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Assessment of asthma control and lung function in asthmatic children in Sokoto, North Western Nigeria

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ABSTRACT

Objectives: This study aimed at assessing asthma control using Global Initiative for Asthma (GINA) asthma assessment, and determining its relationship with lung function parameters among asthmatic children in Usmanu Danfodiyo University Teaching hospital, Sokoto.

Materials and Methods: This was a cross-sectional study among 60 children with asthma diagnosed based on GINA guidelines. It was conducted over a period of 4 months. The GINA asthma control assessment was administered to assess asthma control. Lung function was done using a portable spirometer.

Results: Males accounted for 58.3% of the study population with M: F of 1.4:1 and median age of 9.47 years, with majority from urban domicile (91.7%). Well-controlled asthma accounted for 50.0% while 35.0% had partly controlled asthma and 15.0% had poorly controlled asthma. The median FEV_1/FVC among the study participants was 0.856 (IQR: 0.170). There was no relationship between asthma control and LF parameters (FEV_1: r = 0.044, *P* = 0.736, FVC: r = 0.010, *P* = 0.941, FEV_1/FVC: r = 0.122, *P* = 0.352, and PEFR: r = 0.015, *P* = 0.911).

Conclusion: Majority of the study participants had well-controlled asthma and no relationship was found between asthma control and lung function. Thus, serial monitoring of LF in addition to uniformly agreed standardized assessment of asthma control is required to objectively evaluate asthma control in children.

Keywords: Asthma, Asthma control, Lung function, Global initiative for asthma, Sokoto

INTRODUCTION

Asthma is estimated to affect about 339.4 million individuals of all ages worldwide.[1] It remains the commonest cause of chronic ambulatory respiratory morbidity in the west African subregion.[1,2] Although asthma affects all age groups, children suffer an undue two-fold burden. First, they may be inherently exposed to genetic and environmental factors implicated in the etiology of asthma.[2] Second, negative effects of the disease may retard their development and lead to limitation of their potentials as a result of school absenteeism, stigma, depression, and stunted growth.[3] It also poses a major and detrimental health and economic burden on the individual, family, and government, hence the need for effective management. The goal of asthma management is to achieve and maintain asthma control, and improve quality of life.[1]

The functional hallmark of asthma is a reversible airway obstruction and its detection is often required for the diagnosis of the disease.[1]

The long-term goals of asthma management are to achieve good asthma symptom control and minimize future risk of asthma related mortality, exacerbations, persistent airflow limitation, and side effects of medication adverse outcomes.[1]

Asthma control assesses the effectiveness of current therapy in a patient and the need for modification of therapy.[1,4] Asthma symptom control is a good guide to reduce risk of exacerbations and improve lung function (LF).[1]

LF using spirometry provides objective criteria in asthma diagnosis, follow-up, monitoring, and objective assessment of response to interventions.[1] Spirometry confirms airflow limitation/obstruction with a reduced forced expiratory volume in the first second (FEV_1) and FEV_1/forced vital capacity (FVC) ratio. In general, a FEV_1/FVC ratio of <0.80 in adults, and <0.90 in children indicates a significant airflow obstruction.[4] Reversibility is detected by a >12% and 200 ml increase in FEV_1 15 min after inhaled short acting beta-2 agonist or 2–4 weeks trial of oral corticosteroids. The severity of obstruction is a known risk factor for exacerbations; therefore, functional monitoring is essential to achieve optimal control.[1]

Studies have assessed asthma control using different conventional clinical assessment by standardized questionnaires and LF to establish the most appropriate measure for asthma evaluation and correlation between the two. However, there has been a disagreement and inconsistency between these reports.[5-9]

Aim and objectives

This study aimed at assessment of asthma control using GINA asthma control and also to determine its relationship with LF parameters among children with asthma in Usmanu Danfodiyo University Teaching Hospital (UDUTH) Sokoto, Nigeria.

MATERIALS AND METHODS

This was a hospital-based cross-sectional study conducted in UDUTH, Sokoto from October 2019 to January 2020.

Sample size was calculated and adjusted for finite population as follows:

$$n = \frac{\left(Z_{1-\alpha/2} + Z_{\beta}\right)^2 \sigma^2}{D^2}$$

$Z_{1-\alpha/2}$ = Percentage point of the normal distribution corresponding to the required (two-sided) significance level (α) of 0.05 = 1.96.

Z^{β}= The value of the standard normal distribution cutting off probability β, which is 0.84 for 80% power.
σ = Standard deviation of variable under study.
D = Margin of error

A total of 60 subjects were enrolled aged 5–15 years by a systematic random sampling technique. Participants were enrolled from the Pediatric Pulmonology and Allergy clinic and Emergency Pediatric Unit of department of Pediatric, UDUTH, Sokoto with a diagnosis of childhood asthma based on GINA guideline. Patients with chronic respiratory or cardiac diseases such as pulmonary tuberculosis and congenital heart diseases were excluded from the study. History, examination, anthropometric measurements weight measured using seca digital weighing machine to the nearest 0.1 kg, height measured using seca stadiometer to the nearest 0.1 cm, body mass index (BMI) = weight (kg)/height (m^2), and BMI percentile calculated as follows:

A. Underweight = <10th percentile
B. Normal weight = 10th–<85th percentile
C. Overweight = 85th–<95th percentile
D. Obesity = >95th percentile

were plotted on the growth chart accordingly.

The GINA classification[10] asthma control assessment was administered and answered appropriately to asthmatic subjects and was categorized appropriately as follows:

1) Well controlled asthma - None of these symptoms
2) Partly controlled asthma - 1–2 of these symptoms
3) Poorly controlled asthma - 3–4 of these symptoms

Detailed spirometry was performed on all the children enrolled in the study to assess their LF according to American Thoracic Society guideline using BTL-08 Spiro Pro portable spirometer. The spirometer was calibrated daily and procedure done under ambient temperature, pressure and humidity. The procedure was explained and demonstrated to all the study participants. An incentive spirometer was used to encourage the participants while the subjects sat on a chair and instructions were given. The subjects were allowed two-three practice trial blows and 3 test blows for 4–6 s, the personal best (FVC, FEV_1, FEV_1/FVC, and peak expiratory flow rate [PEFR]) was recorded.

Data analysis

Data analysis was done using Statistical Product and Service Solutions version 20.0. Non-parametric tests were used after testing for normality with Shapiro–Wilk test. Descriptive statistical analysis such as median and interquartile range was done for quantitative variables, Mann–Whitney U-test was used to compare if differences existed in LF parameters and gender/age-group, while Kruskal–Wallis H test was used to compare if differences existed LF parameters and

asthma control. Chi-square was used to determine if any relationship existed between childhood asthma control and LF. Correlation was determined using Spearman's correlation rank test.

The study was approved by Research Ethics committee of UDUTH (UDUTH/HREC/2020/995/V1) which is affiliated to the Usmanu Danfodiyo University, Sokoto. All patients' parents/caregivers were required to sign a written informed consent form; parents/caregivers who could not sign, used a thumb print on the consent form. Assent was obtained from children aged 7 years and above.

RESULTS

Sixty asthmatic children were enrolled, males accounted for 58.3% of the study population with M: F of 1.4:1. Thirty-three (55.0%) were aged <10 years while 55 (91.7%) of the participants were from the urban domicile with median age of the study population of 9.47 years (IQR 3.98 years), while normal weight accounted for 56.6% of the participants as shown in [Table 1].

Table 1: Socio-demographic and anthropometric characteristics of the study participants.

Parameters	N (%)	Median	IQR
Age-group			
5–<10 years	33 (55.0%)		
10–15 years	27 (45.0%)		
Gender			
Males	35 (58.3%)		
Females	25 (41.7%)		
Domicile			
Urban	55 (91.7%)		
Rural	5 (8.3%)		
Age		9.47	3.98
BMI (kg/m^2)		14.68	2.60
BMI percentile			
Underweight	22 (36.7%)		
Normal weight	34 (56.6%)		
Overweight	1 (1.7%)		
Obesity	3 (5.0%)		

kg: Kilogram, cm: Centimetre, m^2: Metre square, BMI: Body mass index, N: Number of subjects, IQR: Interquartile range

Asthma control assessment and LF amongst study participants

Nineteen (31.7%) of male participants and age group 5–<10 years had well-controlled asthma respectively. Asthma control had no relationship with gender (P = 0.457), nor with age group (P = 0.425). Thirty (50.0%) of the study participants had well- controlled asthma, the median LF among the study participants was 0.856. However, there was no significant difference in the median LF parameters between well controlled, partly, and poorly controlled asthma as shown below in [Table 2]. There was no association between asthma control and LF parameters (FEV_1: r = 0.044, P = 0.736, FVC: r = 0.010, P = 0.941, FEV_1/FVC: r = 0.122, P = 0.352, and PEFR: r = 0.015, P = 0.911).

LF among asthmatic children based on gender and age group

The FEV_1/FVC was 0.885 in females and 0.855 in the age group of 10–15 years study participants. There was no significant difference in the FEV_1 between male and female study participants (U = 430, P = 0.928). There was no significant difference FEV_1/FVC between study participant's age group 5–<10 years and 10–15 years of age (U = 355, P = 0.179) as shown in as depicted below in [Table 3].

DISCUSSION

The goal of asthma management is to achieve good control and improve quality of life. In this study, majority (50.0%) of the study participants had well-controlled asthma. Studies reported by Ayuk *et al*.[11] and Omole *et al*.[12] had similar findings with this study. Kuti and Omole[13] reported a higher percentage of 83.7% of well-controlled asthma among Ilesa children. The high percentage of well controlled asthma in this study could be due to the good care given by the asthma specialist as it has been reported that asthma patients seen by specialists are more likely to have better management than those followed by non-specialists or general pediatrician.[14,15] However, Kuti and Omole study attributed their findings to the fact that most of the children had mild intermittent asthma (82.7%).

However, Banjari *et al*.[16] and Al Zahrani *et al*.[17] had a contrasted report, with well-controlled asthma having lower percentages (16.0% and 12.0%, respectively) among Saudi Arabian asthmatic children. These studies used a different measurement tool of asthma control evaluation which was the Arabic validated version of ACT test for evaluation of asthma control. Whereas this study used GINA asthma control assessment which varies in evaluation of asthma symptom domain and scoring system which could account for the disparity noted. Studies that used ACT test as a measurement tool for asthma control evaluation have failed to match test scores to other objective measures of asthma control,[18] while some studies found a significant disagreement between c-ACT and GINA and between c-ACT and pediatrician's assessment of asthma control.[19,20] In addition, discrepancies in environmental condition in that Saudi Arabia's climate has many dust storms (which serve as trigger factor or environmental allergen exposure) and is more developed (which is associated with industrialization and air pollution with resultant poor air quality index)

Table 2: Asthma control assessment and LF among study participants.

	GINA Asthma control assessment							
	Well controlled		Partly controlled		Poorly controlled		Total	*P*
	N (%)		N (%)		N (%)		N (%)	
Male	19 (31.7%)		10 (16.7%)		6 (10.0%)		35 (58.3%)	0.457
Female	11 (18.3%)		11 (18.3%)		3 (5.0%)		25 (41.7%)	
Age								
5–<10 years	19 (31.7%)		10 (16.7%)		4 (6.6%)		33 (55.0%)	0.425
10–15 years	11 (18.3%)		11 (18.3%)		5 (8.3%)		27 (45.0%)	
LFT	**Median**	**IQR**	**Median**	**IQR**	**Median**	**IQR**		
FEV_1	59.50	16.00	55.00	21.00	57.00	12.00		0.418
FVC	69.00	14.75	65.00	17.00	68.00	11.50		0.471
FEV_1/FVC	0.855	0.170	0.852	0.120	0.915	0.130		0.368
PEFR	66.50	25.00	70.00	31.50	67.00	19.50		0.748
Total	30 (50.0%)		21 (35.0%)		9 (15.0%)		60.0 (100.0%)	

N: Number of subjects, values differ significantly at $P<0.05$. LF: Lung function, FEV_1: Forced expiratory volume in the first second, FVC: Forced vital capacity, PEFR: Peak expiratory flow rate

Table 3: Lung function parameters among asthmatic children based on gender and age group.

LFT parameters	Gender	N	Median	IQR	*P*
FEV_1	Male	35	56.00	14.00	0.928
	Female	25	57.00	17.00	
	5–10 years	33	60.00	17.00	0.145
	10–15 years	27	65.00	10.00	
FVC	Male	35	68.00	13.00	0.845
	Female	25	69.00	17.00	
	5–10 years	33	71.00	16.50	0.252
	10–15 years	27	65.00	12.00	
FEV_1/FVC	Male	35	0.853	0.070	0.376
	Female	25	0.885	0.100	
	5–10 years	33	0.855	0.170	0.179
	10–15 years	27	0.833	0.090	
PEFR	Male	35	67.00	27.00	0.376
	Female	25	68.00	21.00	
	5–10 years	33	70.00	30.00	0.562
	10–15 years	27	65.00	13.99	

U: Mann–Whitney U-test, N: Number of participants, FEV_1: Forced expiratory volume in the first second, FVC: Forced vital capacity, PEFR: Peak expiratory flow rate

compared to Nigeria. These factors have been shown to play a major detrimental role in asthma control and could account for the low percentage of well-controlled asthma in their studies.[21]

LF assessment with the use of spirometer is a reliable test for evaluating airway obstruction.[1] Forced expiratory techniques are reliable for use in most children as young as 5–6 years of age.[22,23] Thus, FEV_1 and FEV_1/FVC are sensitive markers to predict airway obstruction.[22,23] Dissociation of asthma symptom reports with the degree of airflow obstruction has been noted and form part of written management plans, with LF monitoring to improve asthma control.[24] LF results have reportedly changed management decisions in 15% of visits.[22,23] Therefore, it is recommended that LF should be performed at each visit to improve asthma control and identify patients at risk for progressive loss of LF.[10,23]

This study found no association between asthma control types and spirometry indices (FEV_1, FVC, FEV_1/FVC, and PEFR). This observation was also reported by these studies.[25-27] This might reflect a disassociation between a patient's asthma symptoms and their perception of those symptoms[5,18,28] or a temporal delay between changes in symptoms and spirometric values.[24]

Moreover, asthma symptoms and LF parameters represent and assess different domains of asthma and they correlate poorly over time in an individual, so both need to be monitored and evaluated differently to assess asthma control in clinical practice.[29]

However, in contrast to this study, Sommanus *et al*.[30] in a retrospective cohort study among 279 Thailand children reported significant positive correlations between c-ACT score and FEV_1 at enrollment. Lee *et al*.[31] observed a significant correlation between FEV_1 and ACT scores among Korean children. This significant correlation probably was a result of the fact that the sample size was large (1000 participants) and it was cohort prospective study which followed up the subjects over time as contrasted to this study which had a cross sectional study at LF parameters and asthma control assessment.

Furthermore, the baseline level of asthma control of the study participants in this study differs from the aforementioned studies[30,31] which may play an important factor that influences the correlation between the asthma control and

LF. Extensive literature reviews[5,25-28,31-33] to date on the relationship between asthma control and LF has had varied reports. This is not surprising as these studies differed with respect to study design, measurement tool used, sample design, sample size, methodology, and statistical analysis; thus, direct comparisons may not be justifiable and will lack objectivity. In addition, measurements of LF require a high degree of patient's cooperation which may not be adequate in children, couple with the readings of a onetime measurement of the child's LF status.[34] This may not truly reflect the inherent variability of the disease; hence, the LF parameters are of questionable value to make a tentative conclusion.[34]

Serial follow ups and monitoring of the LF measures are more reliable than a single reading which usually does not convey much meaning especially in a chronic variable disease such as asthma, more so that some studies[35,36] have reported persistent abnormal LF or airway reversibility even among asthmatic children who were classified as controlled by GINA or c-ACT guideline. This highlights the need for periodic LF measurement and harmonization of methods of asthma control evaluation in clinical practice.

Limitation of the study

This was a cross-sectional, tertiary hospital-based study which was not accessible to all the populace in the state especially the rural domicile; hence, this result may not be generalized to the whole community.

CONCLUSION AND RECOMMENDATIONS

There was no association between asthma control assessment and LF, Serial monitoring and measuring of LF in addition to uniformly agreed standardized assessment of asthma control is required to objectively evaluate asthma control in children. More studies are needed to determine longitudinal relationships between asthma control and LF.

Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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