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ASTHMA CONTROL

Assessment of the Level of Asthma Control among Adult Patients in Two Tertiary Care Centers in Nigeria

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Background. According to the Global Initiative for Asthma (GINA) guidelines, the goal of asthma management is to achieve clinical control. Uncontrolled asthma places a significant social and economic burden on patients. *Objective*. The two aims of this study were to (1) assess the level of asthma control (according to the GINA definition of "control") among adult patients attending two tertiary care centers in Nigeria and (2) to determine the predictors associated with uncontrolled asthma. *Methods*. This cross-sectional study was carried out from June 2009 to December 2010. The participants were all 18 years old or older with physician-diagnosed asthma. First, the participants completed an interviewer-administered questionnaire, which included items that collected their socio-demographic information and clinical data. Second, anthropometric indices were measured and spirometry was conducted to determine each participant's lung function. Finally, the researcher team members assessed each participant's inhaler device technique. The outcome measures were (1) uncontrolled asthma, (2) partly controlled asthma, and (3) controlled asthma. *Results*. One hundred and twenty-four asthma patients participated in the study. Of these, 69.3% had uncontrolled asthma, 22.6% had partly controlled asthma, and 8.1% had controlled asthma. Multivariate analysis showed that uncontrolled asthma was strongly associated with asthma severity based on clinical features, the incorrect use of an inhaler device, the use of oral corticosteroids, an abnormal pulmonary function test, the presence of comorbidity, and the lack of adherence to inhaled corticosteroids (ICSs). The results also revealed that increasing age and a lack of tertiary education were weakly associated with asthma control. In this study, gender, marriage, smoking status, occupation, socioeconomic status, income, and the duration of the asthma were not associated with asthma control. *Conclusion*. A significant proportion of the sampled patients had uncontrolled asthma. To reduce this number, health care providers must reinforce the education of each asthma patient and promote the regular assessment of asthma control at every clinic visit, identify those with poor control, and institute the appropriate therapy needed to achieve clinical control.

Keywords asthma control, Nigeria, predictors, tertiary care center

INTRODUCTION

Asthma also affects millions of adults. About 235 million people worldwide suffer from this noncommunicable disease (1). The incidence of asthma has been growing over the past 30 years due to changing environmental factors, particularly in the low- and middle-income countries that are least able to absorb its impact (1).

Asthma can be fatal and causes an estimated 250,000 deaths annually (1 in 250 deaths worldwide) (1, 2). In addition, the World Health Organization estimates that around 15 million disability-adjusted life years (DALYs) are lost annually through this disease (2).

In consideration of these burdens and the severe consequences of asthma, the asthma management guidelines recommended by many respiratory societies reveal that health care providers must treat asthma adequately at all levels of health care. According to the 2010 Global Initiative for Asthma (GINA) guidelines, the goal of asthma management is to achieve clinical control, which can be attained through pharmacotherapy and through physician–patient partnership (2). The clinical control of asthma is now the primary outcome variable in asthma clinical trials (3, 4). The Gaining Optimal Asthma Control (GOAL) study published in 2004 showed that current therapeutic asthma treatments are efficient and are capable of achieving good asthma control in patients (5).

Despite the array of drugs that are available to help asthma patients and despite recent advances in asthma pharmacotherapy, worldwide surveys on asthma severity and control in real-life situations have revealed that most patients do not achieve asthma control (6–8). Some of the factors that have been associated with poor asthma control are smoking, comorbidities, individual variations in response to treatment, poor adherence, and poor inhaler device technique (9). Other factors are asthma severity; a recent history of cold, flu, or sinus infection; less education; increased body mass index (BMI); and a history of gastroesophageal symptoms (9–11).

Uncontrolled asthma places a significant social and economic burden on asthma patients. Thus, uncontrolled asthma is a significant public health problem worldwide (1, 2). A paucity of data on the predictors of asthma control in sub-Saharan Africa exists. In addition, due to the geographical variations in the epidemiology of the disease and sociocultural dynamics, data from other regions of the world cannot be easily adopted and extrapolated to institute preventive measures in sub-Saharan African society. Therefore, the goals of this study were to assess the current level of asthma control (according to the GINA definition) among adult patients attending two tertiary care centers in Nigeria and to determine the predictors associated with uncontrolled asthma.

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METHODS

Study Design and Setting

A prospective cross-sectional study was conducted in two tertiary care hospitals located in north-central and south-western Nigeria between June 2009 and December 2010. The inclusion criteria specified that all participants must be at least 18 years of age and that a minimum of 1 year must have elapsed since their asthma diagnosis. The exclusion criteria specified that the participants could not have cognitive impairment, a severe exacerbation of asthma, or comorbid chronic pulmonary disease (e.g., emphysema, chronic bronchitis, or bronchiectasis).

Procedures

Participants' Selection. Data collection was commenced after the receipt of ethical approval from the participating tertiary center. Postgraduate residents and medical officers screened the patients who were coming into the general medical outpatient and pulmonary clinics for a scheduled appointment for eligibility. The residents and medical officers then asked the eligible patients if a researcher could meet them.

Thereafter, the patients who were willing met a member of the research team, who informed them about the study. At this time, the study information note and consent form were given to the eligible patients to acquaint them with the study procedure and to obtain their informed consent. The patients who provided consent and met the inclusion criteria were recruited as study participants.

Survey Instrument

The survey instrument was a pretested, structured questionnaire that was prepared using the GINA guidelines and the GINA definition of asthma control (12). This questionnaire was used previously in similar studies in Brazil and North America (12, 13). The questionnaire was written in English, which is the official language of communication in Nigeria. For patients who could not communicate in English, the researchers provided a Yoruba translated version that had been translated by linguistic experts and pretested on a sample of five patients to ensure its equivalence with the English version. The questionnaire included items asking the patients to provide socio-demographic and clinical data including their age, gender, household utilities, the number of years since asthma diagnosis, perceived asthma symptoms, medication, smoking status, and self-reported symptoms of rhinitis (excessive sneezing, nasal itching, nasal discharge, or nasal congestion) (14, 15).

The researcher administered the questionnaire to patients either at the time of a clinic visit or prior to a lung function assessment in the cardiopulmonary laboratory. The patients' chart records were also reviewed at this time to gather any information not recalled by the patients. The administration of the questionnaire was followed by a measurement of the patients' anthropometric indices, spirometry, and an assessment of their inhaler techniques, respectively.

Biologic Measures

We measured the body weight and height of patients using beam balance and stadiometer, respectively. The BMI (kg/m^2) was obtained from the patients' weight (kg) and height (m) by dividing each patient's weight by the square of their height (m^2).

The next phase of the study involved performing a spirometry using a micro GP MS07 Gold standard transducer spirometer (Micro Medical Limited, Rochester, Kent, UK). Spirometry was conducted with a 12% adjustment for the African population in accordance with the European Respiratory Society guidelines (16). The highest values for forced expiratory volume in 1 s (FEV_1), forced vital capacity (FVC), FEV_1/FVC ratio, and peak expiratory flow (PEF) obtained with a difference of <0.2 L were used for each participant. A few minutes after the completion of the spirometry, we assessed the participant's inhaler technique.

Inhaler Device Techniques

Each participant was asked to demonstrate his or her inhaler technique to a member of the research team using a dummy device. If the patient was using a metered-dose inhaler (MDI) or an accuhaler, the defined steps were evaluated according to the recommendations of the GINA guidelines. The incorrect handling of a device was defined as an improper technique and if there is incorrect performance of any of the predefined steps.

Operational Definitions

Each participant's asthma control and its severity was assessed and classified according to the GINA guidelines (12).

Asthma control assessment was derived from the patients' daytime asthma symptoms, nocturnal symptoms/awakening, daily use of inhaled short-acting β2-agonist (SABA), limitation of physical activities, and lung function test over the past week. Each participant's level of asthma control was assigned to one of the three categories: (1) controlled, (2) partly controlled, or (3) uncontrolled asthma (2, 12).

Controlled asthma was defined as the reported absence or twice or less daytime symptoms in the past week, no nocturnal symptoms/awakening, no limitation of activities, no or a need for reliever/rescue medication twice or less in the past week, and normal lung function. Partly controlled asthma was defined as the reported presence of any of the following measures in the past week: more than two daytime symptoms, any nocturnal symptoms/awakening, any limitation of activities, a need for reliever/rescue medication more than twice, and abnormal lung function (<80% of the predicted or personal best if known). Uncontrolled asthma was defined as the presence of three or more features of partly controlled asthma in the past week. An exacerbation in any week made that week an uncontrolled asthma week.

The assessment of asthma severity based on clinical features was determined from the patients' asthma

symptoms, their daily use of inhaled SABA, and their peak flow rate. The severity was classified as (1) intermittent, (2) mild persistent, (3) moderate persistent, or (4) severe persistent asthma (12). Abnormal pulmonary function in a patient was defined as a measured $FEV_1 < 80\%$ of the predicted for the patient's age, sex, and race (2). Obesity in a patient was defined with BMI ≥ 30 kg/m^2 (15).

The socioeconomic statuses (SESs) of the patients were derived from their level of education, monthly income, occupation, and household utilities (17). For easy determination of the SES, we adapted and modified the method of Gwatkin et al. (17) by creating an arbitrary score of 1–4. One mark was allocated to each of the four determinants of SES: (1) owning some basic household items, (2) earning >200,000 naira per month (equivalent to US$1300), (3) having tertiary level of education, and (4) employed as professional, senior administrators, and top political appointees. A patient who received a score of 4 was classified as having a high SES, a patient with a score of 2–3 was classified as having a middle SES, and a patient with a score of 0–1 was classified as having a low SES.

Statistical Analysis

The obtained data were analyzed by using SPSS statistical software (version 15) (SPSS Inc., Chicago, IL, USA). The data were reviewed manually for missing data and appropriate coding before data entry. They were also checked for outliers and for the normality of distributions of the continuous variables. Descriptive statistics were used to summarize the general demographic and clinical characteristics of the sample. The outcome measure of asthma control was collapsed into two categories: (1) controlled asthma (partly and controlled) and (2) uncontrolled asthma (12, 13). The association between the level of asthma control and the categorical variables was determined by the χ^2-test and the Fisher's exact test. A series of independent Student's *t*-tests were used to determine the associations between parametric continuous variables and asthma control. Mann–Whitney *U*-test was used to determine the association between one nonparametric (skewed distribution) variable and asthma control. The variables that had a significant association with asthma control were entered into a multivariate analysis to obtain the crude risk ratio (RR). Stratification was done to detect the effect of the confounding variables (age, sex, education, income, asthma severity, comorbidity, and medication), and adjustments were made to obtain the adjusted RR. Finally, *p*-values <.05 were considered significant.

Ethics and Consent

The ethics and research committees of the two tertiary centers approved the study. Informed verbal and written consent was obtained from each participating patient. To ensure anonymity, each participant's questionnaire was randomly assigned a numerical code and any information that could identify an individual was excluded.

The written data after entry were stored in a computer in the custody of the principal investigator (PI). The PI placed an encrypted password system on the computer files and data sheet to prevent unauthorized access. In addition, the PI stored the hard copies of the consent forms and questionnaires in a locked cabinet in his personal office. Access to the electronic database and the hard copies of the consent forms and questionnaires was restricted to the members of the research team.

RESULTS

One hundred and twenty-four asthmatic patients participated in the study. Of these, 88 (71.0%) completed the English survey and 36 (29.0%) completed the Yoruba survey. Forty-six (37.1%) participants were males and 78 (62.9%) were females (a male to female ratio of 1:1.7). The mean age of the participants was 42.5 ± 14.9 years, and the median duration of asthma since the year of diagnosis was 25 (10–30) years. The majority of asthmatic patients were married (71%). About 80.6% were in the low socioeconomic class and 64.5% were low-income earners. The majority (59.7%) of asthma patients were on inhaled SABA, while a minority were on oral corticosteroids (OCSs), inhaled corticosteroids (ICSs), and xanthines (47.6%, 16.1%, and 9.7%, respectively). A significant proportion (97 participants or 78.2%) were using their inhaler devices incorrectly. The other characteristics of the study sample are shown in Table 1.

Of the 124 study participants, 86 (69.3%) had uncontrolled asthma, 28 (22.6%) had partly controlled asthma, and 10 (8.1%) had controlled asthma. The results of independent Student's *t*-tests and χ^2-tests showed that there were significant associations between the dichotomous variable of asthma control (partly controlled or controlled vs. uncontrolled) and asthma severity, age, educational attainment, SES, the presence of comorbidity, the results of the pulmonary function test, and the use of controller medication. Other associated factors were an adherence to ICS medications and the inhaler usage technique among the studied patients ($p < .05$) (Table 2). Tobacco smoking, either as active (4.8% vs. 0%, $p = .17$) or as secondhand exposure (6.38% vs. 1.62%, $p = .33$), was not significantly associated with asthma control.

The multivariate analyses showed that uncontrolled asthma was strongly associated with asthma severity (RR = 1.81 (1.33–2.46)), the use of OCSs (RR = 1.61 (1.23–2.38)), the incorrect use of an inhaler device (RR = 1.60 (1.02–2.80)), an abnormal pulmonary function test (RR = 1.60 (1.30–2.78)), and the presence of comorbidity (RR = 1.37 (1.04–1.82)). In addition, a lack of adherence to ICS among the 102 patients with persistent asthma was slightly associated with uncontrolled asthma (RR = 1.30 (0.97–1.80)) (Table 3). Asthma patients who were aged ≥40 years and who lacked tertiary education were more likely to have uncontrolled asthma, but these associations were not statistically significant. Also, the participants' gender, SES, income, and smoking status were not significantly associated with asthma control.

TABLE 1.—General characteristics of the asthma patients in the study.

Characteristics	*N* (%)
Age[a]	42.5 (14.9)
Median duration of asthma	25 (10–30)
Sex	
Male	46 (37.1)
Female	78 (62.9)
Education	
None/primary/Arabic	41 (33.1)
Secondary	38 (30.6)
Tertiary	45 (36.3)
Occupation	
Professional	20 (16.1)
Administrators/clerks	12 (9.7)
Craftsmen	26 (20.9)
Students/homemakers	20 (16.1)
Trading	20 (16.1)
Others	26 (20.9)
Income per month (*N*)	
<50,000	80 (64.5)
50–99,999	24 (19.4)
100–200,000	6 (4.8)
>200,000	14 (11.3)
Socioeconomic status (SES)	
Low	100 (80.6)
Middle	20 (16.1)
High	4 (3.2)
Marriage	
Married	88 (71.0)
Others	36 (29.0)
Asthma severity	
Intermittent	22 (17.7)
Mild persistent	16 (12.9)
Moderate persistent	28 (22.6)
Severe persistent	58 (46.8)
Asthma medication[b]	
Inhaled SABA (pMDI)	74 (59.7)
Oral SABA	7 (5.6)
LABA + ICS	19 (15.3)
ICS	1 (0.8)
Oral xanthines	12 (9.7)
OCS	59 (47.6)
Self-reported adherence to ICS[c]	
No	82 (80.4)
Yes	20 (19.6)
Pulmonary function test	
Normal	52 (41.9)
Abnormal	72 (58.1)
Inhaler technique	
Incorrect	97 (78.2)
Correct	27 (21.8)
Presence of comorbid condition[b]	68 (54.8)
Obesity (BMI ≥ 30)	10 (8.1)
Reported allergic rhinosinusitis	62 (50.0)
Reported GERD symptoms/chronic acid peptic disease	12 (16.1)
Others	13 (10.5)
Smoking	
Active	6 (4.8)
Secondhand	10 (8.1)

Notes: BMI, body mass index; GERD, gastroesophageal reflux disease; LABA, long-lasting β2-agonist; N, Nigerian Naira; SABA, short-acting β2-agonist; OCS/ICS, oral corticosteroid/inhaled corticosteroid.
[a]Mean (SD).
[b]Patient may be on more than one medication or have more than one comorbid condition.
[c]$n = 102$.

TABLE 2.—Characteristics of the patients according to the level of asthma control.

Characteristics	Controlled, $N = 38$	Uncontrolled, $N = 86$
Age (years)		
18–39	20 (41.6)	28 (58.3)
40–59	10 (17.2)	48 (82.8)
≥60	8 (44.4)*	10 (55.6)*
Median duration of asthma (years)	30 (25–40)	20 (10–30)*
Sex		
Male	18 (25.6)	28 (74.4)
Female	20 (39.1)	58 (60.9)
Education		
None/primary/Arabic	18 (43.9)	23 (56.1)
Secondary	6 (15.8)	32 (84.2)
Tertiary	14 (31.1)	31 (68.2)*
Occupation		
Professional	6 (30.0)	14 (70.0)
Administrators/clerks	4 (25.0)	12 (75.0)
Craftsmen	4 (50.0)	4 (50.0)
Students/homemakers	8 (28.6)	20 (71.4)
Trading	6 (27.3)	16 (72.7)
Others	10 (31.3)	22 (69.7)*
Income/month (*N*)		
<50,000	24 (30.0)	56 (70.0)
50–99,999	8 (33.3)	16 (66.7)
100–200,000	4 (28.6)	4 (66.7)
>200,000	2 (33.3)	10 (71.4)
Socioeconomic status (SES)		
Low	30 (30.0)	70 (70.0)
Middle	4 (20.0)	16 (80.0)
High	4 (100.0)	0 (0.0)*
Marriage		
Married	26 (29.5)	62 (70.5)
Others	12 (33.3)	24 (66.7)
Smoking status		
Current smoker	0 (0.0)	6 (100.0)
Others	38 (32.2)	80 (67.8)
Asthma severity		
Intermittent	18 (75.0)	4 (25.0)
Mild persistent	6 (37.5)	10 (62.5)
Moderate persistent	14 (50.0)	14 (50.0)
Severe persistent	0 (0.0)	58 (100.0)*
Pulmonary function test		
Normal	26 (50.0)	26 (50.0)
Abnormal	12 (16.7)	60 (83.3)*
Body mass index (kg/m^2)		
<30	35 (30.7)	79 (69.3)
≥30	3 (30.0)	7 (70.0)
Asthma medication[a]		
Inhaled SABA (pMDI)	6 (8.1)	68 (91.9)
Oral SABA	0 (0.0)	7 (100.0)
Controller (OCS/ICS/LABA/xanthine)	14 (20.0)	56 (80.0)*
Inhaler technique		
Correct	13 (50.0)	13 (50.0)
Incorrect	25 (25.5)	73 (74.6)*
Self-reported adherence to ICS[b]		
No/partly	9 (11.0)	73 (89.0)
Complete	7 (30.0)	13 (70.0)*
Presence of comorbid condition(s)		
Yes	36 (39.1)	56 (60.9)
No	2 (6.3)	30 (92.7)*

Notes: LABA, long-lasting β2-agonist; SABA, short-acting β2-agonist; OCS/ICS, oral corticosteroid/inhaled corticosteroid.
[a]Patient may be on more than one medication.
[b]$n = 102$ Subjects with persistent asthma requiring ICS.
*$p < .05$.

TABLE 3.—Multivariate analysis of the predictors of uncontrolled asthma.

Predictors	Crude RR	Adjusted RR
Age (years)		
18–39	1.00	1.00
≥40	1.31 (1.01–1.75)	1.30 (1.01–1.75)
Duration of asthma (years)		
>20	1.00	1.00
≤20	1.39 (1.08–1.79)*	1.16 (0.95–2.14)
Education		
No tertiary	1	1
Tertiary	0.99 (0.75–1.26)	1.27 (0.99–1.67)
Socioeconomic status (SES)		
High	1.00	1.00
Low–middle	1.13 (0.53–2.41)	1.15 (0.95–1.40)
Asthma severity		
Intermittent	1.00	1.00
Persistent asthma	10.18 (3.70–28.07)*	1.81 (1.33–2.46)*
Pulmonary function test		
Normal	1.00	1.00
Abnormal	1.67 (1.25–2.23)*	1.60 (1.30–2.78)*
Self-reported adherence to ICS		
Complete	1.00	1.00
No/partly	1.37 (1.03–1.99)*	1.30 (0.97–1.80)*
Use of OCS		
None	1.00	1.00
OCS	1.93 (1.43–2.63)*	1.61 (1.23–2.38)*
Use of OCS/ICS		
None	1.00	1.00
Combined OCS/ICS	1.23 (0.74–1.46)	1.22 (0.73–1.47)
Use of oral xanthine		
None	1.00	1.00
Xanthines used	1.16 (1.07–1.27)	1.10 (1.00–1.52)
Inhaler technique		
Correct	1.00	1.00
Incorrect	1.49 (1.03–2.43)*	1.60 (1.02–2.80)*
Presence of comorbid condition(s)		
No	1.00	1.00
Yes	1.70 (1.28–1.89)*	1.37 (1.04–1.82)*

Notes: RR, risk ratio related with the other categories of each variable; OCS/ICS, oral corticosteroid/inhaled corticosteroid.
*p-Value <.05.

DISCUSSION

The prevalence of uncontrolled asthma among adults in our study was 69.3%. This is higher compared with the prevalence of uncontrolled asthma in other parts of the world. For example, the prevalence of uncontrolled asthma has been reported at 50.9% in North Africa (18). In Europe, the prevalence of uncontrolled asthma ranged from 20% in Iceland to 48.5% in Turkey, to 56.2% in Lithuania, and to 67% in Italy (6, 19, 20). In the Americas, a prevalence of 55.6% was reported in Brazil (13), a prevalence of 58% was reported in the United States, and a prevalence of 59% was reported in Canada (10, 21).

In reality, the current level of asthma control worldwide falls far short of the goals for long-term management that are stated in the international guidelines (8). The high prevalence of uncontrolled asthma in our study may be due to patient- and physician-related factors, environmental factors, and a lack of infrastructures to ensure standard therapy (1, 2, 12, 22).

The predictors of uncontrolled asthma were the severity of the asthma, the incorrect use of an inhaler device, the use of OCSs, the presence of comorbidity, an abnormal pulmonary function test, and a nonadherence to ICS. The most important predictor of asthma control in this study was the severity of the asthma. Patients who had severe asthma were twice more likely to have uncontrolled asthma compared with those who had mild (intermittent) asthma. This result is consistent with the previous studies in other parts of the world (10, 13, 20, 23–25). In contrast, a study in France reported no association between asthma severity and control (26). The strong association between asthma severity and control may be attributed to the overlapping clinical and physiological characteristics used in the classification of asthma severity and for assessing asthma control (2, 12). Asthma severity is defined as the difficulty in controlling asthma with treatment after the exclusion of modifiable factors such as poor adherence, smoking, and comorbidities. Asthma severity is variable and may fluctuate over days and months (2, 12, 27, 28). The majority of asthma patients have mild to moderate asthma and about 5–10% have severe refractory asthma (28).

In order to identify patients with severe asthma, an assessment period of about 6 months is required. During this period, optimal management is undertaken to assess and manage comorbid conditions such as reflux and sinusitis; to reevaluate exposure to triggers, adherence to medication, and trigger avoidance; and to optimize medication (27, 28). This 6-month management period for confirming the diagnosis of severe refractory asthma could be a limitation to the use of asthma severity as a clinical practice.

Asthma severity also has limited value in predicting the required therapy for a patient and in predicting a patient's response to the treatment (12, 27, 28). Patients with mild persistent asthma who have not received appropriate therapy are more likely to have poor asthma control, experience frequent hospitalization, undergo emergency department management, miss school or work, and experience more symptoms. In contrast, patients with severe persistent asthma who receive appropriate therapy can be well controlled (12, 27). In addition, discordance between the clinical presentation of a patient's asthma and the patient's level of lung function can complicate the assessment of severity, lead to an underestimation of the severity of the disease, and cause undertreatment (29). This produces poor asthma control.

The severity assessment of asthma in clinical practice can be more complex. Sometimes, the severity assessment in clinical practice is associated with the frequent overestimation of severity (30). Although the severity of asthma is strongly correlated with asthma control, health care utilization (including hospitalizations and emergency department visits) correlate more closely with asthma control than with asthma severity (31). Therefore, a periodic assessment of asthma control is more relevant and useful than a periodic assessment of asthma severity in clinical practice (1, 2, 12, 27, 28).

The use of OCSs was the second most important predictor of uncontrolled asthma. This association has been

reported in previous studies (11, 21, 24) and it did not surprise us as most of the study participants were in the low socioeconomic class and were financially constrained to afford appropriate asthma care. These patients mostly resorted to the nonprescription use of OCS (a quick-fix method used when asthma worsens) rather than incurring the additional costs of consultation and hospitalization. Furthermore, the nonprescription use of OCS was enhanced further by the high cost of ICS in Nigeria. Aït-Khaled et al. (32) conducted a survey of the prices and policies for the components of asthma treatment in eight developing countries and reported that the cost of 1 year of drugs for the treatment of a moderate, persistent case of asthma exceeded the monthly salary of a nurse in most of the countries. Therefore, the cost and availability of medications represent an important barrier to the effective management and clinical control in some low- and middle-income countries (22, 32).

An incorrect inhaler technique and abnormal lung function were the third leading predictors of asthma control in this study. The patients who incorrectly used their inhaler device were twice more likely to have uncontrolled asthma compared with those who used their device correctly. This result is consistent with three large observational studies, which found that inhaler mishandling has a negative impact on asthma control (33–35).

Similarly, the patients with abnormal lung function tests were twice more likely to have uncontrolled asthma than the patients with normal lung function tests. Our finding is corroborated by similar studies on asthma control (19, 36). The relationship between asthma control and pulmonary function is not surprising because it is one of the characteristics used in determining the level of asthma control.

We also found that a lack of adherence to ICS was weakly associated with uncontrolled asthma. This result also supported the results of several other studies on asthma control (2, 10, 24, 37, 38). A lack of adherence to ICS may be due to socioeconomic factors, poor patient–physician communication, a lack of patient knowledge on the function of inhaled steroids, and certain patient-held health beliefs (39). The findings that (1) few of the study participants were on ICSs and that (2) a significant majority of the participants was not using their inhaler devices correctly might indicate poorly coordinated medical management.

The presence of comorbidity among asthma patients was also found to be weakly associated with asthma control. The presence of comorbidity has been known to have a negative impact on the level of asthma control (10, 11, 38). In a population study, Desalu et al. (22) also found that subjects with allergic rhinitis (AR) and asthma comorbidity had a reduced lung volume when compared with those who had no comorbidity. The impacts of AR, gastroesophageal reflux diseases (GERDs), obesity, diabetes mellitus (DM), and menstruation on asthma control have been studied extensively. Despite the fact that some of these comorbidities showed an association with poor asthma control, they had no causal relationship (40). Weight reduction in the obese and the treatment of other forms of comorbidity have been demonstrated to improve lung function, asthma symptoms, morbidity, and quality of life in asthma patients (2, 12).

Patients who were in the older age category or in the lower education category tended to have uncontrolled asthma, but the results of the statistical analyses were not significant. Also, the patients' sex, income, and duration of asthma were not significantly associated with uncontrolled asthma.

The results of this study reveal the current status of asthma control and the predictors of uncontrolled asthma in two tertiary care centers in Nigeria. The early identification of the predictors of uncontrolled asthma is essential to instituting appropriate treatment. Although we are cautious of generalizing the findings from the centers to the whole nation of Nigeria, this study gives an insight on the perspective of asthma control in a sample of asthma patients in a poor resource nation.

The limitations of the study are (1) the small size of the sample, (2) the nonvalidation of the method of SES classification, and (3) the nonvalidation of the translated version of the survey instrument. In addition, some of the clinical parameters that were self-reported by the patients (such as medication adherence, exposure to smoking, AR, and gastroesophageal reflux) were not obtained through objective methods of assessment and must be considered as limitations.

In clinical practice, this study has highlighted the need to discourage the use of OCS, to encourage physicians to prescribe ICS when indicated, and to promote adherence to controller medications by ensuring the availability of low-cost ICS or ICS + LABA combination treatment in hospitals in Nigeria. The evaluation and treatment of comorbidity in patients who have poor asthma control cannot be overemphasized.

The results of this study also support the need for continuing asthma education in all patients and physicians in charge of asthma care to remove the myths and cultural misconceptions around asthma care and to cost-effectively teach patients and caregivers how to use their inhalers and spacers. In a poor resource setting like Nigeria, where spacers are unavailable (22) or unaffordable, we highly recommend that physicians employ a modified plastic bottle for use as a spacer considering the high rate of inhaler mishandling.

In view of the high level of the incorrect use of inhaler devices and the low level of ICS use, the findings of this study may provide an impetus for studying the handling of inhaler devices among medical professionals, the predictors of poor inhaler technique among asthma patients, and the factors associated with the use of ICS.

Conclusion

In conclusion, the results of this study have shown that a significant proportion of the asthma patients attending two tertiary care centers in Nigeria had uncontrolled asthma. The study has highlighted the need for continuing the

asthma education of patients and the regular assessment of asthma control by health care providers at every clinic visit to identify those with poor control and to institute appropriate therapy needed to achieve clinical control.

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Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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