Original Article

Exercise-Induced Bronchospasm in Ilesa, Nigeria: A Comparative Study of Rural and Urban School Children

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ABSTRACT

Background: Exercise-induced bronchospasm (EIB) described as transient airway narrowing shortly after or during exercise is an important tool in epidemiological study of childhood asthma which has been increasing in prevalence globally. This study sets out to determine the prevalence of EIB in poor rural and affluent urban school children in Ilesa, South West Nigeria.
Methods: School children in four secondary schools (two rural and two urban) in Ilesa were selected using multistage sampling. Their sociodemographic characteristics and history of wheeze/asthma were noted. The children had their forced expiratory volume in 1 s (FEV_1) measured before, 5, 10 and 15 min after 6 min of free running exercise to achieve 80% of their maximal pulse rate. EIB was calculated as the change in FEV_1 pre- and post-exercise expressed as a percentage of the pre-exercise value ≥10%. The prevalence of EIB among the children as well as factors associated with it were determined.
Results: A total of 230 children (129 rural and 101 urban) aged 9–17 years participated in the study over a 9 month period. Mean (standard deviation [SD]) age was 12.6 (1.9) years and Male:Female 1:1.1. Past history of wheeze in the children was obtained from 14 (13.9%) versus 2 (1.6%) of the urban and rural children, respectively. The mean (SD) FEV_1% for the urban and rural children was 85.5 (18.5)% versus 78.5 (15.5)%, respectively. The prevalence of EIB was significantly higher among the urban children at 23.8%, 19.8% and 14.9% versus 8.5%, 5.4% and 3.1% for 5, 10 and 15 min post-exercise, respectively. History of wheezing in the past 12 months was the only factor significantly associated with EIB among the urban children.
Conclusion: The prevalence of EIB is significantly higher among urban school children observed in about one in every five children. We recommend exercise testing as part of routine pre-entry school evaluation to Nigerian children in urban centers.

Key words: Exercise-induced bronchospasm, rural, school children, urban

How to cite this article: Kuti BP, Omole KO, Kuti DK, Oso BI, Mohammed LO, Ologun BG, *et al*. Exercise-induced bronchospasm in Ilesa, Nigeria: A Comparative study of rural and urban school children. Niger J Health Sci 2017;17:25-34.

INTRODUCTION

Asthma is a heterogeneous disease characterised by chronic airway inflammation, recurrent episodic wheeze, shortness of breath, chest tightness and cough that vary over time and in intensity, together with variable expiratory airflow limitation.[1] Bronchial asthma is estimated to affect about 334 million persons globally and 14% of the world's children are estimated to have had asthma symptoms in the past 1 year. The prevalence of asthma is increasing over the decades.[1,2] Many children suffering from this condition are often unrecognised and undiagnosed thus they remain untreated or poorly treated.[3] Consequently, childhood asthma remains a leading cause of school absenteeism, Visit to the emergency room, poor exercise tolerance and poor quality of life of children and their parents.[4,5]

Physical activities and exercises are important requirements for healthy growth and development of children.[6] Children often take part in exercises as part of organized educational or sporting activities and/or as leisure or recreational activities.[6] Often some children are rushed into hospital emergency units with breathlessness, wheezing and prolonged chest

Submission: 04-June-2017 **Revised:** 04-December-2017 **Accepted:** 23-January-2018
Published: 26-November-2019

Access this article online
Quick Response Code:
Website: www.chs-journal.com
DOI: 10.4103/njhs.njhs_7_17

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tightness following physical activities and some could not take part in these activities because they often have severe, continued breathlessness following exercises.[7,8] These individuals who may not have daily symptoms of asthma, but manifest with symptoms or evidence of airway constriction during and/or after exercise are said to have exercise-induced bronchospasm (EIB).[9,10]

EIB which is often used interchangeably with the term exercise-induced bronchoconstriction is characterised by symptoms of coughing, wheezing, shortness of breath and chest tightness shortly after exercise or rarely during exercise, and is associated with demonstrable airway obstruction as a drop in pulmonary function parameters.[9,10] The definitive diagnosis of EIB according to the American Thoracic Society (ATS) guidelines requires symptoms associated with objective demonstration of a drop in flow rates, generally ≥10% for forced expiratory volume in 1 s (FEV_1) and ≥12.5%–15.0% for peak expiratory flow rate (PEFR) after a physical exercise.[10] EIB often affect children and may remain undiagnosed because of poor perception of the symptoms by the children and/or their parents or caregivers.[11,12] It can limit the potentials of the children and often affect their physical and emotional development.[7] Moreover, undiagnosed asthma is a recognised cause of untimely death among active individuals.[13] EIB has, therefore, become an important tool in the epidemiological study of childhood asthma.[1,14]

The prevalence of EIB among apparently healthy children vary widely depending on the population studied (rural vs. urban), the parameter of bronchoconstriction used (FEV_1 vs. PEFR), the cuff off of the lung function parameters used to define bronchoconstriction and the type and intensity of the exercise.[9,10] Ng'ang'a *et al.*[15] reported a prevalence of EIB to be 22.9% and 13.2% among school children in urban and rural Kenya, respectively, using a ≥10.0% fall in FEV_1 after free running exercise as the yardstick. Addo-Yobo *et al*.[16] reported significant increase in the prevalence of EIB using ≥12.5% decrease in peak expiratory flow among Ghanaian school children over a period of 10 years with more increase observed among urban than rural school children. In northern Nigeria, Onazi *et al.*[17] using changes in PEFR >15.0% post free running exercise as a measure of EIB reported a prevalence of 6% among school children.

There is a dearth of studies about EIB among school children in Nigeria and the factors associated with EIB in school children in rural and urban regions in Nigeria have also been poorly studied. This study, therefore, sets out to determine the prevalence and factors associated with EIB among rural and urban school children in Ilesa, Nigeria.

METHODS

Study design

This was a school-based cross-sectional study.

Study location

This study was conducted in four secondary schools in Ilesa East Local Government Area, South West Nigeria. Ilesa is situated on latitude 7°35'N of the equator and longitude 4°51'E of the meridian and is the largest town in Ijesaland.[18] Ilesa is home to about 620,000 people with about 25% of the population being children <5 years and up to 40% of children <15 years.[18] Ilesa is a semi-urban region with a mixture of individuals across the social classes and both urban and rural settlements.[18]

Sample selection

The multistage sampling method was used to select the study participants thus: the local government has 24 secondary schools, 11 public (middle school) and 13 private secondary schools.[19] The participating schools were selected by multistage sampling– all the schools in Ilesa East LGA were categorised into two, i.e., schools in rural and urban settlements, (the sampling frame) then two schools (one each from the rural and urban settlements) were then selected each from the pools of schools by simple randomisation method.

The selected urban school which is a private school has 6 arms-Junior Secondary School (JSS) 1–3 and to senior secondary school 1–3, while the selected rural public middle school has 5 arms– primary 5–6 and JSS 1–3. A class from each of the arms was randomly chosen from the selected schools and the students in the selected classes were recruited until the sample size was achieved.

Sample size determination

The minimum sample size for this study was estimated using open Epi sample size software (R)[20] Using 5% significance (alpha) level, 80% study power and 95% confidence interval (CI). Assumptions: mean difference of FEV_1 among rural and urban school children = 0.06 L and the standard deviation (SD) of 0.29 and 0.28 L for rural and urban, respectively.[15] Ratio of urban to rural school children to be recruited = 1:1. Imputing these parameters into Open Epi software® (Atlanta, GA, USA) generated 200 minimum sample size (100 urban, 100 rural), but 230 (129 rural and 101 urban) school children were studied.

Ethical consideration

The permission of the local education authority and institutional ethical approval from the Institute of Public Health, Obafemi Awolowo University, Ile-Ife, Nigeria (HREC approval no IPH/OAU/12/254) was obtained to carry out this study. The permission and approval of the principals and head teachers of the participating schools, as well as parental consent and assent (from the study participants), were also obtained. Consent from all the teachers in the selected schools was obtained and they were sensitised about the nature and reasons for the study.

Study procedure

Interviewer's administered pre-tested questionnaires modified from the validated International Study of Asthma and Allergic conditions in Children (ISAAC) questionnaire was used to obtain information about the study participants. Information obtained included sex, age, tribe and family size (including the number of children in the household). Overcrowding for this study was defined as having three or more persons sleeping in the same room as the child.[21] Furthermore, parental highest level of education and occupation was also obtained to ascertain the socioeconomic class of the children based on the method described by Oyedeji.[22] The type of fuel used for household cooking, heating and lighting were also ascertained and recorded and whether the family keeps animals, pets, poultry in the household. Personal and family history of wheeze as well as the history of recurrent wheeze in the last 12 months was also obtained. Also of interest was the history of recurrent nasal discharges, sneezing and blocked nostrils.

The children were then examined for features of allergic diseases such as allergic rhinitis and conjunctivitis. Their pulse rate at rest and after exercise was also recorded, likewise their anthropometric measurements including weight and height and their body mass index (BMI) calculated from the formula: (weight in kg)/(height in m).[2] The nutritional status of the children was determined using the World Health Organisation (WHO) growth reference chart.[23] Stunting and severe stunting were defined as height for age <15th and 3rd centiles, respectively. Underweight was defined as BMI <15th centile and overweight and obese as BMI >85th and 95% centile, respectively, on the WHO growth reference chart.[23]

The children then had lung function tests to determine their forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) using a spirometer (MIR Spirolab III Medical International Research srl Italy) following ATS/ERS recommendation.[24] The procedure was explained and demonstrated to all the children. With the children comfortably seated on a chair with a backrest, they were instructed to inhale maximally (to total lung capacity) then nose clips were worn by the study participants to ensure only mouth breathing. The children were then instructed to exhale as fast and as long as possible (to residual volume) through the mouthpiece into the spirometer to get the required parameters.[24] The predicted values used in this study were based on the data of Knudson *et al*.[25] The lung function tests were done at rest (baseline test), these were repeated 5, 10 and 15 min after free running exercise for 6–8 min to achieve an 80%–85% of the maximum heart rate (assumed to be 220-age in years).[10] Each study participant had a minimum of three readings and a maximum of eight readings as recommended by the ATS/ERS.[24] The best reading out of those that met the acceptability and or usability criteria was used for the interpretations of the lung function parameters.[24] The ratio of FEV_1 to FVC was calculated and expressed in percentage. A minimum of three flow-volume loop results within 150 ml (100 ml if FVC <1.0 L) of highest and next highest FVC were recorded and the flow-volume loop with the highest FEV_1 was analysed.

Definition of exercise-induced bronchospasm

For this study, EIB was defined as the greatest decrease in FEV_1 following exercise expressed as a percentage of the baseline FEV_1 (change in FEV_1/baseline FEV_1) × 100%. A positive response to exercise was defined as a decrease in FEV_1 of 10% or greater (EIB-positive).[10] This was calculated at 5, 10 and 15 min for each participant. EIB was further categorised into mild ≥10 to <25%; moderate ≥25 to <50% and severe ≥50%.[10]

Emergency and resuscitative facilities were made available for appropriate interventions as the needs arose throughout the study.

Quality control

The lung function test was done using incentive spirometry to instruct as well as encourage the children to do acceptable or at least usable tests following ATS/ERS guidelines.[24] Furthermore, the tests were carried out between 10:00 am to 12:00 noon each day to limit the effects of ambient temperature changes on the readings and to ensure the baseline test was done before the children were involved in any physical activity. Calibration checks were carried daily using a 3 L calibration syringe to ensure high-quality readings by the spirometer during the study.

Data analysis

This was done using the Statistical Program for Social Sciences (SPSS) software Version 17.0 (SPSS Inc., Chicago 2008, IL, USA). The prevalence of EIB at 5, 10 and 15 min post-exercise was calculated from the proportion of children with EIB over the total children who participated in the study at the urban and rural schools. Continuous variables such as ages, weight, height FEV_1 and FVC were tested for normality and summarised using mean and SDs for normally distributed variables and median and interquartile range (IQR) for non-normally distributed ones. Proportions and percentages were determined for categorical variables such as sex and age categories. Differences between the means (SD) or median (IQR) of continuous variables were analysed using Student's *t*-test or Mann–Whitney U-test, whereas categorical variables were analysed using Pearson's Chi-square test and Fisher's exact test, as appropriate. Level of significance at 95% CI was taken at $P < 0.05$.

RESULTS

Sociodemographic and general information of the study participants

Table I highlights the sociodemographic and general information including personal and family history of wheeze and allergic diseases among the study participants.

A total of 248 school children participated in the study, 18 (7.3%) could not perform an acceptable or usable spirometer tests hence were excluded. These included those who could not follow instruction for the performance of spirometry, those with early termination and persistent

Table I: Sociodemographic and general information of the rural and urban school children

Variables	Rural children (*n*=129), *n* (%)	Urban children (*n*=101), *n* (%)	Total (*n*=230)	*P*
Sex				
Male	60 (46.5)	51 (50.5)	111	0.549
Female	69 (52.5)	50 (49.5)	119	
Age (years)				
9-11	39 (30.2)	36 (35.7)	66	0.386
12-14	70 (54.3)	48 (47.5)	127	0.109
15-17	20 (15.5)	17 (16.8)	37	0.786
Mean (SD) age	12.7 (1.9)	12.5 (2.0)		0.440#
Tribe				
Yoruba	119 (92.2)	92 (91.1)	211	0.752
Ibo	7 (5.4)	6 (5.9)	13	0.867
Others	3 (2.4)	3 (3.0)	6	0.762
Number of children in household				
≤3	21 (16.3)	45 (44.6)	66	<0.001
>3	98 (83.7)	56 (55.4)	154	
Mean (SD)	4.8 (1.4)	3.8 (1.5)		<0.001
Socioeconomic class				
Upper	1 (0.8)	70 (69.3)	71	<0.001
Middle	64 (49.6)	24 (23.8)	88	<0.001
Lower	64 (49.6)	7 (6.9)	71	<0.001
Overcrowding				
Yes	74 (58.9)	25 (24.8)	99	<0.001
No	55 (41.1)	76 (75.2)	131	
Fuel for household cooking*				
Clean fuel	16 (12.4)	66 (65.3)	82	<0.001
Unclean fuel	113 (87.6)	35 (34.7)	148	
Keep household pets				
Yes	51 (39.5)	41 (41.6)	92	0.823
No	78 (61.5)	59 (58.4)	137	
Family history of asthma				
Yes	4 (3.1)	9 (8.9)	13	0.058
No	125 (96.9)	92 (91.1)	217	
Past history of wheeze				
Yes	6 (4.7)	14 (13.8)	20	0.014
No	123 (95.3)	87 (86.2)	210	
Allergic rhinitis				
Yes	9 (7.0)	11 (10.9)	20	0.296
No	120 (93.0)	90 (89.1)	210	
Known asthmatic				
Yes	0 (0.0)	7 (6.9)	7	<0.001
No	129 (100)	94 (93.1)	223	

*Clean fuel-gas and electric; unclean fuel-kerosene, coals, firewood and other biomass fuel, #Independent *t*-test applied. Others are Urhobos, Ebiras.
SD: Standard deviation

cough in the first second of the manoeuvre. 230 (129 rural and 101 urban) children thus form the basis of further data analysis.

Age and sex

The ages of the school children ranged from 9 to 17 years with a mean (SD) age of 12.6 (1.9) years. No significant difference in the ages of the children in rural and urban schools. The male to female ratio of the school children was 1:1.1, no significant difference was observed in the sex distribution of the rural and urban children.

Ethnicity

Majority (91.7%) of the children were Yoruba which is the predominant tribe in the study location. Other tribes represented are highlighted in Table I.

Parental socioeconomic class

Significantly more children from urban schools were from high socioeconomic class, while the children from rural school were more from low- and middle-socioeconomic classes.

Home environment of the study participants

Number of children in the household

The number of children in each household of the study participants ranged from one to eight with a mean (SD) of 4.3 (1.5) children. The children from rural schools had larger family size with a mean (SD) number of children in their household of 4.8 (1.4) which was significantly larger than 3.8 (1.5) children per household among the urban school children ($P < 0.001$). Similarly, more proportions of the children from rural schools live in overcrowded homes and use unclean fuels (such as firewood, coal and kerosene) for household cooking compared to their counterparts from urban schools. No significant difference was however found among the two categories of study participants as regards the proportion of the children with household pets [Table I].

Personal and family history of asthma and allergic diseases among the study participants

Significantly more urban school children had past history of recurrent wheeze and had been diagnosed with asthmatic in the past compared to the rural school children [Table I]. Although more proportions of urban school children had history to suggest allergic rhinitis compared to the rural children, the difference was not statistically significant.

Anthropometric indices and baseline lung function parameters of the study participants

Table II highlights the anthropometric indices and lung function parameters of the school children.

Weight and height of the study participants

The weight of the 230 school children ranged from 19.0 kg to 68.0 kg with a mean (SD) of 38.1 (10.0) kg. Their height ranged from 1.29 m to 1.78 m with a mean (SD) height of 1.49 (0.11) m. The urban children were significantly heavier (40.7 [11.1] kg vs. 30.3 [8.7] kg t-test = 8.00; $P < 0.001$) and taller (1.51 [0.12] m vs. 1.46 [0.10] m; t-test = 3.45; $P = 0.001$) than the rural children. Similarly, their BMI indices were significantly higher than that of their rural counterpart (t-test = 2.46; $P < 0.001$) [Table II].

Nutritional status of the study participants

Significantly, more rural children were underweight ($P = 002$) and stunted ($P = 0.007$) compared to their urban counterpart. However, more proportions of the urban children were overweight/obese compared to the rural children, though the difference was not significant.

Baseline lung function parameters of the study participants

The mean (SD) FEV_1 at rest of the 230 school children was 1.89 (0.52) L which ranged from 0.80-3.49 l. The mean (SD) FEV_1% was 82.5 (17.5) %. The mean (SD) FEV_1 was significantly higher among the urban than the rural school children. Similarly, the pre-exercise FVC was significantly higher in urban than rural school children [Table II]. However, no significant association was observed between the FEV_1 at 5, 10 and 15 min between the two groups.

Changes in forced expiratory volume in 1 s in response to free running exercise

The changes of FEV_1 in response to 6–8 min free running exercise among the urban and rural school children are highlighted in Figures 1 and 2. The median (IQR) changes in FEV_1 value were significantly different among the two categories of study participants (Median (IQR) urban 4.5 [0.29−12.39] vs. 1.6 [−5.5−9.0 rural]; Mann–Whitney U-test = 5.220; $P = 0.010$),

Table II: Anthropometric indices, nutritional status and lung function parameters of the study participants

Variables	Rural children (n=129), n (%)	Urban children (n=101), n (%)	P
Anthropometric indices			
Weight mean (SD) (kg)	30.2 (8.7)	40.7 (11.2)	<0.001
Height mean (SD) (m)	1.46 (0.10)	1.51 (0.12)	0.001
BMI (kg/m^2)	16.65 (2.3)	17.43 (2.5)	<0.001
Nutritional status			
Obese	0 (0.0)	2 (2.0)	0.069ǂ
Overweight	8 (6.2)	11 (10.9)	0.200*
Underweight	30 (23.3)	8 (7.9)	0.002*
Stunting	21 (16.3)	5 (5.0)	0.007*
Normal	91 (70.5)	80 (79.2)	0.794*
Lung function parameters			
Pre-exercise FEV_1 (s) mean (SD)	1.79 (0.46)	2.00 (0.56)	0.002
Pre-exercise FEV_1 (%) mean (SD)	78.5 (15.5)	85.5 (18.5)	0.002
Pre-exercise FVC (s) mean (SD)	2.13 (0.57)	2.49 (0.81)	<0.001
Pre-exercise FVC% mean (SD)	80.5 (16.5)	88.5 (13.5)	<0.001
FEV_1/FVC (%) mean (SD)	84.89 (9.94)	82.73 (11.86)	0.134
FEV_1 5 min post-exercise (s)	1.75 (0.45)	1.86 (0.59)	0.110
FEV_1 10 min post-exercise (s)	1.77 (0.48)	1.87 (0.57)	0.138
FEV_1 15 min post-exercise (s)	1.78 (0.46)	1.89 (0.56)	0.103

*Chi-squared test applied, ǂFischer's exact test applied, other variables analysed with independent t-test. Obese-BMI >97th centile, overweight BMI >85th, underweight BMI <3rd centile on WHO growth char. FEV1: Forced expiratory volume in one second, FVC: Forced vital capacity, SD: Standard deviation, BMI: Body mass index, WHO: World Health Organization

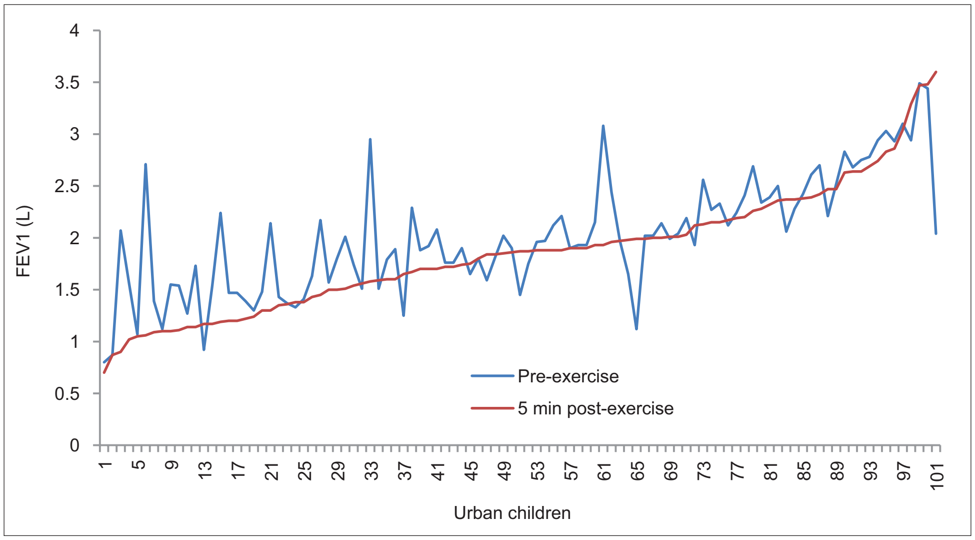

Figure 1: Pre-exercise and 5 min Post-exercise forced expiratory volume in 1 s of the urban school children

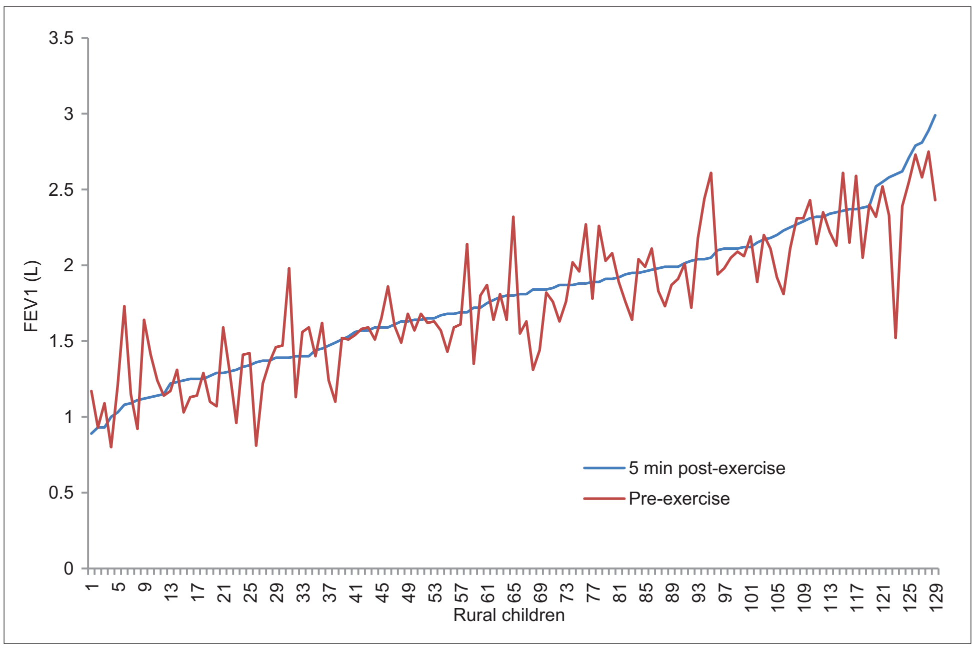

Figure 2: Pre-exercise and 5 min post-exercise forced expiratory volume in 1 s of the rural school children

at 10 min (Mann–Whitney U-test = 5.054; $P = 0.040$), but was insignificant at 15 min (Mann–Whitney U-test = 5.660; $P = 0.088$).

Prevalence and severity of exercise-induced bronchospasms among the study participants

Thirty-five (15.2%) of the 230 study participants had EIB at 5 min post-exercise. These included 24 (23.8%) of the 101 children in urban schools and 11 (8.5%) of the 129 rural children. Figure 3 highlights the prevalence of EIB at 5, 10 and 15 min post-exercise among the urban and rural school children.

At 5 min post-exercise, more proportion of urban children had moderate and severe bronchospasms than rural school children [Table III].

Management of children with exercise-induced bronchospasms

The majority (91.4%) of the 35 children with EIB recovered spontaneously after few minutes of rest, three children with severe bronchoconstriction had to be actively managed with inhaled short-acting bronchodilator (salbutamol) in two and with additional intravenous corticosteroid in one of the children. They are presently being followed up at the paediatric chest clinic of the Wesley Guild Hospital, Ilesa.

Factors associated with the presence of exercise-induced bronchospasms at 5 min among the study participants

Tables IV and V highlighted the factors related to the presence of EIB_5 post-exercise among the school children

Table III: Severity of the exercise induced bronchospasm at 5 min among the study participants

Severity of EIB_5	Rural (n=11)	Urban (n=24)	Total	P
Mild	9 (81.8)	11 (45.8)	20	0.039
Moderate	2 (18.2)	10 (41.6)	12	0.160
Severe	0 (0.0)	3 (12.5)	5	0.122

EIB: Exercise induced bronchospasm

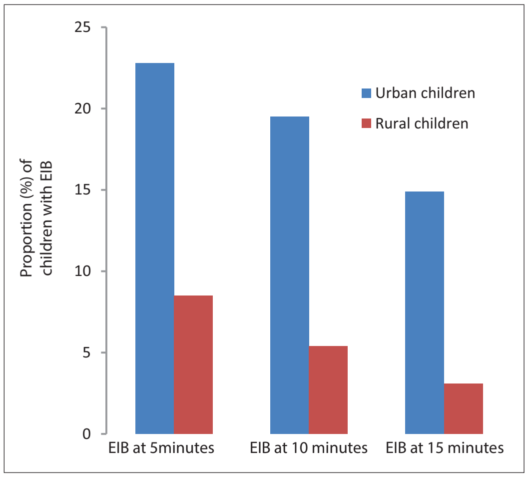

Figure 3: Proportion of the study participants with exercise-induced bronchospasm at 5, 10, and 15 min post-exercise

Sociodemographic characteristics of the study participants as related to the presence of exercise induced bronchospasms

The presence of EIB at 5 min post-exercise was not significantly related to the age, age-range, sex, overcrowding and number of children in the household, use of biomass (unclean fuel for cooking). Similarly, the presence of family history of asthma and allergic rhinitis were not significantly related to EIB among the study participants.

Urban children with history of recurrent wheeze were more likely to have EIB at 5 min as 7 (50%) of the 14 urban children with history of recurrent wheeze compared to 17 (19.5%) of the 87 urban children with no wheeze had EIB at 5 min (χ^2 = 6.176; P = 0.013). Likewise being a known asthmatic was significantly associated with having EIB at 5 min among the urban children (57.1% vs. 21.3%; χ^2 = 3.893; P = 0.049).

DISCUSSION

This study had highlighted the prevalence and severity of EIB among apparently healthy children in affluent urban and poor rural schools in Ilesa, Nigeria, highlighting the factors associated with the condition.

The prevalence of EIB observed to be 23.8% among urban children in this study was similar to the reported prevalence of 22.9% among urban Kenya children using the same parameter for airway bronchoconstriction. The prevalence of EIB observed in this study was, however, higher than a prevalence of 6.0% reported by Onazi *et al.*[17] among school children in Gusau, Northwest Nigeria and 8.3% among Ghanaian children.[16] The difference in the prevalence of EIB observed in this study from the reports by Onazi *et al.*[17] and Addo-Yobo *et al.*[16] may be related to the difference in the diagnostic criteria of EIB used in the studies. While changes in FEV_1 ≥10% was used in this study, Onazi and Addo-Yobo used changes in PEFR ≥15% as their measure of airway bronchoconstriction. Changes in PERF using peak flow meter as a measure of airway bronchoconstriction being efforts dependent has been reported to be less effective compared to changes in FEV_1 measured using a standard quality-assured spirometer.[26]

The higher prevalence of EIB observed in this study among school children in urban compared to those from rural schools was also reported by Addo-Yobo *et al.*[16] in Ghana and Ng'ang'a *et al*.[15] in Kenya. Global trends as related to childhood asthma also corroborated higher prevalence in urban than rural areas as reported in the ISAAC phase III study.[2] The reason for this observation may not be known with certainty. However, westernised lifestyle and diet (including early introduction to cow milk, and increased consumption of processed food and decreased intake of fruits and vegetables which are good sources of antioxidants) which is more common among urban dwellers have been proposed as possible reasons for increased prevalence of asthma and allergic diseases among urban dwellers including children.[1] In addition, the children from urban schools were from affluent homes and high socioeconomic class. These children live in less crowded homes and are less likely to have been exposed to childhood infections and dirty, unhygienic environmental conditions unlike the children from rural areas. This may also explain the higher prevalence of allergic disease and asthma among the urban children bearing in mind the 'hygiene hypothesis' which attributes the higher prevalence of allergic diseases and asthma in urban more hygienic environment to the up-regulation of T-helper cells type 2 (rather than viral induced T-helper cell type 1) with the attendant release of pro-inflammatory and pro-allergic cytokines and recruitment of inflammatory cells and mediators resulting in allergy and asthma.[27]

Worthy of note in the present study is that the urban school children had more severe airway bronchoconstriction than the rural children; however, the prevalence of EIB reduced with increasing period of rest post-exercise. The finding was also reported by other investigators.[14-17] The severity of EIB may be related to having the previous history of recurrent wheeze and other co-morbid factors like other allergic condition and obesity.[10] As more proportion of urban children were from high socioeconomic class with a higher proportion of overweight/obese children as well as higher frequency of allergic diseases than in their rural counterpart, they are therefore more likely to have severe forms of EIB as observed in this study.

The observed higher prevalence of EIB among children previously diagnosed asthmatic in this study is in keeping with

Table IV: Sociodemographic characteristics and general information of the rural and urban school children as related to the presence of exercise induced bronchospasm at 5 min

Variables	Rural school children (*n*=129)		*P*	Urban school children (*n*=101)		*P*
	EIB (*n*=11), *n* (%)	No EIB (*n*=118), *n* (%)		EIB (*n*=24), *n* (%)	No EIB (*n*=77), *n* (%)	
Sex						
Male	3 (27.3)	57 (48.3)	0.172	10 (41.7)	41 (53.2)	0.332
Female	8 (72.7)	61 (51.6)		14 (58.3)	36 (46.8)	
Age range (years)						
9-11	3 (27.3)	36 (30.5)	0.822	7 (29.2)	29 (37.7)	0.448
12-14	8 (72.7)	62 (52.5)	0.189	12 (50.0)	36 (46.8)	0.781
15-17	0 (0.0)	20 (17.0)	0.294	5 (20.8)	12 (15.5)	0.548
Social class						
Upper class	0 (0.0)	0 (0.0)	NA	19 (79.2)	51 (66.2)	0.230
Middle class	5 (45.5)	59 (50.0)	0.773	3 (12.5)	21 (27.3)	0.118
Lower class	6 (54.5)	59 (50.0)	0.773	2 (8.3)	5 (6.5)	0.761
Place of residence						
Within ilesa	11 (100.0)	118 (100.0)	NA	12 (50.0)	47 (61.0)	0.338
Outside ilesa	0 (0.0)	0 (0.0)		12 (50.0)	30 (39.0)	
Ethnicity						
Yoruba	9 (81.8)	110 (93.2)	0.235	23 (95.8)	69 (89.6)	0.314
Igbo	2 (18.2)	5 (4.2)	0.108	1 (4.2)	5 (6.5)	0.662
Others	0 (0.0)	3 (2.6)	0.462	0 (0.0)	3 (3.9)	0.198
Children in household						
<3	0 (0.0)	21 (17.8)	0.209	11 (45.8)	34 (44.2)	0.885
≥3	11 (100.0)	97 (82.2)		13 (54.2)	43 (55.8)	
Overcrowding						
Yes	6 (54.5)	68 (57.6)	0.843	5 (7.0)	20 (26.0)	0.589
No	5 (45.5)	50 (42.4)		19 (88.4)	57 (74.0)	
Cook fuel						
Clean fuel	2 (19.2)	14 (11.9)	0.564	17 (70.8)	49 (63.6)	0.518
Unclean fuel	9 (81.8)	104 (88.1)		7 (29.2)	28 (36.4)	
Smokers in the house						
Yes	0 (0.0)	4 (3.4)	0.395	0 (0.0)	3 (3.9)	0.198
No	11 (100.0)	114 (96.6)		24 (100.0)	74 (96.1)	
Own pets						
Yes	6 (54.5)	45 (38.1)	0.287	12 (50.0)	29 (37.7)	0.304
No	5 (45.5)	73 (61.9)		12 (50.0)	48 (62.3)	
Obese/overweight	1 (9.1)	7 (5.9)	0.714	3 (12.5)	10 (14.1)	0.863

*Fisher's exact test applied. NA: Not applicable. The figures in parentheses are percentages of the total in each column

reports from Africa[15-17] and other parts of the world.[11,12,14] In general, EIB has been reported to occur in 40–90 of asthmatics and 3%–10% of non-asthmatics.[9] It has been diagnosed in children even with no history to suggest asthma or recurrent wheeze[11] as also reported in this study. This may be related to poor perception of caregivers and the children alike about asthma and EIB.[12] Nevertheless, not all children with EIB are asthmatic, but the presence of EIB often indicate the need for further evaluation of the children for asthma and allergic diseases.[9-11]

Exposure to cigarette smoke and biomass fuel were not significantly associated with EIB among the study participants. This was similar to reports from Kenya.[15] Though active and passive exposure to cigarette smoke and biomass fuel have been reported to increase the frequency of exacerbations in childhood asthma and make symptoms control very difficult,[28,29] The effects of these factors on the prevalence of childhood asthma remain controversial.[1,29] More longitudinal studies to ascertain the impact of exposure to cigarette smoke and indoor air pollution on childhood asthma will be worthwhile.

The present study used standardized lung function parameter (FEV_1) which had been reported to reflect airway changes better than the PEFR as it is less efforts dependent, has better repeatability and is more discriminating than PEFR.[9,26] The study participants were coached and encouraged using incentive spirometry to produce acceptable and/or useable spirometry tracing for the interpretation of their FEV_1. Furthermore, free running exercise around the school field was done by the school children for this study which had been

Table V: Personal and family history of asthma and allergic disorders among the children as related to the presence of exercise induced bronchospasm at 5 min

Variables	Rural school children (*n*=129)		*P*	Urban school children (*n*=101)		*P*
	EIB (*n*=11), *n* (%)	No EIB (*n*=118), *n* (%)		EIB (*n*=24), *n* (%)	No EIB (*n*=77), *n* (%)	
Family history of asthma						
Yes	0 (0.0)	4 (3.4)	0.395	3 (12.5)	6 (7.8)	0.495
No	11 (100.0)	114 (96.6)		21 (87.5)	71 (92.2)	
Past history of wheeze						
Yes	2 (18.2)	4 (3.4)	0.075	7 (29.2)	7 (9.1)	0.013
No	9 (81.8)	114 (96.6)		17 (70.8)	70 (90.9)	
Allergic rhinitis						
Yes	1 (9.1)	9 (7.6)	0.865	3 (12.5)	3 (3.9)	0.149
No	10 (89.9)	109 (92.4)		21 (87.5)	74 (96.1)	
Known asthmatic						
Yes	0 (0.0)	0 (0.0)	NA	4 (16.7)	3 (3.9)	0.049
No	9 (81.8)	118 (100.0)		20 (83.3)	74 (96.1)	

NA: Not available, EIB: Exercise induced bronchospasm

reported to be very asthmogenic and to mimic the natural physical activities the children daily engage in.[9,10,14] These constitute great strengths of this study. We however appreciate the limitation that the environmental conditions which can affect the lung function parameters could not be controlled in this study, nevertheless the performance of the test at the same period of the day (10:00 am and 12:00 noon) during the course of the study helped to reduce the effect of weather changes on the lung function parameters of the study participants.

CONCLUSION

EIB was observed to be about three times more common among affluent urban than poor rural school children in Ilesa, Nigeria and they also have more severe airway constriction following exercise. History of recurrent wheeze and being a known asthmatic were significantly associated with EIB. We recommend routine exercise challenge test for urban school children as part of the pre-entrance evaluation for early detection of children with EIB and appropriate management of this condition to improve the quality of life of the children.

Acknowledgment

The authors acknowledge the Proprietress, Principals and Head teachers of the selected schools for giving their kind permission for the conduct of the study. They also acknowledge the parents of the study participants who kindly gave consent for their children/wards to participate in the study, and the children who enthusiastically participated in the study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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