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ORIGINAL ARTICLE

Reproducibility of spirometry in asthmatic children between 5-12 years of age.

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ABSTRACT... Objective: To investigate how consistently children (aged 5-12) attending the asthma clinic at Abbasi Shaheed Hospital could perform forced expiratory maneuvers during standard spirometric evaluation. **Study Design:** Cross-sectional. **Setting:** Department of Paediatric, Abbasi Shaheed Hospital, Karachi. **Period:** October, 2021 till April, 2022. **Methods:** Prospective data collection was conducted on 128 suspected asthmatic patients following verbal consent. Simple descriptive statistics, including mean and standard deviation, were used to summarize quantitative data, while qualitative variables were reported as frequencies and percentages. Stratification was used to manage effect modifiers and evaluate their influence on the outcome variable. A post-stratification chi-square test was employed, with a significance level set at $p \leq 0.5$. **Results:** A total of 128 suspected asthmatic patients were included in this study. Mean age in our study was 9.14±2.09 years. 58 (45.3%) were male and 70 (54.7%) were female. Out of 128 suspected asthmatic patients, 95 (74.2%) and 33 (25.8%) had and did not have reproducibility. **Conclusion:** In a busy clinical environment, a significant number of school-aged children demonstrate the ability to perform technically acceptable and repeatable spirometry. This indicates that spirometry could serve as an effective screening tool for identifying abnormal lung function, such as asthma, in this age group.

Key words: Asthma, GINA Guidelines, Reproducibility, Spirometry.

INTRODUCTION

Asthma, characterized by variable symptoms, reversible airflow obstruction, and bronchospasm, is a chronic inflammatory condition of the airways. Children, whose airways are smaller than those of adults, are particularly affected, are especially vulnerable to the effects of asthma.[1] It is the most common chronic disease in childhood and a significant cause of chronic illness and death worldwide. The occurrence of asthma symptoms among children shows significant variation across populations and is experiencing an upward trend, especially among young children.[2]

Pediatric asthma is a major public health concern affecting both children and their caregivers. Approximately one in five children with asthma require emergency department (ED) care, and about half of children with asthma miss at least one day of school per year due to their condition.[3] Managing chronic respiratory diseases like asthma in children requires appropriate medication and objective measures to assess treatment success.[4] Pulmonary function tests, especially spirometry, are essential in the diagnosis, management, and monitoring of respiratory diseases, such as asthma.[5]

Spirometry, which involves measuring changes in lung volumes during forced breathing maneuvers, stands as the most commonly utilized pulmonary function test. It is essential for diagnosing, managing, and monitoring various respiratory diseases, including asthma. Spirometry results can be affected by a range of factors, including age, weight, sex, height, ethnicity, environmental factors, patient cooperation, prematurity and technical considerations.[6] While spirometry is commonly employed in managing respiratory conditions in adults. Despite its feasibility in primary care settings for children, spirometry is often not utilized enough in pediatric patients.[7,8]

In a survey concerning the utilization of

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spirometry by primary care physicians managing children with asthma, it was discovered that only half were employing spirometry, and nearly half were misinterpreting the results. Spirometry is a common recommendation for children experiencing chronic cough, persistent wheezing, and for the diagnosis and monitoring of asthma.[9] It is imperative that spirometry be included as a crucial component in assessing asthma control in children. Physical symptoms reported by children with asthma include general coughing, nightmare cough, wheezing, and trouble sleeping due to cough. Approximately two-thirds of these children had abnormal forced expiratory volume in 1 second values.[10,11] The role of spirometry in assessing acute asthma exacerbations in children is not well defined, as many children with moderate to severe exacerbations cannot perform acceptable spirometry tests.[12,13]

To ascertain the frequency with which school-aged children (5-12 years old) attending the asthma clinic at Abbasi Shaheed Hospital can replicate forced expiratory maneuvers reliably during standard spirometric assessments.

METHODS

This Cross-sectional study was conducted at Department of Paediatric, Abbasi Shaheed Hospital, Karachi. Six months from 01-10-2021 till 30-04-2022. The sample size needed for the research is 128 patients. This calculation, using the WHO software, was based on a prevalence rate of 69.27% with a margin of error of 6% and a confidence level of 95% by Convenience sampling technique

Inclusion Criteria

Children aged between 5 to 12 years, suspected of having asthma with symptoms less than 6 months were included.

Exclusion Criteria

Incomplete questionnaire and those who did not provide consent were excluded.

After explaining the purpose of the study, oral and written informed consent was taken from parents or guardians prior the commencement of study. In this study, suspected asthmatic patients were enrolled to evaluate the outcome variable, reproducibility. The principal investigator collected demographic and clinical history from the patients and conducted spirometry under the supervision of a consultant with more than 5 years of experience. Data collection was done using a pre-designed form. Confounding variables and biases were minimized by strictly adhering to the predefined inclusion and exclusion criteria.

Statistical Package for the Social Sciences (SPSS) version 21 was utilized for both data entry and analysis in this study. The study analyzed quantitative variables like age and duration of symptoms to determine their mean and standard deviation. It also assessed frequency and percentages of qualitative variables such as gender, residence, mother's education, socioeconomic status, family history of asthma, and reproducibility. To control for effect modifiers, the data was stratified based on age, gender, residence, mother's educations, socioeconomic status, family history of asthma and duration of symptoms to assess the effect of these variables on outcome variables. Post-stratification chi-square tests were performed at a significance level of $P < 0.05$.

Permission from ethical review committee was taken from institutional research and ethnic review committee (07-09-21).

RESULTS

Demographic characteristics are mentioned in Table-I. Out of 128 suspected asthma patients who satisfied the inclusion and exclusion criteria 58 individuals (45.3%) were male whereas 54.7% were female. 43.8% were aged between 5 to 8 years and 56.2% were aged in 9 to 12 years. On the basis of reproducibility distribution, 74.2% had shown reproducibility. Frequency distribution of duration of symptoms showed that out of 128 suspected asthmatic patients, 68 (53.1%) and 60 (46.9%) had the symptoms for < 3 months and > 3 months respectively. Out of 128, 91 individuals resided in urban. 73.4% of mothers were educated and 26.6% mothers uneducated. On the basis of socioeconomic status, 36 (28.1%), 47 (36.7%)

and 45 (35.2%) belonged to socioeconomic group of < 15000, 15000-35000 and > 35000 respectively. The frequency distribution of family history of asthma among the 128 suspected asthmatic patients revealed 28 (21.9%) and 100 (78.1%) had and did not have family history of asthma respectively.

S. No.	Variables	Frequency	Percentage
1	**Gender**		
	Male	58	45.31%
	Female	70	54.69%
2	**Age**		
	5-8 Years	56	43.75%
	9-12 Years	72	56.25%
3	**Reproducibility Distribution**		
	Yes	95	74.22%
	No	33	25.78%
4	**Duration Of Symptoms**		
	>3months	68	53.12%
	<3months	60	46.88%
5	**Residence Status**		
	Urban	91	71.09%
	Rural	37	28.91%
6	**Mother Education Status**		
	Educated	94	73.44%
	Uneducated	34	26.56%
7	**Socioeconomic Status**		
	<15000	36	28.12%
	15000-35000	47	36.72%
	>35000	45	35.16%
8	**Family History of Asthma**		
	Yes	28	21.88%
	No	100	78.12%

Table-I. Demographic characteristics of participants (n=128)

Variable	Mean ± Sd	Standard Deviation	Min-Max
Age (Years)	9.14	±2.09	5-12
Duration Of Symptoms (Months)	4.32	±1.74	1-6

Table-II. Descriptive statistics (n=128)

The study included 128 patients with ages ranging from 5 to 12 years the mean age was 9.14 years, with a standard deviation of ±2.09. The mean duration of symptoms was 4.32 years, with a standard deviation of ±1.74, as indicated in Table-II.

Age (Years)	Reproducibility		Total
	Yes	No	
5-8	47 (49.5%)	09 (27.3%)	56 (43.8%)
9-12	48 (50.5%)	24 (72.7%)	72 (56.2%)
Total	95 (100%)	33 (100%)	128 (100%)
P-Value	0.02		

Table-III. Reproducibility according to age (n=128)

Stratifying by age regarding reproducibility revealed that 47 (49.5%) and 48 (50.5%) of patients aged 5-8 years and 9-12 years, respectively, achieved reproducibility. There was a significant association between age and reproducibility. Specifically, 27.3% of patients aged 5-8 years and 72.7% of those aged 9-12 years did not achieve reproducibility, with a p-value of 0.02.

Socioeconomic Status	Reproducibility		Total
	Yes	No	
< 15000	23 (24.2%)	13 (39.4)	36 (28.1%)
15000-35000	31 (32.6%)	16 (48.5)	47 (36.7%)
> 35000	41 (43.2%)	04 (12.1)	45 (35.2%)
Total	95 (100%)	33 (100%)	128 (100%)
P-Value	0.01		

Table-IV. Reproducibility according to socioeconomic status (n=128)

Stratifying by socioeconomic status concerning reproducibility revealed that 23 (24.2%), 31 (32.6%) and 41 (43.2%) achieved reproducibility who belonged to socioeconomic group of < 15000, 15000-35000 and > 35000 respectively. Whereas 13 (39.4%), 16 (48.5%) and 04 (12.1%) did not achieve reproducibility who belonged to socioeconomic group of < 15000, 15000-35000 and > 35000 respectively. P-value was 0.01 so significant association was found as p-value is <0.05.

Duration of Symptoms	Reproducibility		Total
	Yes	No	
< 3 Months	53 (55.8%)	15 (45.5)	68 (53.1%)
> 3 Months	42 (44.2%)	18 (54.5%)	60 (46.9%)
Total	95 (100%)	33 (100%)	128 (100%)
P-Value	0.20		

Table-V. Reproducibility according to duration of symptoms (n=128)

When stratified for duration of symptoms, the data revealed that 55.8% (53 patients) and 44.2% (42 patients) achieved and did not achieve

reproducibility, respectively, who had symptoms for <3 months and >3 months achieved reproducibility respectively. Whereas 15 (45.5%) and 18 (54.5%) who had symptoms for <3 months and >3 months did not achieve reproducibility respectively. Significant association was not found as P-value was 0.20.

DISCUSSION

The evaluation of pulmonary function is a valuable tool in studying the development of children and adolescents, as well as managing chronic diseases. Spirometry is used as a reliable instrument to assess respiratory health. Conducting spirometry requires the individual being tested to cooperate and perform the required maneuvers. In pediatric cases, special strategies from the technical team are often necessary to ensure the exam is successful.

In our study, 128 suspected asthmatic patients were included in this study. Mean age in our study was 9.14±2.09 years. 58 (45.3%) were male and 70 (54.7%) were female. Out of 128 suspected asthmatic patients, 95 (74.2%) and 33 (25.8%) had and did not have reproducibility.

Another study indicated that 35% of children experienced at least one wheezing episode (18% had two or more episodes), and 4% were diagnosed with asthma. Wheezing occurred more frequently in children with a family history of atopy, lower respiratory tract infections (LRTIs), bronchiolitis maternal smoking during pregnancy, and allergy to aeroallergens. Children who had a history of LRTIs and allergy to aeroallergens were more likely to develop asthma. About 55% of the spirometry measurements met the standards set by the American Thoracic Society and the European Respiratory Society. Children with wheezing had lower z scores for forced expiratory volume in 1 second (FEV1), the ratio of FEV1 to forced vital capacity (FEV1/FVC), and forced expiratory flow between 25% and 75% of FVC (FEF25-75), and they also had a higher incidence of abnormal FEV1, FEV1/FVC, and FEF25-75/FVC.[14,15]

Another study conducted in Iran found that age, weight, and height were all positively correlated with lung function parameters in both male and female participants. Boys exhibited significantly higher lung function values compared to girls.

In general, lung function parameters were higher in urban children compared to rural children, except for inspiratory reserve volume (IRV) and forced expiratory flow at 25% of forced vital capacity (FEF25%). Height demonstrated the strongest independent correlation with lung function among all anthropometric parameters, as indicated by the highest correlation coefficient.[16,17]

Another study, which involved 573 participants, reported a median age of 8.8 years with an interquartile range (IQR) of 6.8 to 11.5 years. Among the study's participants, 57% were African-American, 60% were male and 58% were covered by Medicaid insurance. The study found that spirometry was successfully performed by 331 participants (58% of the total), respiratory resistance (Rint) tests by 561 participants (98%), and fractional exhaled nitric oxide (FENO) tests by 354 participants (70% of the 505 who attempted the test). The study also noted that 60% of participants with mild to moderate exacerbations underwent spirometry, in contrast, only 17% of those with severe exacerbations achieved reproducibility (P=0.0001). In addition, there was a higher likelihood of spirometry participation among participants aged 8 to 12 years (67%) compared to those aged 5 to 7 years (48%) (odds ratio [OR] = 2.23, 95% confidence interval [CI]: 1.45–3.11) or 13 to 17 years (58%) (OR = 1.61, 95% CI: 1.00–2.59).[18,19,20]

There is significant variability in the performance of these tests, which is clinically important. Nearly all children with acute asthma can undergo airway resistance testing, suggesting the need for additional development and authentication of this technology. There is a substantial unmet need for training and education among physicians regarding antimicrobial prescribing. Local antimicrobial guidelines should be revised to make them more pertinent and useful for health practitioners.

CONCLUSION

Spirometry serves as an objective tool to prevent misclassification of asthma severity and inappropriate administration of asthma medication in children with asthma. Its use has significantly influenced asthma diagnosis. Improving adherence to guidelines among healthcare professionals can further enhance asthma care. To achieve this, implementation plans should include interactive and ongoing education, discussions on evidence-based practices, local consensus building, feedback on performance, and the development of personal and group learning plans.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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2	Sultan Mustafa	Conceiving of study idea and editing of manuscript.	
3	Sidra Hassan	Data analysis, literature review, writing of results.	
4	Saba Siddiqui	Collection of data, literature search and writing of manuscript.	
5	Areeba Tanveer	Literature review.	
6	Sarah Aslam	Collection of data.	
7	Ayesha Khatoon	Writing and editing of manuscript.	