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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 State, Nigeria

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Abstract: Values of Peak Expiratory Flow Rate (PEFR), in 250 females at their reproductive ages, made up of 123 pregnant subjects and 127 non-pregnant control groups, living and / or working in Kura local government area and its environs were obtained. Pearson's correlation coefficient between PEFR and ages as well as other anthropometric measurements were calculated in both groups. Multiple regression analyses were carried out to obtain the best prediction formulae using the measured variables in both subjects and control groups. Further more, graphs were plotted to show the variation of PEFR with age in the subjects and controls. Data for plotting the graphs were generated using the prediction formulae generated from this study and previous studies among Nigerians, whose best prediction formulae incorporated age and height. The graphs illustrate the limitation of applying formulae derived from a different race, tribe and / or generation to an entirely different people with dissimilar characteristics. This lends credence to the need to make use of recent locally generated formulae for local predictions.

Key words: Prediction formula, expiratory flow rate, pregnant women, PEFR

INTRODUCTION

Ventilatory functions in Caucasians subjects have been extensively studied by a number of investigators, Korry and Hamilton (1961). Published work on Peak Expiratory Flow Rate (PEFR) on Africans, particularly Nigerians by investigators, Oduntan (1970), Femi Pearse and Elebute (1971), Onadeko *et al*. (1976), Abid Ali (1983) and Njoku (1999) dwelt more on adult male and non pregnant women.

This study was aimed at obtaining values of PEFR in normal pregnant and non-pregnant female at their reproductive ages and also to derive a prediction formula for predicting the normal values in kura local government area of Kano State.

MATERIALS AND METHODS

Subjects for the study: Two fifty apparently healthy females at their reproductive ages, made up of 123 pregnant subjects and 127 non-pregnant controls living and/or working in Kura local government area of Kano State were recruited for this study. Study cohorts were picked by a random sampling method. The inclusion criteria were:

- Willingness and ability to participate fully in the study.
- No history of hypertensive disorders i.e. BP >140/90 mmHg.
- No history or sign of pre eclampsia.
- No history of pulmonary disease e.g. asthma or pneumonia.
- No history of recent ingestion of drugs that may affect their cardio respiratory systems.
- Not alcohol or cigarette users.
- Absence of any chest or physical deformities and other signs of systemic disease on physical examination.

Collection of anthropometric data: Anthropometric data collected on each subject included : Weight (Kilogram) On bare feet using a bathroom scale (Beexon, Hungry); height (centimeter) on bare feet using standard measuring meter rule; chest circumference (centimeter) in expiration at the level of the 4th intercostals space and thoracic length (centimeter) measured at the back from the root of the neck to the last rib with an inelastic tape measure (gold fish brand superior tailoring rule chine; body mass index, calculated by using the measured height and weight from this study.

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The Peak Expiratory Flow Rate (PEFR): This was determined using the portable Wright's peak flow meter (clement Clarke international Harlow England) whose calibration was checked at regular interval. It has a central graduation and a pointer. The pointer moves in proportion with the volume and pressure of the expired gas from the mouth. The apex of the flow meter is connected to a disposable mouthpiece. Several mouthpieces were used. Each sterilized at the end of used by one subject, using a cotton wool and chlorohexidine solution. Explanation of the purpose of study and a demonstration of the method of performing the test were given prior to the commencement of the test. Subjects were then made to stand erect, all tight buttons, belt or girdles (where applicable) were loosened. Each subject was made to hold the flow meter lightly with fingers of both hands, emphasis placed on not occlude the movement of the pointer. They, then blow the expired gas from the month with full pressure into the month pieces. Three readings were taken at one-minute interval. The highest of the readings was taken as the representative value.

Statistical analyses: Statistical analyses of the data were carried out with an EPI- info software programme. PEFR was correlated with anthropometric measurements. Linear regression coefficient for predicting PEFR from the measured variables in subjects and controls were calculated using different combinations of variables. The Standard Error of Estimate (SEE) for each combination of variable was worked out to enable us make a choice as to the best combination that can near accurately predict PEFR in the subjects and controls. Graphs were drawn using Microsoft Excel package, to compare the observed variation of PEFR with age. Data for plotting these graphs were generated using the prediction formula generated from this study and other prediction formula generated from previous study among Nigerians by Njoku and Anah (1999).

RESULTS

The mean and standard error of estimate of the anthropometric variables are presented in Table 1. The mean value of PEFR among those studied were 375.20 (3.1) L min^{-1} in subjects and 371.18 (4.3) L min^{-1} in the controls. Table 2 shows the cohorts included in this study according to their occupation. The unemployed constitute most of the study population. Table 3 shows the subjects and controls grouped in their quintiles with the observed mean values of PEFR in each group. Those in their twenties contributed much to the study population. The mean values of PEFR showed an increase with increasing age reaching a peak in the 20-24 years age range in both groups. The values began to decrease with increasing age thereafter. The correlation coefficient between the PEFR and the measured variables among the two groups is shown in Table 4.

Chest circumference shows a strong and positive correlation with PEFR in the subjects but a weak correlation in the control group. Thoracic length shows a significant correlation with PEFR in the controls and an insignificant correlation in the subjects. Table 4 and 6 show the results of multiple regression analyses of the measured variables on PEFR in both the subjects and controls, respectively. From Table 5, the formula incorporating age and weight i.e. 0.36AGE-0.47WT + 391.67 had the lowest Standard Error of Estimate (SEE): (25.58) and therefore, will be the best prediction formula for PEFR in the subjects. The formula incorporating age and Body Mass Index (BMI) i.e.

Table 1: Anthropometric variables of subjects and controls

Variable (Unit)	Subjects Mean (SEM)	Controls Mean (SEM)
Age (Yrs)	22.73 (0.54)	25.71 (0.64)
Height (cm)	156.93 (0.005)	157.48 (0.005)
Weight (kg)	52.83 (0.60)	51.52 (0.89)
Chest circumference (cm)	81.58 (0.42)	80.05 (0.60)
Thoracic Length (cm)	38.04 (0.18)	38.67 (0.24)
PEFR (L min^{-1})	375.20 (3.1)	371.18 (4.3)

Table 2: Grouping of subjects and controls according to their occupation

	Pregnant		Non–pregnant	
	Number	(%)	Number	(%)
Full time house wife	73	59.35	52	40.95
Trader	49	39.84	71	55.9
Civil servant	1	0.81	4	3.15
Total	123	100%	127	100%

Table 3: Variation of PEFR with age among subjects and controls

	Subjects		Controls	
Age range (Years)	Number (%)	Mean PEFR (SEM)	Number (%)	Mean PEFR (SEM)
15-19	38(30.89)	368.95(7.00)	21(16.54)	354.80(12.8)
20-24	48(39.04)	379.58(4.43)	38(29.92)	380.26(7.60)
25-29	17(13.82)	377.06(6.57)	20(15.75)	375.50(8.48)
30-34	14(11.38)	373.57(8.93)	29(22.83)	370.93(9.28)
35-39	3(2.44)	363.30(14.5)	7(5.51)	358.57(4.04)
40-44	1(0.81)	390.00(*)	10(7.87)	355.00(18.2)
45-49	1(0.81)	350.00(*)	2(1.58)	380.00(20.0)
50-54	1(0.81)	350.00(*)	0	0
Total	123( )	375.20(3.1)	127( )	371.18(4.3)

(*) a single subject represented the groups indicated

Table 4: Pearson's correlation coefficient between PEFR and measured variables

	Subjects		Controls	
Measured variable	R	P	R	P
Age	0.031	0.736	0.09	0.316
Height	-0.1	0.271	0.078	0.381
Weight	-0.072	0.430	0.056	0.534
Chest circumference	0.175	0.053	0.097	0.278
Thoracic length	0.09	0.324	0.238	0.007
BMI	-0.02	0.826	0.019	0.836

Key; BMI-Body Mass Index, R-correlation coefficient, P-level of significance

Table 5: Linear regression coefficient for predicting PEFR from measured variables in the subject group

Predictors used	Coefficient for age (yrs)	Height	Weight	BMI	Chest circum-ference	Thoracic length	Constant	Multiple correlation coefficient	Standard error of estimate
Age, Weight	0.36		-0.47				391.67	0.01	25.58
Age, Height	0.32	-67.8					474.33	0.01	88.17
Age, BMI	0.24			-0.38			377.96	0	28.16
Age, C.C	0.004								
					1.29		269.94	0.03	54.19
Age, T.L. BMI	0.21			-0.64		1.65	321.22	0.01	62.02
Weight, C.C			-1.37		2.43		249.34	0.08	53.55
Weight, T. L.			-0.62			2.3	320.56	0.02	59.52
Weight, C.C. T.L.			-1.48		2.3	1.44	210.65	0.08	69.65
Age, T.L.	0.17					1.5	314.21	0.01	60.13

C.C. = Chest Circumference, T. L. = Thoracic Length

Table 6: Linear regression coefficient for predicting PEFR from measured variables in the control group

Predictors used	Coefficient for age (yrs)	Height	Weight	BMI	Chest circum-ference	Thoracic length	Constant	Multiple correlation coefficient	Standard error of estimate
Age, Weight	0.5		0.15				350.37	0.01	24.1
Age, Height	0.59	64.85					253.98	0.01	113.8
Age, BMI	0.6			-0.19			359.67	0.01	26.36
Age, C.C	0.41				0.56		316.12	0.01	50.78
Age, T.L. BMI	0.21			-2.13		5.41	200.77	0.07	59.33
Weight, C.C			-0.014		0.7		315.94	0.01	51.87
Weight, T. L			-0.69			5.71	186.13	0.07	61.32
Weight, C.C. and T.L.			-0.78		0.28	5.58	173.68	0.07	70.89
Age, T.L.	0.002					4.15	210.57	0.06	59.26

C.C. = Chest Circumference T.L. = Thoracic Length

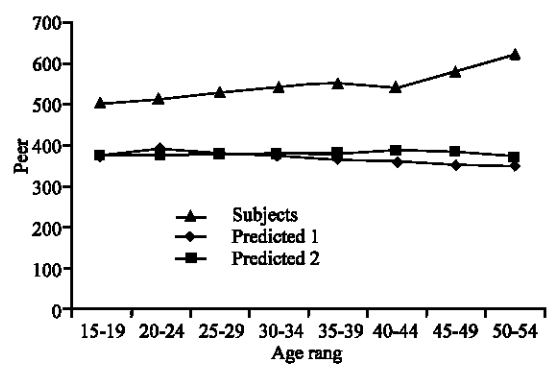

Fig.1: Variation of PEFR with age among the subjects, 1. PEFR observed from this study; 2. PEFR predicted from this study; 3. PEFR predicted by Njoku (1999)

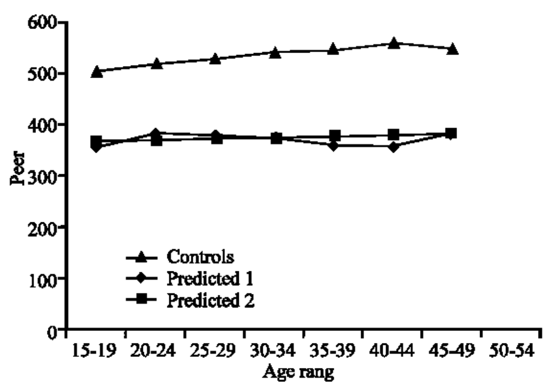

Fig. 2: Variation of PEFR with age among the control, 1.PEFR observed from this study; 2. PEFR predicted from this study; 3. PEFR predicted by Njoku (1999)

0.24AGE-0.38BMI+377.96 follows closely with SEE value of 28.16. Similarly, from Table 6 the formula incorporating age and weight i.e. 0.5AGE + 0.15WT + 350.37 had the lowest standard error of estimate (24.1) and therefore, is the best prediction formula for PEFR in non-pregnant controls. This is followed closely by the one incorporating age and BMI (SEE; 26.36); i.e. 0.6AGE-0.19BMI + 359.67.

Figure 1 and 2 are graphical displays of the observed variation of PEFR with age in subjects and controls respectively, along with graph showing predicted variation of PEFR with age, using different formula by Njoku and Anah (1999). Using the keys to the graphs, it would be noted that in Fig. 1, the best linear equation for the subjects produced a graph that ran closely with the observed values. Njoku and Anah's (1999) formula produced graphs that showed that the predicted values were above the observed values. Similar trends can also be noted between the observed values and predicted values using formulae generated from the same studies among the controls in Fig. 2.

DISCUSSION

The study involved Hausa- Fulani females at their reproductive ages, who attended Antenatal and other clinics at Kura General hospital in Kura local government area, Kano state, from August 2005-December 2005. The cohorts were free from chest illness and with relatively little exposure to any form of air pollution. They enjoyed environmental and nutritional background similar to a typical rural community in the northern part of Nigeria.

More than 60% of the females that participated in this project work were less than 30 years of age as of the time of conducting this research.

This study has a smaller sample size when compared with other similar studies in Nigeria (Njoku and Anah, 1999) and elsewhere (Gregg and Nunn, 1989). It is limited to females of child bearing age; hence it will have limited application. The age range of the cohorts is similar to those of (Abid Ali, 1983).

It is observed that considerable variations exist between accepted normal values of ventilatory functions of Caucasian as compared to Nigerians, (Cote *et al*., 1966; Femi-Pearse, 1971). Similar cross-cultural variations in Nigerians have been documented by Abid Ali (1983) and Njoku and Anah (1999). The result from this study show that the values of peak expiratory flow rate, determined with the Wright's peak flow meter is lower in females residing in the Northern part than those residing in the southern part of Nigeria and their European counterparts. This agrees with the findings of Abid Ali (1983) who reported lower values not only on PEFR but also on other Spirometric measurements, like FVC, FEV1 etc.

Similarly, values of PEFR by recent workers (Njoku *et al*., 1999) in Nigeria are higher than those recorded in this study. Differences in the environment generally and in education may be a contributory factor to this trend as more than 50% of both groups in this research work do not have the formal education. Also, subjects used in recent studies were on the average taller, older and heavier than those used in this study and these may be other contributory factors. From this study, there is no statistical difference in the mean PEFR values between the subjects and controls and also in between the second and third trimesters of the pregnancy. This shows that PEFR is not affected by pregnancy. The values presented here, while lower than those from Caucasian studies, support the work of (Brancazio *et al*., 1997) who showed that PEFR is not affected by pregnancy and lactation. In this study, age correlated positively in both subjects and controls. It usually forms part of the prediction formula in most studies (Njoku and Anah, 1999; Abid Ali, 1983) whose results have wide application. The prediction formula for the women in this part of the country incorporated age and weight, while that in the southern part incorporated age and height, this is largely because of differences in height and body built. It seems likely that below certain height limit, the weight is much more significant in correlation with PEFR than the height. Therefore, BMI may be more important than the use of a single height or weight in using prediction formula in short stature individuals and in some localities. The chest circumference and thoracic length correlated positively with PEFR in both the subjects and controls, which are in support of the normal assertion, since the lungs are housed in the thorax.

The best prediction formula for the subjects from this study was PEFR = 0.36AGE – 0.47WT+391.67. The predicted values using this formula does not differ significantly with those generated by using the second best formula – PEFR= 0.24AGE – 0.38BMI + 377.96 (SEE = 25.58 and 28.16, respectively).

CONCLUSION

It can be concluded that prediction formula generated from a different population may produce values which are higher or lower than the observed value; hence leading to wrong conclusion. There is therefore the need to apply prediction formula with caution when the populations involved have widely differing variables.

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