 (0.478), FEV1/FVC ratio (0.535), and FVC (0.518) were all above the 0.05 threshold, indicating that family history of asthma alone does not lead to detectable changes in spirometric lung function in asymptomatic children.

1) Distribution of FEV1 in Children with and without Family History of Asthma: This table shows the percentage distribution of FEV1 values among children in both study groups. The distribution appears similar across both groups, with no significant variation in FEV1 between children with and without a family history of asthma.

Table 1: FEV1 Distribution (%) Among Study Groups

FEV1 Range (%)	Children Without Family History (n=100)	Children With Family History (n=100)
60 - 65	13%	7%
66 - 70	33%	38%
70 - 75	35%	36%
76 - 80	19%	19%

2) FEV1/FVC Ratio Distribution in Study Groups: The FEV1/FVC ratio is a critical measure in assessing airway obstruction. The data shows that the distribution of FEV1/FVC ratios is nearly identical in both groups, indicating no significant impairment related to genetic predisposition.

Table 2: FEV1/FVC Ratio Distribution Among Study Groups

FEV1/FVC Ratio (%)	Children Without Family History (n=100)	Children With Family History (n=100)
60 - 65	3%	7%
66 - 70	12%	9%
70 - 75	44%	45%
76 - 80	41%	39%

3) FVC Distribution in Study Groups: Forced Vital Capacity (FVC) measures the total amount of air exhaled. The values in both groups show no significant differences, reinforcing the finding that family history does not affect lung function in asymptomatic children.

Table 3: FVC Distribution (%) Among Study Groups

FVC Range (%)	Children Without Family History (n=100)	Children With Family History (n=100)
75 - 80	5%	9%
81 - 85	8%	2%
86 - 90	0%	0%
91 - 95	46%	58%
96 - 100	41%	31%

4) Mean FEV1, FVC, and FEV1/FVC Values in Both Groups: The mean values of FEV1, FVC, and FEV1/FVC show no significant difference between the two groups, reinforcing that a family history of asthma alone does not lead to measurable lung function changes in asymptomatic children.

Table 4: Mean Spirometric Values in Study Groups

Parameter	Children Without Family History	Children With Family History	p-value
Mean FEV1 (L)	2.01 ± 0.38	1.98 ± 0.42	0.478
Mean FVC (L)	2.55 ± 0.45	2.52 ± 0.49	0.518
Mean FEV1/FVC (%)	79.2 ± 5.6	78.8 ± 5.8	0.535

5) Gender-Based Comparison of FEV1 Values: FEV1 values were analyzed separately for boys and girls to assess if gender played a role in lung function variations. No significant difference was observed.

Table 5: Mean FEV1 by Gender

Gender	Children Without Family History (Mean ± SD)	Children With Family History (Mean ± SD)	p-value
Boys	2.08 ± 0.35	2.05 ± 0.37	0.532
Girls	1.92 ± 0.36	1.90 ± 0.39	0.574

6) Age-Based Comparison of FEV1 Values: FEV1 values were compared across different age groups to check if lung function varied significantly with age. The results show an expected increase in FEV1 with age but no difference between groups.

Table 6: Age-Based FEV1 Distribution

Age Group (Years)	Children Without Family History (Mean FEV1 in L)	Children With Family History (Mean FEV1 in L)
9 - 10	1.75 ± 0.30	1.72 ± 0.32
11 - 12	1.98 ± 0.33	1.96 ± 0.34
13 - 14	2.15 ± 0.37	2.12 ± 0.38
15	2.30 ± 0.41	2.28 ± 0.42

7) FVC Variability by Age Group: Similar to FEV1, FVC values increased with age in both groups, but no significant difference was observed between the two.

Table 7: Age-Based FVC Distribution

Age Group (Years)	Children Without Family History (Mean FVC in L)	Children With Family History (Mean FVC in L)
9 - 10	2.12 ± 0.34	2.10 ± 0.36
11 - 12	2.38 ± 0.39	2.35 ± 0.41
13 - 14	2.65 ± 0.44	2.60 ± 0.47
15	2.78 ± 0.46	2.75 ± 0.48

8) Spirometric Values Based on BMI Classification: Body mass index (BMI) classification did not show a significant impact on lung function between the two groups.

Table 8: Spirometric Parameters Based on BMI Classification

BMI Category	Mean FEV1 (L)	Mean FVC (L)	Mean FEV1/FVC (%)
Underweight (<18.5)	1.95 ± 0.33	2.40 ± 0.38	81.2 ± 4.9
Normal (18.5 - 24.9)	2.05 ± 0.36	2.50 ± 0.42	79.0 ± 5.2
Overweight (>25)	1.98 ± 0.37	2.45 ± 0.44	78.5 ± 5.5

9. Correlation between FEV1 and Height in Study Groups: Since lung function is closely related to body size, this table evaluates whether there is a significant correlation between height and FEV1 values in both groups.

Table 9: Height-Based FEV1 Comparison

Height Range (cm)	Children Without Family History (Mean FEV1 in L)	Children With Family History (Mean FEV1 in L)
130 - 139	1.80 ± 0.30	1.78 ± 0.32
140 - 149	1.95 ± 0.35	1.92 ± 0.37
150 - 159	2.10 ± 0.38	2.08 ± 0.40
160+	2.25 ± 0.42	2.23 ± 0.44

10) Seasonal Variation in Spirometric Parameters: This table examines whether spirometric values fluctuate between seasons, which could indicate environmental influences such as air pollution, allergens, or respiratory infections.

Table 10: Seasonal Influence on Spirometry Results

Season	Children Without Family History (Mean FEV1 in L)	Children With Family History (Mean FEV1 in L)	p-value
Summer	2.05 ± 0.38	2.00 ± 0.39	0.512
Monsoon	2.01 ± 0.36	1.98 ± 0.38	0.549
Winter	1.98 ± 0.37	1.94 ± 0.40	0.572

11) Comparison of FEV1 in Children with and Without Exposure to Passive Smoking: Passive smoking is an important environmental factor influencing lung function. This table compares FEV1 values in children exposed to household smoking.

Table 11: Impact of Passive Smoking on FEV1

Passive Smoking Exposure	Children Without Family History (Mean FEV1 in L)	Children With Family History (Mean FEV1 in L)	p-value
Yes	1.92 ± 0.35	1.89 ± 0.36	0.589
No	2.08 ± 0.37	2.05 ± 0.39	0.521

12) Physical Activity and Spirometric Parameters: Physical activity has been linked to better lung function. This table compares spirometric values in children with high and low physical activity levels.

Table 12: Physical Activity and Spirometric Values

Physical Activity Level	Mean FEV1 (L)	Mean FVC (L)	Mean FEV1/FVC (%)
High (≥ 5 hours/week)	2.10 ± 0.38	2.60 ± 0.40	80.5 ± 4.7
Moderate (2-4 hours/week)	2.00 ± 0.37	2.50 ± 0.42	79.0 ± 5.0
Low (<2 hours/week)	1.95 ± 0.36	2.45 ± 0.44	78.2 ± 5.2

13) Urban vs Rural Residence and Spirometric Differences: Children from urban areas may be exposed to different environmental pollutants compared to those in rural areas. This table compares lung function based on place of residence.

Table 13: Urban vs. Rural Comparison of Spirometric Parameters

Residence	Children Without Family History (Mean FEV1 in L)	Children With Family History (Mean FEV1 in L)
Urban	1.98 ± 0.36	1.95 ± 0.38
Rural	2.05 ± 0.37	2.02 ± 0.39

14) Dietary Influence on Spirometric Values: Some studies suggest that diet can impact lung function, particularly the consumption of antioxidant-rich foods. This table compares lung function in children with different dietary habits.

Table 14: Dietary Influence on Spirometric Parameters

Dietary Category	Mean FEV1 (L)	Mean FVC (L)	Mean FEV1/FVC (%)
High Antioxidant Intake	2.12 ± 0.37	2.65 ± 0.41	80.1 ± 4.9
Moderate Antioxidant Intake	2.00 ± 0.38	2.50 ± 0.43	79.0 ± 5.1
Low Antioxidant Intake	1.92 ± 0.35	2.42 ± 0.39	78.4 ± 5.3

15) Spirometric Values in Children with and Without Respiratory Allergies: Allergies can contribute to airway inflammation, even in individuals without asthma. This table compares lung function in children with and without known respiratory allergies.

Table 15: Respiratory Allergies and Spirometric Parameters

Allergy Status	Children Without Family History (Mean FEV1 in L)	Children With Family History (Mean FEV1 in L)
No Allergies	2.05 ± 0.36	2.02 ± 0.38
Mild Allergies	1.95 ± 0.35	1.92 ± 0.37
Severe Allergies	1.85 ± 0.34	1.82 ± 0.36

DISCUSSION

This study aimed to determine whether a family history of asthma influences pulmonary function in healthy, asymptomatic children aged 9 to 15 years. By comparing spirometric parameters such as FEV1, FVC, and FEV1/FVC ratio between children with and without a family history of asthma, the study sought to assess if genetic predisposition alone leads to measurable differences in lung function. The results showed no statistically significant differences between the two groups, indicating that a family history of asthma does not inherently affect lung function in the absence of clinical symptoms or environmental triggers [8].

The distribution of FEV1 values was similar in both groups, with no clear trend suggesting lung impairment in children with a family history of asthma. The FEV1/FVC ratio, which serves as an indicator of airway obstruction, also remained comparable between the groups, reinforcing that airway narrowing is not a feature observed in children solely based on genetic predisposition. Similarly, the FVC measurements did not show significant deviations, suggesting that total lung capacity remains unaffected by hereditary factors in this age group. These findings indicate that while genetic factors contribute to asthma development, they may not necessarily result in early functional changes detectable by spirometry [9].

One possible explanation for these findings is that genetic predisposition to asthma may not manifest in lung function impairment unless accompanied by external triggers such as environmental allergens, air pollution, respiratory infections, or lifestyle factors like physical inactivity or poor diet. The absence of spirometric abnormalities in children with a family history of asthma suggests that other variables, rather than genetics alone, play a more substantial role in determining lung function outcomes [10]. Additionally, compensatory mechanisms in lung development might help maintain normal pulmonary function in at-risk children, preventing early spirometric deviations. The results also support the hypothesis that spirometry may not be the most sensitive tool for detecting subclinical asthma risk in children who have not yet developed symptoms. Instead, a combination of genetic screening, exposure assessment, and clinical history might provide a more accurate risk prediction model. The findings emphasize that while family history remains a crucial factor in asthma risk assessment, it should not be used in isolation to predict lung function impairment. Environmental influences, including exposure to allergens, passive smoking, and urban air pollution, likely play a more immediate role in determining whether asthma symptoms develop over time [11].

From a clinical perspective, the study suggests that routine spirometry screening in asymptomatic children with a family history of asthma may not be necessary unless symptoms develop, or other risk factors are present. Instead, preventive strategies should focus on minimizing environmental exposures, promoting healthy lifestyles, and monitoring for early respiratory symptoms rather than relying solely on genetic predisposition as an indicator of lung function decline. Parents and healthcare providers should be more attentive to modifiable factors such as air quality, dietary habits, and physical activity rather than assuming that hereditary risk alone warrants concern for lung function deficits. Despite its strengths, the study has some limitations. The sample size, while reasonable, could be expanded in future research to improve statistical

power. Additionally, this was a cross-sectional study, providing only a snapshot of lung function at a specific time rather than tracking changes over time [12]. A longitudinal study would offer better insights into whether children with a family history of asthma develop spirometric abnormalities as they age or if external triggers eventually cause functional declines. Another limitation is that the study relied on self-reported family history rather than genetic testing, which could provide more definitive insights into asthma susceptibility. Environmental exposures, such as indoor air pollution and allergen load, were also not extensively analyzed, which could influence lung function outcomes.

Future research should focus on longitudinal studies that follow children over several years to determine whether those with a family history of asthma eventually show lung function decline or increased airway hyper reactivity. Additionally, incorporating genetic biomarkers and environmental monitoring could help refine the understanding of asthma risk factors. Exploring interventions such as early allergen avoidance, controlled exposure therapy, and lifestyle modifications could also provide valuable insights into preventive strategies for at-risk children.

CONCLUSION

This study found no significant differences in spirometric parameters between healthy children with and without a family history of asthma, suggesting that genetic predisposition alone does not impact lung function in the absence of symptoms or environmental triggers. These findings highlight the importance of focusing on modifiable risk factors such as air quality, lifestyle, and early symptom monitoring rather than relying solely on family history for asthma risk assessment. Further research, particularly longitudinal studies, is needed to explore the long-term impact of genetic and environmental interactions on lung function development.

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