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Evaluating Pulmonary Function in Pediatric Emergency Department Patients Experiencing Acute Wheezing/Asthma Exacerbation

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RR TMB SS conceived idea, RR AR MI ZIB drafted the study, SS TMB ZR collected data, RR MI ZIB did statistical analysis and interpretation of data, SS RR TMB critical reviewed manuscript, All approved final version to be published.

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The authors declare that there is no conflict of interest.

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ABSTRACT

Background: Asthma poses a substantial worldwide health issue, particularly during childhood, where it stands as the most common chronic condition. Pulmonary function tests (PFT) have been designed to assess children's tidal breathing may have limited cooperation due to their age or respiratory condition.

Objective: The present study aimed to assess the pulmonary function in pediatric emergency department patients, experiencing acute wheezing/asthma exacerbation.

Methodology: This prospective observational study investigated 52 acute wheezing/asthma exacerbation in Emergency Department of Children Hospital, Lahore from November 2020 to October 2021. All the patients with age range 2-16 years presented with wheezing or asthma exacerbation as a chief compliant were enrolled. Pulmonary function tests were conducted initially, before initiating the standard care treatment (specifically, protocol- driven care for patients with asthma). The primary metrics evaluated included the feasibility of testing, patient compliance, and the tests' ability to predict whether the patient should be admitted to the hospital or discharged.

Results: Of the total 52 patients, there were 33 (63.5%) male and 19 (36.5%) females. The overall mean age was 8.8±4.7 years. The incidence of mild, moderate, and severe asthma patients were 53.8% (n=28), 28.8% (n=15), and 17.3% (n=9) respectively. Admitted patients exhibited elevated heart rates, higher phase angle, labored breathing index, and asthma score. Bases on prior history of patients, asthma/wheezing, allergic rhinitis, eczema, and smoke exposure was found in 18 (34.6%), 14 (26.9%), 9 (17.3%), and 4 (7.7%) respectively. Among 52 patients, the admitted and discharged patients were 19 (36.5%) and 33 (63.5%) respectively.

Conclusion: The current study endorsed the use of Pulmonary Function Tests (PFTs) as an objective assessment tool for evaluating the asthma/wheezing severity and exacerbation in an Emergency Department.

Key words: Acute Wheezing/Asthma; Pulmonary Function Test; Pediatric patients

Introduction

Asthma poses a substantial worldwide health issue, particularly in childhood, where it stands as the most common chronic disease.[1] The global prevalence of asthma in children aged 6–7 and 13–14 is 9.1% and 10.2%, respectively.[2] Poorly managed asthma disrupts sleep, daily activities, and school attendance, significantly affecting overall well-being. Additionally, severe or uncontrolled asthma increases the risk of morbidity and mortality.[3] Several factors, such as nutrition, allergen exposure, tobacco smoke, and psychosocial influences, play a role in childhood asthma.[4] Interventions addressing multiple aspects, particularly reducing allergen exposure, have proven effective in mitigating asthma risk and preventing its onset. Identifying these risk factors and allergen sensitization among asthmatic children is crucial.[5] A study conducted on adults revealed that maternal smoking during pregnancy, family smoking, and a family history of allergies were significant asthma risk factors.[6] Surprisingly, having a nearby rice field reduced the risk. Skin tests conducted in this study demonstrated allergen sensitization in 87.9% of asthmatic adults, with common allergens.[7] About 74% of asthmatic children tested positive for allergens in skin prick tests.[8] Asthma frequently leads children to seek care in the emergency department (ED), making it one of the primary reasons for pediatric hospitalization following an ED visit.[9] While most asthma cases in children involve mild or moderate exacerbations, they usually respond well to initial treatments involving inhaled bronchodilator therapy and systemic steroids.[10] However, there is a subset of children with severe asthma who require more intensive interventions, such as intravenous (IV) medications, endotracheal intubation, and/or admission to intensive care.[11] Managing acute severe asthma presents challenges due to the numerous available treatment options and significant discrepancies between self-reported and actual medical practices.[12] For acute severe pediatric asthma, various medications are employed, including IV bronchodilators like salbutamol/albuterol, and aminophylline.[13] Nebulized magnesium, inhaled heliox, and IV ketamine are also utilized. In cases where intensive medical treatment proves ineffective, respiratory support through non-invasive and/or invasive ventilation may be necessary.[14]

Methodology

This prospective observational study investigated 52 acute wheezing/asthma exacerbation in Emergency Department of Children Hospital, Lahore from November 2020 to October 2021. All the patients with age range 2-16 years presented with wheezing or asthma exacerbation as a chief compliant were enrolled. Patients required severe respiratory distress requiring urgent intervention, presence of underlying lung conditions, and age <3 or >18 years were excluded. Pulmonary function tests were conducted initially, before initiating the standard care treatment (specifically, protocol- driven care for patients with asthma). The primary metrics evaluated included the feasibility of testing, patient.

Compliance, and the tests' ability to predict whether the Patient should be admitted to the hospital or discharged. Pattern of flow, actual tidal volume, respiratory rate, and ETCO2 were monitored and examined using PT test. Each patient was assigned an asthma score. Pulmonary breathing pattern, air flow and volume, and respiratory volume were determined.

SPSS version 27 was used for data analysis. Quantitative

Table 1. Demographic details and baseline characteristics (N=52)

Variables	Value (Mean ± SD) N (%)
Age (years)	8.8±4.7
Gender	
Male	33 (63.5%)
Female	19 (36.5%)
Hospital duration (hours)	4.6±1.8
Vital Signs	
Hear beat	113.4±19.9
Respiratory rate	29.4±8.6
Pulse oximetry	97.5±2.8
Asthma score	2.7±1.7

variables were presented as mean and standard deviation, while categorical variables were represented using frequencies and percentages. T-test and Chi-square test was used for the comparison of quantitative and categorical variables by taking 95% confidence interval and 5% level of significance.

Results

Of the total 52 patients, there were 33 (63.5%) male and 19 (36.5%) females. The overall mean age was 8.8±4.7 years. The incidence of mild, moderate, and severe asthma patients were 53.8% (n=28), 28.8% (n=15), and 17.3% (n=9) respectively. Admitted patients exhibited elevated heart rates, higher phase angle, labored breathing index, and asthma score. Bases on prior history of patients, asthma/wheezing, allergic rhinitis, eczema, and smoke exposure was found in 18 (34.6%), 14 (26.9%), 9 (17.3%), and 4 (7.7%) respectively. Among 52 patients, the admitted and discharged patients were 19 (36.5%) and 33 (63.5%) respectively. Demographic details and baseline characteristics of patients are shown in Table-I. Figure-1 illustrate the previous history of asthma, rhinitis, eczema, and smoke exposure. Figure-2 depicts the severity of asthma. Table- II represent the comparison of patient's characteristics in admitted and discharge patients. Pulmonary function test parameters are compared in discharge and admitted patients in Table-III.

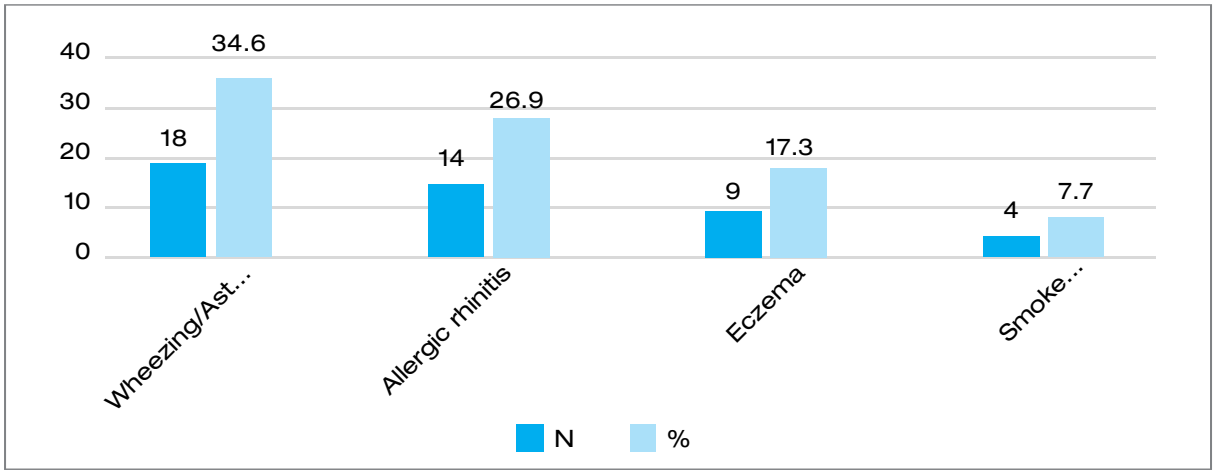

Figure 1. Pertinent history (N=45)

Discussion

The present study mainly investigated the pulmonary function tests in children suffering from acute wheezing/asthma and found that use of Pulmonary Function Tests (PFTs) as an objective assessment tool for evaluating the asthma/wheezing severity and exacerbation in an Emergency Department. The frequent occurrence of nighttime wheezing and coughing, coupled with recurrent wheezing episodes throughout the past year, generally indicates inadequate control of asthma symptoms. Furthermore, there were high rates of severe asthma symptoms, emergency room visits, and hospitalizations due to asthma exacerbations. Interestingly, our study found lower rates of exercise-induced wheezing in asthmatic individuals compared to other research studies, which reported a 90% prevalence of exercise-induced asthma in this population.[15,16] Nevertheless, the incidence was higher than in the general pediatric population. As expected, our asthmatic children exhibited a higher prevalence of concurrent allergic rhinitis and allergic rhino conjunctivitis in comparison to non-asthmatic children, consistent with findings from previous studies.[17,18] It has been observed that majority of parents and children underestimated the asthma associated symptoms. Children who have been dealing with symptoms for a long time are more susceptible to displaying asthma and hypoxia and severe, life-threatening asthma exacerbations.[19] Pulmonary function tests, such as Respiratory Inductive Plethysmography (RIP) and Pneumotachography (PT) conducted through a mask with the aid of a pediatric respiratory profile monitor, have been developed specifically to assess patients who may have limited cooperation due to their age and their clinical conditions.[20-22] These same pulmonary function test methods have been employed in previous studies in children diagnosed with asthma.[23,24] A study showed that individuals with a history of either typical or atypical pneumonia had a higher prevalence of asthma.[25] Another study indicated that early pneumonia is linked to impaired

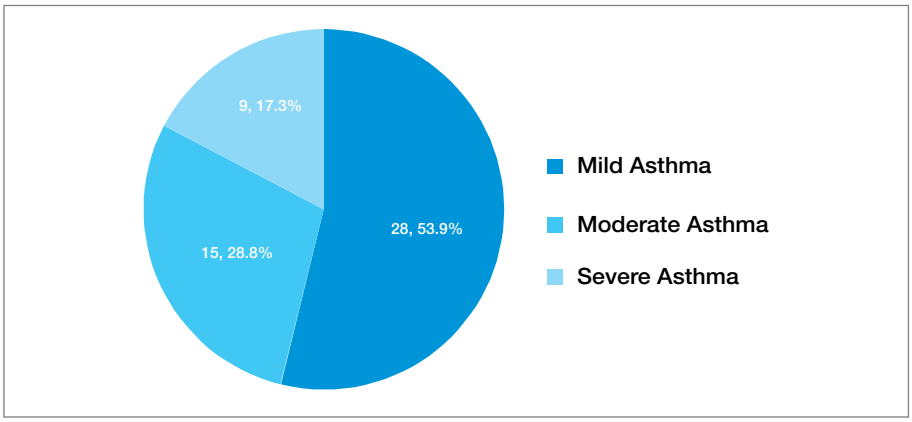

Figure 2. Severity of Asthma (N=52)

airway function and an elevated risk of developing asthma.[26] In our study, antibiotic use emerged as a notable risk factor for severe asthma, aligning with findings from previous research. This association is reinforced by a cohort study and a meta-analysis, both suggesting that early- life antibiotic use is associated with an increased risk of asthma.[27] Another potential explanation is that reduced exposure to pollutants in grass field environments might lead to fewer asthma symptoms. Pollutants like nitric oxide, carbon monoxide, carbon dioxide, formaldehyde, and particulate matter, often originating from industries, vehicles, and combustion processes, are generally less common in grass field environments. Previous studies have shown that pollutants, especially those found outdoors and near major roads, can significantly affect respiratory health and elevate the risk of asthma.[28] It has also been reported that as many as four million new cases of pediatric asthma could be linked to exposure to air pollution from traffic-related sources.[29]

Conclusion

Children diagnosed with persistent asthma, who ceased long-acting beta agonist (LABA) therapy, faced a 39.4% risk of losing asthma control, necessitating intensified maintenance treatments. Clearly, relying solely on long-acting beta agonist (LABA) therapy as a standalone treatment is not viable. Moreover, the utilization of combination inhaled corticosteroid (ICS) and LABA therapy in a single device is the best alternative for asthma control.

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Table 1. Demographic details and baseline characteristics (N=52)

Variables	Admitted (N=19)	Discharged
		(N=33)
Age (years)	7.9±4.3	9.7±5.1
Gender Male Female	 13 (68.4) 6 (21.6)	 20 (60.6%) 13 (39.4%)
Hospital duration (hours)	5.4±1.9	3.8±1.1.7
Vital Signs Hear beat Respiratory rate Puls eoximetry Asthma score	 124.6±20.4 32.6±8.9 98.4±1.7 4.5±0.89	 101.4±19.4 26.2±8.3 96.6±3.9 2.7±2.51

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