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EXPERT REVIEW OF RESPIRATORY MEDICINE
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ORIGINAL RESEARCH

Asthma management and control in Nigeria: the asthma insight and reality Nigeria (AIRNIG) study

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ABSTRACT

Background: The state of asthma management and asthma control at the population level in Nigeria is unknown. We aimed to determine the level of asthma control and asthma management practices in Nigeria.

Methods: A cross-sectional population-based study of 405 participants with current asthma (physician-diagnosed with use of asthma medication or asthma symptoms in the preceding 12 months). We determined the level of asthma control, self-perception of asthma control, health-care use, missed work/school, and medication use.

Results: Asthma was controlled in 6.2% of the participants. Night-time awakening and limitation in activity in the preceding 4 weeks were reported by 77.5% and 78.3%, respectively, 56.3% and 14.1% missed work/school and had emergency room visits, respectively, and 11.6% and 38.8% used inhaled corticosteroid and short-acting beta-2 agonist, respectively, in the preceding year. About a third (34.3%) had spirometry ever performed and 46.7% had training on inhaler technique. Nearly 90% with uncontrolled asthma had self-perception of asthma control between somewhat and completely controlled.

Conclusion: The level of asthma control in Nigeria is poor with a high burden of asthma symptoms and limitation in activities. This calls for a broad-based approach for the improvement in asthma care that encompasses education and access to medications.

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Asthma; control; Nigeria

1. Introduction

Asthma is the most common chronic respiratory disease with a substantial burden on the individual, the family and the health-care system [1]. According to the Global Burden of Disease (GDB) report in 2015, asthma ranked 23rd as a cause of disease burden measured by the disability-adjusted life years (DALYs) [1]. The GBD report also documented a decline in asthma mortality measured by the years of life lost (YLL) from asthma but an increase in the years lived with disability (YLDs) [1]. This suggests high disease morbidity from asthma, most likely a consequence of inadequate asthma management and poor asthma control.

The Global Initiative on Asthma (GINA) defines asthma control as the extent to which the manifestations of asthma can be observed in the patient, or have been reduced or removed by treatment [2]. Controlled asthma is characterized in terms of symptom control and absence of future risk of adverse events. Symptom control entails the absence of all of the following: daytime symptoms more than twice a week, nighttime symptoms, need for reliever medications more than twice a week and limitation in daily activity. Future adverse events include the risk of exacerbations, lung function decline and side effects of medications. Asthma severity on the other hand refers to the underlying disease pathology which may change over time depending on the step in the treatment of asthma required to achieve control. Despite this widespread understanding and consensus on the goals of asthma treatment, the availability and potential value of adherence to guidelines, reports of high rates of poor asthma management and control remain prevalent worldwide [3,4]. Poorly controlled asthma increases the risk of exacerbations, reduces quality of life, increases health-care utilization and health-care costs and the risk of asthma-related mortality [2,4].

The Asthma Insight and Reality (AIR) studies are community-based studies that were designed to evaluate the level of asthma control and state of asthma management from a randomly selected samples of children and adults. The AIR studies have

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Supplemental Materials data for this article can be accessed here.

Article highlights

- This was the first AIR survey in sub-Saharan Africa that assessed the level of asthma control and asthma management practice at the population level.
- The rate of asthma control among children and adults in Nigeria is poor and asthma management practices are also not optimal.
- Only 6.2% of the participants had well-controlled asthma based on the GINA criteria and there was a poor perception of the level of asthma control.
- There was a high burden of asthma with frequent episodes of nighttime symptoms (77.5%), limitations in daily activities (78.3%), absenteeism (56.3%), and emergency room visits (14.1%) in the preceding year.
- Only 27.9% made scheduled hospital visits for asthma, one third had spirometry testing ever performed and 46.7% and 24.7% had received training on inhaler technique and differences between controller and reliever medications, respectively.
- Reliever medications were the most frequently used medications and only 11.6% and 6.4% used inhaled steroids and oral montelukast, respectively. Most participants (67.8%) were non-adherent to medications and only used them when symptomatic.
- Poor asthma control and asthma management practice have been reported in previous AIR studies and this situation had not changed in the last decade.

been conducted in many parts of the world and demonstrate a wide variations in asthma severity, asthma control and the state of asthma management across countries [5–8]. However, most of these studies were conducted over a decade ago and may not represent the current state of asthma management. Furthermore, to the best of our knowledge, there is currently no comparable report from sub-Saharan Africa, where the burden of asthma is increasing across all age groups [9], with associated high rates of poverty and a poorly developed healthcare system.

Nigeria has the seventh largest population in the world (198 Million) and the largest in Africa and the current state of asthma management and asthma control at the population level are largely unknown [10]. Previous studies that evaluated asthma management and control in Nigeria were hospital based, mostly among adults and were constrained by the small sample sizes [11–13]. The aim of this study, the Asthma Insight and Reality in Nigeria (AIRNIG) was to provide a comprehensive and standardized population-based report on the level of asthma control and asthma management practices and the impact of asthma on productivity. We also aimed to assess how closely asthma management practices relate to the recommendations of the GINA guideline. Findings from this study may guide health-care planning and inform policy on the development of strategies for the optimization of asthma care in Nigeria and possibly other sub-Saharan African countries.

2. Methods

The AIRNIG study was a cross-sectional population-based survey conducted between June 2017 and March 2018 across five major cities: Lagos (South West), Kano (North West), Benin (South South), Enugu (South East), and Ilorin (North Central), selected from five of the six geopolitical zones in Nigeria. Three of the cities (Lagos, Kano and Benin city) are the most populated cities in Nigeria and the other cities were selected to provide a representative geographical distribution of the sample population. Ethical approval was obtained from the ethical review committees of all participating institutions and from the National Health Research Ethics Committee of the Federal Ministry of Health.

2.1. Selection of participants

Sampling method was designed to provide a nationally representative sample of households that could be screened to identify a community sample of persons with current asthma. The total sample of households was proportionally divided across the five cities from the five geopolitical zones based on their current population using a defined multistage sampling frame with the enumeration areas (EAs) as the primary sampling unit. All households within each EA were the secondary sampling unit from which eligible household members were selected. Detail of the sampling frame and participant selection is available in supplementary Figure 1.

Sampling limitations as already identified in previous AIR studies limited the study population to only urban areas [3]. Only one participant from each household identified to have current asthma after initial screening completed the asthma management and control questionnaire to reduce bias from similar management practices within households. Current asthma was defined as in previous AIR surveys as physician-diagnosed asthma with asthma symptoms or asthma attack and/or the use of asthma medication in the preceding 12 months [3].

2.2. Recruitment

Using a door to door approach, we screened individuals (6 years old and above) who were physically present in selected households to identify persons with 'current' asthma for full interviews. Screening and interviews were conducted in the evenings (3 pm to 7 pm) on weekdays and all day (9 am to 7 pm) at weekends and public holidays. Where more than one eligible participant was identified in a household, the interviewer selected only one respondent for complete interview according to the standard Kish selection grid methodology for selecting a sample of one from a predefined subpopulation [14]. For eligible participants, less than 16 years of age, interviews were conducted with the parent or guardian most knowledgeable about the child's asthma and treatment. We obtained informed consent from the head of each household to gain access into the household as well as individual consent or assent from each participant.

2.3. Data collection

Trained interviewers conducted all screening and detailed interviews. We utilized a face to face approach to screen household members and recruit participants with 'current' asthma using a structured questionnaire on an electronic data collection system the Open Data Kit (ODK®). The data was collected offline on the field and uploaded to a secure server at the end of each day after review by the study

supervisor. We used the ODK® to improve data accuracy and minimize missing data.

The survey questionnaire was similar to that used in previous AIR studies with some additional questions relevant to the current GINA guideline and to our region. The AIR questionnaire has been previously described in detail and validated and the screening questions were similar to those used in other epidemiological study questionnaires such as the European Community Respiratory Health Survey (ECRHS) questionnaire and the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire [15,16]. The questionnaire obtained socio-demographic information and detailed information regarding asthma management (medication use, hospital visits, previous investigations) to enable us assess how closely asthma management related to the GINA recommended management guideline. The GINA guideline recommends lung function testing for the demonstration of expiratory airflow limitation at the time of asthma diagnosis and at intervals thereafter for future monitoring of the level of asthma control and to assess the risk of adverse events. It also recommends asthma education on self-management practices which includes training on inhaler technique, differences in asthma medications and need for adherence to medications. The use of controller medications for asthma treatment is also a major recommendation of the GINA guideline. We assessed the burden of asthma based on the history of overnight hospitalization due to asthma, emergency room visits for asthma exacerbations, activity limitations, absenteeism and emotional burden of asthma.

We used the Asthma Control Test (ACT) questionnaire and the GINA asthma control criteria, respectively, to assess the level of asthma control [2,17]. The adult version of the ACT is a five-item questionnaire that includes four symptom/reliever questions (activity limitation, daytime symptoms, nighttime symptoms and use of rescue inhaler) plus a patients' self-assessed level of asthma control question to assess the level of asthma control in the preceding 4 weeks. The childhood version of the ACT asks questions to both the child and the mother to assess asthma control. Responses are based on a Likert scale and scores range from 5 to 25 (higher is better). Scores 20–25, 16–19 and 5–15 were considered as controlled, somewhat controlled and poorly controlled asthma, respectively [17]. The ACT has been demonstrated to be a reliable surrogate for assessing asthma control in Nigeria [13]. The GINA classification of asthma control in the preceding 4 weeks assesses similar measures to the ACT dichotomously (Daytime symptoms more than twice a week, any nighttime symptoms, reliever needed for symptoms more than twice a week and any limitation in activity due to asthma). According to the GINA classification, asthma is well controlled when none of these symptoms is present, partly controlled when one to two symptoms only are present and uncontrolled if three to four of these symptoms are present [2]. Self-perception of asthma severity was categorized as mild, normal, moderate or severe, respectively, and self-perception of control was categorized as completely controlled, well controlled, somewhat controlled, poorly controlled and not controlled at all, respectively.

In addition, participants completed the Score for Allergic Rhinitis (SFAR) validated questionnaire to identify participants with allergic rhinitis [18]. The SFAR questionnaire is an eight-item questionnaire that asks for nasal symptoms, periodicity (perennial versus seasonal), associated conjunctivitis, specific triggers, allergic status, results of allergy test, allergic diagnosis, and family history of atopy. A score of ≥7 (maximum score 16) is positive for the presence of allergic rhinitis.

The English version of the questionnaires was translated and back translated into the local languages (Yoruba, Igbo, Hausa, and pidgin English) by trained translators following the standard protocol and we used the version preferred by the participant for interview. The questionnaires were piloted in Lagos in a non-participating Local Government Area and amended for clarification as required.

2.4. Sample size determination

A sample of at least 400 participants with current asthma was required to allow equal sample precision in the population as used in previous AIR studies [9]. Based on an estimated asthma prevalence in adolescents and adults of 10% from previous meta-analysis, we needed to screen at least 4000 households to identify persons with asthma [19]. This number was increased to 5600 households to enable us to recruit up to 400 participants per household with current asthma.

2.5. Data handling and analysis

We downloaded the data from the secure data unto an excel sheet and anonymized, cleaned and categorized the items of interest. The data obtained across the five cities were categorized into two categories: children 6–16 years and adults >16 years.

We used descriptive statistics (mean ± Standard deviation (SD), median (Interquartile range (IQR)) and frequencies) to expressed participant characteristics as appropriate. We compared asthma symptoms, asthma control, asthma management practices between adults and children and between asthma control categories, respectively, using the chi-square test for categorical variables and the student's t-test for continuous variables. Disruption in activities of daily living due to asthma was graded on a Likert scale from 'none at all' to 'extremely'. The relationship between self-perception of asthma severity and control, respectively, with level of asthma control was assessed using the chi-square test. A two-sided level of significance of 0.05 was considered significant for all comparisons.

3. Results

A total population of 20,063 participants were screened from 6024 households across the five Nigerian cities. Full interviews were conducted for 405 participants (84 children and 321 adults) with physician-diagnosed asthma. There were 84 participants with current asthma who were not interviewed due to the Kish selection grid and two were excluded due to incomplete data. The mean age ± SD in years for all participants was 32.9 ± 18.1. Table 1 shows demographic and clinical characteristics of all participants. The median (IQR) age of onset of asthma symptoms and asthma diagnosis was 15 (9–22) and 16 (10–24) years, respectively.

Breathlessness, chest tightness and cold associated with difficulty in breathing were the most frequently reported pre-diagnosis symptoms. Figure 1

Table 1. Participants' characteristics.

Characteristics	Participants n = 405 (%)
Age range	
6-16	84 (20.7)
17-25	81 (20.0)
26-35	67 (16.5)
36-45	84 (20.7)
>45	89 (22.0)
Sex	
Male	175 (43.2)
Female	230 (56.8)
City	
Lagos	170 (42.0)
Kano	72 (17.8)
Benin	114 (28.1)
Enugu	35 (8.6)
Ilorin	14 (3.5)
Level of education	
None	23 (5.7)
Completed primary	68 (16.8)
Faith based school	18 (4.4)
Some secondary	46 (11.4)
Completed secondary	127 (31.4)
Technical post-secondary	38 (9.4)
Post-secondary certificate	21 (5.2)
Completed university	52 (12.8)
Postgraduate	12 (3.0)
Source of household cooking fuel	
Kerosene	175 (43.2)
LPG	156 (38.5)
Wood	48 (11.9)
Charcoal	12 (3.0)
Coal	9 (2.2)
Electricity	4 (1.0)
Agricultural waste	1 (0.2)
Employment status	
Employed	198 (48.9)
Student	136 (33.6)
Stay at home parent	27 (6.7)
Unemployed	25 (6.2)
Retired and not working	14 (3.5)
Disabled or too ill to work	5 (1.2)
Monthly Household income	
< $50	113 (27.9)
$50-99	72 (17.8)
$100-149	124 (30.6)
$150-199	52 (12.8)
$200-249	25 (6.2)
≥$250	19 (4.7)
Current smoking	14 (3.5)
Use of medications for Comorbidities	
Hypertension	19 (4.7)
Diabetes	1 (0.2)
Peptic ulcer	18 (4.4)
Others	10 (2.5)
Seasonal asthma	288 (71.1)
Perennial asthma	117 (28.9)
Co-existent allergic rhinitis	348 (85.9)
Family history of atopy (asthma, allergic rhinitis or eczema)	240 (59.3)

3.1. Current asthma symptoms, asthma control, and burden of asthma

Table 2 shows the frequency of asthma symptoms, asthma control and burden of asthma. Overall, 314 (77.5%) and 317 (78.3%) had nighttime symptoms and limitation in activities due to asthma in the preceding 4 weeks. Adults significantly reported more nighttime awakening compared to children ($p = 0.003$), and children had significantly more acute episodes of asthma compared to adults ($p = 0.005$). (Table 2).

Based on the GINA control criteria, 25 (6.2%) 226 (55.8%), and 154 (38.0%) had well-controlled, partly controlled, and uncontrolled asthma, respectively, and based on the ACT score category 137 (33.8%), 140 (34.6%), and 128 (31.6%) had controlled, somewhat controlled and poorly controlled asthma, respectively. On the ACT score criteria, adults had significantly higher rates of controlled asthma and children had significantly higher rates of poorly controlled asthma. There was a significant association between the level of asthma control categorized by the GINA category and ACT category, respectively, $p < 0.001$.

Figure 2 shows the level of disruption in activities of daily living due to asthma. Asthma disrupted work/school activities, social life and family life/home responsibility moderately to extremely in 30.1%, 36.5%, and 26.2% of the participants, respectively.

Burden of asthma was significantly higher among participants with partly controlled and uncontrolled asthma compared to those with well-controlled asthma (with the exception of emergency room visits) (Table 3).

3.2. Relationship between self-perception of asthma severity and asthma control and GINA defined level of control

Asthma was self-perceived as mild, normal, moderate, and severe in 116 (41.0%), 125 (30.9%), 104 (25.7%) and 10 (2.5%) of the participants, respectively. Among participants with uncontrolled asthma by the GINA criteria, 35.1% and 6.5% had a self-perception of asthma severity as mild and severe, respectively (Figure 3). Three hundred and sixty-two participants reported on self-perception of asthma control, with 35 (9.7%), 162 (44.8%), 142 (39.2%), 21 (5.8%), 2 (0.6%) reporting it to be completely controlled, well controlled, somewhat controlled, poorly controlled, and not controlled at all, respectively. Among the participants with uncontrolled asthma, 31.8% and 12.6% had self-perception of asthma control as completely controlled or well controlled and poorly controlled or not controlled at all, respectively (Figure 3).

3.3. Asthma management practices

Table 4 shows asthma management practices among participants. Compared to adults, more children had scheduled clinic visits, previous spirometry testing and training on asthma medications and inhaler techniques. However, these differences were not significant. A general practitioner or a family physician made the initial diagnosis of asthma in 302 (74.6%) participants and 201 (49.6%) visited the hospital regularly for asthma management.

Regarding asthma management practices and the GINA guideline for evidence of airflow limitation, spirometry test, and peak flow measurement had been performed in 139 (34.3%) and 134 (33.1%) participants, respectively. For the GINA recommended essential skills and self-guided asthma management, about half had received asthma education on self-monitoring and need for adherence to medications and

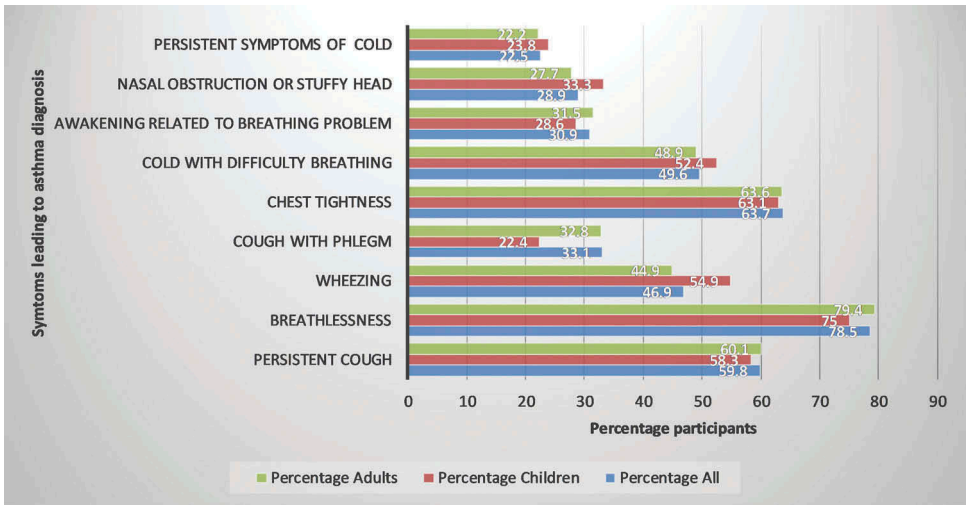

Figure 1. Frequency of pre-diagnosis symptoms.

Footnote: Multiple responses allowed, n = 403 for wheezing and n = 401 for cough with phlegm.

Table 2. Asthma symptoms, asthma control and burden of asthma among children and adults.

	Overall	Children	Adults	
Criteria	n = 405 (%)	n = 84 (%)	n = 321 (%)	p value
Daytime symptoms more than twice a week*	135 (33.3)	27 (32.1)	108 (33.6)	0.80
Any night awakening due to asthma*	314 (77.5)	55 (65.5)	259 (80.7)	0.003
Reliever needed for symptoms more than twice a week*	131 (32.3)	31 (36.9)	100 (31.1)	0.43
Any activity limitation due to asthma*	317 (78.3)	61 (72.6)	256 (79.8)	0.18
GINA asthma control*				0.91
Well controlled	25 (6.2)	6 (7.1)	19 (5.9)	
Partly controlled	226 (55.8)	47 (56.0)	179 (55.8)	
Uncontrolled	154 (38.0)	31 (36.9)	123 (38.3)	
Mean ACT score ±SD*	17.2 ±4.2	15.6 ±5.2	17.6 ±3.8	<0.001
ACT asthma control				0.001
Controlled	137 (33.8)	24 (28.6)	113 (35.2)	
Somewhat controlled	140 (34.6)	20 (23.8)	120 (37.4)	
Poorly controlled	128 (31.6)	40 (47.6)	88 (27.4)	
Acute asthma episode#	250 (61.7)	63 (75.0)	187 (53.8)	0.005
Emergency room visit#	57 (14.1)	14 (16.7)	43 (13.4)	0.44
Asthma hospitalization ever	106 (26.2)	17 (20.2)	89 (27.7)	0.17
Missed school or work#	228 (56.3)	46 (54.8)	182 (56.7)	0.75
Reduced productivity#^	199 (58.9)	44 (56.4)	155 (59.6)	0.86
Emotional effects of asthma				0.17
Very embarrassed	37 (9.1)	7 (8.3)	30 (9.3)	
Quite embarrassed	100 (24.7)	24 (28.6)	76 (23.7)	
Not embarrassed	131 (32.3)	21 (25.0)	110 (34.3)	
Certainly not embarrassed	110 (27.2)	22 (26.2)	88 (27.4)	
Don't know	27 (6.7)	10 (11.9)	17 (5.3)	

Footnote: *in the preceding four weeks, # in the last 12 months, ^ for 338 participants, SD=Standard deviation, p value for comparison between adults and children

189 (46.7%) and 100 (24.7%) had received training on inhaler technique and difference between controller and reliever medications, respectively. (Table 4).

3.4. Use of asthma medications

Among all participants, 315 (64 children and 251 adults) had taken any asthma medications at any time since diagnosis. Two hundred and sixty-four (65.2%) had taken medication in the preceding 12 months and 196 provided information on specific type of medications. The type and pattern of use of asthma medications in the preceding 12 months are shown in Table 5. The use of inhaled salbutamol was significantly higher among children compared to adults. More children used oral montelukast while more adults used oral aminophylline containing medications.

Regarding the relationship to the GINA guideline for asthma treatment with controller medications, use of inhaled corticosteroid (ICS) in combination with long-acting beta-2 agonist (LABA) and montelukast was reported by 47 (11.6%) and 26 (6.4%) of all participants, respectively, and 45 (11.1%) reported use of oral aminophylline containing medications for symptom relief only. Among the participants on medications in the preceding 12 months, 85 (32.2%) were adherent to medications and 179 (67.8%) skipped taking their medications regularly. Absence of symptoms was the most reported reason for poor adherence to medications.

Supplementary Table 1 shows details of asthma symptoms and level of asthma control by asthma medication use. Of the 47 participants on ICS and LABA, 27 (57.4%), 2 (4.3%), 39 (83.0%), 23 (48.9%), and 42 (89.4%) had uncontrolled asthma,

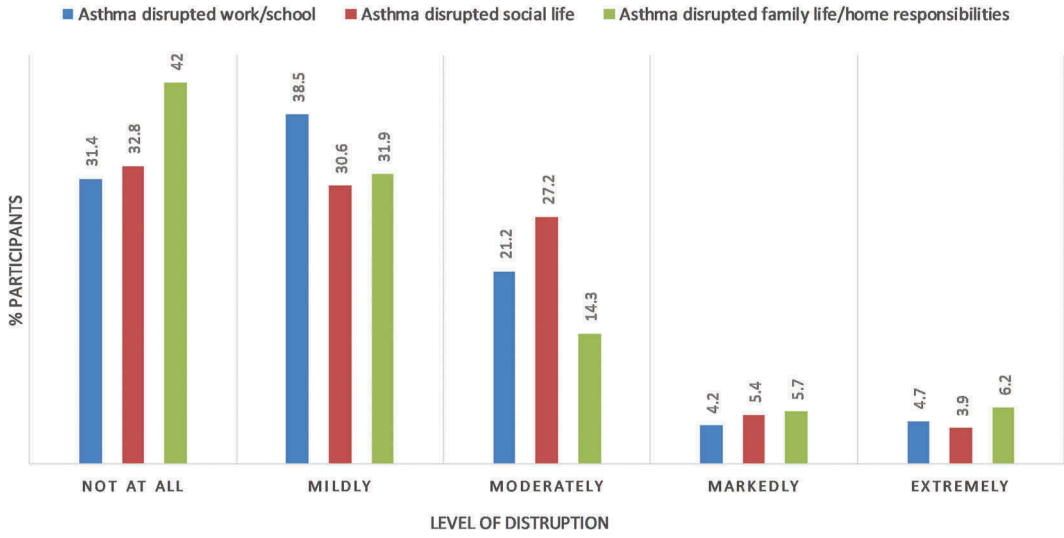

Figure 2. Level of disruption in activities of daily living due to asthma.

Table 3. Symptoms and burden of asthma by the level of GINA defined asthma control.

	GINA defined asthma control			
	Well controlled	Partly controlled	Uncontrolled	
Parameter	n = 25 (%)	n = 226 (%)	n = 154 (%)	p value
Acute asthma episode	8 (32.0)	134 (59.3)	108 (70.1)	0.001
Missed school or work	1 (4)	112 (49.6)	115 (74.7)	<0.001
Asthma hospitalization*	5 (20.0)	49 (21.7)	52 (33.8)	0.02
Emergency room visit	2 (8.0)	26 (11.5)	29 (18.8)	0.09
Very or quite embarrassed by asthma	1 (4.0)	51 (22.6)	86 (55.8)	<0.001
Moderate to extreme disruption of work or school	0	39 (17.3)	83 (53.8)	<0.001
Moderate to extreme disruption of social life	1 (4.0)	56 (24.8)	91 (59.0)	<0.001
Moderate to extreme disruption of family life	0	40 (17.7)	66 (42.9)	<0.001

Footnote: *Ever hospitalized for asthma, p value for comparison between levels of asthma control

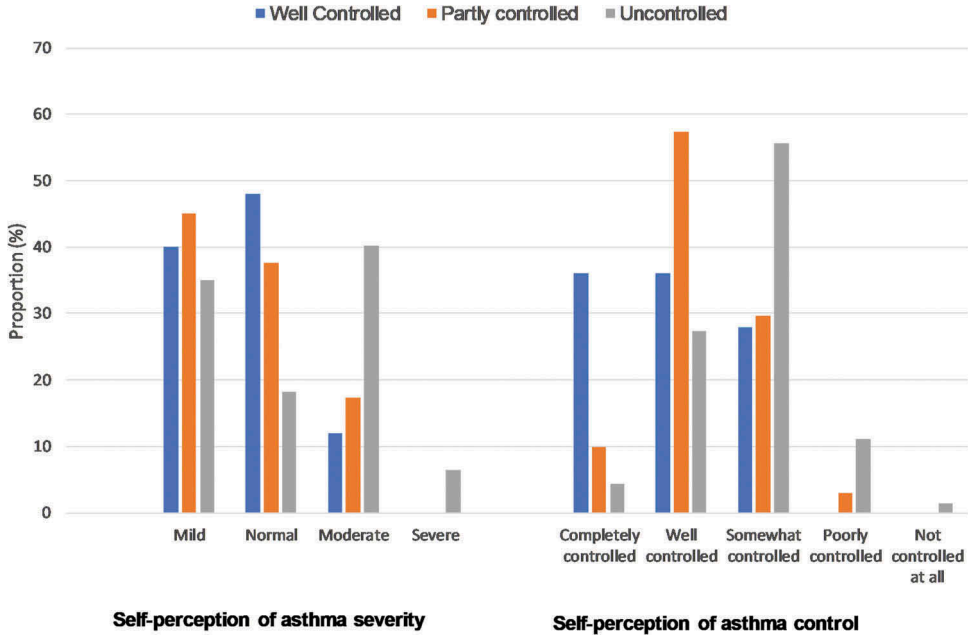

Figure 3. Self-perception of asthma severity and asthma control, respectively, and GINA defined level of control.

Footnotes: All the participants with self-perception of severe asthma had uncontrolled asthma based on the GINA criteria ($p < 0.001$). None of the participants with self-perceived poorly controlled asthma or not controlled at all asthma had well-controlled asthma based on the GINA criteria ($p < 0.001$).

Table 4. Asthma management practices among children and adults.

Asthma practice	ALL n = 405 (%)	Children n = 84 (%)	Adults n = 321 (%)	p value
Type of physician that diagnosed asthma				0.47
General/Family physician	302 (74.6)	61 (72.6)	241 (75.1)	
Ear, nose and throat doctor	12 (3.0)	3 (3.6)	9 (2.8)	
Pulmonologist	84 (20.7)	18 (21.4)	66 (20.6)	
Allergist	2 (0.5)	0	2 (0.6)	
Pediatrician	1 (0.2)	1 (1.2)	0	
Others	4 (1.0)	1 (1.2)	3 (0.9)	
Type of physician seen on follow-up visits for asthma management				
General/Family physician	299 (73.8)	59 (70.2)	240 (74 .8)	
Ear, nose and throat doctor	13 (3.2)	2 (2.4)	11 (3.4)	
Pulmonologist	82 (20.2)	21 (25.0)	61 (19.0)	
Allergist	1 (0.2)	1 (1.2)	0	
Others	8 (2.0)	1 (1.2)	7 (2.2)	
Missing	2 (0.5)	0	2 (0.6)	
Type of hospital visited regularly for asthma management*				0.66
Teaching/University hospital	66 (16.3)	14 (16.7)	52 (16.2)	
Private hospital	92 (22.7)	14 (16.7)	78 (24.3)	
Public hospital (General hospitals)	226 (55.8)	51 (60.7)	175 (54.5)	
Primary healthcare center	14 (3.5)	3 (3.6)	11 (3.4)	
Other	7 (1.7)	2 (2.4)	5 (1.6)	
Patients that ever visited the hospital for asthma (Yes)	201 (49.6)	44 (52.4)	157 (48.9)	0.57
Frequency of hospital visit for asthma in last 12 months				0.3
None	128 (31.6)	22 (26.2)	106 (33.0)	
Once	117 (28.9)	93 (29.0)	24 (28.6)	
every 3-6 months	82 (20.2)	16 (19.0)	66 (20.6)	
longer than 3-6 months	78 (19.3)	22 (26.2)	56 (17.4)	
Scheduled visit or unscheduled visit				
Scheduled visit	113 (27.9)	28 (33.3)	85 (26.5)	0.06
Spirometry test ever performed (Yes)	139 (34.3)	36 (42.9)	103 (32.1)	0.06
Peak flow ever measured (Yes)	134 (33.1)	33 (39.6)	101 (31.5)	0.18
Skin prick test ever performed (Yes)	105 (25.9)	27 (32.1)	78 (24.3)	0.14
Received a Positive skin test result*	92 (87.6)	23 (85.2)	69 (88.5)	0.66
Blood IgE test ever conducted	69 (17.0)	17 (20.2)	52 (16.2)	0.31
Imaging tests ever conducted	178 (44.0)	43 (51.2)	135 (42.1)	0.13
Advised to reduce asthma triggers	324 (80.0)	67 (79.8)	257 (80.1)	0.95
Educated on asthma self-management strategies (Yes)	330 (81.5)	67 (79.8)	263 (81.9)	0.65
Received asthma patient education on the following:				
Self-monitoring	238 (55.8)	43 (51.2)	195 (60.7)	0.11
Difference between reliever and controller	100 (24.7)	27 (32.1)	73 (22.7)	0.08
Adherence to medication	235 (58.0)	45 (53.6)	190 (59.2)	0.35
Inhaler technique	189 (46.7)	47 (56.0)	142 (44.2)	0.06
Received Oxygen therapy in the last 12 months	39 (9.6)	8 (9.5)	31 (9.7)	0.97

Footnote: * n = 105, p value compares responses between adults and children.

emergency room visit in the preceding year, nighttime awakenings and daytime symptoms, respectively, in the preceding 4 weeks. Eight (25.5%) were adherent to ICS and LABA.

Among the 264 participants who had taken asthma medication in the preceding 1 year, 120 (45.5%), 128 (48.5%), 6 (2.3%), 8 (3.0%), and 2 (0.8%), respectively, reported their asthma symptoms to be 'much to very much better', 'a little better', 'no change' 'a little worse' and 'much to very much worse'.

3.5. Perception and attitude toward asthma management

One hundred and ninety-three (47.7%),165 (40.7%), 18 (4.4%), 11 (2.7%), and 18 (4.4%) participants were very satisfied, somewhat satisfied, somewhat dissatisfied and very dissatisfied with the level of management of asthma received from their doctors, respectively. Two hundred and fifty (61.7%), 151 (37.3%), and 4 (1.0%) reported understanding on how to manage asthma completely to mostly completely, somewhat to not too well and not at all, respectively, and 199 (49.1%), 163 (40.2%), 37 (9.1%), and 6 (1.5%) felt very well informed, adequately informed, less than adequately informed and very poorly informed about asthma, respectively. Two hundred and thirty-four (84.4%), 55 (13.6%), and 8 (2.0%) expressed strong need, moderate need and not much of a need, respectively, for better asthma education.

3.6. Comparison of the present study with some previous AIR studies

Supplementary Table 2 shows a comparison of asthma symptoms and level of control with some previous AIR studies. Frequency of controlled asthma using the GINA criteria was consistently low in most AIR studies (2.4–7.6%). The frequency of daytime symptoms ranged from 38% to 68% in most studies and emergency room visit in the preceding year was 11–18% in Europe and 32.9% in North Africa.

Table 5. Pattern of asthma medication use among participants in the preceding 12 months.

	Overall	Children	Adults	
Pattern of medication use	n = 405 (%)	n = 84 (%)	n = 321 (%)	p value
Taken any asthma medication	264 (65.2)	53 (63.1)	211 (65.7)	0.65
Type of medication				
Inhaled steroids plus LABA	47 (11.6)	9 (10.7)	38 (11.8)	0.87
Oral steroids	11 (2.7)	1 (1.2)	10 (3.1)	0.41
Inhaled salbutamol	99 (24.4)	24 (28.6)	75 (23.4)	0.03
Oral salbutamol	57 (14.1)	8 (9.5)	49 (15.3)	0.48
Oral aminophylline	45 (11.1)	4 (4.8)	41 (12.8)	0.06
Oral montelukast	26 (6.4)	8 (9.5)	18 (5.6)	0.08
Others	5 (1.2)	2 (2.4)	3 (0.9)	0.20
Non-adherence to medications (Yes)	179 (67.8)	36 (67.9)	143 (67.8)	0.98
Reasons for non-adherence#				0.13
No symptoms	111 (62.7)	28 (77.8)	83 (58.9)	
Symptoms not bothersome	36 (20.3)	5 (13.9)	31 (22.0)	
Cost of medication	27 (15.3)	2 (5.5)	25 (17.7)	
Ineffective symptoms control	3 (1.7)	1 (2.8)	2 (1.4)	
Frequency of use of increased dosage of medicine*				0.52
Daily or nearly everyday	15 (5.7)	4 (7.5)	11 (5.2)	
Several times a week	18 (6.8)	3 (5.7)	15 (7.1)	
Few times a month	38 (14.4)	10 (18.9)	28 (13.3)	
Rarely	104 (39.4)	16 (30.2)	88 (41.7)	0.28
Never	89 (33.7)	20 (37.7)	69 (32.7)	

Footnote: *n = 264, #n = 177, LABA = Long acting beta-2 agonist, Aminophylline was usually taken in combination tablets with pseudoephedrine, others comprised antihistamines, cough syrups and herbal medications.

4. Discussion

The impetus to constantly evaluate the level of asthma control and management practice is based on a recognized well-defined benchmark for good asthma control and strong evidence that good control is achievable [2]. Furthermore, a consistent association between poor asthma control and increase in asthma morbidity and mortality makes it a public health priority that warrants continual appraisal.

This AIR Nigeria survey provides a comprehensive evidence of the current state of asthma management and asthma control at the population level in Nigeria. The main findings are the very low rates of controlled asthma and the poor state of asthma management. Only 6.2% of the participants had well-controlled asthma based on the GINA defined criteria. The burden of asthma was high with frequent acute asthma episodes, emergency room visits, hospitalization, absenteeism, and reduced productivity, respectively. Participants with uncontrolled asthma had a significantly higher burden of asthma compared to participants with well-controlled asthma. Asthma management practices were mostly at variance with the GINA recommended guideline regarding the use of objective tools in diagnosis and monitoring, asthma education and asthma treatment. Lung function testing was not regularly performed (34.3% ever had spirometry) and less than half of the participants received training on inhaler technique and types of asthma medications. The most frequently taken asthma medications (more so among children) were reliever medications, and only 11.2% of all participants were on inhaled corticosteroid steroid (ICS).

Poor asthma control has been documented in previous studies in Africa and elsewhere and rates of controlled asthma appear unchanged over the last two decades. The rates of controlled asthma have ranged between 2%-56% [5–7,20], and the rate in this present study is similar to the 5.3% and 7.6% reported in the AIR studies in Europe and North Africa, respectively, [5,20] much lower than 56% reported in the Gulf and near East region [6], but higher than 2.4% and 2.5% in Latin America and Asia Pacific, respectively, [7,21]. In Nigeria, comparable low rates of controlled asthma (8%-43%) were reported in previous hospital-based studies which further underlines the validity of this present study but also bring to the fore the direr situation in the general population [11–13]. Rates of controlled asthma reported among patients with mild to moderate asthma from hospital-based studies in Europe (>60%) is generally higher than in the Nigerian studies and may imply better quality care for patients attending hospitals for asthma in these countries [22,23]. This present study demonstrates poor health-seeking behavior among asthma patients in Nigeria (less than half of the participants attended the hospital regularly) and this is likely to contribute to poor asthma control. A hospital-based study in Cameroun, a Central African country, also reported that irregular hospital visit was an independent predictor of poor adherence to asthma medications which influences asthma control [24]. Although challenges to good asthma control exist worldwide, they are more profound in low to middle-income countries (LMIC) where limited access to health-care and affordable medications persist [25,26]. Also, universal health coverage is still developing in sub-Saharan Africa and controller medications are often not covered under many schemes [27]. For example, in a previous report evaluating out-of-pocket costs for asthma in Nigeria, the monthly cost of asthma care was $30.7 ± 19 of which $26.7 was spent on asthma medications [28]. Therefore for about half of the participants in this present study whose household income is less than $100 monthly asthma medications are likely to be unaffordable based on the World Health Organization (WHO) definition of affordable medicine [29]. The WHO defines affordable medicine as one that has a maximum 30-day cost of a day's wage of the least paid worker [29]. Poor adherence to controller medications may also explain the

inconsistency between the level of asthma control and the use of controller medications reported in this study. However, poor adherence to controller medications is not limited to low resource settings and has been reported worldwide (8–20%) regardless of accessibility to medical care [2,30,31]. This may suggest a poor understanding of the basis for the use of controller medications and possibly the fear of side effects from these medications (particularly among children) resulting from inadequate asthma education. There is a strong need therefore for comprehensive asthma education that highlights the rationale for use of controller medications, the cost-effectiveness of its use and the potential benefit in mitigating future risks. In sub-Saharan Africa, there is also an additional need for community-level asthma education due to the low levels of health literacy at the population level with co-existence of myths and stigma about asthma [32,33]. Also, fundamental to good asthma management is the widespread recognition of the most frequent symptoms of asthma (persistent cough, breathlessness and chest tightness) at the population level which is likely to promote asthma diagnosis and treatment [2,34].

Underutilization of lung function testing in the evaluation of asthma as seen in our study bodes for diagnostic inaccuracies and poor asthma control. This is due to its value as an objective measure of airflow limitation that supports asthma diagnosis andassesses asthma control and future risk of adverse effects. The finding of low lung function and airflow limitation as part of asthma assessment is likely to encourage asthma treatment and medication adherence. In contrast to our findings, over 55% of patients attending hospitals in two European countries had previous spirometry testing in the preceding year. This may contribute to higher rates of controlled asthma among hospital patients reported in that region [35]. Challenges to the use of spirometry in asthma management in Nigeria is likely related to the limited access to good quality spirometry particularly at the primary and secondary care hospitals where most patients with asthma receive treatment [36]. However, under-utilization of spirometry in asthma diagnosis and management is a recognized shortcoming in most primary care settings worldwide regardless of availability and accessibility [37]. This makes improvement in access to good quality spirometry services in Africa another potentially effective intervention for enhanced asthma care. Besides, the widespread household use of unclean cooking fuels in Nigeria is an additional factor associated with more severe asthma symptoms and low rates of controlled asthma and also needs to be addressed [38,39].

A disparity between self-perception of asthma control and the actual level of control has been consistently reported [5–7]. Nearly 90% of the participants with uncontrolled asthma based on the GINA criteria in this study rated their level of asthma control between somewhat controlled and completely controlled despite a very high frequency of sleep disturbances (75%), limitation in activities of daily living (75%), missed school or work (56%) and emergency room visit (14%) due to asthma. This may infer low expectations from asthma treatment, far short of the GINA defined criteria, and unawareness that complete control is achievable. Conversely, it may also be a reflection of the reported low level of asthma knowledge and poor adherence to guideline-based asthma practice among doctors in Nigeria [40,41]. This is plausible because despite evidence of inadequate management practice, for example, limited lung function testing and training on inhaler techniques, 80–90% of the participants expressed satisfaction with the quality of asthma management received. Therefore, enhancing asthma education for doctors through a well-designed comprehensive continuing medical education program and the inclusion of nurses and pharmacist into the asthma management team to augment asthma education and training on inhaler technique is a recognized strategy that has the potential to improve asthma management and control [2]. Such multi-disciplinary teams are scant in Nigeria and should be harnessed as a cost-effective measure to improve asthma care.

Results of this present study and the commonalities with previous reports provide underpinning evidence of the many unmet needs in asthma management and control globally. This makes the adoption of the key recommendations of the 2018 Global Asthma Report imperative particularly for LMIC to enable us to achieve the United Nations' Sustainable Development Goal 3 that aims to ensure healthy lives for all [42]. According to the report, the reduction in both direct and indirect costs from asthma is attainable through the implementation of policies for broad-based and all-inclusive asthma education, improvement of access to guideline-based asthma care, inclusion of inhaled controller medications on the essential drug list and ensuring that these medications are free, subsidized or reimbursed through effective insurance schemes [42].

The strengths in this study include the stringent definition of clinical asthma that required physician diagnosis thus limiting misclassification of persons with similar symptoms. Secondly, the door to door recruitment of participants from the community ensured the inclusion of participants across social cadre beyond the limits of those who attended hospitals or schools. However, the conduct of the AIR Nigeria survey only in urban areas across cities is a recognized limitation due to the wide urban-rural divide with significant gaps in income and access to healthcare that is more profound in Africa [43]. The implication is that the state of asthma management and level of control we have reported may actually be worse in these areas. Furthermore, the additional requirement for the presence of current symptoms or use of asthma medications in persons with diagnosed asthma may have excluded participants with mild asthma.Also, the self-reported information obtained from participants relied on recall and could not be verified. We included participants that were 6 years and above because the diagnosis of asthma is hardly made among very young children in Nigeria despite the presence of typical symptoms. Despite these limitations, our findings provide a reliable appraisal of asthma management and control in Nigeria and a source of valuable information for the development and implementation of interventions to improve asthma care.

5. Conclusion

In conclusion, the level of asthma control in Nigeria is very poor with a high burden of asthma symptoms and limitation in activities of daily living. The current state of asthma management is modest with very limited utilization of diagnostic

and monitoring tools and poor adherence to controller medications. This information serves as a call to action on stakeholders and policymakers to develop and contextually implement a broad-based approach for the improvemnet in asthma care, that includes but not limited to comprehensive education programs and expansion in accessibility to guideline-based asthma care and affordable medications.

Author contributions

OBO: Conceptualization and design, data analysis and interpretation of data, drafting of the manuscript, revision for intellectual content and approval of the final version for publication. ACA: Conceptualization and design, drafting of the manuscript, revision for intellectual content and approval of the final version for publication. KNU: Conceptualization and design, interpretation of data, revision for intellectual content and approval of the final version for publication.OOD: Conceptualization and design, drafting of the manuscript, revision for intellectual content and approval of the final version for publication.

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