AFRICAN JOURNAL OF MEDICINE and medical sciences

VOLUME 24, NUMBER 4, DECEMBER 1995

EDITOR: B.O. ONADEKO
ASSISTANT EDITORS:
B.O. OSOTIMEHIN and A.O. UWAIFO

SPECTRUM BOOKS LIMITED
Ibadan • Owerri • Kaduna • Lagos

ISSN 1116–4077

Afr. J. Med. med. Sci. (1995) **24** *379-384*

Peak expiratory flow rate in Nigerian school children

S.I. JAJA* and A.O. FAGBENRO
Department of Physiology, College of Medicine, University of Lagos, Lagos, Nigeria.

Summary

Peak expiratory flow rate (PEFR) was measured using the Wright's peak flow meter in 263 school boys and 275 school girls living in Lagos, Nigeria. Their ages ranged from 6.0 years to 19.0 years (mean 11.9 ± 3.8 yrs. for boys and 11.8 ± 3.9 yrs. for girls). Mean PEFR was 359.2 ± 102.0 L/min (range 160.0 — 610 0 L/min) in boys and 327.7 ± 81.3 L/min (range 160.0 — 500.0 L/min) in girls. Apart from ages 17, 18 and 19, peak expiratory flow rates were similar in both boys and girls. In both sexes, PEFR correlated positively and significantly with age, height, weight and body surface area. Also in both sexes and in all age groups studied, PEFR was significantly higher than predicted values obtained from previous Nigerian and caucasian prediction equations. When compared with values obtained from a second caucasian prediction equation, observed values were significantly higher in the 6 — 10 years and 16-19 years age groups in boys and 11-15 years and 16-19 years age groups in girls. New prediction equations for calculating PEFR in Nigerian boys and girls are presented. Observed PEFR may be due to enhanced stature in Nigerian children resulting from improved environment and genetic factors.

Résumé

Le taux de bebit expiratoire (PEFR) de 263 ecoliers et 275 écolieres habitant Lagos, Nigeria, a été mesuré utilisant' l'instrument de Wright; Leurs âges varient de 6 à 19 ans (moyen = 11.9 ± 3.8 ans pour les garcons et 11.8 ± 3.9 pour les filles).

Le moyen PEFR etait de 359.2 ± 102.0 L/min (160.0 — 610.0 L/min) chez les garcons et 327.7 ± 81.3 L/min (160.0 — 500.0 L/min) chez les filles. A part ceux âgés de 17.18 et 19 ans, le taux le plus haut de débit expiratoire (PEFR) était similaire, chez les garcons et les files. Chez les deux sexes, il y'avait une correlation positive et significative entre PEFR et l'âge, la taille, le poids et la superficie totale du corps. Encore, chez les deux sexes et dans tous les groupes d'âge étudiés PEFR était significativement plus haut que les-valeurs prédites obtenues d'après une deuxième equation de prédiction caucasoide. Ou les valeurs observées étaient significativement plus hautes chez ceux âgés de 6 à 10 ans et ceux de 16 à 19 ans pour les garcons et les groupes d'âge de 11 à 15 ans et de 16 à 19 ans en ce qui concerne les filles.

De nouvelles équations de prediction pour calculer le PEFR de jeunes Nigérians sont presentées. Le PEFR observé est probablement dû à la grande taille de ces enfants Nigerians due à de meilleurs environments et à des facteurs génétiques.

Introduction

Pulmonary function in adult Nigerians has been studied extensively [1-6]. Conversely very few pulmonary function studies have been reported in Nigerian children [7-9]. Fewer studies still have been reported on the pattern of peak expiratory flow rates (PEFR) in Nigerian children [8,9]. The determination of PEFR in children could be valuable in the diagnosis and treatment of obstructive airway disorders in them. The use of the Wright's peak flow meter in the measurement of PEFR has become popular because of its lower cost of operation,

* Correspondence: Dr. S.I. Jaja, Department of Physiology College of Medicine, P.M.B. 12003, Lagos, Nigeria.

independence of electric power and the speed with which the test can be carried out [2,4,8].

The aim of this study is to determine PEFR values in Nigerian school children and to present equations for predicting PEFR in Nigerian children. This will aid the proper evaluation and management of certain respiratory diseases in children.

Materials and methods

Five hundred and thirty eight school children made up of 263 boys and 275 girls, aged between 6.0 years and 19.0 years were randomly selected from four schools in Lagos, Nigeria.

Two of the schools were primary schools. One was fee-paying, attended by children from a high socio-economic background. The other, the University staff primary school, was attended by children from a middle socio-economic background. The other two schools were secondary grammar schools. One is fee-paying and attended by children from a high socio-economic background while the other is a non-fee paying public school. Children from middle and low socio-economic background are predominant here.

None of the children that participated in the study had a history of respiratory disorder. None also was a cigarette smoker. It was ensured that subjects were capable of adequate co-operation during the tests. A few of the subjects were rejected on this basis.

The following parameters were recorded for each subject: age (years), height (centimeters) and weight (kilograms). Body surface area (m^2) was calculated from the formula of Dubois and Dubois [10]. Height was measured without shoes. Weight was measured without shoes and with light clothing. Peak expiratory flow rate (PEFR; L/min) was measured at ambient temperature, pressure, saturated with water vapour (ATPS) with the Wright's peak flow meter. The measurements were performed with the subject standing and the best of three trials was recorded. The method of measurement has been described by earlier workers [4,8].

Results are presented as mean ± SD ($\bar{x}$ ± SD). Correlation coefficients (r) were calculated between peak expiratory flow rate and age, height, weight or body surface area. Linear and multiple regression analyses were carried out incorporating measurements of age, height, weight and body surface area for the formulation of a prediction equation for predicting PEFR in either sex. The chosen prediction equation had the least standard error of estimates (S.E.E.). An IBM computer (IBM PC AT286) employing the statistical package for social studies (S.P.S.S.) programme was used in the analysis.

The student's t-test was used to assess the statistical difference between PEFR of the male and female subjects of the same age. The student's paired t-test was used to make comparisons between observed and predicted values calculated from a Nigerian [8] and caucasian [11,12] prediction equations. Statistical significance was accepted as $p<0.05$.

Results

A summary of mean, standard deviation and range of values obtained in male and female subjects is presented in table 1. Fig. 1 shows that PEFR values were similar in both sexes except at ages 17, 18 and 19 years where male values were significantly higher ($p<0.001$, $p<0.001$ and $p<0.05$ respectively).

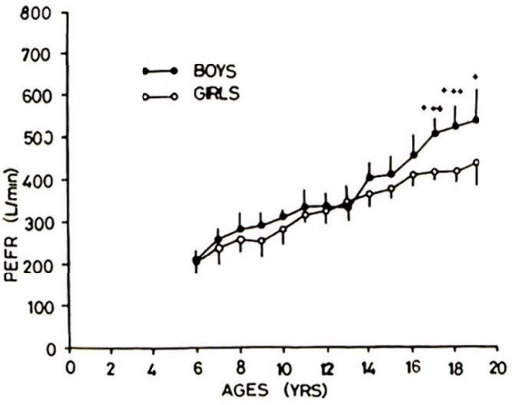

Fig. 1: Peak expiratory flow rate in relation to age. Values are mean ± SD. * P <0.05; * P <0.01; *** P <0.001.

Table 2 shows the correlation coefficients (r) between PEFR and the measured variables in both sexes. In males, body surface area had the highest correlation coefficient (r = 0.89; p 0.001) with PEFR while in females age had the highest correlation coefficient with PEFR (r = 0.90; p 0.001). However in both sexes, weight correlated better with PEFR than height.

Table 1: Summary of results

Measured Variable	Boys		Girls	
	Mean ± S.D	Range	Mean ± S.D.	Range
Age (years)	11.9±3.8	6.0—19.0	11.8±3.9	6.0±19.0
Height (cm)	146.2±20.1	112.0—186.0	141.9±15.9	113.5±180.0
Weight (kg)	38.6±13.1	19.5—81.0	38.0±11.3	21.0±68.3
Body surface Area (m^2)	1.25±0.3	0.78—1.97	1.23±0.3	0.81±1.70
PEFR (L/min)	359.2±102.0	160.0—610.0	327.7±81.3	160.0±500.0

Table 2: Correlation coefficients (r) between PEFR and measured variables in boys and girls

	Boys		Girls	
	r	p	r	p
Age	0.87	0.001	0.90	0.001
Height	0.73	0.001	0.76	0.001
Weight	0.82	0.001	0.87	0.001
Body surface area	0.89	0.001	0.84	0.001

Table 3: Comparison of observed and predicted PEFR (L/min) in various age-groups in males.

Age-groups (yrs)	Present study	Predicted values	p value
6-10 yrs. (n=110)	274.1±36.4	233.2±28.7 (8)	p<0.001
		242.8±35.7 (11)	p<0.01
		254.9±34.1 (12)	p<0.01
11-15 yrs. (n=111)	354.2±29.7	324.0±32.6 (8)	p<0.001
		350.6±40.1 (11)	NS
		368.6±41.5 (12)	NS
16-19 yrs. (n=63)	515.1±34.4	421.8±7.1 (8)	p<0.001
		478.2±8.9 (11)	p<0.001
		493.0±9.0 (12)	p<0.001

(8) Onadeko *et al*
(11) Nairn *et al*
(12) Murray and Cooke

Table 4: Comparison of observed and predicted PEFR (L/min) in various age-groups in females.

Age-groups (yrs)	Present study	Predicted values	p value
6-10 yrs. (n=110)	252.1±27.6	231.3±14.0 (8)	p<0.001
		241.8±20.5 (11)	p<0.05
		261.9±18.1 (12)	NS
11-15 yrs. (n=100)	352.7±25.4	292.5±36.4 (8)	p<0.001
		320.6±17.1 (11)	p<0.01
		332.9±20.0 (12)	p<0.05
16-19 yrs. (n=59)	425.8±10.4	343.7±9.6 (8)	p<0.001
		407.6±14.4 (11)	p<0.01
		405.0±12.4 (12)	p<0.01

(8) Onadeko *et al*
(11) Nairn *et al*
(12) Murray and Cooke

Tables 3 and 4 show a comparison of observed and predicted PEFR values of different age groups in males and females respectively. Predicted values were calculated from earlier prediction equations for Nigerians [8] and caucasians [11,12]. In males (table 3), and in all age groups studied observed PEFR values were significantly higher ($p<0.001$ in all age groups) than predicted values obtained from the formulae of Onadeko *et al* [8]. When compared with predicted values obtained from caucasian prediction equations [11,12], observed values were significantly higher in the lowest (6-10 years) and highest (16-19 years) age groups. No significant differences were observed in the intermediate (11-15 years) age group (table 3).

In female subjects, mean observed values were significantly higher than predicted values in all age groups except in the 6-10 years age group where the predicted value from formula of Murray and Cooke [12] was slightly higher than observed value (table 4).

Regression analyses incorporating measurements of age, height, weight and body surface area were performed for the calculation of a prediction equation in each sex. The chosen equation had the least standard error of estimates (S.E.E.). In boys, a combination of age and weight had the least standard error of estimates while in the girls a combination of age and body surface area produced the equation with the least standard error of estimates (Table 5). Thus for boys, PEFR (L/min) = 11.3 Age (years) + 4.34 Weight (kilograms) + 58.4 (± 36.2). For girls, PEFR (L/min) = 13.9 Age (years) + 76.5 BSA (m^2) + 73.3 (± 32.1).

Discussion

This study shows that PEFR is similar in both sexes of the same age except at ages 17, 18 and 19 where male children have significantly higher PEFR. This is similar to the earlier observation made in Nigerian children by Onadeko *et al*. [8]. That PEFR could be similar in both sexes is in contrast to observations made in adult Nigerians [2,4] and caucasians [13,14]. The significantly lower values seen in the older female subject in comparison to their male counterparts may be due to the difficulty encountered in persuading them to make a maximal effort. Other workers [12] have suggested that lower values may be due to respiratory muscle weakness or inefficiency.

Results also show a positive and significant correlation of PEFR with age, height, weight or body surface area in both male and female children. It was also observed that in both sexes, the correlation coefficient (r) of PEFR with weight was higher than with height. These results are similar to earlier observations in Nigerian children [8,9] and adults [4]. That PEFR correlates better with weight than height however is in contrast to observations made in caucasian children which showed that PEFR correlated more closely with height than weight [11].

Table 5: Coefficients for predicting PEFR from age, weight, height and body surface area in Nigerian children.

Predictors used	Sex	Coefficients for age (yrs)	Coefficients for weight (kg)	Coefficients for height (cm)	Coefficients for BSA* (m^2)	Constant	Standard Error of Estimates (S.E.E.)
Age	M	23.2	—	—	—	82.05	47.1
	F	18.4	—	—	—	113.5	33.3
Weight	M	—	7.22	—	—	82.17	43.3
	F	—	6.00	—	—	101.0	39.9
Height	M	—	—	4.07	—	−236.4	59.6
	F	—	—	3.30	—	−135.6	52.2
Body Surface	M	—	—	—	308.1	−26.76	47.3
	F	—	—	—	264.7	8.02	40.4
Age, wt	M	11.3	4.34	—	—	58.4	36.2+
	F	13.9	1.70	—	—	100.7	32.2
Age, ht	M	17.8	—	1.25	—	−36.5	45.0
	F	16.3	—	0.60	—	53.7	32.6
Age, BSA*	M	12.6	—	—	165.6	0.77	39.5
	F	13.9	—	—	76.5	73.3	32.1++
Ht, wt	M	—	5.70	1.19	—	−33.05	41.0
	F	—	4.75	1.05	—	−0.09	37.9

*BSA = Body surface area.
+Least standard error of estimates for boys
++Least standard error of estimates for girls

The present findings also show that in both sexes and in all age groups the observed PEFR is significantly higher than values predicted from the formula of Onadeko *et al.* [8]. Such differences may be attributed to differences in the physical characteristics of the subjects studied. This study also reveals that in both sexes and in almost all the age groups studied observed PEFR is significantly higher than predicted values derived from caucasian prediction equations [11, 12]. This is a surprise finding as it has consistently been shown by earlier workers that peak expiratory flow rates are lower in Nigerian children [8,9] and adults [2,5] than in their caucasian counterparts of the same age and sex. The enhanced PEFR values seen in this study may be due to enhanced stature in Nigerian children resulting from improved environmental and genetic factors.

Prediction equations calculated from this study will serve as a guide in the assessment and treatment of certain respiratory diseases in children. Table 5 shows coefficients for predicting PEFR from anthropometric measurements. A combination of age and weight in boys or age and body surface area in girls give the equations with the least standard error of estimates (S.E.E.).

Acknowledgement

We are grateful to the headmasters/headmistresses of the schools that participated in this study. They are; University Staff School, Idi-Araba, Lagos; Idi-Araba High School Idi-Araba, Lagos; Chrisland Primary School, Opebi, Ikeja and Chrisland Secondary School, Opebi, Ikeja. We are grateful to Mr. P.C.M. Obiefuna for use of his personal computer and Mr. C.O. Owunna for secretarial assistance.

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(Accepted 18 May, 1993)