Bayero Journal of Pure and Applied Sciences, 2(2): 16 - 18
Received: November, 2008
Accepted: June, 2009

REFERENCE POPULATION EQUATIONS USING PEAK EXPIRATORY FLOW METERS: AN OVER VIEW

Salisu, A. I.
Department of Human Physiology Faculty of Medicine, Bayero University, Kano

ABSTRACT
Many formulae for predicting lung function values for Nigerians have been produced by a lot of investigators. The same principle but different statistical methods were adopted by different authors in generating these equations, hence the variability observed among these formulae. Most equations in current use are based on linear statistical models which are subject to change and they did not express the lower limit of normal. Therefore, in this study an attempt was made to give an over view of the currently available PEFR prediction equations that are in use in some of our out patient clinics in Nigeria. Some recommendations were also given on how to improve on future prediction formulae.

Keywords: Reference population equations, PEFR, over view

INTRODUCTION

Peak expiratory flow rate is one of the pulmonary function tests that provide a quantifiable measure of lung function. It is used to evaluate and monitor diseases that affect lung function, to monitor the effects of environment, occupational exposures, to assess risks of surgery and to assist in evaluations performed before employment or for insurance purposes. Peak expiratory flow is measurement of the movement of air into and out of the lungs during various breathing maneuvers Robert and Crapo (1994). This test should be readily available and routinely used in medical offices and hospitals where patients with lung diseases are treated.

Peak expiratory flow test allows the severity of an abnormality to be quantified and the presence of reversible air flow obstruction to be determined. Serial measurements (monitoring) of PEFR values may be useful in tracking pulmonary expressions of disease, quantifying responses to therapy, and making early diagnosis of lung injury after occupational exposures and drug or radiation therapy Bates (1989). When lung function test is used as an aid in diagnosis, the signal is usually the patient's results compared with the expected result for subjects without disease but similar in the personal characteristics that determine lung function such as sex, age, height, height and ethnic or race of an individual. Monitoring of PEFR allows the physician to identify and quantify pulmonary involvement incases of asthma. Monitoring is useful only when adequate base- line studies are available for comparison. A change from a patient's base-line value is more likely to indicate pulmonary injury than is the traditional comparison of values measured in the patient with reference values obtained from population studies. Changes from base-line that are as small as 5 to 10 percent may be substantial for a person and could be missed if only reference values are used in comparison Robert and Crapo (1994). Unfortunately, personal base-line measurements are lacking in most settings in Nigeria. In addition, many physicians attending to asthma cases in most accident and emergencies are not conversant with the use of peak flow meters vis-à-vis the patients they treat. Therefore, continuing medical education training and seminars will help to acquaint our young physicians on the modern ways in management of asthma cases. Variability (noise) is higher in lung function testing than any other clinical testing because of the inconsistency of the subject's effort during the process Becklake (1986).

Substantial racial and ethnic differences in PEF have been established in various studies, with Blacks having lower values than their European counterparts (Dufetel et al., 1990; Chin et al., 1997). A difference of 10-15% in spirometric measurements has been established, and this difference is attributed to the variation in trunk to leg length ratio, which is lower in Blacks compared to Caucasians Le Souef (1997). In considering the variability of a PEF test, a distinction must be made between precision and accuracy. Precision refers to the repeatability of the measurements, even if the values obtained are not accurate Jay (1984). Accuracy, which is not easy to establish, refers to how close the measurements made by an instrument are to the "true" value. Because most instruments have better precision than accuracy, between instruments variation usually contributes more to total measurement variability than within instrument variation Jay (1984). Therefore, detection of instrument problem is an integral part of interpretation of a PEF result. It is recommended that instruments and procedures used in developing reference values and those used to evaluate patients should meet the current ATS (American Thoracic Society) recommendations. Other causes of variation include biologic and disease variations. The biologic variations are related to disease, environment, intake of drugs, smoking, failure of the subject to inspire or expire maximally during the PEF maneuvers, body and head positions and circadian rhythms.

The objectives of this research are:

1. To assess the contribution of different Scholars on population reference equations produced using PEF meters in Nigeria
2. To highlight on the limitations observed on some of these population driven reference equations
3. To suggest other methods to improve on the reference equations produced

Contribution of Scholars in generating PEFR prediction equations in Nigeria

Normal values of PEFR need to be re-evaluated from time to time in order to accommodate changes related to environment, occupations, social and personal factors like education which blend with development of the society. Peak expiratory flow rate, which is measured with simple, portable, and relatively inexpensive equipment that is independent of electricity, is still a suitable test of lung function for use in some parts of Africa where medical facilities are poor Elebute (1971).

Studies for obtaining formulae for predicting normal lung function values for Nigerians have been produced by a lot of investigators. Some of the prediction formulae reported in literature considered very few numbers (less than 300) of females (Oduntan, 1970; Ali, 1983; Jaja, 1989; Suzanne *et al.,* 1994; Salisu *et al.,* 2007). Singh *et al.,* (1983) used a population of more than 600 women, while Njoku & Anah (1999) used a population of 1009 male and female adult Nigerians. Some other workers focused mainly on PEFR (Aderele and Oduwole, 1983; Jaja and Ojo, 1983; Jaja and Ogungberu, 1996; Njoku and Anah, 1999; Okoroma& Oviaore, 2000 and Salisu *et al.,* 2008). In other studies the prediction equations were mainly in FVC and FEV_1 (Oduntan, 1970; Patrick and Femi pearse, 1976; Onadeko *et al.*, 1976; Ali, 1983; Ahuja and Ahuja, 1983). In all these studies, all the parameters that affect lung function namely; age, body weight and height were not taken into consideration in the formulation of prediction equations for lung function indices namely; FVC, FEV_1 and PEFR according Nku *et al.,* (2006). For instance, Chehreh *et al.,* (1973) and Singh *et al.,* (1983) believed that gross weight contributes comparatively little to the resulting prediction formulae regardless of the race being studied, hence it was not considered in their prediction formula. Also, Suzanne *et al.,* (1994) did not consider age as contributing significantly to any equation, so their equations were thus, derived without age as a factor. Equally, Njoku and Anah (1999) did not include weight, while Salisu et al., (2007), based on the format adopted by Njoku and Anah (1999) did not include height in our prediction equation on PEFR. Nku *et al.,* (2006) thus, found most of these prediction equations fall short of including all the parameters known to affect lung function; age, weight and height. They therefore produced a prediction equation that include these three parameters and also considered FVC and FEV_1 in addition to PEFR.

Limitations of Currently Available PEFR Equations in Nigeria

Reference equations available so far include relatively few results for adolescents and the elderly. None of the equations span the ages from childhood through adolescent to the elderly. They are mostly discontinuous for children and for adults, for instance; (Jaja, 1989; Jaja and Fagbenro, 1995). Being cross sectional studies, are subject to bias called cohort effect because of a variety of host and other environmental factors. Most equations in current use are based on linear statistical models which are subject to change for instance, Njoku and Anah (1999); PEF (L/min) = 2.40Age + 3.04HT- 14.28, Nku et al (2006); PEF (L/min) = -38.80+ (210.83H) + (1.650A)+(0.252W), and Salisu et al (2007); PEF (L/min) = 0.5A+0.15W+350.37. In addition, these equations did not express the lower limit of normal. Ideally, publications describing reference populations should include not only the prediction equations but also a means of defining their lower limits.

Nku's *et al.,* (2006) PEFR prediction formula which is thought to be an updated reference equation for use on Nigerian women has some limitations too; because it did not consider the standard error of estimate in their regression analyses. The most commonly reported measures of how well regression equations fit the data described the square of the correlation coefficient (r^2) and the standard error of the estimate (SEE), ATS (1991). The proportion of variation in the observed data explained by the independent variables is measured by the r^2 while the SEE is the average standard deviation (SD) of the data around the regression line. SEE will decrease and r^2 will increase as regression methods diminish the differences between predicted and observed pulmonary function values in the reference population. Therefore, Nku's *et al.*, (2006) formulae need to be re-evaluated to include the correlation coefficient r^2 and the standard error of estimate SEE.

Caution

The choice of reference formulae for PEFR has implications for those who conduct asthma research, those who design asthma practice guidelines, and primary and emergency care clinicians, who must make treatment and disposition decisions for the individual patient. The issue of asthma research is affected when investigators attempt to compare studies and outcomes of asthma care based on different reference formulae. Across Nigerian hospitals, utilization of different formulae may show wide variability in outcomes, as the severity classification will not be truly comparable. Unless we are told that two studies are comparing percent predicted PEF based on the same formula, then we must use caution in interpreting the results.

The choice of formula to select as a standard should satisfy several criteria. First, the population studied should be representative of the patient's seen in the emergency department (ED) in terms of age, sex, and race and tribe/ethnicity. This increases the generalizability of the formula.

Second, the number of subject should be large so that the estimate of the predicted PEFR includes wide range of variations. The confidence interval of an estimate is determined by the standard deviation of the measurement divided by the square root of the sample size. Consequently, the larger the number of subjects tested, the more the confidence we can have in the estimated PEFR predicted by the formula. Third, the more recently the measurements have been taken, the more likely that it will be that the equipment used in the investigation will be representative of the equipment in current practice. This allows investigators an easier opportunity to reproduce the results. Therefore, if one equation led to a given age group's predicted PEF being systemically higher or lower then future guidelines should adjust their cutoff, predicted PEFRs to reconcile their recommendations to the instrument available in clinical practice.

Recommendations

1. The first step in interpretation is to evaluate and comment on the quality of PEFR test. Border line "normal" values should be interpreted with caution. Such interpretations should, when possible, use clinical information in the decisions as to what is normal and what is abnormal.
2. Ideally, reference values should be based on data obtained using equipment and procedures that conform to the current ATS (American Thoracic Society) standard. This is also a challenge to our Nigerian Thoracic Society to produce standard guidelines on respiratory function tests in Nigeria.
3. Subjects used to generate reference values should be free from respiratory symptoms and disease. It is preferable to choose reference values separate for men and women from the same population source.
4. Prediction equations should come from studies that present lower limits of normal or present information from which such lower limits can be calculated. Computer calculations should be validated anytime changes are made in the software or hardware.
5. Tests performed on children are best interpreted by those who are familiar with pulmonary function in children.

REFERENCE

Aderele, W. I. and Oduwole, O. (1983): Peak expiratory flow rate in healthy school children. *Nig.J.Paed.* 10:45-55

Ahuja, G. G. and Ahuja, I. S. (1983): A comparative study of ventilatory pulmonary function test in health and disease in Nigerain males. *West. Afr. Med. J* 2:61-65.

Ali, M. A. R. (1983): Ventilatory function in non-smoking healthy Nigerian adults. *West.Afr.J. Med*. **2:**1-8

Chehreh, M. N., Young, R. C., Viaene, H., Ross, C. W; Scott, R. B. (1973).Spirometric standards for healthy inner-city black children. *Am. J. Dis. Child.* **126:**159-163.

American Thoracic Society (1991): Lung Function Testing; Selection of Reference Values and Interpretative Strategies. 1202 – 1214

Bates, D.V. (1989): Respiratory function in disease. 3rd ed. Philadelphia: W.B. Sunders.

Becklake, M.R. (1986): Concept of normality applied to the measurement of lung function. *Am. J. Med*. **80:** 1158-64

Chin, N.K. Hui, K.P. Tan, W.C. (1997): Population based standard for pulmonary function in non-smoking adults in Singapore. *Respirology* **2:** 143-9

Dufetel, F. Sambiani, K. Toghey. K, Kolani, M. (1990): Characteristic of lung volumes and expiratory flow seen in black African adults. *Rev. Mal. Respir*. **3:** 215-222.

Elebute E.A., Femi – Pearse (1971): Peak flow rate in Nigeria. Anthropometric determinants and usefulness in assessment of ventilator function. *Thorax*; **26:** 597 – 601

Jaja, S. I. (1989): Ventilatory function in adult Nigerians. *Nig. J. Physiol. Sci*. **5:** 96-101

Jaja, S. I. and Ogungberu, S. A. (1996): Peak expiratory flow rate in Nigerians aged between 50 and 80 years. *Nig. Qt. J. Hosp. Med*. **6:** 305-308

Jaja, S. I. and Ojo, G. O. (1983): Peak flow rate in young Nigerian adults. *Nig. J. Physio. Sci*. **1:** 24-30

Jaja, S.I. and Fagbenro, A.O. (1995): Peak expiratory flow rate in Nigerian Children. *Afr. J. Med. Sci.*

Jay, F.ed. (1984): standard dictionary of electrical and electronic terms. 3rd ed. New York Institute of Electrical and Electronic Engineers, Inc.

Lu Souef, P.N. (1997): Paediatric prediction equations for PEF (growth, ageing, gender, race and health). *Eur Respir J;* 10 Suppl **24**: 75s-79s

Njoku, C. H. and Anah, C. O. (1999). A new formula for predicting peak expiratory flow rate in adult Nigerians. *Sahel med. J* **2:** 39-44

Nku, C.O, Peters E.J, Eshiet A.I, Bisong, S.A, Osim E.E. (2006): Prediction formulae for lung function parameters in females of south eastern Nigeria. *Nig. J. of Physiol. sci.* **21:** 43-47.

Oduntan, S. A. (1970): Spirometric studies of normal and preoperative patients in Nigeria. *Afr.J.Med.Sci.* **1:**79-84

Okoroma, C. N. and Oviawe, O. (2000): Peak expiratory flow rate in Children living in Enugu urban area, Nigeria. *Nig. Qt. J. Hosp. Med*. **10:** 171-174.

Patrick, J. M. and Femi-Pearse, D. (1976): Reference values of FEV_1 and FVC in Nigerian men and women. A graphical summary. *Nig. Med. J.* **4:**380-385

Robert and Crapo (1994): Review article: Pulmonary function testing. *N. Eng. J. of Med.***331**: 25-29.

Salisu, A.I, Adelaiye, A.B, and Babashani, M. (2007): A formula for predicting peak expiratory flow rate in non-pregnant and pregnant women at second and third trimesters of pregnancy in kura local government area, kano, Nigeria. *Medwell Res. J. Med. Sci.* **5:** 279- 283.

Singh, R., Singh, H. J., Sirisinghe, R. G. (1992): FVC in Malaysians females. *Jpn. J. Physiol.* **42:** 407-414.

Suzanne, M. B., David, A. A. and Mark, W. C. (1994): Pulmonary function test outcome in healthy Nawajo native American adolescents. *Am. J. Resp.*