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Association between exercise-induced asthma and parental socio-economic status among school-aged adolescents in a semiurban community in Nigeria

Adekola A. Adewumi[1,2], Rufus A. Adedoyin[2], Taofeek O. Awotidebe[2,*], Gregory E. Erhabor[3,4], Olayemi F. Awopeju[3,4], Rita N. Ativie[5], Kayode I. Oke[6]

[1]Department of Physiotherapy, Federal Teaching Hospital, Ido-Ekiti, Ekiti State, Nigeria
[2]Department of Medical Rehabilitation, College of Health Sciences, Obafemi Awolowo University, Ile-Ife, Nigeria
[3]Chest Unit, Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Nigeria
[4]Department of Medicine, College of Health Sciences, Obafemi Awolowo University, Ile-Ife, Nigeria
[5]Department of Medical Rehabilitation, Faculty of Health Sciences and Technology, University of Nigeria, Enugu Campus, Enugu, Nigeria
[6]Department of Physiotherapy, School of Medical Sciences, University of Benin, Benin City, Nigeria

This study investigated the prevalence and association between exercise-induced asthma (EIA) and parental socio-economic status (PSES) among school-aged adolescents in a semiurban community in Nigeria. Three hundred and eighty-five adolescents (185 male and 200 female adolescents) whose ages ranged between 10 and 19 years participated in this cross-sectional study. Participants were recruited from four government approved secondary schools in Ido-Ekiti using a multistage sampling technique. Peak expiratory flow rate (PEFR) was assessed at baseline and after 6-min run test (6-MRT) on a level playing ground using a standard peak flow meter. PEFR measurements were repeated at 5th, 10th, 15th, and 20th min post 6-MRT. Participants who had >15.0% PEFR fall were considered to have EIA. PSES was assessed using a validated socio-economic status questionnaire. Descriptive and inferential statistics were used to analyze data. Alpha level was set at $P<0.05$. The mean ages of males and females were 13.9±2.0 and 13.8±1.6 years, respectively. More than half of the participants, 58.2% had EIA (>15.0% PEFR scores) while 53.5% belonged to middle PSES class. There was no significant difference between PEFR scores of male and female participants at baseline and 5th min post 6-MRT. However, male participants had significant higher PEFR than the female counterparts at 10th ($t=2.090$, $P=0.037$), 15th ($t=2.162$, $P=0.031$), and 20th min ($t=2.978$, $P=0.003$). There was significant association between EIA and PSES ($\chi^2=152.4$; $P=0.001$). The prevalence of EIA is very high among school-aged adolescents in Nigeria and was significantly associated with PSES.

Keywords: Exercise-induced asthma, Parental socio-economic status, School-aged adolescent, Southwest Nigeria

INTRODUCTION

Asthma is a chronic inflammatory respiratory tract disease that affects individuals of all ages which could be severe and even fatal (Cukic et al., 2012). Currently, more than 300 million people are suffering from asthma globally and its prevalence among children is on the increase (Adeloye et al., 2013; Shimwela et al., 2014). The prevalence of asthma has also been reported to be on the increase over the past few decades with the highest increase among children and adolescents living in the inner cities and regions where low prevalence had previously been reported (Crain et al., 1994; Matsui, 2014).

The prevalence of asthma is on the increase in both developed and developing countries over the last three decades (Okada et al., 2010; Onazi et al., 2012). For instance, the phase one report of the International Study of Asthma and Allergies in Children

*Corresponding author: Taofeek O. Awotidebe http://orcid.org/0000-0002-8583-9467
Department of Medical Rehabilitation, College of Health Sciences, Obafemi Awolowo University, Ile-Ife, Nigeria
Tel: +234-80-3719-6021, Fax: +234-81-2612-6284
E-mail: tidebet@yahoo.com/ tawotidebe@cartafrica.org
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(ISAAC, 1998) reported that the prevalence of asthma symptoms ranged from less than 5% in developing countries to more than 20% in developed countries (Shimwela et al., 2014). This increase has mainly been attributed to the increasing urbanization in developing countries including Africa (Akanbi et al., 2009). Nonetheless, the burden of respiratory disease still remains largely unknown in Africa.

Asthma is characterized by recurring symptoms of coughing, wheezing, difficulty in breathing, reversible airflow obstruction and bronchospasm (Erhabor et al., 2006). Because many respiratory conditions mimic asthma symptoms in children and adults, standardized research instruments such as ISAAC questionnaire and the European Community Respiratory Health Survey have been developed to gain better insight into the prevalence of asthma and other allergic diseases respectively (Janson et al., 2001). It is believed that good understanding of disease progression and its prevalence may help to prevent disease proliferation and develop an effective strategy for controlling it. Furthermore, there is growing advocacy among many health authorities to include regular participation in physical exercise as a strategy for curtailing the scourge of many chronic diseases including respiratory diseases such as asthma (USDHHS, 2008; World Health Organization, 2010).

Studies have shown that physical exercise is beneficial for improving endurance capacity and breathing work efficiency among apparently healthy individuals and improving health-related quality of life, reducing disability in people with respiratory challenges independent of disease severity (Lan et al., 2011). Therefore, exercise has been recommended as an integral part of management for patients with chronic obstructive pulmonary disease (COPD) including asthma (Ries et al., 2007). However, exercise as a form of health behaviour could be hamstrung by a number of factors including personal, disease progression and lack of self-efficacy (Awotidebe et al., 2016). More importantly, participation in regular exercise among adolescents may also be hindered by parental economic situation.

Socio-economic status (SES) is a complex concept that has been associated with many chronic diseases. There is growing evidence that parental SES (PSES) is associated with aetiological development of asthma in children (Mohammed et al., 2012). Although respiratory conditions in childhood may not actually result into asthma, presence of underlying respiratory pathology may trigger narrowing of the airways in individuals with unsuspected asthmatic condition during exercise programme. Thus, leading to exercise-induced asthma (EIA) despite no previous history of asthma related conditions (Anderson and Holzer, 2000). Similarly, presence of EIA may limit regular participation in exercise programme for healthy living among adolescents. Unfortunately, there is dearth of information on the prevalence of EIA among adolescents. Furthermore, the association between EIA and parental SES has not been objectively explored among adolescents in Nigeria. The outcome of this study may be used to increase awareness on EIA and develop strategy for prevention of future asthmatic condition. Therefore, the objective of this study was to assess the prevalence of EIA and its association with parental SES of school-aged adolescents in Ido-Ekiti, Ekiti State, Southwest, Nigeria.

MATERIALS AND METHODS

Participants and location

Participants for this study were school-aged adolescents attending approved government secondary schools in Ido-Ekiti, Ekiti State, Southwest, Nigeria. Ido-Ekiti is the headquarters of Ido/Osi Local Government Area (LGA) which is situated in the northern part of the state and comprises of other towns and rural communities such as Aaye, Ayetoro, Ido, Ifaki, Ilogbo, Igbole, Ora, Orin and Usi. The local government is bounded in the east by Ipere and Iludun, in the south by Igbole and Ifinsin axis and in the north and northwest by Usi and Ilogbo Ekiti. Ido-Ekiti is one of the fastest growing towns in Ekiti State and many people were attracted to the town due to the presence of a Federal Teaching Hospital formerly known as Federal Medical Centre, School of Nursing and many financial institutions. Recently, the teaching hospital has been affiliated with a private university; Afe Babalola University, Ado-Ekiti for the training of undergraduate medical students and as well as postgraduate medical fellowship in different specialties (Government of Ekiti State, Nigeria, 2015).

Participants for this study were selected using a multi-stage sampling method. Firstly, Ido/Osi LGA was purposively selected and secondly, four out of seven government approved secondary schools were randomly selected. Furthermore, three junior and three senior out of four classes were also randomly selected from the lists of classes. Lastly, the lists of students in each selected class were compiled and systematic sampling technique was used to select every third participant on the list. Eligibility for inclusion were participants whose ages ranged between 10 and 19 years and no previous history of asthmatic related conditions. They were excluded from the study if presented with persistent cough in the last 3 months. Furthermore, individuals with presence of chest or spinal deformities such as scoliosis or kyphosis were also excluded from the study.

The minimum sample size for this study was calculated using the formula: $n = Z^2(p)(1-p)/e^2$ where, n = required sample size, Z = z-value (z-value for 95% confidence level [1.96], p = the estimated proportion of an attribute that is present in the population, and e = the desired level of precision (i.e., confidence interval, expressed as decimal [0.05] (Kasiulevičius et al., 2006). Considering the prevalence (p) of physical inactivity in Nigerian population to be 25.0% (Abubakari and Bhopal, 2008), a minimum sample size of 354 was arrived at. A total of 400 school-aged adolescents were recruited for this study to allow for 15%–20% attrition or missing data. However, only 385 valid data were used in the analysis yielding participants' rate of 96.3%.

Protocol design

This is a cross-sectional study that involved school-aged adolescents from approved government secondary schools in Ido-Ekiti, Ekiti State, South-Western Nigeria. Ethical approval was sought and obtained from the Health Research and Ethics Committee of the Institute of Public Health, Obafemi Awolowo University Ile-Ife (HREC: IPH/OAU/12/495). Afterwards, approval of the Area Education Officer of Ido/Osi LGA, Ekiti-State was sought and introductory letters were taken to the various heads of selected government approved secondary schools explaining the purpose of the study. Thereafter, participants who met the inclusion criteria voluntarily gave assent to participate in the study and informed consent form was given to the participant to be delivered to their parents or guardians after the purpose for the study had been explained. A copy of validated SES questionnaire was given to each student for their parents or guardians to complete. Physical characteristics including height and weight of each participant were measured and age was recorded.

Assessment of PSES

PSES of participants was assessed using a validated SES questionnaire (Adedoyin et al., 2005). PSES indicators including education, occupation, and income were often combined in the assessment of SES level. Items also included in the questionnaire were parent's possessions of house, cars, and household assets such as television, video, refrigerator, and set of upholstery were considered as part of SES indicators. Parent's position in the community such as community leader or religious leader including pastor, imam or chief was also considered as SES indicator in Nigeria context. The scoring of the items on the questionnaire was based on their importance in Nigerian society. The summative scores of the three socio-economic indicators and respective valued properties and position in the community were added together to yield a maximum obtainable score of 27 points. Actual score was divided by maximum obtainable score and then multiplied by 100. The 25th, 50th, and 75th percentiles were used to label transformed-scores into lower, middle and upper quartiles representing low, middle, and high levels of socioeconomic class. The instrument has good test retest reliability value ($r = 0.86$) (Adedoyin et al., 2005).

Assessment of peak expiratory flow rate

Participant's lung function (peak expiratory flow rate, PEFR) was measured at baseline using a standard peak flow meter (Microlife, PF 100, Clearwater, FL, USA). The device was re-set to zero while placing the mouthpiece in the participant's mouth between the teeth, closing the lips around it without putting the tongue inside the hole (Adedoyin et al., 2010). Participant sat uprightly on a stand chair and was instructed to take a deep breath to fill the lungs and hold the breath. Participant was then instructed to blow out as hard and fast as possible in a single blow because the first burst of the air is the most important part (Adeniyi and Erhabor, 2011). The value got was written down, but with cough or poor result, the value was discarded and process started again, the step was repeated two more times and the highest value among the three was recorded as peak flow value. The mouthpiece was cleaned with methylated spirit and cotton wool after each individual who performed the test to prevent cross infection (Adedoyin et al., 2010).

Assessment of EIA

A 6-min run test (6-MRT) was performed on a level playing ground of 50 m long during school break period (10:30 a.m. and 11.00 a.m.). Participants were encouraged in the standard manner by telling them to run at their own selected pace until the end of six minutes (Shimwela et al., 2014). Five min after 6-MRT, the PEFR was reassessed using the peak flow meter. Measurements of PFER was also reassessed at 5-min intervals post 6-MRT over a period of 20 min (i.e., 5th, 10th, 15th, and 20th min) (Awopeju et al., 2011). A stopwatch (Multifunction Mini Digital Stopwatch, Whenzou Time Co. Ltd., Zhejiang, China) was used to record the duration of 6-MRT and at 5-min intervals over a period of 20 min post 6-MRT. Presence of EIA was determined following a >15.0% fall in the PEFR post exercise using the formula described by (Awopeju et al., 2011; Onazi et al., 2012).

$$\text{Computation: } \frac{(\text{pre exercise value} - \text{lowest of post exercise value}) \times 100}{\text{Pre exercise value}}$$

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Table 1. Physical characteristics and distribution of parental socio-economic status of participants

Variable	No. (%)	Mean±SD		*t*-cal	*P*-value
		Male (n=185)	Female (n=200)		
Age (yr)		13.9±2.0	13.8±1.6	0.021	0.238
Height (m)		1.60±0.1	1.59±0.1	-0.284	0.180
Weight (kg)		40.3±8.4	39.4±3.6	0.064	0.093
Socio-economic status					
Low	162 (42.1)				
Middle	206 (53.5)				
High	17 (4.4)				

SD, standard deviation.

Table 2. Comparison of male and female participants' peak expiratory flow rates at baseline and post 6-min run test at 5-min intervals (n=385)

Variable	Male (n=185)	Female (n=200)	*t*-cal	*P*-value
Baseline PEFR (L/m)	289.4±90.3	249.6±90.8	1.391	0.165
5th min PEFR (L/m)	274.7±92.8	256.3±90.7	1.960	0.051
10th min PEFR (L/m)	291.3±93.5	272.1±86.4	2.090	0.037*
15th min PEFR (L/m)	290.7±100.5	270.1±84.3	2.162	0.031*
20th min PEFR (L/m)	301.6±86.1	275.2±85.3	2.978	0.003*

Values are presented as mean±standard deviation.
PEFR, peak expiratory flow rate.
*$P<0.05$.

Statistical analysis

Descriptive statistics of mean, standard deviation, frequency, and percentage was used to summarize anthropometric characteristics. Inferential statistics of independent *t*-test was used to determine the difference between male and female lung function parameter (PEFR). Chi-square test of association was used to determine association between lung function parameter (PEFR) and parental SES. Alpha level was set at $P<0.05$. The IBM SPSS Statistics ver. 19.0 (IBM Co., Armonk, NY, USA) was used to perform statistical analyses.

RESULTS

The study comprised of 200 female (51.9%) and 185 male participants (48.1%). The mean ages of male and female participants were 13.9±2.0 and 13.8±1.6 years, respectively. The distribution of PSES showed that more than half of the participants, 206 (53.5%) belonged to the middle SES group (Table 1). Table 2 shows comparison of male and female PEFR. Baseline PEFR values for male and female were 289.4±90.3 and 249.6±90.8 L/m, respectively. There were no significant differences between male and female PEFR at baseline ($t=1.391$, $P=0.165$) and at 5th min post 6-MRT ($t=1.960$, $P=0.051$). However, there were significant differences between male and female PEFR at 10th ($t=2.090$, $P=0.037$), 15th ($t=2.126$, $P=0.031$), and 20th min ($t=2.978$; $P=0.003$) post 6-MRT respectively. Table 3 showed the prevalence of EIA of the participants. The result showed that more than half of the participants, 224 (58.2%) were found to have EIA with >15.0% PEFR fall post 6-MRT. Chi-quare test of association showed that there was significant association between EIA and PSES ($\chi^2=152.4$, $P=0.001$) (Table 4).

Table 3. Prevalence of exercise-induced asthma among participants (n=385)

Variable	No. (%)
Induced (>15%)	224 (58.2)
Noninduced (<15%)	161 (41.8)
Total	385 (100)

DISCUSSION

The purpose of this study was to assess the prevalence of EIA and its association with PSES among school-aged adolescents in Nigeria. Findings from our study showed that the prevalence of EIA is very high among school-aged adolescents in Nigeria. This finding is similar to the findings of previous studies in which prevalence of EIA is high among school-aged adolescents (Addo

Table 4. Association between exercise-induced asthma, noninduced and parental socio-economic status

Socio-economic status	Peak expiratory flow rate score		χ^2	*P*-value
	Induced (PEFR > 15.0%)	Noninduced (PEFR ≤ 15.0%)		
Low	94 (42.0)	68 (42.0)	152.4	0.001*
Middle	120 (53.0)	86 (53.0)		
High	10 (5.0)	7 (5.0)		

Values are presented as number (%).
PEFR, peak expiratory flow rate.
*$P<0.05$.

Yobo et al., 1997; Ng'ang'a et al., 1998). Kenya studies reported prevalence rates of 21.0% and 23.0% among school-aged adolescents in a pilot and main studies respectively while South Africa reported a prevalence rate of 23.0% among school-aged adolescents (Ng'ang'a et al., 1998). The plausible explanation for the high prevalence of EIA may be attributed to poor neighbourhood environment where the studies were conducted. Majority of roads of African cities are dusty and full of different allergies that may trigger asthmatic symptoms. It is also possible that the use of biomass materials for cooking food at homes which is still a regular practice in Africa could play a significant role thus precipitating the development of COPD including asthma. Furthermore, presence of poor air quality as a result of exhaust fumes due to an increased number of automobiles in major towns and cities may be part of contributing factors for high prevalence of undetected and undiagnosed respiratory conditions including EIA. However, contrary to the findings of this study, studies from other parts of Africa reported low prevalence of EIA. For instance, studies from Morocco and Zimbabwe reported prevalence rates of 9.5% and 5.8%, respectively (Keeley et al., 1991; Terblanche and Stewart, 1990). In another study from South Africa, prevalence rates of 5.8% and 4.1% were reported among white children living in urban centres and coloured school-aged adolescents in rural South Africa respectively (Mtshali and Mokwena, 2009). The reason for the disparity in African regions may be attributed to the differences in weather condition, home setting including overcrowding, low birth weight and environmental factors.

The prevalence of EIA in this study is higher than a previous study in northern Nigeria and other African countries including Ghana, South Africa and Zimbabwe (Addo Yobo et al., 1997; Keeley et al., 1991; Mtshali and Mokwena, 2009; Onazi et al., 2012). The reasons for the differences may be due to diverse lifestyles including parental smoking habit, poor dietary habit, physical inactivity, obesity, outdoor pollutants and family history of asthmatic symptoms and allergy (Asani et al., 2005; Moshammer et al., 2006). Furthermore, the methodological approaches used in the assessment of EIA may also contribute to these disparities across Africa. Different authors used varieties of cutoff points to determine the PEFR fall. For instance, Ng'ang'a et al. (1998) in Kenya used > 10.0%, Addo Yobo et al. (1997) from Ghana used > 12.5% and > 15.0% while Shimwela et al. (2014) used ≥ 20.0% among school-aged adolescents in Tanzania. We used > 15.0% PEFR which is considered to be the standard criteria (Awopeju et al., 2011; Onazi et al., 2012). The duration of intervals of recording PEFR value in response to exercise test was also different. The usual duration after exercise for measuring the PEFR was from 5th to 20th min at 5-min intervals and the number of trials done to complete single measurement. Others include difference in population selections in terms of age and sex distributions.

Findings from our study show that school-aged adolescents belonged to different parental socio-economic strata. More than half of the participants' parents were found to in the middle socioeconomic class. Interestingly, findings from our study showed that there was a significant association between EIA and PSES. This is in agreement with the findings of previous studies that reported significant association between EIA and SES across different groups (Poyser et al., 2002; Sporik et al., 1999). On the contrary, reports from developed nations including Great Britain, Italy, Sweden, Sydney, and USA showed that there was no significant association between EIA and SES (Peat et al., 1980; Persky et al., 1998; Strachan et al., 1994). However, some of these studies focused on the association between other respiratory allergies and SES. It is possible that SES plays little or no role in the prevalence of EIA in some of these developed nations. Firstly, presence of medical facilities in terms of early diagnosis of EIA may reduce its prevalence and secondly, provision of good nutritional care from childhood may also serve as protective mechanism against EIA. Furthermore, the SES of developed nations is not likely to be comparable with that of developing nations including Africa due to high per capita income which is an important determinant of health (Lobmayer and Wilkinson, 2000; Lynch et al., 1997). Although SES is a complex construct which may be difficult to mea-

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sure in different societies or regions, our study employed standard and known SES indicators such as monthly income, educational level and occupation of the parents or guardian including valuable possessions in the assessment of SES.

Reports of some studies from Britain, Singapore, Hong Kong, and South China showed that prevalence of EIA was high among adolescents of middle or high socio-economic class (Peat et al., 1980; Persky et al., 1998; Poyser et al., 2002). Previously, Mielck et al. (1996) in a population-based study reported that asthma prevalence rates are higher among individuals of high SES based on hygiene hypothesis. It is believed that living in areas with high standards of sanitation with clean houses and environment, frequent access to antibiotics, vaccination and reduced exposure to viral, bacteria and helminthic infections may increase the risk of allergic diseases including asthma (Lynch et al., 1997; Weinberg, 2000). On the other hand, Kalliomaki and Isolauri (2002) suggested that high burdens of viruses and intracellular bacteria as it applied to children with low SES, which frequently cause childhood infections in developing countries may deviate the early childhood Th2-type cytokines (Th2-biased), atopy-prone immune system to a Th1-type cytokines immune system which may protect against the development of allergies. Though presence of infection which may induce strong Th2-type responses with production of interleukin (IL); IL-4, IL-5, and IL-13 and consequently increase the IgE synthesis, helps to provide protection against allergy among active individual (Bloomfield et al., 2012; Mao et al., 2000).

It is now evident that early detection of EIA may be treated to prevent full-blown asthma through prescribed medications and self-managed care such as personal hygienic practices and regular physical activity participation (Chandratilleke et al., 2012). The risk of EIA attacks tends to be low among individuals who are aware of the problem, remain physically active and prepared for the physical exertion (Williams et al., 2008). Physical exercise has been reported to enhance endurance capacity, increase airway clearance and effective lung tissue elastic recoil, and improve immunity against allergies (Stickland et al., 2012; Walsh et al., 2011). Furthermore, aerobic exercise has been reported to reduce airway remodelling, with reduced airway smooth muscle hypertrophy and hyperplasia, a reduction in leukocyte infiltration, pro-inflammatory cytokine production, adhesion molecules expression, and enhanced regulatory T-cell responses (Pastva et al., 2004; Vieira et al., 2011). However, there is general consensus among exercise experts on the type and intensity of exercise that may be beneficial for individuals with asthmatic condition. Most experts favor regular moderate intensity aerobic exercise programmes as vigorous high intensity may trigger EIA (Ries et al., 2007; Vieira et al., 2011). Findings from our study should be interpreted with caution due to some inherent limitations. The study design is a cross-sectional one and may limit its generalizability to other adolescents in different settings. Furthermore, previous history of respiratory conditions in the study population could not be confirmed through medical examination, hence, it may affect the outcome of this study. In conclusion, prevalence of EIA is very high among school-aged adolescents in Nigeria and is significantly associated with PSES. Efforts should be made to increase public awareness about EIA and develop a strategy to reduce future risk of asthmatic and allergic conditions.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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