WEST AFRICAN JOURNAL OF MEDICINE

ORIGINAL ARTICLE

Exercise-Induced Bronchospasm among School Children in Gusau, Nigeria

Prevalence du Bronchospasme Induit Par L'exercice Physique Parmi Les Enfants a L'ecole a Gusau, Nigeria

S. O. Onazi*, A. A. Orogade†, A. M. Yakubu†

ABSTRACT

BACKGROUND: **Childhood asthma was said to be rare in Northern Nigeria three decades ago. However, since then, there has been rapid industrial development with increase in especially textile and quarry factories. Hyperresponsiveness of the bronchi of asthmatic children to various challenge tests differentiate them from non-asthmatic children. One of these, the Exercise-Induced Bronchospasm (EIB) which is a reduction in post exercise Peak Expiratory Flow Rate (PEFR), is widely used to define childhood asthma in epidemiological studies. To determine the current prevalence of asthma in childhood in a Northwestern Nigerian town, pupils aged 5–14years were enrolled in the study.**

METHODS: **A modified ISAAC questionnaire was administered and the subjects trained to use the peak flow meter. Pre exercise PEFR was obtained thereafter they were subjected to a six minute free running exercise challenge test and the best of three post exercise PEFR taken at intervals was obtained. EIB was taken as 15% reduction or more in post-exercise compared to pre-exercise PEFR.**

RESULTS: **The prevalence of EIB was 6.0% (64/1067 subjects) while 12.7% (136/1067) had a history of wheeze. History of wheeze was found to be a sensitive (96.3%) but nonspecific (22.2%) indicator of childhood asthma. The highest prevalence of EIB was among children aged 10–14 years with male: female ratio 1.9:1. The location of the residence of the pupils did not significantly affect the prevalence of EIB.**

CONCLUSION: **The prevalence of childhood asthma in this region is on the increase compared to earlier studies and there should be a high index of suspicion in children with suggestive symptoms who should then undergo further screening tests. WAJM 2012; 31(2): 76–80.**

Keywords: **Exercise, Induced Bronchospasm, Children, Nigeria.**

RÉSUMÉ

CONTEXTE: L'asthme était censé être rare dans le nord du Nigeria, il y a trois décennies. Cependant, depuis, il a été rapid développement industriel avec augmentation surtout des usines de textile et de carrière. Hyperréactivité des bronches des enfants asthmatiques à divers tests de provocation le différencier des enfants non asthmatiques. L'une d'elles, l'exercice - Induced bronchospasme (BEI) qui est une réduction dans l'exercice de poste DEP, est largement utilisée pour définir l'asthme dans des études épidémiologiques. Afin de déterminer la prévalence actuelle de l'asthme dans l'enfance dans une ville du Nord-Ouest de nigériane, élèves de 5 ans-14years étaient inscrits à l'étude.

MÉTHODES: Un questionnaire de ISAAC modifié a été administré et les sujets formés pour utiliser le débitmètre de pointe. Exercice pré que DEP a été obtenue par la suite ils ont été soumis à une minute six libre circulation défi d'exercice test et le meilleur des trois post exerce DEP prise à intervalles a été obtenue. BEI est pris comme la réduction de 15 % ou plus en post-exercice par rapport au yogourt DEP.

RÉSULTATS: La prévalence de la BEI a été 6,0 % (64/1067 sujets) tandis que 12,7 % (136/1067) avait une histoire de respiration sifflante. Histoire de respiration sifflante s'est avéré pour être une sensible (96,3 %) mais l'indicateur non spécifique (22,2 %) de l'asthme. La prévalence la plus élevée de la BEI a été chez les enfants âgés de 10 à 14 ans avec mâle : femelle ratio 1.9:1. L'emplacement de la résidence des élèves n'affecte pas significativement la prévalence de la BEI.

CONCLUSION: La prévalence de l'asthme dans cette région est à la hausse par rapport aux études antérieures, et qu'il devrait y avoir un indice élevé de suspicion chez les enfants présentant des symptômes évocateurs qui devrait subir des tests de dépistage advantage. **WAJM 2012; 31(2): 76–80.**

Mots clés: Exercice, Induced, Bronchospasme, Enfants, Nigeria.

***Federal Medical Centre, Gusau, Zamfara State. †Department of Paediatrics, Ahmadu Bello University Teaching Hospital Shika, Zaria, Nigeria.**

***Correspondence: Dr A.A Orogade,** Department of Paediatrics, Ahmadu Bello University Teaching Hospital Shika, Zaria, Nigeria. E-mail: orogade@yahoo.com

Abbreviations: EIB, Exercise-Induced Bronchospasm; **ISAAC,** International Study on Asthma and Allergy in Childhood; **PEFR,** Peak Expiratory Flow Rate

INTRODUCTION

Worldwide, the prevalence of childhood asthma varies from country to country, within regions and among geographical areas within a country.[1] A prevalence rate of 1.6–36.8% has been reported in different populations worldwide and is about 8–10 times more in developed countries than in the developing countries.[2, 3] The reasons for these variations include genetic factors, lifestyle, environmental factors as well as methodology used by various authors in defining clinical asthma in childhood. The exact prevalence of asthma in childhood in Nigeria is unknown. However, it is generally accepted that in a given community, about 5–10% of children have asthma.[4] Oviawe[5] in a rural community in Edo State, southern Nigeria found a low prevalence of 0.69%. In Zaria, Northern Nigeria, about 3 decades ago, asthma was described as being rare in childhood while only a decade ago, Abubakar found a prevalence of 4.1% in the same place.[6,7]

Gusau, another town in Northern Nigeria, located further Northwest lies close to Niger Republic border. It is a rapidly developing state capital with 15 industries involved in cotton processing and 3 quarry factories located in its metropolis. Being a state capital, it will continue to witness economic growth and development of industries with further increase in air pollutants as a result of by products from these industries The present study was therefore designed to find out the prevalence of EIB among school children as well as to describe the age, sex, variation and effect of residential location if any.

SUBJECTS, MATERIALS AND METHODS

Between March and July 2008, a multistage randomized cross sectional study was carried out in Gusau among pupils aged 5–14 years selected from 18 primary schools in the metropolis. A sample size of 1,067 subjects was determined using Cochran's sample size formula for categorical data,[7] with an estimated prevalence of 50% (no previous study in Gusau), precision of 3% and 95% confidence interval set at 1.96. Pupils with significant musculo-skeletal abnormality and cardio-pulmonary disease were excluded from the study. Ethical clearance for the study was sought and obtained from the IRB, Ahmadu Bello University Teaching Hospital, while relevant permission was obtained from the Executive secretary of Local Education Authority and Heads of participating schools and written consent was also obtained from parents/ guardians of the children studied. Ten nurses from Federal Medical Centre Gusau were trained as research assistants by one of the investigators in the use of mini peak flow meter (Micro Medical, Kent, U.K) to measure PEFR (blowing through the meter from the peak of deep inspiration with maximum effort and without air leaking from around the mouth piece). A modified ISAAC phase III questionnaire was administered to the pupils which was used to obtain demographic data and asses the individual's risk for asthma. Physical examination was carried out on each of the subjects noting their standing height and weight without shoes, evidence for allergic disorders, pulse rate, respiratory rate and the best of 3 pre exercise PEFR was obtained for each of them. The subjects were then trained on the use of peak flow meter.

A six minutes free range running exercise challenge test was conducted in their school playground. The children were grouped in tens at a time with each child assigned to a research assistant. They were then instructed to run continuously as hard as possible around the play ground field for six minutes to achieve increase in pulse rate of at least 85% maximum for age.[8] With the aid of a stop clock and whistle each assistant timed the free range running exercise and at the end of the exercise, the post exercise PEFR readings were taken at 1, 5, 10 and 20 minutes interval. A 15% reduction or more in the lowest post-exercise PEFR from the pre-exercise PEFR was taken as indicative of asthma.[7] At the end of the exercise, each subject was also observed for another 30 minutes for evidence of wheeze and other signs of respiratory distress by the investigator. Metered dose inhaler salbutamol was made available to reverse signs as the need arose. Parents/guardians of the children with significant EIB were counseled and given referral letters to Federal Medical Centre Gusau for further investigations and treatment.

Statistical Analysis

All data obtained were entered into Epi info version 3.4.1(2007) and results were presented in figures, tables and graphs as appropriate. Chi-Square was used to analyze categorical variables and student t test for continuous variables. A P-value less than 0.05 was considered statistically significant.

RESULTS

A total of 1,067 subjects participated in the study. Table 1 shows the demographic distribution of the subjects with respect to age, sex, residential location and ethnic group. The age range was 5–14 years with mean of 10±2.20 years. More than one third of the children lived near industrial areas and they were mostly of Hausa/Fulani descent.

Previous History of Wheeze

One hundred and thirty-six subjects 136/1,067 (12.7%) admitted having ever wheezed and this was significantly related to history of precipitating exercise (majorly running, football and cycling), family history of asthma and atopic disorders (Table 2). Of these subjects who had past history of wheeze, 48/136 (35.3%) had night symptoms that disturb their sleep, 53/136 (38.9%) were on asthma drugs and 45 (33.0% visited hospital regularly for their asthma symptoms. None of the subjects admitted to cigarette smoking by themselves.1.3% admitted smoking by family members.

Peak Expiratory Flow Rate

Pre-exercise pulse rates ranged from 96–124/min with mean of 110±10/min. The pre-exercise PEFR differed statistically among the sexes: males 100–640L/min (mean 252.66 ± 78.55L/min) and females 80–520L/min (mean 233.66 ± 60L/min) p=0.000. The pre-exercise mean PEFR has a linear relationship with the age and height of the subjects in both sexes. The highest number of subjects with significant change in percentage PEFR post-exercise ($\geq$ 15%) occurred at 10 minutes while by 20 minutes post-exercise, most of the subjects with

Table 1: Demographic Variables of Subjects

Variables	No. of Pupils	%
Age (years)		
5 – 9	436	40.9
10 – 14	631	59.1
Total	**1,067**	**100.0**
Sex		
Male	562	52.7
Female	505	47.3
Total	**1,067**	**100.0**
Residence		
Industrial	393	36.8
Non – Industrial	674	63.2
Total	**1,067**	**100.0**
Ethnic Group		
Hausa	598	56.0
Fulani	320	30.0
Ibo	64	6.0
Yoruba	53	5.0
Others	32	3.0
Total	**1,067**	**100 .0**

Table 2: Significant History in Pupils with past History of Wheeze

Variables	Past History of Wheeze Yes (%)	No (%)	Total (%)	χ^2	P-Value
Exercise Precipitating					
Yes	54 (96.4)	2 (3.6)	56 (100.0)		
No	82 (8.1)	929 (91.9)	1011 (100.0)	372.144	0.00
Total	**136 (12.7)**	**931 (87.3)**	**1,067 (100.0)**		
Family History of Asthma					
Yes	33 (62.3)	20 (37.7)	53 (100.0)		
No	103 (10.2)	911 (89.8)	1014 (100.0)	381.780	0.00
Total	**136 (12.7)**	**931 (87.3)**	**1,067 (100.0)**		
History of Atopic Disorders					
Yes	16 (76.2)	5 (23.8)	21 (100.0)		
No	120 (11.5)	926 (88.5)	1046 (100.0)	146.643	0.00
Total	**136 (12.7)**	**931 (87.3)**	**1067 (100.0)**		

significant changes in PEFR had returned to their 1-minute post-exercise PEFR change.

Exercise Induced Bronchospasm

Sixty-four of the total 1,067 subjects studied were found to be positive for the exercise challenge test, a prevalence rate of about 6.00% of EIB among school children in Gusau. The incidence of EIB was significantly higher in males with male: female of 1.9:1, while neither age nor location of residence was significantly related to EIB. (Table 3). Twenty two percent (30/136) of the subjects that had history of wheeze had EIB. A history of past wheeze is sensitive 897/931(96.3%) but not specific 30/136 (22.0%) as an indicator of childhood bronchial asthma.(Table 4). Indoor cooking and family history of asthma were significantly related to EIB. 40/64 (63%) of the subjects had other atopic disorders, the commonest of which were vernal conjunctivitis and atopic eczema. Fifty out of the 64 subjects who had EIB were symptomatic post exercise in addition to having a 15% reduction PEFR had symptoms of cough (50%), breathlessness (15%) and wheezing (5%) distribution of the symptoms. Only the pupils who had wheeze (bronchospasm) warranted the use of Salbutamol metered dose inhaler. None of the subjects sustained bodily injuries during the exercise.

DISCUSSION

Previous History of Wheeze and EIB

The prevalence of EIB in this study was found to be 6.0% among primary school children in Gusau, northwestern Nigeria. This is higher than in the earlier reports of 4.1% by Abubakar[7] in Zaria, Northwestern Nigeria more than a decade ago and the 3.1% by Yobo *et al*[9] in Ghana. The increased prevalence of EIB observed in this study might be due to increasing level of environmental pollution since Gusau has large concentration of cotton processing factories and quarry factories. Fine particulate matter has been especially linked to increase in respiratory symptoms and is known to precipitate and aggravate bronchial asthma.[10]

However, the 6.0% prevalence of EIB found in this study was lower than the 13.2% reported in urban area of India by Sudhir and Prasad[11] Though a region with comparative environmental pollution as Gusau, this variation could be due to the difference in diagnostic criterion used. In their study, EIB was defined as a change between the pre-exercise PEFR and post-exercise PEFR greater than 10% as compared to a change of 15% or more used in the current study. Several studies have used fall in PEFR ranging from 10% to 20%.[12–16] These are usually developed from standardized exercise tests that define response in normal populations and from which abnormal responses can be identified. In this study 15% was used as had been by previous authors from Northern Nigeria and to give comparable results. Despite such a high pre to post PEFR it is noteworthy that history of wheeze was not a specific indicator.

A cardinal feature in the International Study on Asthma and Allergy in Childhood (ISAAC) study that currently

Table 3: EIB and Demographic Variables

Variables	Exercise Induced Bronchospasm(EIB) Test		Total (%)	χ^2	P-Value
	Positive (%)	Negative %)			
Age (yrs)					
5 – 9	23 (5.3)	413 (94.7)	436 (100.0)		
10 – 14	41 (6.5)	590 (93.5)	631 (100.0)	0.683	0.41 NS
Total	**64 (6.0)**	**1003 (94.0)**	**1,067 (100.0)**		
Sex					
Male	42 (7.5)	520 (92.5)	562 (100.0)		
Female	22 (4.4)	483 (95.6)	505 (100.0)	4.583	0.03 S
Total	**64 (6.0)**	**1003 (94.0)**	**1,067 (100.0)**		
Residential Area					
Industrial	28 (7.1)	364 (92.6)	392 (100.0)		
Non-Industrial	36 (5.3)	639 (94.7)	675 (100.0)	1.426	0.23 NS
Total	**64 (6.0)**	**1003 (94.0)**	**1067 (100.0)**		

Table 4: Significant History in Pupils with EIB

Variables	Exercise Induced Bronchospasm(EIB) Test		Total (%)	χ^2	P-Value
	Positive (%)	Negative %)			
History of Wheeze					
Yes	**30(22.0)**	106 (78.0)	136(100.0)		
No	34 (3.7)	**897 (96.3)**	931(100.0)	71.307	0.00
Total	**64 (6.0)**	**1003 (94.0)**	**1,067(100.0)**		
Indoor Cooking					
Yes	8 (20.0)	32 (80.0)	40 (100.0)		
No	56 (5.5)	971 (94.5)	1027 (100.0)	14.450	0.00
Total	**64 (6.0)**	**1003 (94.0)**	**1,067(100.0)**		
Family History of Asthma					
Yes	25 (47.2)	28 (52.8)	53 (100.0)		
No	39 (3.8)	975 (96.2)	1014 (100.0)	167.667	0.00
Total	**64 (6.0)**	**1003 (94.0)**	**1,067(100.0)**		

gives worldwide prevalence rates of asthma is anchored mainly on a past history of wheeze. This question has a drawback of not having local interpretation and so responses are subject to variability. Using this tool alone, the prevalence of asthma in this study would have been 12.7% which is twice the prevalence of 6.0% that was obtained from the 6 minutes free range running exercise challenge test. As shown in this study though a highly sensitive tool, it has a poor specificity. Using the questionnaire alone without EIB test can give rise to overdiagnosis of asthma in childhood.[8] The history of past wheeze should be used as a screening tool and then EIB performed.[15]

Relevance of EIB and Associated Factors

EIB describes the transient increase in airways resistance that follows vigorous exercise in 80% of patients with asthma and is also present in nonasthmatics especially athletes and subjects with allergies and sinusitis.[17] Exercise also causes hyperventilation, hyperinflation and arterial hypoxaemia which in turn increases the burden of the lower airways to warm inspired air. Osmotic and thermal changes therefore occur in pulmonary mucosa which stimulate mast cells degranulation with subsequent release of inflammatory mediators: histamine,leukotrienes, prostaglandins among others which in turn stimulate bronchial smooth muscle spasm.[17] Since EIB is found not only in asthma, it serves as screening and further lung function tests would be needed to confirm asthma.

The age specific prevalence of EIB was higher in the age group 10–14 years than among 5–9 years old children. Although this observed difference was not statistically significant, it is similar to that reported by Abubakar in Zaria.[7] The prevalence of EIB in this study was significantly higher in males than females with a male: female ratio of 1.9:1. This finding is also similar to reports by other authors from Zaria, Ghana and Kenya.[7,9,18] Boys in these studies consistently have more asthma prevalence than girls, but this tends to change at puberty and into adulthood as the trend is reversed. This is largely believed to be due to hormonal changes.[19]

Family history of asthma was present in 62% of those with past history of wheeze which is similar to the result obtained by Asani[20] *et al* in Kano. Children with EIB similarly had a significant family history. A strong family history is therefore an important factor for early screening in childhood asthma using both history of wheeze and EIB as tools. Of the 64 children who had EIB, 40 had various forms of atopic disorders with vernal conjunctivitis being the most common. This finding is in agreement with earlier works reported from Zaria[21] and Ibadan.[22] However, the finding in ISAAC study done by Falade *et al*[23] reported that eczema was the most common allergic disorder.

This study was unable to demonstrate a significant difference in asthma prevalence between children living in industrial and non-industrial areas of Gusau town. This finding was similar to that reported by Abubakar in Zaria.[7] The reason for inability of the study to show a difference between the two areas cannot be easily determined and will require further environment air pollution indices and measurements out of the scope of this study. Previous studies that have shown significant differences were usually conducted between urban and rural areas that were located far from each other.[11, 12, 24]

Safety of EIB Test

Only 3 of the subjects had post exercise symptoms severe enough to require the use of salbutamol inhaler. This finding was similar to what was reported by Abubakar in Zaria[7] and Oviawe *et al*[25] in Benin except that the Benin studies none of the subjects needed the use of bronchodilator. It can therefore be stated that the 6 minutes free range running exercise is a safe and useful tool for epidemiological study of asthma in childhood.

Conclusion

This study has shown that the prevalence of EIB is on the increase in Northwestern Nigeria and that prevalence of asthma is higher in male school children. Since 6 minutes free range running exercise is safe in childhood, any child alluding to past history of wheeze should be further subjected to an exercise challenge test in order to avoid labeling the child wrongly as asthmatic. A rising prevalence of EIB is also an indicator that environmental pollution needs to be measured and monitored.

ACKNOWLEDGEMENTS

We wish to thank the parents and pupils that participated in the study. We also acknowledge the following: Prof. Njokanma, Dr Bode-Thomas, Dr T. S. Kene, Dr O.O. Ogunrinde, Alh. Bashir Gusau LGEA, and Pharmacist C. N. Chidi GSK Pharmaceuticals, Kaduna.

Duality of Interest

The authors declare no potential conflict of interest.

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