1.0 Abstract

1.1 Background

Exercise-Induced Bronchospasm (EIB) is a condition in which vigorous physical activity triggers acute airway narrowing in individuals with increased airway hyper-responsiveness. It is a common condition in children and young adults, probably because of a high level of physical activity and also common among Asthmatic patients were up to 90% of them have EIB. EIB is characterized by Shortness of breath, decreased exercise endurance, chest pain or tightness, cough, or wheezing during or immediately following sustained exercise.

However, this condition is preventable and treatable. Quiet often, it is a condition that goes unnoticed by patients, parents and guardians, physical education instructors and primary health care workers.

The main objective of the study was to determine the prevalence of EIB in school children aged 10 – 14 years in Lusaka Urban, Zambia. The minor objective was to determine the risk factors associated with EIB and to make recommendations to patients, parents/guardians, Physical Education instructors and Primary Health Care providers on how to manage this condition.

1.2 Data Collection Method

This was a school-based mini epidemiological survey that was conducted in Lusaka urban school children aged 10-14 years. A questionnaire was used to collect demographic information, medical history and risk factors associated with EIB. Spirometry using a Mini-Wright Peak flow meter was done pre-exercise. This was followed by free running exercise for 6 minutes in the school play ground after which spirometry was repeated at 5 and 10 minutes. A reduction of 15% or more in Peak Expiratory Flow Rate (PEFR) at either 5 or 10 minutes post exercise was taken to be positive for EIB.

1.3 Results

Data was analyzed using STATA 9.2 software (stata Corp, College station, Texas, USA). Simple proportions were used to calculate prevalence rates of EIB in the study population. Chi^2 test and odds ratio were used to compare different variables for significant associations with EIB. Simple and multivariable Logistic Regression was used to determine factors associated with EIB.

The prevalence of EIB among school children in Lusaka Urban was found to be 12%. The risk factors that were found to be significantly associated with EIB in this study were a family history of asthma and atopy. Gender, BMI, age, keeping pets at home and exposure to tobacco smoke at home were found not to be associated with EIB in this study.

Type of cooking energy used in the house could not be analyzed because most children have electricity in their home.

1.4 Conclusion

EIB is a common condition occurring in children aged 10 – 14 years in Lusaka Urban schools. The risk factors associated with EIB are mainly a family history of asthma and/or atopy. Therefore, this is a condition which patients, parents/guardian, physical education instructors and Primary Health Care providers need to be aware of. EIB is a condition that is preventable and treatable. Therefore, children with this condition should fully participate in sporting activities without any hindrance.

2.0 Introduction

Exercise-Induced Bronchospasm (EIB) is a condition in which vigorous physical activity triggers acute airway narrowing in individuals with increased airway responsiveness. It is also described as a significant decrease in Forced Expiratory Volume at one second (FEV_1) in relation to exercise. Typically, EIB begins a few minutes after vigorous physical activity and peaks at 5-10 minutes after exercise [1,2,3].

EIB is a common condition in children and young adults, probably because of a high level of physical activity[3]. It is a condition that is also common among asthmatic patients where about 90% of them are affected. It can be the only manifestation of Airway Hyper-Responsiveness (AHR) in asthmatic patients before any recurrent bronchospasms occur. Therefore, EIB can be measured before the onset of asthmatic symptoms, and this could reflect a state of latent bronchial asthma. It is known that when such patients are followed up for sufficient periods of time, they tend to develop recurring episodes of airway obstruction independent of exercise[1,2,,4,5,6,7,8].

EIB can limit physical activity in those who are affected, which may be compounded by lack of awareness of this condition[9]. However, this is a fully treatable and preventable condition that should not hinder any child from full participation in sporting activities at school.

The prevalence rate of EIB varies widely in different populations. EIB has been widely used in epidemiological surveys as an objective parameter to formulate a case definition of asthma.

3.0 Literature Review

Some authors have suggested a distinction between EIB and Exercise Induced Asthma (EIA). EIB is said to occur in a person who has no asthma while EIA occurs in a known asthmatic patient in relation to exercise. EIA is generally regarded as a measure of control or manifestation of chronic asthma rather than a distinct entity. Other authors have maintained that EIB and EIA are the same and the two terms have been used interchangeably [2,7,10].

Various studies done to determine the prevalence of EIB in children has found figures ranging from 2 – 22.9 % [3,4,5,7,11,12]. As an isolated manifestation of asthma, it is reported to be present in 6 – 19 % of the population [5].

The prevalence of EIB in children varies widely from place to place and within the same population. This is because of the various standards used to formulate a case definition of EIB. These differences include the questions asked of the study population (were questionnaires have been used to make a diagnosis), the type, duration and intensity of exercise, the diagnostic criteria used (i.e. the percentage fall in FEV1 or in PEFR) and the environmental conditions under which the exercise challenges are done have also differed [1].

EIB seems to be more prevalent in some winter or cold weather sports. Some studies have demonstrated rates as high as 35 to 50 % in competitive calibre figure skaters, ice hockey players and cross country skiers [2,3]. PJ Helms in his commentary on the paper by Seear et al raises concerns that some of the high levels of reporting in these athletes may not be due to asthma at all but rather due to the breathlessness associated with extreme exercise[13].

Larry A. Sonna et al found a prevalence rate of 7% among US army recruits [3] while Shally Awasthi et al in India found a prevalence of 2.3 – 6.2% in children aged between 6 – 14 years[14]. A study done in Ghana to compare prevalence of EIB in urban Vs rural school children found an overall prevalence of 3.1%[12]. A prevalence rate of 22.9% in urban vs. 13.2% in rural school children[15] was found in a similar Kenyan study [11].

In Libyan school children, a prevalence rate of 10% was found[15] while soccer player children aged 7 – 16 in Iran had a prevalence of 2.1% in children who did not have any history of asthma and allergy [5]. In RSA a prevalence rate of 3% in children aged 6-9 years was found [16]. A Zimbabwean study also found a similar trend of 5.8% [17].

In Zambia, statistics on the prevalence of EIB or asthma in children is lacking. A study by Allen SC and Powar J to study the clinical pattern of asthma in adults showed a strong association between asthma and rhinorrhoea and other atopic features. They also found a 3.2% association of asthma with food in the study population[18].

EIB Pathology occurs distal to the glottis in the lower airways [2]. It must be noted that it is a condition that will only be triggered by vigorous physical activity in individuals with increased airway responsiveness.

Typically, EIB begins a few minutes after vigorous physical activity. There is initially bronchodilation during exercise related to catecholamine release, and shortly thereafter symptoms of EIB follow within 5 min of 5–8 min of vigorous exercise. Symptoms reach a peak 5–10 min after exercise. These symptoms persist for 30 min if no bronchodilator medication is used. Spontaneous recovery occurs within 60 minutes [7,10].

The exercise challenge suitable for the diagnosis of EIB should be one that is vigorous and intense enough to enable an individual to reach at least 75 - 95% of their maximum heart rate within 5-8 minutes of exertion or achieve maximum oxygen uptake (peak oxygen uptake) [3,19].

There are two theories as to how the symptom complex is triggered. The first one is the airway humidity theory, which suggests that air movement through the airway results in relative drying of the airway. This in turn is believed to trigger a cascade of events that includes release of inflammatory mediators, which cause airway edema secondary to hyperaemia and increased perfusion in an attempt to combat the drying. This cascade of events results in bronchospasm[2,19].

The other theory is based on airway cooling and assumes that the air movement in the bronchial tree results in a decreased temperature of the bronchi, which may also trigger a

hyperaemic response in an effort to heat the airway. This causes release of inflammatory markers. Again this result is bronchospasm[19].

The inflammatory markers that have been associated with EIB are histamine and cysternyl leukotrienes. Many authors think that there may be a combination of the above two mechanisms in the aetiology of EIB.

Certain sports, their intensity and the environment where they are played predispose individuals with airway hyper-responsiveness to experience EIB. Sports that have an aerobic component and are played in cold and dry environments usually result in more symptom manifestation for athletes with this condition [2]. This is thought to be due to the role of consistent and repetitive air movements through the airways, which affects airway humidity and temperature [2]. Sports that have been cited as high risk for manifestation of EIB are track events, ice hockey, swimming, racquet sports, cross country running, cross country skiing, soccer and field hockey. Sports that are low risk for development of EIB are weight lifting, baseball and many others which are also vigorous but involve short bursts of intense activity rather than repetitive exercise [7,5].

The major factors that determine severity of EIB are thought to be the pulmonary ventilation reached and sustained during exercise. The water content and temperature of the inspired air is also said to play a role in the severity of EIB. However, EIB has been known to occur even in warmed up environments where the inspired air temperature is hotter than 37^0C and therefore in the absence of cooling [20].

Given the above observations of EIB occurring both in cold and hot inspired air conditions, it can be concluded that the most important factor in aetiology of EIB is the rate of water loss from the airways and the content of water in inspired air[20]. Airway hyper-responsiveness is the most important factor that determines the expression of EIB.

It is estimated that 12% of the pediatric population has EIB with about a third of them likely to develop asthma in adulthood. Twenty three percent of school children are thought to have EIB with slightly over a third never having been clinically diagnosed with asthma[7].

Medical history of asthma and /or atopy in the patient has been identified as one of the most important risk factors for having EIB. Up to 90% of asthmatic patients are known to have EIB. Asthmatic patients have hyper – responsive airways which predispose them to develop EIB and is associated with sputum eosinophilia. It is also known that allergen exposure increases the response to exercise. EIB alone without known asthma is less predictably associated with atopy[7,21].

Other factors that have been identified as risk factors for EIB include early life events. These include history of prematurity or low birth weight, history of severe pneumonia (viral induced) in infancy and early cessation of breast feeding [21].

Eating habits, particularly eating food with low or no nutritional value has been associated with increased risk of EIB. These foods have additives and preservatives which may be allergenic to predisposed children. On the other hand, eating vegetables and fruits has been noted to be protective for EIB [11,12,21].

Environmental risk factors include exposure to allergens and pollutants. These include tobacco smoke, traffic and industrial pollution, fumes from cooking fuels used in the home and proximity to pets. Children exposed to tobacco smoke from parental smoking are at increased risk for EIB. Pets that are kept indoors, especially in urban areas, pause more risk for EIB than pets that stay outdoors [21].

EIB is characterized by Shortness of breath, decreased exercise endurance, chest pain or tightness, cough, or wheezing during or immediately following sustained exercise – thus it has also been dubbed "locker Room cough" [1,2]. Cough is the symptom most commonly reported by athletes who are positive for the exercise challenge. However, athletes who are negative for the exercise challenge reported EIB symptoms as often as those who were positive for the exercise challenge. This therefore means that diagnosis of EIB based on reported symptoms only generates high rates of false positives[7]. Other symptoms in young children may include a stomach ache or a sore throat, fatigue, headache, muscle cramps, dizziness, nocturnal cough, inability to keep up with peers and sensation of heaviness in the legs. Pediatric athletes may fail to recognize or may under report symptoms because of poor perception or denial. Therefore EIB may present

without any recognizable symptoms but simply manifesting as a patient refusing to participate in exercise or competitive sports because of an unrecognized inability to breathe normally[1, 2 ,7,9.]

Diagnosis of EIB can be made in two ways. Firstly, a detailed history suggestive of shortness of breath, decreased exercise endurance, chest tightness, cough or wheezing during or immediately following sustained exercise may suggest the diagnosis. This has to be coupled with a normal FEV_1 at rest. The history should also inquire about other triggers of bronchospasm. Athletes who perform short bursts of exertion may perform well without becoming symptomatic. This therefore will require a detailed history from family, coaches and team mates[1,7]. Therein is the problem of subjectivity in using this method.

Secondly, a diagnosis of EIB can be made using Objective methods. Spirometry pre – and post an exercise challenge is one method. Exercise challenges that have been used include exercise on a treadmill or cycle, and free running challenges. These are specific but not sensitive. The newer hyperosmolar indirect challenge called Eucapneic hyperventilation (EVH) approved by the International Olympic Committee has a sensitivity of 96% and a specificity of 92% to confirm a positive response of EIB. This method has the advantage of being performed in the environment known to cause symptoms to the patient [2,7].

Eucapneic hyperventilation requires hyperventilation of a gas mixture of 5% CO2 and 21% O2 at 85% of maximum voluntary ventilation for 6 min and the evaluation of FEV1 at specified intervals after the test. EVH has been demonstrated to have greater specificity for EIB. As it is portable, inexpensive, and standardized between labs and has high specificity and sensitivity, it is highly desirable as a screening test as approved by the Olympic Committee. EVH may provide increased detection of EIB higher than previously reported. Other diagnosis need to be entertained in an athlete with exercise associated symptoms suggestive of EIB whose spirometry and broncho-provocation tests are negative [2,7].

The most objective measure of EIB is a pulmonary function test coupled with an appropriate exercise challenge [8]. Symptom history forms a basis for the definition of EIB, but objective evidence of variable airway obstruction is usually required or at least regarded as beneficial. For the clinician, objective evidence gives support to the diagnosis of asthma. For the epidemiologist, the tests of bronchial hyper-responsiveness may help in formulating the case definition of asthma[8]. These tests are less influenced by recognition or awareness of symptoms, and by linguistic or cultural differences, than the data based on symptom questionnaires alone [22]. Therefore EIB testing provides an objective tool for determining airway hyper-responsiveness, which is a cardinal feature of asthma[23]. Therefore, the objective and subjective criteria put together are a powerful and useful tool to make an early diagnosis of asthma in children[8].

Most patients with EIB will have a normal physical examination. Nevertheless, a focused physical examination should be done to exclude conditions which may mimick EIB [1]. The differential diagnosis of EIB encompasses cardiac or respiratory diseases that are associated with dyspnea on exertion, exercise-related laryngeal dysfunction (including vocal cord dysfunction and laryngeal prolapsed)[2], conditioning, gastroesophageal reflux disease (GERD) and exercise -induced hyperventilation and exercise-induced anaphylaxis with or without a food trigger. These conditions can largely be ruled out with a comprehensive history, physical examination, spirometry, bronchial hypersensitivity evaluation, and cardiopulmonary monitoring of exercise challenge performed by a boarded allergy specialist Katten et al established that Peak Expiratory Flow rate (PEFR) and FEV_1 were the most sensitive tests in detecting EIB. The Spirometry diagnostic criteria used in different studies varies from 10 – 20 % reduction in FEV_1 or 15 – 25% reduction in PEFR following exercise[5,8]. These percentages are related to the natural variability of the tests and represent significant airway obstruction.

Of the various exercises that have been used in the diagnosis of EIB, the free running exercise is the one most commonly used in epidemiological studies. This is because of its comparative low cost and also easy to perform. Its main limitations however are that it is not easily standardized, it depends on the ability of the participant to run for the duration and intensity required and it requires space to carry out.

EIB is however an under diagnosed condition because symptoms usually appear after exercise and the individuals performance may not be limited. This is especially true in exercises that are characterized by short bursts of exertion. Larry A. Sonna et al, in their study of prevalence of EIB among US concluded that EIB did not hinder their physical performance during basic training as the bronchospasm only occurred after the exercise. However, this may also cause under reporting of the problem as it may therefore go unnoticed. However, children may simply avoid exercise because of the symptoms they experience in relation to exercise [3,15].

EIB is a condition that is preventable and treatable. This is important because children with both EIB and asthma and those with EIB only can have a chance to perform optimally in physical activities. EIB is a serious condition which has resulted in fatalities on the sports field [2]. Becker et al recorded deaths associated with asthma during a sporting activity. Eighty one percent of these deaths occurred in young people less than 21 years while fifty seven percent were in people with poorly controlled asthma. Ten percent deaths occurred in those with no known asthma or atopy [7].

EIB on the playing field can be treated by immediately removing the patient from competition or play. Immediate administration of a rapid onset short – acting beta 2 agonist is the treatment of choice. The patient can return to play when the respirations become stable [1,2]. However, if the patients' response to medication is not adequate, immediate transportation to an emergency facility is necessary as the attack can be life threatening. Subcutaneous epinephrine can be administered in such life threatening Situations [2]. Addition of inhaled anti-inflammatory agents may become necessary if symptoms are not fast to resolve[1,2].

Therapy with beta 2 agonists (β2 receptor agents) 15 min before exercise results in a peak bronchodilator effect in 15–60 min and bronchoprotection from EIB for a minimum of 3 h in most individuals However, continuous use of β2 agonists has been demonstrated to lead to tachyphylaxis with loss of bronchoprotection, desensitization of the mast cell, and paradoxical bronchoconstriction exacerbating existing EIB and asthma. Long-acting beta agonists (LABA) such as formoterol or salmeterol are also effective. Formoterol can be

taken shortly, i.e., 5 min before exercise, whereas salmeterol has an onset that is delayed up to 90 min for complete protection from EIB. Additionally, Formoterol can protect against EIB for up to 12 hours. This has been cited as an advantage that can be exploited in children who may engage in unplanned physical activities and therefore need to take this drug only once a day [1,2,7].

Nonpharmacologic therapy encompasses warm-up for 10–15 min and warm-down for 10–15 min. Avoidance of allergen or irritant triggers, overtraining and immunotherapy for relevant allergic triggers where indicated are recommended. Athletes discover empirically that warm-ups are helpful in attenuating the EIB. This phenomenon is known as the refractory period and constitutes a two hour period after exercise during which the athlete with asthma is "refractory" to further asthma. It is only noted in athletes with asthma, but may not be observed in those with EIB alone. The refractory period is postulated to be secondary to catecholamine release including norepinephrine and epinephrine, which are bronchodilators, and simultaneous depletion of mast cell mediators including histamine and leukotrienes, which are bronchoconstrictors [1,2,7].

However, many patients have bronchospasm only during exercise[1,4,5]. This has been demonstrated to be a risk factor for the development of asthma. Therefore, EIB can be measured before the onset of asthmatic symptoms and this could reflect a state of latent asthma in the airways. It is known that when such patients are followed up for sufficient periods of time, they tend to develop recurring episodes of airway obstruction independent of exercise. The Odense study in Denmark followed up children with EIB in childhood into young adulthood, and found that such children are at increased risk of developing new symptoms related to wheezing in adulthood [24].

Asthma is the most common chronic medical condition affecting children [21,22]. It is also widely known that the prevalence of asthma in childhood has dramatically increased in recent years, particularly in industrialized countries. This increase in cases of childhood asthma continues to be debated and is of critical health concern because the onset of asthma in children is particularly debilitating [9,21,26,27].

Changes in prevalence can be confounded by factors such as differing levels of awareness of the disease by health care providers and family, changes in access to medical care and changes in medical diagnosis. The prevalence of Asthma within the same population can be known to significantly differ based on the definition used and the questions asked of the study population [21].

In some children, asthma symptoms decrease in adulthood. Fifty percent will continue to be affected throughout their life. The effects of asthma on children and adolescent social role function, including children's ability to play and participate in school activities and construct meaningful social and family relationships are important to consider in accounting for the overall burden of disease [9,21].

It has been reported that asthma is under diagnosed and under treated, especially in children[12,28.] There is an increasing demand for diagnosing asthma as early as possible. Recent studies suggest that the treatment of asthma should be initiated at an early phase of the disease before any lung function abnormality have developed. It has been suggested that the failure to treat airway inflammation may cause airway remodeling [10,23,28]. EIB is very common in asthmatic patients and has been recognized as a manifestation of poor control of symptoms [9].

4.0 Statement of the Problem

EIB is a common problem which is frequently unrecognized, especially in children. It is important because affected children may underperform in sports and other exertion activities. Physical activity is generally accepted to be of advantage to young children in terms of bone development, motor skills, improved cardiovascular fitness, and self esteem. With improved Physical activity in children and young people with asthma, some studies have identified significant improvements in aerobic fitness and asthma-related benefits such as reduced hospital admissions, reduced absenteeism from school, fewer consultations with health professionals, reduced medication use, and improved ability to cope with asthma. In addition, it remains clear that being able to participate in physical activity, particularly at school, is an important contributing factor for psychological well-being by, for example, reducing the body dissatisfaction that can be associated with asthma [9,31,32,33,34].

Because of this range of physical, psychological and social benefits, current evidence suggests that children and adolescents with asthma should be encouraged to participate in regular physical activity. This may improve asthma management, general health and minimize the generic risks associated with low levels of physical activity [35,36]. Although the existence of a respiratory condition might be expected to prevent engagement in such activities, the overwhelming majority of studies show that people with asthma *can* exercise safely if medicated appropriately and can significantly improve their cardiovascular fitness and quality of life by doing so [9,37]. Indeed, a substantial proportion of sportsmen and women who compete at the elite international level have a diagnosis of asthma or experience exercise-induced bronchospasm [38]. The consensus of many authors is therefore that inactivity or reduced activity in the presence of an asthma diagnosis should not be accepted [39]. Instead, an exercise 'prescription' should be part of the management plan for all people with asthma [9,31,32,37]. Without proper management, they may be excluded from taking part in competitive sports and in physical activities in schools. They may actually be stigmatized as lazy and this may affect the way they interact with their peers.

Because exercise triggers asthma symptoms, sufferers of EIB may avoid vigorous activity with damaging consequences to their physical and social well being. Parents may be reluctant to allow their youngsters with EIB to participate in sporting activities and teachers may fear to take responsibility for a child's asthma attacks [10].

Awareness of EIB among the general population, healthcare providers and teachers is low. This could be the reason why it is generally not reported. Consequently, children suffer in silence with a treatable condition.

EIB measurement is an objective method of confirming the presence of hyper-responsive airways in an individual, which is a cardinal feature of asthma. EIB has been widely used in epidemiological studies as a measure of the prevalence of Asthma. Information on the prevalence of asthma in children in Zambia is very scanty.

5.0 Study Justification

EIB is a condition that is not commonly recognized as a medical problem. This is unfortunate because it is treatable. This study was necessary to highlight this problem in children. Identification of affected children will facilitate for recommendations of interventions in schools and in healthcare centres. This in turn will give affected children a chance to fully participate in physical exercise and thus attain their full potential of physical fitness and intellectual ability like their peers without EIB.

The study will also help to sensitize health care providers on the recognition and treatment of this condition. Similarly physical education instructors, teachers, parents will also be sensitized.

This study adds knowledge to medical science in Zambia and the world at large. Most importantly, statistical data on the prevalence of EIB in Zambia will become available. EIB measurement is a simple and non invasive way of demonstrating the presence of airway hyper-responsiveness in an individual, with very minimal side effects. It however has the potential to positively change the life style of an individual who is affected.

EIB diagnosis allows for early identification of children at risk of developing asthma. This therefore facilitates intervention and follow up of the affected children. EIB may be a manifestation of poorly controlled Asthma. Therefore, children who are asthmatic and manifest EIB need stringent control of their asthma.

Determination of the prevalence of EIB in children in Zambia will help planning and policy budgeting at national level for the management of this problem.

6.0 Objectives

6.1 Main Objective

To determine the prevalence of Exercise-Induced Bronchospasm in school children aged 10 – 14 years in Lusaka urban, Zambia.

6.2 Specific objectives

6.2.1 To determine some of the risk factors associated with EIB in school children in Lusaka.

6.2.2 To make recommendations to school authorities on the management of EIB.

6.3 Hypothesis

Exercise induced bronchospasm is a common problem among school children aged 10 – 14 years in Lusaka urban.

7.0 Study Methodology

7.1 Study design

This is a school-based cross-sectional study that was conducted in Lusaka Urban schools. Lusaka is the capital city of Zambia and is located in the southern part of the central plateau of the country. It has a population of 1,084,705(Central Stastical office – 2000) and is considered one of the fastest growing (in terms of population) cities in Africa and the most urbanized city in Zambia.. It is a commercial centre as well as centre of government, and the four main highways of Zambia radiate north, south, east and west from it. It is divided into urban and rural areas depending on the availability of social and economic services. Lusaka urban has about 250 registered schools. These schools are further divided based on the constituency they are in. Due to the difficulty in sampling the schools in the whole of Lusaka urban, only schools in Lusaka central constituency were sampled. This constituency has a total of 31 registered schools. The pupils in these schools come from near and far within Lusaka urban and are representative of Lusaka urban pupils' population between the ages of 10 and 14 inclusive.

The Government of Zambia, through the Ministry of Education has a School Health and Nutrition (SHN) programme. The main aim of this programme is to address the health and nutritional challenges that impede learner's participation in the education sector. The strategic plan for the programme cites the fact that children who are unwell or malnourished cannot attend school on a regular basis and that even when they do, their participation is compromised. It is through this programme that health education concerning EIB and other related health problems will be channeled.

Because of financial, human resource and time constraints, this study was undertaken as an epidemiological mini-survey. Two research assistants were engaged in the data collection exercise. The assistants were appropriately trained in the relevant aspects of the study including administering the questionnaire, completing the data collection sheet, the exercise challenge, PEFR measurements, data entry and administering first aid on the playing field.

7.2 Study Sites

Lusaka central schools, Lusaka Zambia.

7.3 Inclusion and Exclusion criteria:

7.3.1 Inclusion Criteria

- Registered pupils at the selected schools
- Age between 10 – 14 years inclusive
- Residence in Lusaka urban
- Pupils who gave assent and had parental consent
- Pupils who were able to perform effective PERF (see details in section 8.2 of data collection phase 11.)
- Pupils who attained 80% of their maximum predicted pulse rate

7.3.2 Exclusion criteria

- Pupils with a history of cold, cough, runny nose or sore throat in the last four weeks
- Pupils with any medical or surgical condition that could limit their ability to participate in the exercise challenge were excluded. This included known patients with cancer, diabetes mellitus, tuberculosis, heart disease, recent surgery and any other condition that was deemed to put any participant at risk.
- Pupils with pre-exercise PEFR of 60% or below the expected for their age, sex and height.
- Pupils who did not attain 80% of the maximum expected pulse rate for their age during exercise.

7.4 Sample Size

The sample size was calculated using the formula:

$$n = \frac{1.92 * 2 * g\,(1-g)}{2d}$$

(Adopted from Elise Whitley and Jonathan Ball Statistics review 4: Sample size calculation critical care August 2002 Vol 6 no 4. http://ccforum.com/content/6/4/335)

Where:

n = theoretical sample size

g = estimated prevalence of EIB (23% being the worst case scenario from literature)

d = P-Value (0.05)

$$n = \frac{1.92 * 2 * 0.23\ (1-0.23)}{2*0.05} = 261$$

For the design effect, the actual sample size had to be inflated by 100%. Hence the actual sample size was 522.

Assuming a respondent rate of 85%, the final sample size for a full epidemiological (n_{final}) survey would be:

$$n_{final} = \frac{522}{0.85} = 614$$

Considering that this is a mini-survey, the sample size was reduced by 50% of n_{final} representing 307 . The sample size was therefore set at 300.

7.5 Sampling Technique

A multi-stage sampling was used to select schools from Lusaka central constituency. Probability proportion to size sampling technique was used to sample schools from Lusaka central. This sampling technique is designed for use in surveys or mini-surveys where there is a large population to be sampled from. The technique ensures that those in large sites have the same probability of getting into the study as those in smaller sites.

This method also facilitates planning for field work because a predetermined number of respondents are interviewed at each site. It is recommended that 20 – 30 sites are sampled in a full epidemiological survey corresponding to 10 – 15 sites for a mini-survey.

For this study, 10 schools were sampled out of which two schools did not have the target age groups inspite of being listed as such. For the target sample size of 400, 50 pupils were selected from each school. 10 pupils were selected in each age group between 10 and 14 years. The selected schools therefore defined the primary sampling site.

Systematic sampling was used to select pupils at each school from classes with the target age group. Every third pupil on the class register was selected, as long as they met the age criteria, until the required number was achieved. The selected classes defined the secondary sampling site.

8.0 Data Collection

8.1 Phase -I

The first phase was an acquaintance session where the principal investigator and the research assistants were introduced to the participants. The study protocol was outlined to the participants and any clarifications and questions were addressed.

The questionnaire was then administered to the participants one on one in the classroom. This was done by the principal investigator (Questionnaire in appendix 1). Demographic and anthropometric information were collected on the data collection sheet (Appendix 2). The expected PEFR for each child was determined and recorded. Standing weight (using a calibrated beurer bathroom weight scale) and height (using a calibrated Shorrboard stadiometer) were measured without shoes and recorded before the exercise challenge.

8.2 Phase - II

The second phase involved PEFR measurements and the exercise challenge as follows:

8.2.1 First PEFR Measurement

Study participants, in groups of five, were shown how the Mini-Wright peak flow meter works and how it is used. Each participant was given a chance to practice how to use the Mini-Wright peak flow meter until conversant with the instrument. Succeeding the practice, three consecutive readings with a difference of less or equal to 5% between each pair of readings were taken using the same flow meter throughout the exercise. This was to minimize technical sources of error. The best of the three readings was taken as the PEFR for each participant.

8.2.2 Exercise Challenge

An exercise challenge in the form of free running exercise in the school playground was administered by the research assistants. The exercise lasted 6 minutes. The pulse rate of the participants was monitored with a Polar Pulse monitor until they achieved at least 80% of their expected maximum heart rate.

Those not achieving the required heart rate were asked to run for another 2-4 minutes.

8.2.3 Second PEFR Measurement

After exercise, PEFR was done at 5 and 10 minute intervals. Again, the best of three readings was taken as the PEFR post exercise. From these values, the percentage reduction in PEFR was calculated and recorded.

9.0 Management of Data

Data was collected on 2 forms:

9.1 Data Collection Sheet

Personal information (age, sex, height and weight), expected PEFR, pre and post exercise PEFR and diagnosis of EIB) were recorded

9.2 Questionnaire

The questionnaire was adopted from the International study of asthma and Allergy in childhood (ISAAC)[1,2]. The questionnaire was administered to all the participants one on one by the principle investigator in a classroom setting. This was done before the exercise challenge was administered. The questions included the following categories;

i. Family history of Asthma and/or atopy.

The questions inquired directly if any of the child's siblings, parents or any household members had any medical history of asthma, wheezing, hay fever and eczema or recurrent rash.

ii. Cooking Energy, household Pets and Cigarette exposure

These were direct questions on the household situation regarding type of energy used for cooking, presence and type of pet at home and exposure to cigarette smoke.

After each session, the forms were checked for completeness and any corrections were done by the research assistants. The forms were double checked by the principal investigator before being filed.

9.3 BMI Calculation

The BMI was calculated using weight and height as follows:

$$BMI = \frac{Weight\ (kg)}{Height\ (cm)\ x\ 1000}$$

(Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion: **http://www.cdc.gov/growthcharts**)

Normal BMI was taken to be between the 5th and 95th percentile for age. Below 5th percentile was classified as underweight while above 95th percentile was classified as obese.

9.4 Calculation of predicted Maximum Heart Rate

The predicted maximum heart rate was calculated using the formula:

$$HR_{max} = 205.8 - 0.685\ x\ Age$$

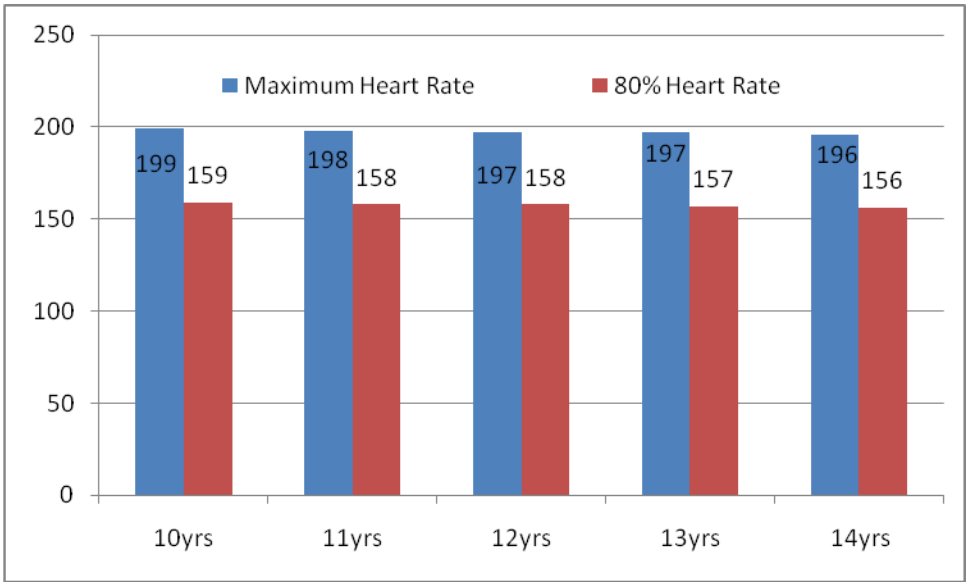
(JEP online Volume 5 Number 2 May 2002.)

Where:

HR = predicted maximum heart rate

205.8 and 0.685 = constants for estimated predicted error for estimating HR_{max}

A participant was deemed to have done vigorous exercise if they achieved at least 80% of their calculated predicted maximum heart rate for age. For the age groups participating, the maximum heart rates were as in graph *9.4.*.



Graph 9.4 Graph showing maximum heart rate for age

The participants' heart rates were monitored using Polar Pulse rate exercise monitor which has a chest strap for heart rate monitoring and wrist watch counter.

9.5 Calculation of Percentage Reduction in PEFR

The expected PEFR was calculated based on the participant's height (cm) and gender. Standardized charts by Godfrey et al (Chest 1970, 64 15) were used for determining the PEFR for each participant. From these charts, it was possible to check if any participant was able to reach at least 60% of their expected PEFR.

The difference between the pre and post exercise PEFR was then used to calculate the percentage reduction as follows:

$$Percentage\ Reduction\ in\ PEFR\ at\ 5\ minutes = \frac{PEFR_0 - PEFR_5}{PEFR_0} * 100$$

$$Percentage\ Reduction\ in\ PEFR\ at\ 10\ minutes = \frac{PEFR_0 - PEFR_{10}}{PEFR_0} * 100$$

Where

$PEFR_0$ = *Pre exercise PEFR*

$PEFR_5$ = *PEFR at 5 Min*

$PEFR_{10}$ = *PEFR at 10 min*

A reduction in either the 5 minutes or 10 minutes PEFR of 15% or more was taken to be positive for EIB.

10.0 Data Entry

A data base was created on Stata version 9.0. Data was entered initially by a research assistant and counter checked by another research assistant and the principal investigator before being analyzed.

11.0 Ethical Approval

- Permission for the study was approved by The Biomedical Research Ethics Committee (REC) of the University of Zambia.

- Permission to enroll school children was granted by The Ministry of Education and the various school authorities.

- All the procedures done on the participants were fully explained to them and to their parents. Participants gave informed assent and written informed consent was obtained from their parents. Enrolment was on a voluntary basis.

- No penalty was imposed on any participant who declined to participate in this study or those who withdrew from the study at any stage after giving informed consent.

- Strict confidentiality was maintained at all times during the study and the participants' rights were respected at all times.

- All research assistants were taught how to administer first aid treatment to any participant who needed it during the exercise challenge.

- Findings were made available to the participants and health education was given where appropriate. Participants who needed treatment on the playing field were attended appropriately. Recommendations on the management of EIB were given to the school authorities as outlined in appendix …..

12.0 Study Limitations

The main limitation for this study was the fact that it is a mini survey with a small sample size compared to a full epidemiological survey. This therefore means that the results may carry a larger deviation from the ideal.

13.0 Results

13.1 Study Population

With an initial sample size set at 300, the respondant rate was very poor. This necessitated the sample size to be increased to 400. 253 participants responded out of the 400 pupils recruited. 147 pupils did not bring the consent back to school and were thus eliminated. With the sample size for the study set at 300, 253 responses gave a response rate of 84%.

Of the 253 pupils who responded, 38 pupils did not give parental consent to participate in the study. Of the remaining 215, 12 were eliminated for the following reasons:

- Six were absent from school due to ill health (even after revisiting the school a week later),
- Four were excluded because they could not complete the exercise challenge due to severe breathlessness and
- Two could not complete the questionnaire and the exercise challenge because they were collected from school before they finished the two tasks.

So only 203 children fully participated in the study and their data were analysed. With an initial respondant rate estimated at 85% and a p value of 0.05, a respondant rate of 84% in this study means that the findings in this study could indeed be a true representation of EIB in the study population.

13.2 Demographics

13.2.1 Gender

The gender distribution of the 203 participants was as shown in pie chart 13.2.1:

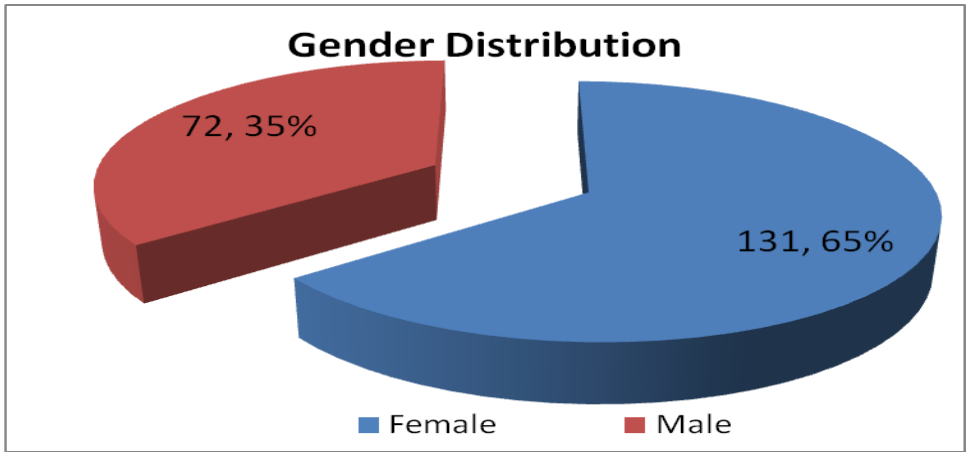


Chart 13.2.1

The schools that were randomised were a mixture of co-education and single sex schools. Of the 8 schools that were selected, one was a girl's only school. This may have contributed to the apparent slight preponderance of girls randomised as compared to boys.

13.2.2 Age

Chart 13.2.2 illustrates the Age distribution.

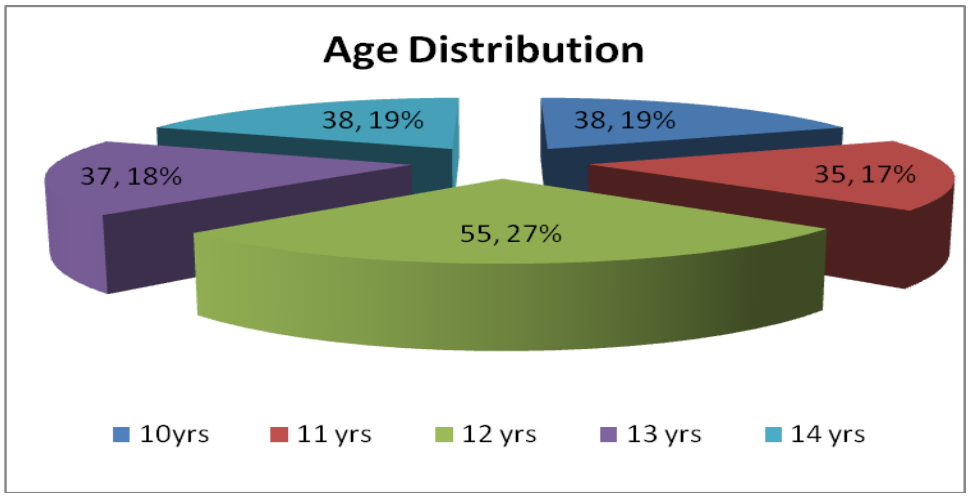
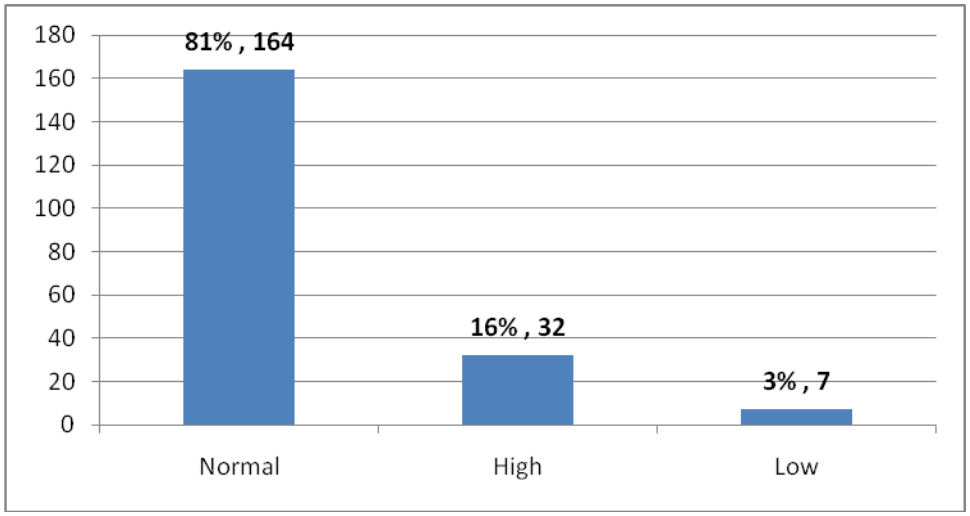


Chart 13.2.2

At each school, an equal number of children in each age category were chosen, i.e. 10 children in each age group. There were more respondents in the 12 years age group, accounting for 27% and the lowest was 11 years old accounting for 17%.

13.2.3 BMI distribution

Figure 13.2.3 shows the BMI distribution.



Graph 13.2.3 Graph for BMI distribution

13.2.4 Type of pet kept at home

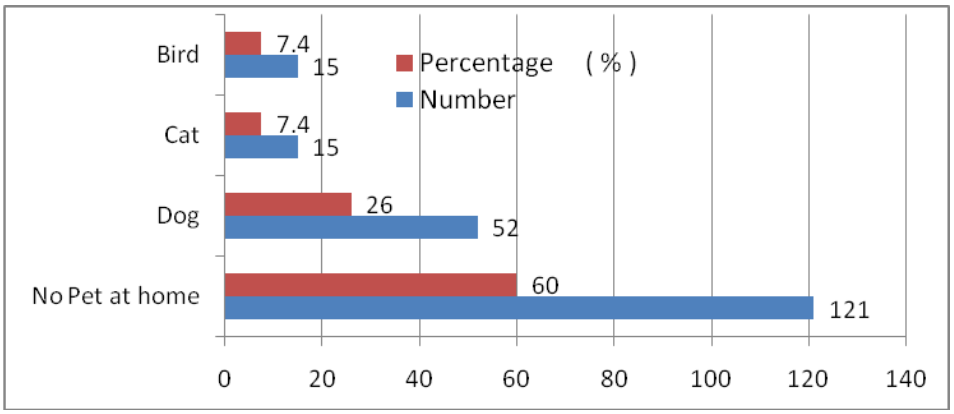


Chart 13.2.4 Distribution of types of pets at home

Nearly 60% of the children did not keep any pets at home. All the children who have pets at home reported that these pets are not kept inside the House.

13.2.5 Family History of Asthma and atopy

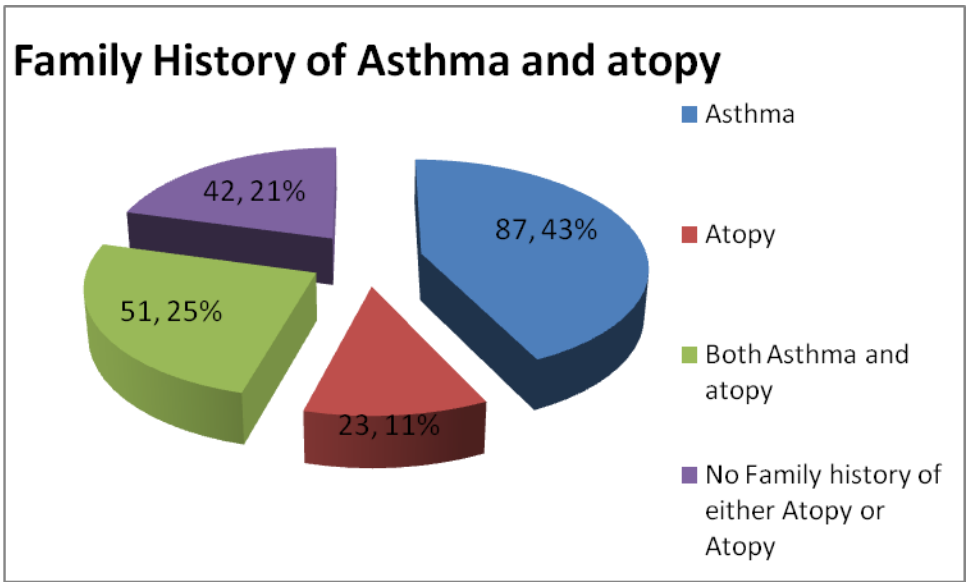


Chart 13.2.5 Distribution of family history of Asthma and atopy

Family history in this circumstance represents a parent, a sibling or a relative the child stays with at home. 79% of the participants reported a family history of asthma and / or atopy.

13.2.6 Cooking energy at home

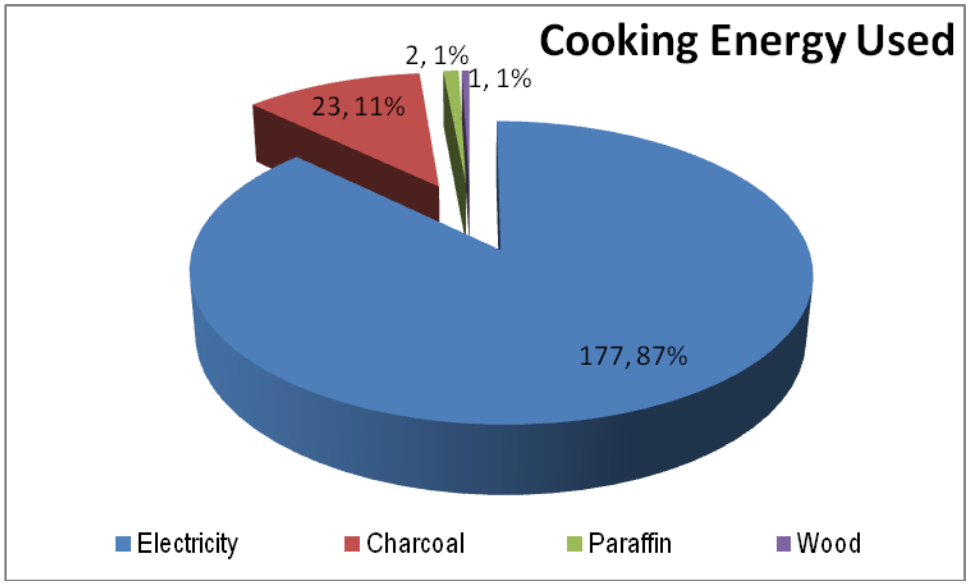


Chart *13.2.6 Types of cooking energy used at home*

The majority of the households in Lusaka urban use electricity as cooking fuel in the home. This is expected because Lusaka is an urban town where the majority of residents have access to electricity. The other types of cooking energy are used as a cost cutting measure and are mainly used outside the house.

13.2.7 Household Smoking.

Category	Number	Percentage
Household Smoking	21	10.34
No Smoking	182	89.66

Table 13.2.7

The majority of children are not exposed to tobacco smoke in their house hold.

14.0 Data Analysis

Data was analysed using STATA 9.2 software (stata Corp, College station, Texas, USA). Simple proportions were used to calculate prevalence rates of EIB in the study population. Chi^2 test and odds ratio were used to compare different variables for significant association with EIB. Simple and multivariable Logistic regression was used to determine factors associated with EIB.

The questions concerning wheezing, ear nose and throat, coughing and treatment were included on the questionnaire but were not analysed. This was because the majority of participants expressed uncertainty on answering these questions.

14.1 Prevalence of EIB

EIB	**Frequency**	**Percentage %**
Positive	25	12
Negative	178	88
Total	**203**	**100**

Table 14.1

The prevalence of EIB was found to be 12%. This is as shown in the table above.

14.2 Independent Variables

These were analysed using logistic regression to determine if there is any significant association with EIB. The variables analysed were gender, BMI, family history of asthma and /or atopy, cooking fuel used in the home, keeping a pet at home and exposure to parental Cigarette smoke.

14.2.1 Association of EIB and Age

Age (Years)	total number	EIB (+ve)	Percentage EIB +ve Per Age Group	Percentage of EIB +ve per Age grp to EIB Total (25)
10	38	7	28%	18%
11	35	3	12%	9%
12	55	9	36%	16%
13	37	2	8%	5%
14	38	4	16%	11%

Table 14.2.1

14.2.2 Association of EIB with Gender

Gender	Number with EIB	% with EIB	P-Value	Odds Ratio	95% CI
female	131	64.5	-	1.00	-
males	72	35.5	0.549	1.313	0.537 - 3.208

Table 14.2.2

Gender was not significantly associated with EIB in this study. This is as illustrated in the table above

14.2.3 Association of EIB with BMI

BMI	Number with EIB	% with EIB	Odds ratio	P value	95% CI
Normal	164	81	1.00	-	
High	32	16	0.8289	0.811	0.177 – 3.865

Table 14.2.3

BMI was found not to be significantly associated with EIB in this study.

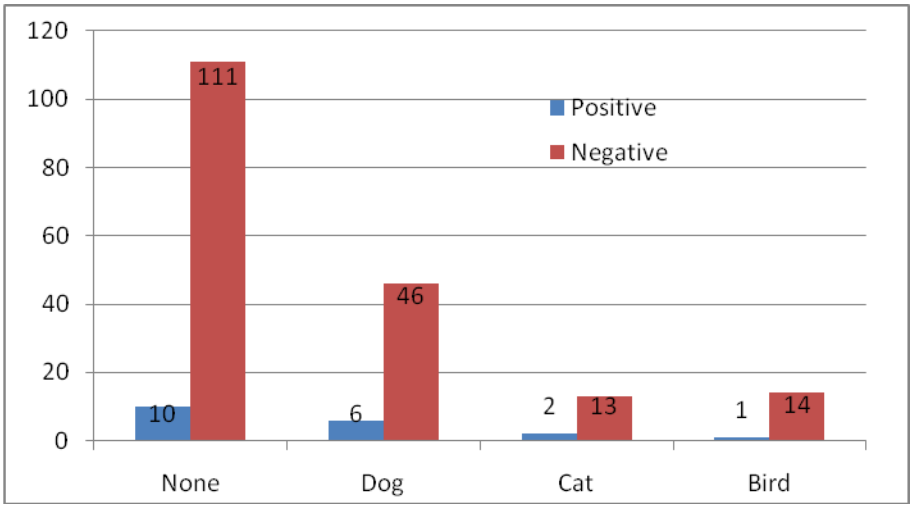
14.2.4 Association of EIB with Family history of Asthma and/or atopy

EIB	**Odds ratio**	**P value**	**95% CI**
Fhx Asthma	11.805	0.005	2.120 – 65.722
Fhx of Atopy	7.906	0.011	1.608 – 38.863
Fhx of asthma/Atopy	13.281	0.001	2.758 – 63.944

Table 14.2.4

Children with history of asthma and / or atopy, and those with family history of both asthma and/or atopy were significantly associated with EIB.

14.2.5 Association of EIB with Pets at Home



Graph 14.2.5

Type Of Pet	Odds Ratio	P Value	95% CI
None	1.00	-	-
Dog	1.188	0.727	0.449 – 3.141
Cat	0.587	0.622	0.713 – 4.843
Bird	1.910	0.359	0.479 – 7.612

Table 14.2.6

There was no significant association between EIB and keeping pets at home

14.2.6 Association of EIB with Cigarette smoke exposure in the household

Category	Odds Ratio	P Value	95% CI
Non smoking	1.00	-	-
Smoking	0.723	0.676	0.157 – 0.310

Table 14.2.7

There was no association between EIB and children who live with adults who smoke cigarettes in the house.

14.2.7 Association of EIB with Cooking energy used in the home

This statistical package could not analyse the association between EIB and type of energy used in the home. In this study, 87% of the participants use electricity compared with 13% who use other forms of energy.

14.3 Multivariable regression analysis

Using Multivariable regression analysis to determine which independent variables are more significantly associated with EIB, only family history of asthma and atopy was significantly associated with EIB. The table below illustrates the point above.

EIB	Odds ratio	P value	95% CI
Gender	0.938	0.9	0.399 - 2.550
BMI	0.674	0.634	0.133 - 3.405
Asthma Fhx	10.934	0.007	1.924 - 62.121
Atopy Fhx	7.682	0.013	1.534 - 38.454
Asthma/atopy Fhx	14.393	0.001	2.877 - 71.985
Pet – dog	1.446	0.506	0.487 - 4.287
Pet cat	0.485	0.514	0.055 - 4.264
Pet- bird	1.562	0.553	0.357 - 6.821
Smoking	0.697	0.675	0.129 - 3.760

Table 14.3

15. Discussion

The prevalence rate of EIB, which was defined as a decrease of ≥ 15 % in PEFR at either 5 minutes or 10 minutes post exercise, was found to be 12 % in this study.

This prevalence rate is similar to the findings in a study done in Kenya (Nganga 1992), involving urban children in the age group 9 – 12 years. A prevalence rate of 10.5% was found while using 15 % fall in FEV_1[39]. The same study found a higher prevalence rate of 21.3% when a fall of 10% in FEV_1 was used. The same author in another study in 1998 found a prevalence rate of 10.3% and 21.1% for 15% and 10% fall in FEV_1 respectively in children 8 – 12 years [39]. However a study done by Addo Yobo 1997 in Ghana found lower prevalence rates of 4.7% and 2.2% in rich and poor urban children respectively[12]. This was using a fall of 12.5% in PEFR in children aged 9 – 16 years. Similarly, Van Niekerk (1979) in South Africa found a prevalence rate of 3.17% in urban children aged 6 – 9 years using a 15% fall in PEFR or FEV_1[16]. Terblanche (1990) in South Africa found 5.87% in urban population aged 6 – 20 years[36]. A Zimbabwean study by Keeley in 1991 had similar findings of 5.8% in an urban population of 7 – 9 year olds[17]. Other studies done to determine the prevalence of EIB in children has found figures ranging from 2 – 22.9 % [2,21,22,23,27,28]

Factors that have been found to be associated with EIB in this study are family history of asthma and / or atopy. The other factors, gender, age, BMI, keeping a pet at home, exposure to cigarette smoke at home and type of cooking energy used at home were not significantly associated with EIB.

This variance in prevalence rates of EIB in children can be attributed to various factors;

1. The standards that are used to diagnose EIB are different. PEFR and FEV_1 have been used to make a diagnosis of EIB. These parameters are both specific for EIB and have been used in various epidemiological studies. FEV_1 is the preferred parameter to use than PEFR, though PEFR is more practical for use in epidemiological surveys where there are large sample sizes, is less costly and has

an easy technique compared to FEV_1. The main draw back in using PEFR is its low sensitivity and inability to detect small airway obstruction.

2. The fall in PEFR or FEV_1 that has been used in various studies differs. This ranges from a fall of 10 to 20% in FEV_1 and 15 to 25% in PEFR. Higher prevalence rates have been found were the lower ranges have been used compared with the higher ranges[38]. In this study, the lower range of PEFR fall was used and still found a high prevalence rate.

3. Different types of exercises have been used in various studies. However, the exercise used should be vigorous enough to enable the participant to reach at least 75 – 95% of their maximum heart rate within 5 – 8 minutes of the exercise challenge. In this study, free running exercise in the school play ground was used. Other exercises that have been used in other studies include a cycle ergometer (exercise bicycle), soccer and a treadmill[5,7].

   Eucapneic voluntary hyperventilation is a new technique that has been used under laboratory conditions that have been altered to mimic environmental conditions of the sport under question. This method has been used by the US Olympic Committee in circumstances were a formal diagnosis of EIB is critical[7].

   The free running exercise is the one most commonly used in epidemiological studies. This is because of its comparative low cost. Its main limitations are that it is not easily standardized; it depends on the ability of the participant to run for the duration and intensity required and it requires space. This therefore could have contributed to the findings in this study.

4. The environmental conditions under which the exercise challenge is done also impact on the results. EIB is best elicited in a dry and cold environment [2,3]. This study was done during the cool dry months of the year from March to July 2009. The temp during this time of the year averaged 28^0C and the average relative humidity was 80% given by the Zambia Meteorological Department (2009 ZMD). Given the above conditions, we would therefore anticipate that the

prevalence of EIB would be low. The high prevalence rate in this study may indeed reflect the true prevalence of EIB in this population.

Additionally, the school play grounds where the exercise challenge was done are open fields with minimal grass and a lot of dust. The information on the dust pollution and pollen counts was unavailable at ZMD at the time of this study. These factors may have affected the results.

5. The time post - exercise that PEFR is done also differs. The time in various studies range from 3 to 20 minutes [2,7]. In this study, it was done at 5 minutes and 10 minutes after exercise. This also contributes to the variance in prevalence rates found.

6. Within the pediatric population, different age groups have been used and consequently different prevalence rates have been found. Different age groups have been selected for various reasons. This study was done in the age group 10 – 14 years. The selection of this age group was influenced by the need to have children who can answer the questionnaire.

The high prevalence rate in this study could be attributed to various other reasons. One important reason is the fact that all the children in this study are urban dwellers. EIB has been found to be commoner in urban than rural children. These urban children are exposed to industrial and automobile fumes within their localities. This in some studies has been found to be a risk factor for developing EIB [11,21,26,37]. The social economic status of the study participants was not studied in this study. This can be included in future studies.

The other factors that are closely associated with urban dwelling are dietary factors. Urban children are more likely to consume foods that contain additives which may be allergenic and therefore predispose these children to develop EIB. Additionally, urban children are more likely to have stopped breast feeding early in infancy compared to rural children. This is because mothers in urban settings need to work to earn a living. The high population density associated with low social economic status in urban areas also

contributes to increased risk of developing EIB [21]. This study did not stratify the socio-economic status of the participants. It will need to be studied in future.

Immunizations or vaccinations that are given to most children in urban areas have also been cited as increasing the risk for developing EIB. These are known to modulate the immune system of children. Insecticides that are used for indoor spraying in urban areas have also been implicated as risks for EIB. These factors have not been assessed in this study but could have contributed to the high prevalence of EIB. Future studies should explore the impact of these factors on EIB [11,21].

Factors that have been found to be significantly associated with EIB in this study are family history of asthma and / or atopy. Airway hyper responsiveness has been cited as a cardinal feature of asthma which itself is an atopic disease. Therefore, this association is appropriate.

This study did not demonstrate any significant association between EIB and any age group that was studied. This may be attributed to the fact that the age groups included in this study represented adolescents. Gender was equally found not be significantly associated with EIB in this study. Nganga et al (1998) also did not find any significant difference in prevalence of EIB in boys and girls[11].

The association between EIB and the type of cooking fuel used at home was not analyzed. This was due to the limitations of the statistical package that was used. This was attributed to the fact that most of the households in Lusaka urban are electrified and the majority of participants reported that they use electricity. However, other studies have found EIB to be associated with cooking fumes from kerosene. In another study, Cooking with gas was strongly associated with current wheeze and reduction of lung function tests in children[11,21,].

Keeping a pet at home in this study was not found to be associated with EIB. The pets that were reported included dogs, cats and birds. All the children reported that these pets do not live in the house. This could be the reason why there was no significant association with EIB. Nganga reported that one of the reasons his study found a higher

prevalence rate of EIB in urban versus rural children is that urban dwellers keep their pets indoors compared with rural dwellers who keep their pets outdoor[11,39]. This was however not the case in this study.

Children who are exposed to tobacco or cigarette smoke in the house are known to be at increased risk of developing EIB. This study however did not find any significant association with EIB. This could be attributed to the fact that very few children reported being exposed to cigarette smoke at home[11,21].

16. Conclusion

The prevalence rate of EIB found in this study, 12%, demonstrated that EIB is a common condition in school aged 10 – 14 years in Lusaka urban. There are no background data to compare with in Zambia as this may be the first ever study on EIB to be done. This finding is higher than what was found in the sub region in the Republic of South African and Zimbabwe where prevalence rates of 3.17% and 5.8% were found respectively [16,17,40]. But else were in Africa, similar and higher prevalence rates have been found (Kenya) [11,29].

It should be emphasized that, although EIB is suggestive of asthma, this conditions is not equivalent to asthma, as asthma can be present in the absence of positive exercise challenge test, and vice versa[5]. However, Airway hyper-responsiveness has been extensively assessed in epidemiological studies as an objective marker of asthma[11]. Exercise is one of the most common triggers of brief asthma symptoms, and seems to be a specific trigger for patients with asthma, since it rarely causes bronchoconstriction in normal individuals or those with other respiratory conditions[3].

This study has found the test for EIB to be easy to perform and without any side effects. Only 2 children had to withdraw from the exercise due to severe breathlessness. These children responded very well to short acting beta agonist.

EIB has the potential to limit physical activity in the person affected if not managed appropriately. This is mostly unrecognized by the patient, the parent or guardian and the physical education instructor. The primary health care workers may not be aware of this condition and how to manage it. Thus the affected children suffer in silence with a preventable and treatable condition.

A full epidemiological study should be done in future to verify the findings in this study. The risk factors that were not evaluated in this study, like early life events, environmental pollution, crowding in homes, dietary factors and immunizations should be subjects of evaluation in future studies.

Recommendations for the management of EIB shall be submitted to the Ministry of Health in the hope that they will be sent to schools, parents or guardians, physical

education instructors and primary health care workers to sensitize them of this condition and how it is managed.

17. Recommendations on the Management of Exercise Induced Bronchospasm.

17.1 What is Exercise Induced bronchospasm (EIB)

EIB is a condition that occurs during or soon after vigorous exercise. It is characterized by:

- coughing,
- chest pain or tightness,
- wheezing
- difficulties in breathing or shortness of breath
- poor performance on the field of play
- fatigue
- abdominal discomfort
- prolonged recovery time

This condition can occur in those who are asthmatic or those who do not have asthma. It is a preventable and treatable condition and should not hinder any child from participation in sports.

17.2 Advice to the Child with EIB.

It is important that you inform your teacher or coach that you have this condition. The Doctor at your local clinic will prescribe some medication that you are supposed to take at least 10 – 15 minutes before your exercise. This medicine is called a reliever medication. This medication should be carried with you whenever you are going for sports. If you are asthmatic and you have EIB, the Doctor will prescribe some medication to control your asthma that you are supposed to take every day. This medicine is called controller medication. You too will need to take reliever medication 10 – 15 minutes before the exercise.

Your teacher will help you choose sports that will minimize your risk of having an attack of EIB. You should do some warm up exercises before you begin your sports. If you are on the playing field and you begin to experience an attack of EIB, withdraw from play and inform the teacher or coach of your problem. You should then take your reliever medicine. Usually the EIB attack will resolve after taking medication and you may continue playing. But sometimes, the attack may continue and become worse. In this

situation, your teacher or instructor must quickly make arrangements for you to be taken to the hospital were other medication will be given to you.

17.3 Advice to the Physical Education Instructor or Coach.

You must be aware of any children in your class or team who has EIB. The child would benefit from doing warm up exercises before the actual sporting activity. About 10 - 15 minutes before sports begin, the child should be reminded to take the reliever medication. During sports, you should look out for the child and observe how they are coping. If the child shows signs of having an EIB attack, that child must withdraw from play and take the reliever medication. The child should then take a rest for 10 – 15 minutes before they can resume play. They should only do so if their breathing is stable. If not relieved, the child should be taken to the nearest local clinic for further medication.

You should also help the child choose sports that are not a high risk for EIB. These are sports that are not very vigorous. The coach should also encourage the child to take medication as prescribed by the Doctor.

17.4 Advice to the parents / guardians of the child with EIB

The parents must ensure that the physical education teacher or coach knows that the child has EIB. The child should be encouraged to take all medications as prescribed by the Doctor. Make sure that the child carries the reliever medication on all sports days. The parents should encourage the child to choose sports that do not pose a risk to having EIB attacks.

17.5 Advice to the Primary Health Care Provider.

The primary health care provider must be aware of EIB as described above. Short acting beta agonist (SABA) medication should be prescribed to all children with EIB and should be taken 10 – 15 minutes before sports and during sports if the child develops symptoms. In addition to SABA, corticosteroids should be given to asthmatic children to control the asthma symptoms. If this does not help, the child should be referred for specialist care.

18. References

1. Taru Sinha, M.D., Alan K David, M.D., Recognition and management of exercise induced bronchospasm . Medical college of Wisconsin, Milwaukee, Wisconsin AAFP February 15, 2003 Vol. 67/No. 4

2. Anthony J Saglimbeni, M.D., Exercise induced Asthma, emedicine sports medicine http://emedicine.medscape.com/article/88849-overview

3. Larry A Sonna, MD, PhD; Karen C Angel, The prevalence of Exercise Induced bronchospasm among US Army Recruits and its effects on physical performance Chest. 2001;119:1676 – 1684

4. Anna Lucia B. Cabrral, Gleice M. conceicao , Exercise induced bronchospasm in children effects of Asthma severity American Journal of Respiratory critical care medicine1999 Vol 159. Pp 1819-1823

5. Vahid Ziaee, Azizollah yousefi et al, The prevalence of Exercise induced bronchospasm in soccer player children, ages 7 to 16 years. Iran journal of Allergy Asthma immunology March 2007; 6(1): 33-36

6. TK Ninan and G Russell Is exercise testing useful in a community based asthma survey Thorax Vol 48, 1218-1221

7. Chris Randolph, Exercise-induced Bronchospasm In Children Clinic Rev Allerg Immunol (2008) 34:205–216

8. Abdul Ahad, M.Perwaiz Sandila, Nadeem Ahmed Siddiqui, et al Prevalence of exercise induced bronchospasm in national hockey players of Pakistan http://www.ayubmed.edu.pk/JAMC/PAST/15-4/Abdulahad.htm,

9. Brian Williams, Alison Powell2, Gaylor Hoskins3 and Ron Neville4 Exploring and explaining low participation in physical activity among children and young people with asthma: a review *BMC Family Practice* 2008, **9**:40

10. Henry Milgrom and Lynn M. Taussig Keeping Children With Exercise-induced Asthma Active *Pediatrics* 1999;104;e38 DOI: 10.1542/peds.104.3.e38

11. LW Ng'ang'a, JA Odhiambo, M W Mungai, et al Prevalence of exercise induced bronchospasm in Kenyan school children: an Urban –rural comparison Thorax 1998;53; 919-926

12. EO Addo yobo, A Custovic, SC Taggart, an Woodcock Exercise induced bronchospasm in Ghana: difference in prevalence between Urban and rural schoolchildren Thorax 1997;52;161-165

13. PJ Helms. Exercise induced Asthma: Real or imagined? Arch Dis child 2005;90:886-887

14. Shally Awasthi, ekta Kalra, Siddhartha Prevalence and risk factors of asthma and wheeze in school going children in Lucknow north india Indian Pediatrics 2004; 41: 1205

15. F. Sagher and A. Hweta Bronchoconstrictor effect of exercise in healthy Libyan children in Tripoli Eastern Mediterranean Health Journal 1999 Vol 5 Issue2 pp 350-353

16. Van Nierkerk CH, Weinberg EG, Shore SC, et al Prevalence of Asthma: a comparative study of urban and rural Xhosa children Clin Allergy 1979;9:319 -24

17. Keeley D, Neill P, Gallivan S. Comparison of the prevalence of reversible airway obstruction in rural and urban Zimbabwean children. Thorax 1991;46:549-53.

18. Allen S C, Powar J A hospital outpatient study of bronchial asthma in Zambia – clinical pattern Medical Journal of Zambia October 1983;17(4) ; 95-98

19. P. M. O'Byrne_,w, G. M. Gauvreauw and J. D. Brannan_Provoked models of asthma: what have we learnt? Clinical and Experimental Allergy, 39, 181–192

20. American thoracic society – Guidelines for methacholine and exercise challenge testing – 1999

21. Gary W K Wong, Fanny W S Ko, David S C hui, et al Factors associated with difference in prevalence of asthma in children from three cities in china: Multicentre epidemiological survey BMJ 28 august 2004;329:486

22. S T Remes, J Pekkanen, K Remes, In search of childhood asthma: questionnaire, tests of bronchial hyperresponsiveness, and clinical evaluation Thorax 2002;57:120-126

23. Anderson S (2002) Exercise-induced asthma in children: amarker of airway inflammation. Med J Aust 177:S61–S63

24. Finn Rasmussen et al. Asymptomatic bronchial hyperresponsiveness to exercise in childhood and the development of asthma related symptoms in young adulthood: the Odense Schoolchild Study. Thorax 1999;54: 587-589(July).

25. Ayten PU, Aynur G, Nuray Y Prevalence of asthma and Allergic disorders Among children In Duzce Turkey. ISAAC phase 1. The internet journal of epidemiology ISSN: 1540-2614

26. E.O.D. Addo –Yobo, Ashley Woodcock, Adorkor Allotey, et al Exercise Induced Bronchospasm and Atopy in Ghana : Two surveys ten years apart. PloS Med 2007 Feb; 4(2):e70

27. Stanley P gallant, Linda JR Crawford, Tricia Morphew, et al Predictive Value of a cross-cultural asthma Case-detection tool in an elementaery school population Pediatrics Sept 2004 Vol 114 no. 3 pp 307-e316

28. Kitaw Demissie, Neil white, Lawrence Joseph et al Bayesian Estimation of asthma prevalence , and comparison of exercise and Questionnaire diagnostics in the absence of a Gold standard Annals of epidemiology April 1998 Vol 8 issue 3 pp 201-208

29. I T S Yu, T W wong, W Li Using Child reported Respiratory symptoms to diagnose asthma in the community archives of Disease in childhood 2004;89:544-548

30. White J, Flohr JA, Winter SS, Vener J, Feinauer LR, Ransdell LB:Potential benefits of physical activity for children with acute lymphoblastic leukaemia. *Pediatr Rehabil* 2005, 8(1):53-58.

31. Trudeau F, Shephard RJ: Contribution to school programmes to physical activity levels and attitudes in children and adults. *Sports Med* 2005, 35(2):89-105.

32. Ram FSF, Robinson SM, Black PN: Effects of physical training inasthma: a systematic review. *Br J Sports Med* 2000, 34:162-167

33. van Veldhoven NHMJ, Vermeer A, Bogaard JM, Hessels MGP, Wijnroks L, Colland VT, van Essen-Zandvliet EEM: Children withasthma and physical exercise: effects of an exercise programme. *Clin Rehabil* 2001, 15:360-370

34. Welsh L , Kemp JG, Roberts RGD: Effects of physical conditioning on children and adolescent with Asthma. Sports med 2005, 35(2):127 – 141.

35. Mansour ME, Lanphear BP, Dewitt TG : Barriers to asthma care in urban children: parent perspectives. Pediatrics 2000, 106(3): 512 - 519

36. Lucas SR, Platts-Mills TAE: Physical activity and exercise in asthma: relevance to etiology and treatment. *J Allergy Clin Immunol* 2005, 115(5):928-934.

37. Orenstein DM: Pulmonary problems and management concerns in youth sports. *Pediatr Clin N Am* 2002, 49:709-721.

38. Sheth KK: Activity-induced asthma. *Pediatr Clin N Am* 2003, 50:697-716.

39. Nganga LW, Odhiambo, Gichehe CM et al The prevalence of bronchial asthma in Nairobi school children. Eas afr Med J 1997;74;694 – 8

40. Terblanche E, Stewart RI. The Prevalence of exercise induced bronchoconstriction in Cape Town school children. S Afr Med J 1990;78:744-7.

41. Sudhir P, Prasad C.E Prevalence of Exercise induced Bronchospasm in school children: an Urban – Rural comparison. Jour of tropical Paeds April2003 Vol 49/2/104 – 108.

Appendices

Appendix 1

QUESTIONNAIRE FOR PREVALENCE OF EXERCISE-INDUCED BRONCHOSPASM IN ASTHMATIC CHILDREN AND ASSOCIATED RISK FACTORS.

Questions adopted from;
A parent – completed respiratory questionnaire for one year olds - Repeatability— ADC 2007;92;861-865

Questionnaire to be completed by participants.

Study ID _____

Age (years) _____

Sex _____

Date _____

Instructions.

1. Carefully read each question before answering. If you do not understand the question, ask any of the research assistants.
2. Follow the instructions carefully. You may be required to circle, tick or fill in the spaces provided. The instructions are given for each question.

Questions on wheezing

By "wheezing" we mean breathing that makes a high-pitched whistling or squeaking sound from the chest, not the throat.

1. Have you ever had any wheezing or whistling in the chest at any time in the past? yes ☐ no ☐ (If NO Skip to Q6)
2. Have you had wheezing or whistling in the chest in the past year? yes ☐ no ☐
3. Have you ever had wheezing or whistling in the chest during or soon after a cold or flu? yes ☐ no ☐
4. Do these attacks cause you to be short of breath? yes ☐ no ☐
5. Do any of the following things cause you to wheeze?
   - (A) Exercise (playing or running) yes ☐ no ☐ Don't know ☐
   - (B) Laughing, crying or excitement yes ☐ no ☐ Don't know ☐
   - (C) Contact with pets or other animals yes ☐ no ☐ Don't know ☐
   - (D) Food or drinks yes ☐ no ☐ Don't know ☐
6. Have you ever been told that you have asthma or bronchitis by any medical personnel? yes ☐ no ☐
7. Have you ever had an itchy rash which appears and disappears from time to time? yes ☐ no ☐

Questions on ears, nose and throat

8. Have you ever had a problem with sneezing, a running or blocked nose when you did NOT have a cold or the flu? yes ☐ no ☐
9. Have you had recurrent ear infections in the past? yes ☐ no ☐

Questions on Coughing

10. Do you usually have a dry cough without colds? yes ☐ no ☐
11. Do you cough with colds? yes ☐ no ☐
12. Do you have a dry cough at night, when you do not have a cold or a chest infection? yes ☐ no ☐
13. Do the following things cause you to cough?
    - (a) Exercise (playing or running) yes ☐ no ☐ Don't know ☐
    - (b) Laughing, crying or excitement yes ☐ no ☐ Don't know ☐
    - (c) Contact with pets or other animals yes ☐ no ☐ Don't know ☐
    - (d) Food or drinks yes ☐ no ☐ Don't know ☐

Treatment

14. Have you ever gone to the clinic/hospital to seek treatment for coughing or wheezing? yes ☐ no ☐

15. Has wheezing or asthma resulted in you:
    (a) being referred to a hospital? yes ☐ no ☐
    (b) being admitted to hospital? yes ☐ no ☐

16. Do you take any medicine for coughing or wheezing? yes ☐ no ☐

17. Which of the following medicines do you take?

    Salbutamol ☐ Ventolin ☐ Pulmicort ☐ Flixotide ☐
    Becotide ☐ Beclovent ☐ Prednisolone ☐
    If other specify:……..

Questions on the household and Family

18. Do you have brothers and sisters? yes ☐ no ☐
    If yes, How many? …… *(Please fill in number)*

19. How many children ***under*** 16yrs of age live with you?…… *(please fill in number)*

20. How many people ***above*** 16yrs of age live with you?…… *(please fill in number)*

21. How many of them have:

    (a) Asthma?……*(please fill in number)*
    (b) Wheezing?……*(please fill in number)*
    (c) Hay fever?…… *(please fill in number)*
    (d) Eczema or Rash?…… *(please fill in number)*

22. How many rooms are there in your house? (not counting kitchens, bathrooms and toilets)……..
    (please fill in number)

23. Has your ***father*** ever suffered from any of the following conditions?
    (a) Asthma or wheezing? yes ☐ no ☐
    (b) Bronchitis? yes ☐ no ☐
    (c) Hay fever? yes ☐ no ☐
    (d) Eczema or Rash? yes ☐ no ☐

24. Has your ***mother*** ever suffered from any of the following conditions?
    (a) Asthma or wheezing? yes ☐ no ☐
    (b) Bronchitis? yes ☐ no ☐
    (c) Hay fever? yes ☐ no ☐
    (d) Eczema or Rash? yes ☐ no ☐

25. What work does your mother do? ……

26. Which fuel is mainly used for cooking in the home?

Electricity ☐ Gas ☐ Charcoal ☐ Paraffin ☐

Firewood ☐ other (specify) ……..……..

27. Do you keep any household pets? yes ☐ no ☐

If yes, do you keep any of these pets? *(Tick as many as apply)*

Dog ☐ cat ☐ other furry pets ☐ bird ☐

other specify ……..

28. Do any household members smoke cigarettes in the house? yes ☐ no ☐

29. How would you describe the location of your house? ***(Circle appropriately)***

(i) in a street with very dense traffic (main road)

(ii) in a street with moderate traffic (residential road)

(iii) in a quiet street with little or no traffic

30. Did you have problems understanding this questionnaire? yes ☐ no ☐

31. Write any comments that you have concerning this questionnaire

……

……

……

……

……

……

End of questionnaire

Appendix 2

Data Collection sheet – Prevalence of exercise induced bronchospasm in Lusaka Urban school children and associated risk factors.

Demographics

Study Number

Age

Sex

Weight

Height

BMI

Residence

Do you suffer from any of the following illnesses?

Diabetis mellitus Cancer TB Heart disease None

Have you recently undergone an operation to any part of your body

Yes No

Have you had a cold, runny nose or cough in the last 4 weeks

Yes No

Have you had an injury to any part of your body that you think can affect your ability to participate in the exercise challenge.

Yes No If yes, please specify

_____
_____
_____

Expected PEFR _____

PEFR before exercise _____ _____ _____ _____

PEFR at 5mins_____ _____ _____ _____ _____

Percentage reduction _____

PEFR at 10mins _____ _____ _____ _____ _____

Percentage reduction in PEFR _____

EIB Positive____ **Negative**_____

Appendix 3

Information Sheet

My name is Muntanga Kampengele Mapani (principal investigator). I am a Medical Doctor who is currently studying at the University Teaching Hospital to become a specialist in children's health.

I am hereby requesting you to give permission to your child/dependant to take part in the study that I will be conducting at his/her school.

The main aim of the study is to find out what proportion of school children aged between 10-12 years in Lusaka Urban have difficulties in breathing associated with exercise. This Condition is called Exercise-Induced Bronchospasm (EIB). The study will also be determining how common EIB is in children who are known to be asthmatic and what common risk factors are associated with EIB in our environment.

The procedure for the study will be as follows;

1. Registering details of each participating child.
2. Measuring the strength of the child's blow in to a small hand held cylinder called a spirometer.
3. The child will be allowed to run in the school play ground for 6 minutes.
4. This will again be followed by measuring how strong the blow is into the cylinder after the exercise.

There are no serious risks that are anticipated during the procedure for the study. Children will be fully supervised during measurements and exercise. Any children who may have severe breathing difficulty during or after exercise will be given treatment. First aid will be available for any injuries that may arise during exercise.

The benefits to the participants in this study are twofold. Firstly, The participating children will know if they have this condition and they will be advised on what precautions to take in relation to exercise. Secondly, the participating children will have contributed in a significant way in adding to medical science or knowledge in Zambia and the world at large as this study has never been done in Zambia before.

Participating children will be given a bottle of water and some fruit juice after the session.

This is a one off session which will not interrupt with the school programme as it will be done during physical education classes.

All the information about each participant will be confidential and will not be shared among other participants. Each participant will have free access to the results of their test.

Participation in this study is voluntary. No Child will be disadvantaged in any way by the school or the researchers for not participating in this study. Only those children whose parents will give consent will be eligible to participate. Verbal assent will also be obtained from the children after the study and procedure is explained to them.

Participants who wish to withdraw from the study at any time will be free to do so. If there is anything that is not clear on this information sheet or if you have any questions, kindly contact the principal investigator or The University of Zambia Research Ethics committee, at the addresses indicated below.

Find attached to this information sheet the consent form for you to complete.

Thank you.

Dr Muntanga Kampengele Mapani

_____

Department of Paediatrics and child health

University teaching Hospital

P O Box RW1

Ridgeway, Lusaka.

Telephone: 0955 224480, 0211 282253.

University Of Zambia Research Ethics Committee (UNZAREC)

2nd floor basic science building,

Ridgeway Campus,

Ridgeway, Lusaka. Telephone

Consent Form

(Delete as is applicable)

I (name of parent/guardian) _____ have read the information sheet and I have understood/have not understood the content. I therefore allow/do not allow my child/dependant (name of child) _____, to take part in this study.

Signature of Parent/guardian_____

Kindly indicate if you would like more information/clarification on the study.