PEAK EXPIRATORY FLOW RATE IN HEALTHY URBAN NIGERIAN SCHOOL CHILDREN IN ABUJA, NIGERIA.

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Thesis submitted in partial fulfilment of the requirements for degree of Master of Medicine in Paediatrics in the Faculty of Medicine and Health Sciences at Stellenbosch University

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Declaration

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own original work, that I am the owner of the copyright thereof (unless to the extent explicitly otherwise stated) and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Date: December 2018

Signature: Folasade B Adeniyi

Dedication

This study is dedicated to those children who often, struggle to breathe….

Acknowledgements

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Abstract

Background

Recent asthma management guidelines have reiterated the importance of lung function testing, such as Peak expiratory flow rate (PEFR), in the diagnosis and management of childhood asthma. Interpretation of PEFR requires comparison with patient's personal best value or comparison with predicted norms. PEFR has been shown to vary with age, gender, anthropometric indices and importantly with race and ethnicity even within the same country. It is therefore important to establish reference ranges for different population groups.

Objectives

This study aimed to establish the pattern and determinants of PEFR amongst healthy Nigerian children aged 6-12 years attending public schools in Abuja, Nigeria and to derive a prediction equation for PEFR for this population.

Methods

The study was a cross-sectional descriptive study design involving a representative sample of 1067 healthy children aged 6-12 years attending 7 public primary schools in Abuja, Nigeria, obtained by a multistage stratified random sampling technique. Data collection took place in the selected schools following ethics approval and written informed consent in October 2009. Demographic and clinical history data were collected on questionnaires and structured case report forms. PEFR was measured with a mini-Wright's peak flow meter with the best of three readings recorded in litres/minute. Height and weight were measured according to recognized standards. Data was analysed with SPSS™ statistical software version 25. Confidentiality of data was ensured.

Results

A total of 1067 school children aged 6-12 years were included in the study; of these, 512 (48%) were males, while 555 (52%) were females. The mean PEFR in litres/minute ($\pm$2SD) were: females 214.7 (±58.7) and males 217.7(±57.2), respectively. PEFR correlated with age and anthropometric measurements, with height showing the best correlation. Gender was not significantly correlated with PEFR. Using Multiple linear regression analysis, we derived a prediction equation for use in both genders: predicted PEFR (Litres/minute) = 2.6(height in cm) + 6.9(age in years) - 185.

Conclusion

The prediction equation for PEFR derived from this study provides reference values for PEFR which will be useful in the recognition and management of childhood asthma and other respiratory conditions amongst Nigerian children.

Opsomming

Agtergrond

Onlangse riglyne vir die behandeling van asma beklemtoon die belangrikheid van longfunksie toetsing, soos byvoorbeeld Piek ekspiratoriese vloeitempo (PEFR), in die diagnose en hantering van asma in kinders. Interpretasie van PEFR vereis vergelyking met die pasiënt se eie beste waarde of voorspelde norms. PEFR varieer met ouderdom, geslag, antropometriese indekse en, belangriker, met ras en etnisiteit, selfs binne dieselfde land. Dit is dus belangrik om verwysingswaardes vir verskillende bevolkingsgroepe te vestig.

Doel

Hierdie studie het ten doel gehad om om die patroon en determinante van PEFR onder gesonde Nigeriese kinders tussen die ouderdomme van 6-12 jaar wat openbare skole in Abuja, Nigerië, bywoon, vas te stel, en om ‘n voorspellingsvergelyking vir PEFR in hierdie bevolking te herlei.

Metode

Die studie was ‘n deursnee beskrywende studie ontwerp. ‘n Verteenwoordigende monster van 1067 gesonde kinders tussen 6-12 jaar in 7 openbare laerskole in Abuja, Nigerië, is deur ‘n multi-fase gestratifiseerde ewekansige steekproefnemingstegniek verkry. Data versameling het in die verkose skole plaasgevind nadat etiek goedkeuring en geskrewe ingeligte toestemming in Oktober 2009 verkry is. Demografiese en kliniese geskiedenis data is deur middel van vraeboë en gestruktureerde gevalverslagvorms ingesamel. PEFR is deur middel van ‘n mini-Wright piekvloeimeter gemeet, met die beste van drie lesings in liters/minuut aangeteken. Lengte en massa is volgens erkende standaarde gemeet. Data is deur middel van SPSS™ statistiese sagteware weergawe 25 geanaliseer. Konfidensialiteit van die data is verseker.

Resultate

‘n Totaal van 1067 skoolkinders tussen die ouderdomme van 6-12 jaar is in die studie ingesluit; 512 (48%) was manlik en 555 (52%) vroulik. Die gemiddelde PEFR in liter/minuut ($\pm$2SD) was: vroulik 214.7 (58.7) en manlik 217.7 (57.2), onderskeidelik. PEFR het met ouderdom en antropometriese metings gekorreleer, met lengte wat die beste korrelasie getoon het. Geslag het nie aansienlik met PEFR gekorreleer nie. Deur middel van lineêre regressie-analise het ons ‘n voorspellingsvergelyking vir gebruik in beide geslagte herlei: Voorspelde PEFR (Liter/minuut) = 2.6(lengte in sm) + 6.9(ouderdom in jare) - 185.

Samevatting

Die voorspellingsvergelyking vir PEFR wat deur middel van hierdie studie herlei is, verskaf verwysingswaardes vir PEFR wat waardevol sal wees in die herkenning en hantering van asma en ander respiratoriese toestande in Nigeriese kinders.

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List of Abbreviations

AMAC- Abuja Municipal Area Council

cm - Centimeters

COPD-Chronic Obstructive Pulmonary Disease

FCT- Federal Capital Territory

FEV_1- Forced Expiratory Volume In 1 Second

$FEF_{(25-75)}$- Forced Expiratory Flow between 25%-75% of Vital capacity

FMF- Forced Mid- expiratory Flow

FFM – Fat Free Mass

FVC- Forced Vital Capacity

GINA- Global Initiative on Asthma

km^2 - Kilometers Square

LEA- Local Education Authority

L/min- Liters Per Minute

NAEP- National Asthma Education Program

PEFR- Peak Expiratory Flow Rate

PFT- Pulmonary Function Test

SPSS- Statistical Package For Social Sciences

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CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

1.1 Background

Asthma is the single most common cause of airway obstruction in children, and indeed, the commonest chronic disorder of childhood.(1) Globally, the prevalence of asthma is on the increase with prevalence between countries ranging between 1-18%(2). There is however, significant variation in reported prevalence of asthma symptoms between countries with a higher prevalence of symptoms indicating severe asthma, in low and middle income countries (LMICs), compared to high income countries (HICs)(3). Asthma is among the top twenty chronic conditions for global ranking of disability-adjusted life years in children; in the mid-childhood, ages 5–14 years, it is among the top ten causes(1). Asthma ranks within the top ten prevalent conditions causing limitation of activities and loss of school days. In the United States of America, it was estimated in 2007 that the direct and indirect health care costs of asthma was 56 billion US dollars (4). Asthma therefore remains a major public health concern.

Although there is limited data on asthma burden among children in Nigeria, Falade et al, (5) reported a prevalence of 18.9% of physician diagnosed asthma among 13–14 year-old secondary school children and 7.2% prevalence of wheeze among 6-7 year-old children (6) in Ibadan, south-western Nigeria. The surge in the prevalence of the disease has been ascribed to urbanisation, environmental pollution, increasing adoption of a western lifestyle and affluence/improvement in living standards amongst other factors.

Pulmonary function tests (PFT) measured using spirometric devices provide useful information for the management of respiratory tract illnesses including asthma in paediatric practice. These tests including : Forced expiratory volume in one second (FEV_1), Forced vital capacity (FVC); Ratio of FEV_1 to FVC (FEV_1/FVC); Forced Expiratory Flow between 25%-75% of Vital capacity ($FEF_{(25-75)}$), and Peak expiratory flow rate (PEFR), are used to establish the diagnosis or to monitor improvement/deterioration following treatment.(2) The measured values for these parameters are compared to normative data and reported as a percentage of predicted values (for subjects of similar age, height, gender and race) or compared with previously measured values (patient's best values) in the same patient (2).

Spirometers are relatively expensive, and only available in a few hospitals. On the other hand, the peak expiratory flow rate (PEFR) is a useful parameter that can be easily measured using the compact and relatively inexpensive peak flow meter(7) and it is, therefore, a useful tool for out-patient monitoring of asthma, especially in a primary care setting. The Global Initiative for Asthma (GINA), recommends that PEFR monitoring may be used short-term in the diagnosis of asthma, including work-related asthma, and in assessing triggers, flare-ups and response to treatment (8). Long-term home PEFR monitoring is reserved for patients with more severe asthma, as well as those with impaired perception of airflow limitation (8).
As with all observed data in clinical medicine, interpretation of PFT involves comparing measured values with average values from a representative sample of healthy subjects for which a reference range has earlier been determined(9). The American Thoracic Society further recommended that laboratories should use the published reference equations that most closely describe the patient population being tested.(10) In this regard, PEFR studies have been carried out in various populations to establish reference values and prediction equations from which the normal values can be estimated according to age, gender, standing height and occasionally weight.

1.2 Literature review

Peak expiratory flow rate

The peak expiratory flow rate, expressed in litres per minute, may be defined as the maximal expiratory flow rate sustained by a subject for at least 10 milliseconds after a maximal inspiratory effort (11). Whilst several instruments are available for measuring the expiratory flow rate, the reliability, low cost, low technology, portability and ease of use of the inexpensive versions of the mini-Wright peak flow meter (7) have made PEFR measurement a common place procedure in the primary care setting and in the home. In addition, the possibility of it being operable without an electric power supply makes it an attractive option in third world communities like Nigeria, without uninterrupted power supply. Furthermore, the test is non-invasive, and gives results that correlate well with results obtained using spirometry.(12)

Peak flow meters have some important limitations however. Obtained values are highly effort dependent and can be manipulated (13), which is especially important when evaluating the results of younger children. In addition, interpersonal variation can be substantial and clinically significant variations in measured PEFR values can be obtained between devices even of the same brand (13), hence, such results should be interpreted with caution and in line with standard guidelines. PEFR is also better at assessing large airway than small airway obstruction.

For the purpose of making a diagnosis of asthma, reversible airflow limitation should be confirmed prior to initiating controller treatment in the absence of clinical urgency. An increase of 20% or more of pre- bronchodilator PEFR recorded with a peak flow meter, in the presence of a history of typical asthma symptoms is diagnostic, especially in an office setting (2). Peak flow meters are also useful in gauging the severity of asthma exacerbations both by comparing PEFR to normative data or pre-established baseline (personal best) values taken over time. Additionally, PEFR variability determination is an important tool for identifying the risk for exarcebations, and (asthma severity) levels of intervention, according to pre-determined asthma self-management plan for the individual patient (8).

PEFR in healthy children

Several researchers (14)(15)(16)(17) in different localities worldwide have carried out and reported studies on PEFR in apparently healthy children. In all these studies, there was a positive correlation between the PEFR, and one or more of age, gender and anthropometric indices like height, weight and body surface area. Of all the variables explored, the height index clearly showed the best correlation in most of these studies.

PEFR and race

Reports (18) from the western world have documented inter-ethnic, as well as inter-racial differences in PEFR and other pulmonary function parameters. In general, most studies on blacks of African descent found lower PEFR values, compared with the corresponding indices in their caucasian peers (15)(18)(19)(20). Possible reasons for this observation include inherited biologic variations (21) such as chest dimensions(22), anthropometric and environmental differences, as well as some poorly understood (interracial) physiologic differences (18).

PEFR and gender

With respect to inter-gender differences, most studies showed higher mean PEFR for males independent of height at all ages. However, peri-adolescence, there is a trend of an earlier rapid increase in lung function indices including PEFR, documented in girls(15)(23), and this is possibly due to the well known earlier adolescent growth spurt in females. In the study on Libyan adolescents by Mukhtar, et al (23) this difference in the slope of PEFR plotted against age for girls compared with boys was ascribed to obesity/overweight.

PEFR and anthropometric Indices.

Studies done outside (24)(25) and within Africa (15) have shown significant correlation between PEFR and anthropometric indices. In most of these studies, standing height showed the greatest correlation with PEFR and was included in prediction equations for PEFR. Indeed, in studies where the males were significantly taller than the females, for all ages, the well described earlier increase in PEFR in females peri-adolescence attributed to the earlier growth spurt in females was not apparent (25).

The determinants of lung function parameters have also been explored in children from different parts of the African subregion (15); in these studies, PEFR measured by mini Wright peak flow meter correlated well with measurements by spirometry. In addition PEFR correlated strongly with standing height as well as with other PFT indices.

A number of studies have previously been done to determine prediction equations for PEFR from different regions within Nigeria. As with the non-Nigerian studies, PEFR correlated well with age, gender and anthropometric indices, but standing height had the strongest correlation (19)(26)(27). The measured mean PEFR for both genders showed significant differences for similar age, height and weight between regions and sometimes within the same region but different ethnicities(19)(27). Most earlier Nigerian studies reported higher PEFR in boys than girls prior to adolescence as well as mean PEFR significantly lower than that reported for their caucasian peers of similar age, weight and gender (20)(26)(27). Others however found PEFR values to be similar in males and females(19)(28).

In a more recent 2003 report by Agaba, *et al* (19) in Jos, north-central Nigeria, emanating from a study of PEFR values in 1023 healthy urban school children aged 6-12 years, a similar significant correlation of PEFR was shown with age, weight and height in a linear fashion. The strongest correlation of the PEFR values was recorded with respect to height, hence this variable was incorporated into the prediction equation. Furthermore, the mean (±2SD) values of 213(±47.3)L/min in males, and 211.0(±45.9)L/min in females were 100L/min lower than an earlier study done in Lagos (28). These observations are at variance with the reported tendency for higher altitudes to be associated with increasing PEFR values. Jos is located at a higher altitude (1,200m above sea level) when compared with Lagos. Physiological adaptive changes are thought to account for this underestimation of PEFR at high altitudes. (29)

PEFR has also been shown to correlate well with weight though not as strongly, or as consistently as noted for standing height. Glew, *et al* (30) in a comparative study of pulmonary function parameters in children and adolescents (aged 6-18years) living in rural and urban settings in northern Nigeria, explored the possible effect(s) of nutritional status on lung function. In this report, a significant correlation of the PEFR, FVC and FEV_1 values was identified with each of age, weight, height, body mass index, mid arm circumference and free fat mass (FFM). However, weight showed a higher correlation compared to height. This finding, which was similar to some earlier Nigerian studies (20)(26), may be explained by a reduction in diaphragm strength in malnourished children and subsequently impaired ventilation (31). However, obesity has also been associated with reduced PEFR (32). In these studies, weight was therefore incorporated into prediction equations for PEFR in addition to height.

Although a number of these PEFR studies have emanated from different parts of Nigeria, against the backdrop of the reported influence of race and ethnicity, it is neccessary to have reference PEFR values for children in different localities even within the same national boundaries. Furthermore, apart from the work by Agaba, *et al* (19) in Jos, most of the previous data from northern Nigeria was limited by a relatively small sample size (30). Also, there have been differences in the study design of these earlier Nigerian studies, thus making it difficult to draw valid inferences. For instance, some workers took a mean of three readings rather than the highest as the valid PEFR for the individual (33). This is contrary to the standard guidelines for the use of the peak flow meter, which requires that the subject be in a standing position, and that the recorded PEFR is the best (maximum) of three consecutive readings(2). Futhermore, there is no published study on PEFR in children from Nigeria's capital city of Abuja and its environs. With these in mind, this study was designed to determine the pattern and determinants of PEFR in healthy school children aged 6-12 years in Abuja, Nigeria. It was hoped that relevant PEFR reference data would be generated for use by clinicians in the early recognition and management of obstructive airway diseases especially asthma in Nigerian children.

CHAPTER 2: RESEARCH DESIGN AND METHODOLOGY

2.1: Aims and objectives

2.1.1: Aim of the study

The aim of this study was to establish the pattern of peak expiratory flow rate (PEFR) values in healthy urban Nigerian children aged 6 to 12 years, attending public school in Abuja.

2.1.2: Specific objectives:

The specific objectives of this study were:

- Determination of PEFR in healthy children aged 6-12 years attending public school in urban areas of Abuja municipal area council (AMAC), Abuja Nigeria
- Determination of anthropometric measurements: weight, height, and body surface area in the study subjects and the relationship of each anthropometric measurement to PEFR values.
- Derivation of a predictive equation for PEFR in the study population.

2.2: Methods

2.2.1: Study design

We conducted a cross-sectional descriptive study of peak expiratory flow rate values of randomly selected Nigerian public school children aged 6-12 years in urban areas in Abuja . Data collection was done from October to November 2009.

2.2.2: Study population and sampling strategy

The study was carried out in the Abuja municipal area council (AMAC). Only public primary schools were used for this study, as the population structure of the private schools may not be truly reflective of the socio-demographic and economic strata existing in the community.

Study subjects aged 6-12 years were selected by the multistaged random sampling method from 7 out of the 31 urban primary schools. One school was selected from each of the 7 urban wards in AMAC. The schools were randomly selected (having been stratified into the various wards) by a ballot based on numbers allotted to each school on the list of public primary schools in the Abuja Municipal Area Council, provided by the Universal Basic Education Commission (34). Approval was sought and obtained from the FCT Universal Basic Education Commission (see appendix).

In each of the selected schools, the classes were also selected randomly from each level by ballot. The age of 6 years was chosen as the lowest age limit in which adequate co-operation and proficiency in the use of the peak flow meter is expected (11). Pupils in each of the selected classes were then further stratified on the basis of age and gender using the class register with the assistance of the class teachers. Random selection was subsequently carried out by ballot from each stratum for the final recruitment. After a detailed but clear explanation of what the study entailed had been provided by the investigator, written and verbal consent were obtained from the pupils, their parents/ caregivers and the school authorities prior to individual subject recruitment. Ethical permission was obtained from the National Hospital Abuja Ethics Committee (see appendix).

Inclusion criteria

- Age last birthday between 6 and 12 years .
- Continuous residency and school attendance in Abuja in the previous 1 year.
- Absence of clinical parameters of a recent or long standing cardio-pulmonary disease(s).
- Written informed consent.
- Verbal assent from the children

Exclusion criteria

- Refusal of parents to give consent.
- History of current, recurrent or protracted respiratory symptoms, especially cough and/or breathlessness.
- Prior hospital diagnosis of bronchial asthma, recurrent wheeze, cough and/or breathlessness relieved by the use of bronchodilators.
- Clinical parameters (e.g. cyanosis, digital clubbing, chest deformity, breathlessness, cardiac murmur), suggestive of current or previous chronic cardio-respiratory ailments

like congenital heart disease, pulmonary tuberculosis, bronchiectasis and lung abscess.

- Other clinical features of current systemic ill health.
- Refusal of verbal assent by study subject at point of data collection

2.2.3: Sample size and power

We determined the sample size for this study using the formula for one sample descriptive study of a continous variable (35) as detailed below:

N = $4Z^2S^2$ / W²

where n = minimum sample size when population proportion is greater than 10,000

Z_α = standard normal deviate of α =1.96 (if value of α is set at 0.05, the level of significance is set at 1.96, this corresponds to the 95% confidence interval.)

S = standard deviation of the variable from other studies, in this case 47L/min(19)

W = Estimate of the width of desired 95% confidence interval in the study, in this study 6

Thus, the minimum sample size was calculated as follows:

$$\text{Thus } \frac{4 \times 1.96^2 \times 47^2}{6^2} = 943$$

With an expected attrition rate of 15% the final sample size was 1,080.

2.2.4: Data collection variables, definitions and data sources

A structured questionnaire was provided to the prospective subjects in their respective schools, to be filled in by their parents or guardians and returned to the investigator through the school children. Information required from the questionnaire included: age in completed years at last birthday; date of birth; presence of respiratory and cardiac symptoms; allergies; trigger factors for asthma; etc.(see appendix 3). Trigger factors for asthma that were sought included such factors as prior exposure to domestic environmental dust and other potential pollutant such as exposure to cigarette smoke, generator fumes and wood smoke.

Data collection

Activities Carried out at Recruitment:

Anthropometric measurements taken at recruitment included the weight and height and these were determined as follows:

1. Height was determined with a stadiometer. Measurements were taken without shoes, both feet being flat on the ground and apposed at the medial malleoli.The heels, buttocks, and the occiput were placed against the stadiometer with the subject looking straight ahead.The horizontally applied bar was lowered and made to rest on the subject's head and the height in centimeters (cm) read off the scale. Recordings were made to the nearest 0.5cm.
2. Weight measurements in kilograms were taken using a standardised calibrated weighing scale (*Surgifriend Medicals England®*) with a 0.1kg margin of error. Subjects were asked to stand on the scales wearing light fabrics (their school uniforms), without shoes, holding on to nothing. Recordings were made to the nearest 0.5kg. The pointer on the scale was viewed before every measurement and corrected to the zero point.
3. Body surface area (metres^2) was determined using the Mostellers formula (36) as detailed below:

   $$\text{Body surface area} = \frac{\sqrt{\text{Weight x Height}}}{\sqrt{3600}}$$

A thorough clinical evaluation of each subject was carried out by the investigator. Special cognisance was taken of the presence of chest deformities, as well as evidence of respiratory, cardiac and/or other systemic diseases. Similarly, the presence of wheezing, dyspnoea, crackles and other abnormal respiratory sounds, cyanosis, pallor and digital clubbing was sought in each subject as detailed in the appendix. Subjects with these features were excluded from the study.

4. Measurements of the peak expiratory flow rates was taken using a mini-peak flow meter (*MICRO MEDICALS*, ® *UK*) A single peak flow meter was used in order to eliminate inter–instrument error (13), but with a new disposable plastic/ rigid cardboard mouthpiece for each subject to avoid cross-infection.

PEFR readings were taken in the late mornings/early afternoon prior to engagement in strenuous activities (37). The procedure was explained and demonstrated to the subjects. The PEFR measurements were done according to GINA guidelines (2). Each subject was required to hold the peak flow meter lightly and horizontally while standing erect, and ensuring that the fingers are kept away from restricting the movement of the pointer and vents of the meter. With the mouth emptied of food, chewing gum or saliva, it was opened and a slow deep maximum breath taken. Next, the lips were firmly closed around the mouthpiece so as not to permit any air leaks, and the subject asked to blow as hard and as fast as possible (an explosive force) into the mouthpiece with the force coming from deep down the chest (and not just from the cheeks or coughing). Following this manoeuvre, the marker was read in litres/minute (L/min). The marker was then gently returned to the lower end of the scale after use prior to another measurement. Each subject was asked to perform the above process thrice with one minute intervals between the measurements. The best of three readings was taken as the valid PEFR reading for the subject.

The peak flow meter was checked every morning for inconsistencies in the equipment and if found to be faulty, was replaced by a similar peak flow meter of the same brand.

2.2.5: Data management

Anonymised demographic and clinical history data were captured manually from the structured study questionnaire while anthropometry (weight and height) and best PEFR were captured manually from the case report form (see appendix 3) directly onto an electronic database that was password protected. The database included a study identifier and all the study outcome variables with codes assigned to each of them. A data dictionary and a code book were then created for the variables. The data collection process was carried out in an office to which entry was strictly controlled by the principal investigator. During the study data analysis period, anonymised data was shared with the supervisors through emails and Google drive. The information was backed up on an external hard drive stored separately from the study computer to prevent data loss or damage. At the end of the data extraction process, 10% of the forms were randomly selected by an independent party and verified to ensure proper data extraction.

2.2.6: Data analysis

All collected data were entered into an Microsoft Excel® spreadsheet and subsequently exported into and analysed with the Statistical Package for Social Sciences version 25 statistical software. (SPSS Inc., 444 N Michigan Avenue, Chicago, Illinois 60611, USA). Continuous variables (age, weight, height, BSA) were summarised as means and standard deviations. Categorical and dichotomous variables (gender) were expressed as percentages summarised in frequency tables. Means and standard deviations were derived for the different ages, as well as for grouped weights and heights, for both genders. The student t test was applied for comparison of means between both genders. Correlation coefficients were derived for the relationship between PEFR and age, weight, height as well as body surface area, respectively. Multiple linear regression analysis was applied for derivation of a prediction equation. P value less than 0.05 is regarded as statistically significant.

2.2.7: Ethical considerations

Ethics approval was obtained from the research ethics committee of the National Hospital Abuja prior to commencement of the study (appendix 4) Written permission was also sought and obtained from the Nigerian Federal Capital Territory, Abuja Universal Basic Education Board (appendix 5). Furthermore, written informed consent from the parents/legal guardian as well as verbal assent from the children were obtained prior to data collection.

Ethics approval/permission was obtained from Stellenbosch University Human Research Ethics Committee to use the data for Master of Medicine (Paediatrics) thesis (Appendix 6).

CHAPTER 3: RESULTS

3.1: Mean PEFR

A total of 1,150 questionnaires were issued out to pupils. Of these, 59 pupils did not return the questionnaires and consent forms. A further 24 pupils were excluded based on presence of history and clinical findings suggestive of cardiorespiratory illness. 1067 school children aged 6-12 years were included in the study, of these, 512 (48%) were males, while 555 (52%) were females, with a male: female ratio of 0.9:1. The mean PEFR in L/min (±SD) were: females 214.7 (±58.7); males 217.7(±57.2); and for the total population: 216.2(±58.0). See table 3.1 for the breakdown of PEFR values by age range.

Table 3.1 Peak Expiratory rate values by age

	Male		Female	
Age(years)	No of subjects	Mean PEFR(±SD) L/min	No of subjects	Mean PEFR (SD) L/min
6	78	159.7 (±32.2)	72	146.9 (±33.3)
7	74	174.4 (±34.7)	72	168.1(±35.2)
8	73	209.7 (±42.0)	87	201.8 (±37.7)
9	78	222.4 (±41.9)	87	222.01 (±43.6)
10	70	241.6(±42.0)	99	235.6 (±44.2)
11	65	248.3 (±52.0)	74	253.8 (±55.0)
12	74	275.4 (±51.0)	64	273.8 (±51.00
Total	512	217.7 (±57.2)	555	214.7(±58.8)

SD standard deviation; L/min litres/minute.

3.2: Anthropometric characteristics of study participants

In our study population, the mean height was 131cm (SD 12.6cm) while the mean weight was 31kg (SD 9.1kg). Females in this study were heavier (see figure 3.1) and taller (figure 3.2) than their male counterparts (mean weight females 32.3kg; males 30.1kg; mean difference 2.18kg (95% confidence interval 1.1-3.3kg) p<0.001). Mean height in females 132.30cm, males 129.92cm. Mean difference in height 2.38cm; (95%CI 0.87-3.9cm), p=0.02

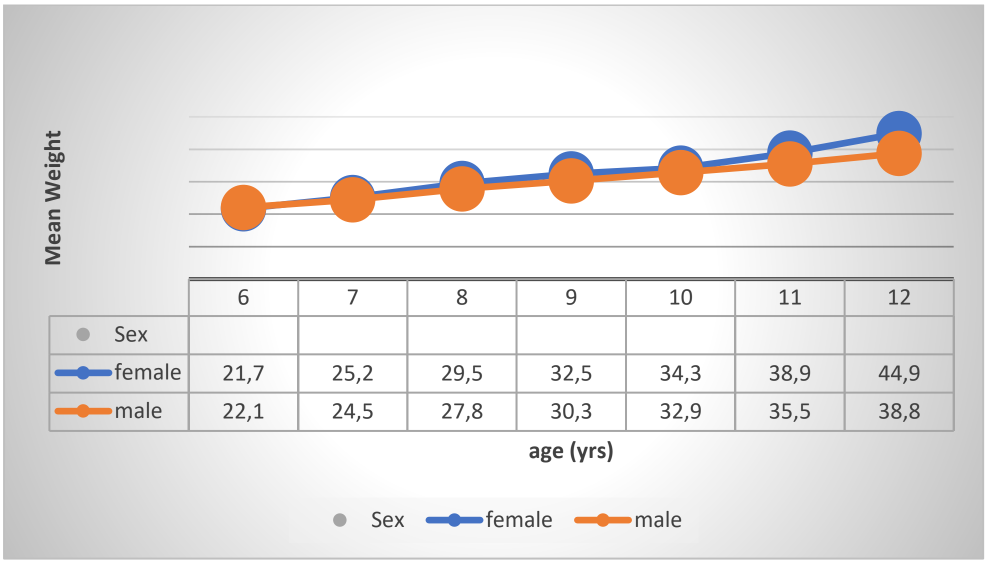

Figure 3.1 Mean weight of study subjects

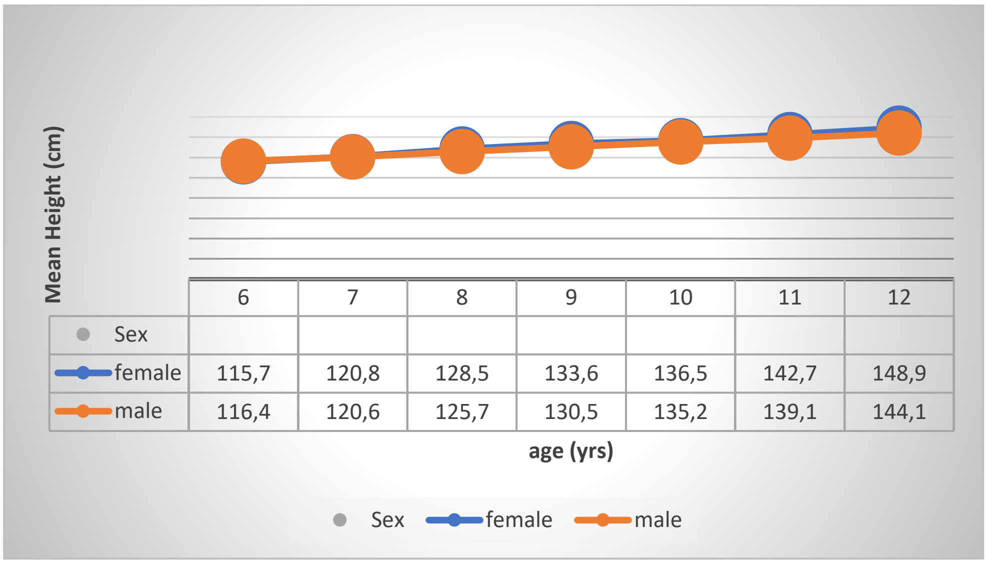

Figure 3.2: Mean height of study subjects

3.3 Factors influencing PEFR

PEFR increased progressively with increasing age, standing height, weight and body surface area. Of these parameters, height showed the strongest correlation (Pearson correlation coefficient: r=0.74), followed respectively by body surface area (r=0.73); weight (r=0.69); and age (r=0.67). Gender was not significantly related to PEFR (student t test p= 0.41). See table 3.2

Table 3.2: Bivariate correlation of PEFR, age, and anthropometric parameters

Correlations						
		PEFR L/M	Height (cm)	BSA	Age (years)	Weight
PEFR L/M	Pearson Correlation	1	.742**	.727**	.668**	.687**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	1067	1067	1067	1067	1067
Height (cm)	Pearson Correlation	.742**	1	.925**	.772**	.859**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	1067	1067	1067	1067	1067
BSA	Pearson Correlation	.727**	.925**	1	.735**	.988**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	1067	1067	1067	1067	1067
Age (years)	Pearson Correlation	.668**	.772**	.735**	1	.683**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	1067	1067	1067	1067	1067
Weight	Pearson Correlation	.687**	.859**	.988**	.683**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	1067	1067	1067	1067	1067

**. Correlation is significant at the 0.01 level (2-tailed).

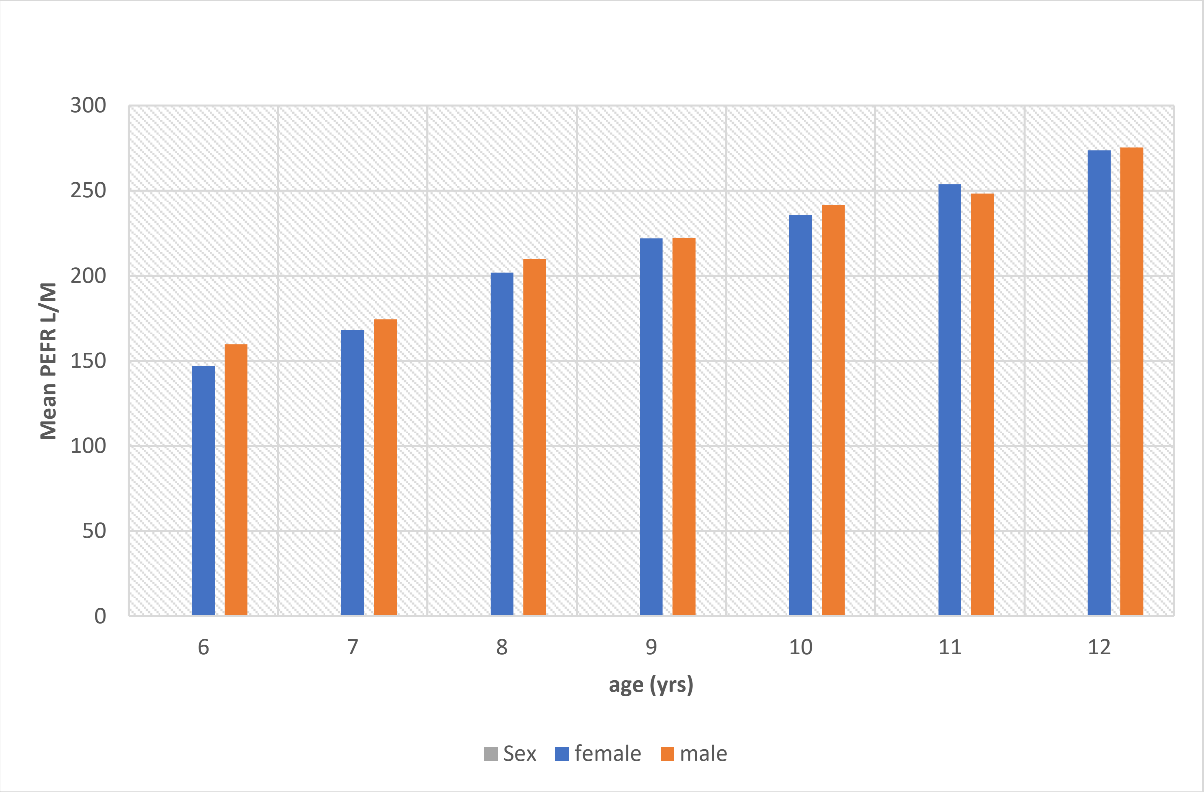

Figure 3.3: Progressive increase in PEFR with age

3.4; Peak Expiratory Flow Rate Prediction

A multiple linear regression model that includes height alone explains 55% of the variance in PEFR (Coefficient of determination: R^2 =0.55); age and body surface area 57% (R^2=0.57); while a model that includes age and height explains 57.3% (R^2=0.57). Using a model that includes age and height as predictors of PEFR, the prediction equation for PEFR in L/min from our study is:

Predicted PEFR L/min = 2.6 (height in cm) + 6.9 (age in years) - 185

An alternate equation Including height alone as predictor in a model

Predicted PEFR L/min = 3.41(height in cm) -231

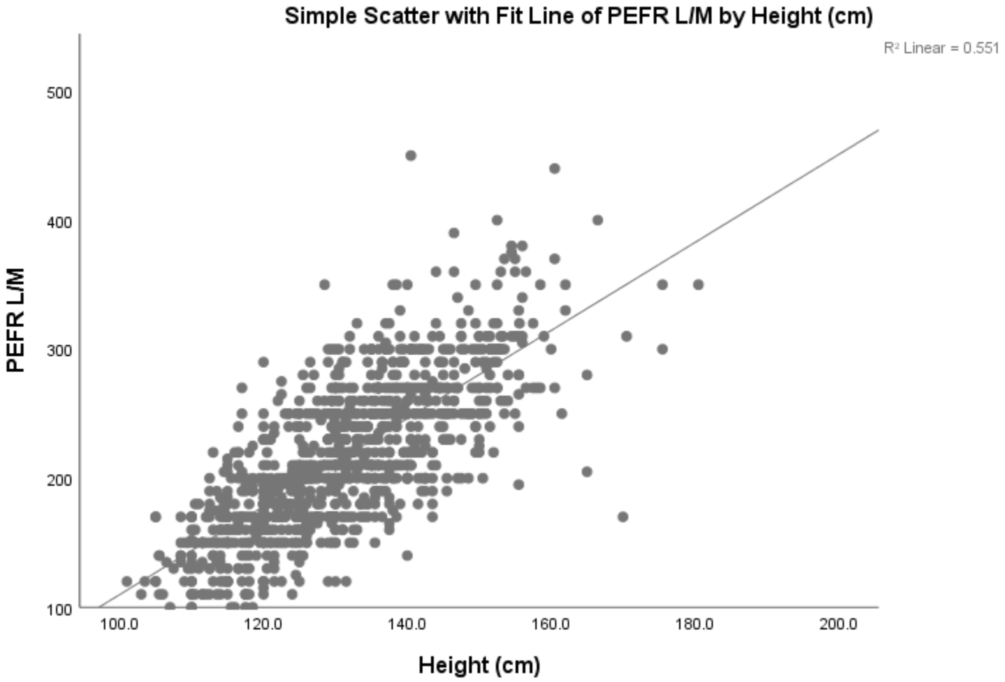

Figure 3.4: scatter plot of PEFR by height

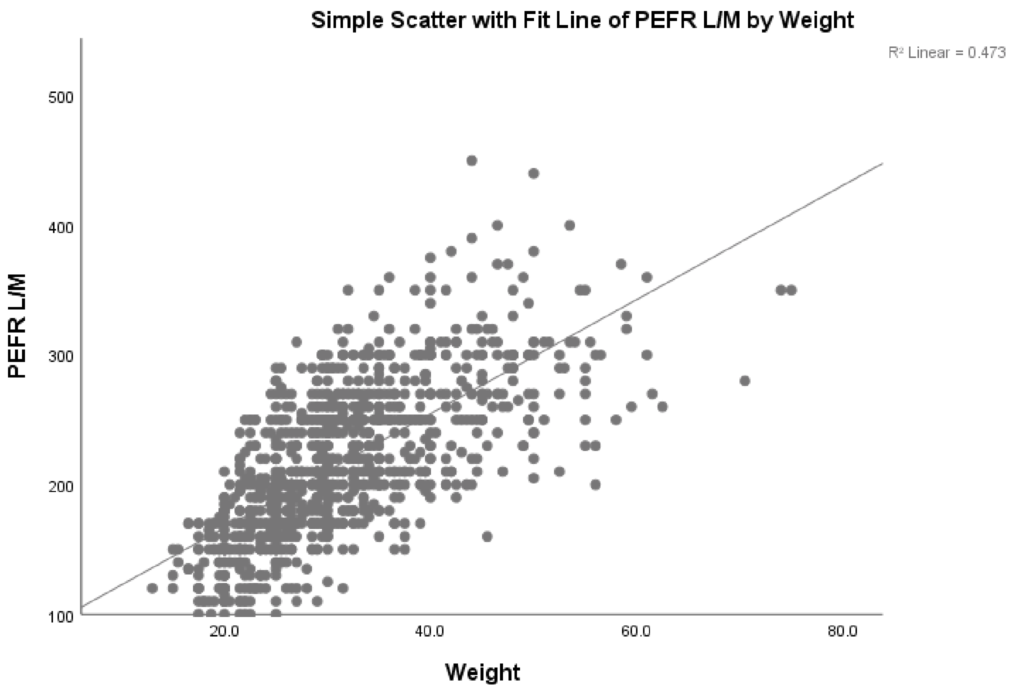

Figure 3.5: scatter plot of PEFR by weight

CHAPTER 4: DISCUSSION

4.1: Discussion

This study reports on the PEFR of a representative sample of 1067 apparently healthy Nigerian school children living in urban areas in Abuja, Nigeria. The mean PEFR in this study was similar to that reported in the study by Agaba, *et al* (19) from Jos, north central Nigeria, but lower than that of an earlier study from Lagos, Nigeria (28). The latter study however included a wider and older age range (6-19years) compared to our study, with the higher PEFR values from the older subjects understandably influencing the mean PEFR upwards.

The mean PEFR in this study was lower than that of European children in published studies (38). This is similar to other studies in black Africans (15)(19).

PEFR increased progressively with increasing age in a linear fashion. ($r = 0.67$; $p < 0.001$). Furthermore, PEFR showed a significant correlation with anthropometric indices height, weight, and body surface area with height showing the best correlation. This is similar to several other published studies(19)(38)(39)

Females in this study were both taller and heavier than their age matched male counterparts with the slope of the graphs (for weight as well height) displaying a sharp upward trend from age of 10years in females compared to males, in keeping with the well-known earlier growth spurt in females. While mean PEFR values were slightly higher in males from ages 6 to 9 years, the actual mean differences were not statistically significant. PEFR values were equal in males and females at 10 years of age while females had higher values at 11 years. This increase coincides with the sharp increase noted in the slope of weight and height in girls which may explain the higher PEFR values in females compared to males. Overall, PEFR was, however, not statistically significantly influenced by gender in our study population ($p=0.41$). While higher overall mean PEFR in males is documented in several studies even after controlling for weight and height, in these studies PEFR values were similar between males and females in age groups where the males were pre-adolescent (15)(38)(40) with rapid increase in PEFR noted in boys from age13years (15)(38), possibly due to immaturity of respiratory muscle function at the preadolescent stage(41). Similarly, a study that included the same age group as our study found no correlation between PEFR and gender(19).

The study population is monoracial and hence effect of race on PEFR could not be investigated. With regards to ethnicity, the study population was quite heterogenous in this respect with children from several ethnic groups with fewer numbers in some categories. Nonetheless, ethnicity was not found to be significantly related to PEFR in the study.

Our study produced a prediction equation for PEFR incorporating height as the best correlate of PEFR amongst all measured anthropometric parameters in our study. Height is easy to measure and is not usually influenced by acute illness, especially in our context where a child's age may be unknown. Where age is available, we also present a second equation incorporating height and age which slightly improves the prediction.

The equation from this study will be useful to estimate predicted PEFR values amongst Nigerian children for diagnosis and monitoring of asthma and other respiratory illnesses according to GINA guidelines, especially in settings where spirometry is not available

4.2: Strength and limitation

Our study is limited by the fact that data was only collected on children aged 6 to 12 years and it therefore only produced reference values for this age group. Furthermore, PEFR (as well as other lung function parameters) is influenced by environmental, ethnic and racial factors, hence the result will be generalizable to the population from which our study sample was derived. However, because our study site Abuja is cosmopolitan, our representative study sample is made up of children from all over Nigeria, making our prediction equation more generalizable to Nigerian children than previous studies that were more ethnic-specific.

4.3 Conclusion

The equation from this study will be useful to estimate predicted PEFR values amongst Nigerian children for diagnosis and monitoring of asthma and other respiratory illness according to GINA guidelines especially in settings where spirometry is not available. Our equation can also form a basis to develop percentile charts for PEFR for this population. Furthermore, in light of the dearth of data from African studies in the recently generated multi-ethnic global lung function reference equations for lung function indices(42), it is hoped that data from this study may in future, contribute towards generation of a global prediction equation for PEFR in African children.

REFERENCES

1. Asher I, Pearce N. Global burden of asthma among children. Int J Tuberc Lung Dis [Internet]. 2014 Nov 1 [cited 2017 May 8];18(11):1269–78. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25299857

2. Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention: 2017 update [Internet]. 2017. Available from: www.ginasthma.org

3. Lai CKW, Beasley R, Crane J, Foliaki S, Lai C. Global variation in the prevalence and severity of asthma symptoms: Phase Three of the International Study of Asthma and Allergies in Childhood (ISAAC). 2009 [cited 2017 May 9]; Available from: http://thorax.bmj.com/content/

4. Barnett SBL, Nurmagambetov TA. Costs of asthma in the United States: 2002-2007. J Allergy Clin Immunol [Internet]. 2011 Jan [cited 2017 May 9];127(1):145–52. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21211649

5. Falade AG, Olawuyi F, Osinusi K, Onadeko BO. Prevalence and severity of symptoms of asthma, allergic rhino-conjunctivitis and atopic eczema in secondary school children in Ibadan, Nigeria. East Afr Med J [Internet]. 1998 Dec [cited 2017 May 9];75(12):695–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10065208

6. Falade AG, Olawuyi JF, Osinusi K, Onadeko BO. Prevalence and Severity of Symptoms of Asthma, Allergic Rhinoconjunctivitis, and Atopic Eczema in 6- to 7-Year-Old Nigerian Primary School Children: The International Study of Asthma and Allergies in Childhood. Med Princ Pract [Internet]. 2003 Dec 5 [cited 2017 May 9];13(1):20–5. Available from: http://www.ncbi.nlm.nih.gov/pubmed/14657614

7. WRIGHT BM, McKERROW CB. Maximum forced expiratory flow rate as a measure of ventilatory capacity: with a description of a new portable instrument for measuring it. Br Med J [Internet]. 1959 Nov 21 [cited 2017 May 10];2(5159):1041–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/13846051

8. Reddel HK, Bateman ED, Becker A, Boulet L-P, Cruz AA, Drazen JM, et al. A summary of the new GINA strategy: a roadmap to asthma control. Eur Respir J [Internet]. 2015 [cited 2017 May 11];46(3). Available from: http://erj.ersjournals.com/content/46/3/622

9. Crapo RO. The role of reference values in interpreting lung function tests. Eur Respir J [Internet]. 2004 Sep 1 [cited 2017 May 9];24(3):341–2. Available from: http://erj.ersjournals.com/cgi/doi/10.1183/09031936.04.00063804

10. Lung Function Testing: Selection of Reference Values and Interpretative Strategies. Am Rev Respir Dis [Internet]. 1991 Nov [cited 2017 May 9];144(5):1202–18. Available from: http://www.ncbi.nlm.nih.gov/pubmed/1952453

11. RA E. Lung Function tests. In: David MD, Evans CE RAE, editor. Special tests, the procedure and meaning of commoner tests in hospitals. New York: Mosby; 2003. p. 67–8.

12. Jones KP, Mullee MA. PRACTICE OBSERVED Measuring peak expiratory flow in general practice: comparison of mini Wright peak flow meter and turbine spirometer. [cited 2017 May 10]; Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1663284/pdf/bmj00184-0035.pdf

13. Miller MR, Dickinson SA, Hitchings DJ. The accuracy of portable peak flow meters. [cited 2017 May 10]; Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC464089/pdf/thorax00371-0008.pdf

14. CB MM, Sc K, Babu M. Peak expiratory flow rate in healthy rural school going children

(5-16 years) of bellur region for construction of nomogram. J Clin Diagn Res [Internet]. 2013 Dec [cited 2017 May 8];7(12):2844–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24551654

15. Shamssain MH. Forced expiratory indices in normal black Southern African children aged 6-19 years. Thorax [Internet]. 1991 [cited 2017 May 10];46:175–9. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC463024/pdf/thorax00351-0023.pdf

16. Wesley AG, Pather M, Becker P. Normal values for simple lung function tests in South African Asian children. Ann Trop Paediatr [Internet]. 1989 Jun [cited 2017 May 10];9(2):70–4. Available from: http://www.ncbi.nlm.nih.gov/pubmed/2473704

17. Mohammadzadeh I, Gharagozlou M, Fatemi SA. Normal values of peak expiratory flow rate in children from the town of Babol, Iran. Iran J Allergy Asthma Immunol [Internet]. 2006 Dec [cited 2017 May 10];5(4):195–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17237573

18. Hsi BP, Hsu KH, Jenkins DE. Ventilatory functions of normal children and young adults: Mexican-American, white, and black. III. Sitting height as a predictor. J Pediatr [Internet]. 1983 Jun [cited 2017 May 10];102(6):860–5. Available from: http://www.ncbi.nlm.nih.gov/pubmed/6854449

19. Agaba PA. Peak Expiratory Flow Rates in Healthy Nigerian Children. J Trop Pediatr [Internet]. 2003 Jun 1 [cited 2017 May 8];49(3):157–9. Available from: https://academic.oup.com/tropej/article-lookup/doi/10.1093/tropej/49.3.157

20. Onadeko BO, Iyun AO, Sofowora EO, Adamu SO. Peak expiratory flow rate in normal Nigerian children. Afr J Med Med Sci [Internet]. [cited 2017 May 11];13(1–2):25–32. Available from: http://www.ncbi.nlm.nih.gov/pubmed/6087636

21. Ortega VE, Kumar R. The Effect of Ancestry and Genetic Variation on Lung Function

Predictions: What Is “Normal” Lung Function in Diverse Human Populations? Curr Allergy Asthma Rep [Internet]. 2015 Apr 1 [cited 2017 May 11];15(4):16. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26130473

22. Whittaker AL, Sutton AJ, Beardsmore CS. Are ethnic differences in lung function explained by chest size? Arch Dis Child Fetal Neonatal Ed [Internet]. 2005 Sep 1 [cited 2017 May 10];90(5):F423-8. Available from: http://fn.bmj.com/cgi/doi/10.1136/adc.2004.062497

23. Mukhtar MS, Rao GM, Morghom LO. Peak expiratory flow rates in Libyan adolescents. Indian J Physiol Pharmacol [Internet]. [cited 2017 May 10];33(4):223–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/2620963

24. Kumaran K, Agrawal A. Normal Peak Expiratory Flow Rate of School Children in Jabalpur, Madhya Pradesh. Indian J Pediatr [Internet]. 2017 Apr 8 [cited 2017 May 10]; Available from: http://www.ncbi.nlm.nih.gov/pubmed/28389922

25. Dhungel KU, Parthasarathy D, Dipali S. Peak expiratory flow rate of Nepalese children and young adults. Kathmandu Univ Med J (KUMJ) [Internet]. [cited 2017 May 11];6(23):346–54. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20071817

26. Olanrewaju DM. Spirometric standards for healthy Nigerian children and adolescents. East Afr Med J [Internet]. 1991 Oct [cited 2017 May 11];68(10):812–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/1813304

27. Mojiminiyi FBO, Igbokwe U V, Ajagbonna OP, Jaja SI, Ettarh RR, Okolo RU, et al. Peak Expiratory Flow Rate in Normal Hausa-Fulani Children and Adolescents of Northern Nigeria. Ann Afr Med [Internet]. 2006 [cited 2017 May 8];5(1):10–5. Available from: http://www.bioline.org.br/pdf?am06003

28. Jaja SI, Fagbenro AO. Peak expiratory flow rate in Nigerian school children. Afr J Med Med Sci [Internet]. 1995 Dec [cited 2017 May 11];24(4):379–84. Available from:

http://www.ncbi.nlm.nih.gov/pubmed/8886154

29. Pedersen OF, Miller MR, Sigsgaard T, Tidley M, Harding RM. Portable peak flow meters: physical characteristics, influence of temperature, altitude, and humidity. Eur Respir J [Internet]. 1994 May [cited 2017 May 10];7(5):991–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/8050558

30. Glew RH. Comparison of Pulmonary Function between Children Living in Rural and Urban Areas in Northern Nigeria. J Trop Pediatr [Internet]. 2004 Aug 1 [cited 2017 May 11];50(4):209–16. Available from: https://academic.oup.com/tropej/article-lookup/doi/10.1093/tropej/50.4.209

31. Arora NS, Rochester DF. Respiratory muscle strength and maximal voluntary ventilation in undernourished patients. Am Rev Respir Dis [Internet]. 1982 Jul [cited 2017 May 11];126(1):5–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/7091909

32. Goswami B, Roy AS, Dalui R, Bandyopadhyay A. Peak Expiratory Flow Rate – A Consistent Marker of Respiratory Illness Associated with Childhood Obesity. Am J Sport Sci Med [Internet]. 2014 [cited 2017 May 10];2(1):21–6. Available from: http://pubs.sciepub.com/ajssm/2/1/4/

33. Abid Ali M, Vahalia K V. Some observations of peak expiratory flow in normal school children in northern Nigeria. West Afr J Med [Internet]. [cited 2017 May 11];10(2):141–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/1911482

34. FCT Universal Basic Education Board: List of public primary schools. session 2008/2009 Abuja.

35. S H. Estimating sample size and power, applications and examples. In: Hulley SB CS, Browner WS, Grady DG N, editor. Designing clinical Research. Philaldephia: Lipincott Williams and Wilkins; 2007. p. 79–90.

36. Mosteller RD. Simplified Calculation of Body-Surface Area. N Engl J Med [Internet]. 1987 Oct 22 [cited 2017 May 11];317(17):1098–1098. Available from: http://www.ncbi.nlm.nih.gov/pubmed/3657876

37. Hetzel MR, Clark TJH. Comparison of normal and asthmatic circadian rhythms in peak expiratory flow rate. Thorax [Internet]. 1980 [cited 2017 May 10];35:732–8. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC471372/pdf/thorax00178-0012.pdf

38. Alexandraki S, Koutsilieris M, Siafakas N, Katsardis C. Spirometric reference values in greek children and adolescents. In Vivo [Internet]. 2010 Mar 1 [cited 2018 Aug 7];24(2):195–200. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20363994

39. Seo WH, Ahn SH, Park SH, Kim J, Ahn KM, Ko BJ, et al. The standard range of peak expiratory flow rates of Korean children. [cited 2017 May 12]; Available from: http://thailand.digitaljournals.org/index.php/APJAI/article/viewFile//10091/9488

40. Bedi U, Dang BK. A Study of Peak Expiratory Flow Rate in Normal Healthy Children of Punjab. Int J Med Dent Sci [Internet]. 2016 Jan 1 [cited 2018 Jun 25];5(1):1042–7. Available from: http://www.informaticsjournals.com/index.php/ijmds/article/view/19064

41. Wang X, Dockery DW, Wypij D, Fay ME, Ferris BG. Pulmonary function between 6 and 18 years of age. Pediatr Pulmonol [Internet]. 1993 Feb 1 [cited 2018 Sep 13];15(2):75–88. Available from: http://doi.wiley.com/10.1002/ppul.1950150204

42. Quanjer PH, Stanojevic S, Cole TJ, Baur X, Hall GL, Culver BH, et al. Multi-ethnic reference values for spirometry for the 3-95-yr age range: the global lung function 2012 equations. Eur Respir J [Internet]. 2012 Dec [cited 2017 Aug 25];40(6):1324–43. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22743675

Appendices

Appendix1: Consent Form

Dear Parent/ Guardian,

I am Dr Adeniyi Folasade B, a Resident doctor in the Department of Paediatrics and Child Health. I am specializing in the care of children (Paediatrics). I am carrying out a study on breathing pattern in children aged 6-12years.

Problems associated with breathing are sometimes seen in Nigerian children as in children from other parts of the world. Sufficient information is however not available on the normal breathing pattern of Nigerian children.

Your child has been selected to take part in this study to determine the normal breathing pattern of children in our community. He/She will be required to blow on a whistle-like instrument (Peak flow meter) through a new mouthpiece attached to the peak flow meter to prevent cross infection. The weight and height of your child will also be measured.

Verbal assent will also be sought from your child before the procedure. We shall not force the child if he/she refuses to participate. The procedure will be done with the school permission in the late morning on the selected day and will not interfere with learning.

Permission for the study has been granted by the Federal Capital Territory Universal Basic Education Board as well as the Research ethics committee of the National hospital Abuja

Kindly indicate your willingness for your child's participation by signing in the space below and completing the questionnaire as it relates to the child. Information obtained shall be confidential. Thank you.

Parent/ Guardian's Signature.................................

Date........................

Dr Adeniyi Folasade Bunmi

National Hospital Abuja, (Investigator).

Appendix 2: Questionnaire (To be filled by parents)

(Please kindly circle appropriate answer (Yes or No) or fill in the required information into the space provided)

Name of School...

Class ....

Personal data of Child

1. Name of child...

   Surname first name

2. Date of Birth...
3. Age (last Birthday)....................................
4. Gender ....
5. Home Address...

....

6. Ethnicity/Tribe ......

7. State of origin..

8. How long has your child lived in Abuja?a)Less than 1 yr. b)1year and above

....

9 Has your child ever smoked? ....Yes/No

a. If yes, for how long.....................................

b.If yes, does he or she still smoke.........................

10 Do any of you (parents) smoke?

Father.............Yes/No

Mother.............Yes/No

11 Does any other person in your house smoke?Yes/No

if yes who?...

12 Do you use a generator very close to your house? Yes/No

13.Does your child often stay by the cooking area? Yes/No

14. Does your child often develop cough when around the cooking area ....yes/No

15. Does your child often develop difficulty in breathing while around the cooking area?....... Yes/No

16. Does your child often develop cough when the floor of your house is being swept?.............Yes/No

Medical History of your child

17. Has your child ever suffered from cough lasting longer than 2 weeks?...yes/No

18. Has your child ever experienced more than 2 episodes of cough in 2 weeks?...Yes/No

19. a.)Has your child ever experienced difficulty in breathing?..Yes/No

b) If yes how long did it last?.......................................

c)Was it associated with cough? Yes/No

d)Was it associated with fever?........Yes/No

e)Was it associated with wheezing or whistling sound?Yes/No

20. a)Was any drug given for 23 above ? ..Yes/No

b)Drug name (if known)................................

26. a) Does your child experience episodes of difficulty in breathing?Yes/No

b)If yes how frequently.............................

27. Is your child a known asthmatic......Yes/No

28. Is your child experiencing cough and cattarrh or difficulty in breathing now or in the last 4 weeks? Yes/No

29. a) Is your child on any medication for any illness Yes/No

b) If yes what is the name of the medication?.............

30. Does your child get easily breathless when:

a) Walking to school........Yes/No

b) Climbing stairs ....Yes/No

c)When playing with peers....Yes/No

d)When engaged in sports in school. Yes/No

Thank you for your co-operation

Appendix 3 - Physical Characteristics

Study No.......................................

Weight...Kg

Height...cm

Body surface area................................M^2

1. Pallor Yes/No
2. Cyanosis Yes/No
3. Finger clubbing Yes/No
4. Chest/Spinal deformity Yes/No

If yes state type........................

5.Wheezing Yes/No

6.Respiratory rate................cycles/min

7.Dyspnea.......................Yes/No

8.Heart rate........................beats/min

9.Auscultation:

a. Rhonci.......................Yes/No

b.Other sounds YesNo

if yes specify...............................

c. Reduced air entry ....Yes?No

d.Prolonged expiration Yes/No

e. Cardiac murmur Yes/No

If yes grade............type...........

10.Any other major signs of illhealth....Yes/No

11.PEFR measurements

1............................L/min

2............................L/min

3.............................L/min

Highest PEFR measurements:...................L/min

Appendix 4 National Hospital Abuja Ethics approval

Appendix 5: Permission from Education Authorities

NATIONAL HOSPITAL
The Presidency
(Established by Act No 36 of 1999).

ABUJA

BOARD CHAIRMAN:
Pharm Hamza A. Sakwa

DIRECTOR OF ADMINSTRATION
J. Odiba Esq
Member/Sec. to the Board

CHIEF MEDICAL DIRECTOR / CEO
DR. Z. O. Ajuwon, OON
MBBS, FMCP

DIRECTOR OF CLINICAL SERVICES/CMAC
Dr. Audu Lamidi Isah
MB. BS, FMC (Paed)

NHA/ADMIN/236/V.VII/987 5th October 2009

Dr. Adeniyi Funmi Folasade
Department of Paediatrics
National Hospital Abuja.

Madam,

RE: PEAK EXPIRATORY FLOR RATE IN HEALTHY URBAN NIGERIAN SCHOOL CHILDREN LIVING IN ABUJA. NHA/EC/061/2009.

Following the 11th meeting (Emergency) of the Ethics Committee held on the 29th September 2009.

I have been directed to convey formal approval to you to commence work as contained in your research proposal. The period of this approval is 2 years with effect from the date of this letter.

... are to please adhere strictly to the research protocol.

... always quote the ethics number NHA/EC/061/2009 in all correspondences ... us.

...ngratulations.

...walu Yaro
...retary, Ethics

Plot 132 Central District (Phase II) P.M.B. 425 Garki, Abuja Nigeria

F. C. T. UNIVERSAL BASIC EDUCATION BOARD, ABUJA

Moshood Abiola Way
Area 2, Section 1,
P. M. B. 163,
Garki, Abuja.

Tel: 09 - 2342608-9
Tel: 34(9) 2345373
Fax: 234(9) 2341..21

Our Ref: FCT/UBEB/ADM/614/454/I Your Ref: .... 17th June 200[illegible]

The Chief Medical Director/CEO,
National Hospital,
Abuja, FCT

Attention: Dr L.I. Audu

Sir,

RE: LETTER OF INTRODUCTION: Dr. ADENIYI F.B.SENIOR REGISTRAR PEDIATRICS

With reference to your letter No.NHA/DCS/PAED/20024 on the above Subject Matter dated 20th April 2009, I am directed to convey to you **Approval of your request please.**

2. In view of the above, Dr Adeniyi F.B. is hereby granted the permission by the FCT UBE Board to carry out her Research as titled **"Peak Expiratory Flow Rate in Nigerian School Children Living in Abuja"**, on the FCT public Primary Schools.

3. The FCT UBE Board would not hesitate to render any other possible assistance within its jurisdiction that could enhance the success of the Research.

4. Thank you.

JOHN JOEL ETSU
HOD (PRS)
FOR : EXECUTIVE CHAIRMAN

Appendix 6: Stellenbosch University Ethics approval

UNIVERSITEIT
STELLENBOSCH
UNIVERSITY

Approved

New Application

24/10/2017

Project ID #: 1180

HREC Reference #: S17/08/161

Title: PEAK EXPIRATORY FLOW RATE IN HEALTHY NIGERIAN SCHOOL CHILDREN LIVING IN ABUJA

Dear Folasadebunmi Adeniyi

The **New Application** received on 04/09/2017 was reviewed by members of the **Health Research Ethics Committee (HREC)** via Minimal Risk Review procedures on 24 October 2017 and was approved.

Please note the following information about your approved research protocol:

Protocol approval period: This project has been approved for a period of one year from the date of this approval letter.

Please remember to use your Project Reference Number (1180) on any documents or correspondence with the HREC concerning your research protocol.

Translation of the consent document/s to the language/s applicable to the study participants should be submitted.

Please note that this decision will be ratified at the next HREC full committee meeting. HREC reserves the right to suspend approval and to request changes or clarifications from applicants. The coordinator will notify the applicant (and if applicable, the supervisor) of the changes or suspension within 1 day of receiving the notice of suspension from HREC. HREC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

After Ethical Review:

Please note a template of the progress report is obtainable on https://applyethics.sun.ac.za/Project/Index/1262 and should be submitted to the Committee before the year has expired. The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly for an external audit.

Provincial and City of Cape Town Approval

Please note that for research at a primary or secondary healthcare facility permission must still be obtained from the relevant authorities (Western Cape Department of Health and/or City Health) to conduct the research as stated in the protocol. Contact persons are Ms Claudette Abrahams at Western Cape Department of Health (healthres@pgwc.gov.za Tel: +27 21 483 9907) and Dr Helene Visser at City Health (Helene.Visser@capetown.gov.za Tel:+27 21 400 3981). Research that will be conducted at any tertiary academic institution requires approval from the relevant hospital manager. Ethics approval is required BEFORE approval can be obtained from these health authorities.

We wish you the best as you conduct your research.

For standard HREC forms and instructions please visit: https://applyethics.sun.ac.za/Project/Index/1262

If you have any questions or need further assistance, please contact the HREC office at 021 938 9677.

Yours sincerely,

Francis Masiye,

HREC Coordinator,

Health Research Ethics Committee 2.

Federal Wide Assurance Number: 00001372

Institutional Review Board (IRB) Number: IRB0005239

The Health Research Ethics Committee complies with the SA National Health Act No.61 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 Part 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2015 (Department of Health).

INVESTIGATOR RESPONSIBILITIES

Protection of Human Research Participants

Some of the responsibilities investigators have when conducting research involving human participants are listed below:

- Conducting the Research: You are responsible for making sure that the research is conducted according to the HREC approved research protocol. You are also responsible for the actions of all your co-investigators and research staff involved with this research.
- Participant Enrolment: You may not recruit or enrol participants prior to the HREC approval date or after the expiration date of HREC approval. All recruitment materials for any form of media must be approved by the HREC prior to their use. If you need to recruit more participants than was noted in your HREC approval letter, you must submit an amendment requesting an increase in the number of participants.
- Informed Consent:You are responsible for obtaining and documenting effective informed consent using **only** the HREC approved consent documents, and for ensuring that no human participants are involved in research prior to obtaining their informed consent. Please give all participants copies of the signed consent documents. Keep the originals in your secured research files for at least fifteen (15) years.
- Continuing Review:The HREC must review and approve all HREC approved research protocols at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period**. Prior to the date on which the HREC approval of the research expires, **it is your responsibility to submit the continuing review report in a**

Appendix 7: Permission from Nigerian Supervisor

On Sat, Aug 12, 2017 at 12:10, Abdul-Wahab Johnson <wahabjohnson@yahoo.com> wrote:

To whom it may concern

Re: Study on Peak Expiratory Flow Rate (PEFR) in Healthy Urban Nigerian School Children

I write to confirm my favorable disposition to the use of the data emanating from the above named study which was carried out by Dr. Folasade Adeniyi in Abuja, Nigeria under my supervision. It is pertinent to state that my supervisory role with respect to the above study was on account of the supervisee's (i.e. Dr. Adeniyi's) initial intention of presenting the data as part of the requirements for the final stage of the pediatric residency training program. This was to be the Part II fellowship examination of the West African College Physicians and the corresponding stage of the National Postgraduate Medical College of Nigeria, towards a fellowship degree in Paediatrics. Following due ethical approval from the National Hospital Abuja Research and Ethics Committee, and permissions from the relevant educational authorities, she eventually initiated and completed the study/data collection. Unfortunately, matrimonial and other personal exigencies did not permit her to analyze and present the data for the purpose of any postgraduate fellowship or degree here in Nigeria, as she subsequently needed to emigrate to South Africa with her spouse.

By this communication, I am giving the said Dr. Folashade Adeniyi the permission for her to utilise the data collected for the above study for the purpose of writing up her dissertation towards the MMed degree in Paediatrics at Stellenbosch University Cape-town South Africa, presumably under the supervision of her new lecturer(s) at her current institution.

Against the background of my academic and professional and acquaintance with her (i.e Dr. Folashade Adeniyi) at both undergraduate and postgraduate stages of her training, I am quite confident she'll make a success of the intended (new) deployment of the data collected under my supervision.

Thank you for assisting her in her new academic and professional quest.

Signed
Abdul-Wahab B. Rotimi JOHNSON, MB;BS(Ibadan), FWACP(Paed.), Cert Hlth Plan Mgt(Ilorin),
Professor of Paediatrics and Child Health,
Consultant Paediatrician/Pulmonologist,
Provost, College of Health Sciences,
University of Ilorin, Ilorin,
Nigeria.