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VARIATIONS OF PEAK EXPIRATORY FLOW RATE WITH ANTHROPOMETRIC DETERMINANTS IN A POPULATION OF HEALTHY ADULT NIGERIANS.

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Summary: PEFR was measured in 300 healthy adult male and female staff and students of the University of Benin, Benin City, and the College of Education, Ekiadolor, near Benin. The variations of Peak Expiratory Flow Rate (PEFR) with respect to height (ht), weight (wt) and chest circumference (cc) were determined in these subjects. PEFR values fell within the middle to the lower limits of the range for the general male and female populations. There was a linear increase in PEFR with respect to the three anthropometric variables (ht, wt and cc) only in the young adult males, whereas in the older adult males and females, PEFR fluctuated considerably with the variables. PEFR correlates more with ht, wt and cc in young adults than in older adults. Respiratory function indices collected from healthy young adults may be more reliable and predictable than those from older adults.

Key Words: *PEFR, Anthropometry, Healthy adult Nigerians.*

Introduction

Ventilatory function tests provide a better understanding of functional changes in the lungs and their significance from the viewpoint of diagnosis. Only a few parameters of ventilatory function have been reported for Nigerians (Elebute and Femi-Pearse, 1971; Jaja and Ojo, 1983; Ali, 1983; Azah *et al*, 2002; Ebomoyi and Iyawe, 2003). Ideally, a sample representative of the whole population should be studied, but this is difficult, expensive and time – consuming, and has scarcely been approached in any country. As an alternative, the factors contributing to variation within the population need to be identified and assessed and the appropriate allowances made. For example, separate standards should be constructed for men and women, and the possible influence of body size, nutrition, socio-economic status, smoking habit, physical fitness and so on, should be allowed for. In fact, the data so far available for Nigerians are few in number and relate largely to the ''better – off'' sections of urban communities. However, assuming that these subjects approach the 'ideal' for the Nigerian society, then their results represent optimum values to which less well-off sections might aspire.

It is well established that sex, age, height and chest circumference are the main factors affecting Peak Expiratory Flow Rate (PEFR), Forced Expiratory Volume in the first second (FEV_1) and Forced Vital Capacity (FVC) (Cotes, 1975). It is essential therefore, to consider men and women separately, and to take into account age, height and chest circumference when comparing individuals or groups. There is a positive correlation between PEFR and FVC or FEV_1. This correlation has been reported previously by several authors and is known to occur both in healthy individuals and patients who have ventilatory defects (Leiner *et al*, 1963; Cotes, 1993). Consequently, PEFR and FEV_1 tests are used interchangeably. In this study, the PEFR test has been chosen. The portability of the peak flow meter and the simplicity of the PEFR test make it particularly suitable for epidemiological studies of respiratory function.

Decreased bronchomotor tone would lead to a fall in airway resistance, and hence increased flow rate of air along it. Tests of PEFR reflect changes in airway calibers (Hughes and Empey, 1981). There have been reports on the variations of various ventilatory parameters with anthropometric determinants in Nigerians. (Elebute and Femi-Pearse, 1971; Femi-Pearse and Elebute, 1971; Onadeko *et al*, 1976; Jaja and Ojo, 1983; Alakija *et al*, 1990). However, comparative studies between different age groups need to be done. This study was therefore to show the variations of PEFR with height, weight and chest circumference in healthy young adult males and healthy older adult males and females living within similar socio-cultural environment, and engaged in similar forms of physical activities. More importantly, it compares data from young adults with those from older adults.

Materials and Methods

The 300 healthy adults used for this study were staff and students of the University of Benin, Benin City, and the College of Education, Ekiadolor, near Benin. Their ages ranged from 18 – 46 years. The criteria satisfied by each of the subjects before being accepted as subjects for the study were: (a) No history of cardio – pulmonary disease, as evidenced from the questionnaires filled out by all subjects prior to the study. Such information were further confirmed by oral interview and observations during the course of the study for symptoms and signs of respiratory disease, such as wheezing and coughing; (b) Availability and capacity to cooperate adequately for the duration of the study; (c) The subjects satisfied the medical requirements of the institution on admission, or on being employed. This would normally include a chest film to show that the individual was free from any disease or injury that could affect cardio - pulmonary function; (d) They were all non – smokers; (e) They were all non – athletes, who were involved in similar daily activities. The ages of the subjects were recorded in years. Standing heights (stature) were measured in centimeters with a standard stadiometer, weights were measured in kilograms with a pair of bathroom scales (HANA BR – 9011), which had been calibrated, and chest circumferences were measured in centimeters with a tape rule at the level of the nipples. PEFR was measured in litres/minute with a standard Wright Peak Flow Meter (W27871).

PEFR was measured with the subject comfortably seated. Instructions and method of carrying out the test was demonstrated to the subjects. Each subject made 3 PEFR maneouvres, and the highest value was recorded, since this parameter requires maximum effort. At the end of all measurements, subjects were grouped according to ranges in height, weight and chest circumference. Results were expressed as mean PEFR ± standard deviation (mean ± S.D), while the students' t-test was used to determine the differences between the means. P-values less than or equal to 0.05 ($P \leq 0.05$) were taken as statistically significant. The PEFR values of young adult males were compared statistically with those of older males, and also the values of older males were compared to those of the older females used. Younger females were not used in the study, as extremely few young females satisfied the selection criteria for participation in the study, especially as regards availability and capacity to cooperate adequately. All the comparisons were made in relation to height, weight and chest circumference.

Results

A total of 300 healthy adults comprising of 172 young adult males (18 – 30 years old), 64 older adult males (30 – 46 years old) and 64 older adult females (30 – 46 years old) were used. Mean PEFR for all the young adult males was 573.18 ± 15.73 L/min while that of the older males was 537.18 ± 53.05 L/min. The mean PEFR for the females was 371.99 ± 65.67 L/min, and this was significantly less than that of the males ($P< 0.05$).

For the young adult males, PEFR increased with height, and these increases were linear (table 1a). PEFR in the height range of 156 – 160 cm (492.57 ± 43.24 L/min) was significantly less than that in the height range of 176 – 180 cm (598.31 ± 35.15 L/min) ($P< 0.05$). PEFR also increased with weight and chest circumference in young adults. However, these increases were not as linear as those observed with respect to height. ($P<0.05$). The results are shown as Tables 1a, 1b and 1c.

Table 1a: *Variations of PEFR with height in normal young adult males*

Height (cm)	No. of persons	PEFR (Mean ± S.D) L/min
156 – 160	10	492.57 ± 43.24
161 – 165	18	523.45 ± 48.15
166 – 170	26	547.53 ± 55.76
171 – 175	32	577.63 ± 52.95
176 – 180	52	98.31 ± 35.15
181 – 185	32	601.31 ± 39.26
186 – 190	2	606.50 ± 38.62

Correlation coefficient (r) = 0.89
P<0.05

Table 1b: *Variations of PEFR with weight in normal young adult males*

Weight (kg)	No. of persons	PEFR (Mean ± S.D) L/min
46 – 50	12	519.17 ± 39.10
51 – 55	26	540.77 ± 68.83
56 – 60	44	592.50 ± 43.72
61 – 65	46	595.44 ± 49.58
66 – 70	28	59.29 ± 49.77
71 – 75	8	600.0 ± 36. 23
76 – 80	8	612.50 ± 41.61

Correlation coefficient (r) = 0.84
P<0.05

***Table 1c**: Variations of PEFR with chest circumference in normal young adult males*

Chest circumference (cm)	No. of persons	PEFR (Mean ± S.D) L/min
71 – 75	2	540.0
76 – 80	8	483.75 ± 24.08
81 – 85	28	555.71 ± 72.80
86 – 90	56	578.80 ± 35.36
91 – 95	48	594.17 ± 52.12
96 – 100	24	583.64 ± 62.25
01 – 105	6	590.0 ± 26. 77

Correlation coefficient (r) = 0.72

P<0.05

For the older adult males, PEFR did not follow a linear increase with height, and there were considerable fluctuations in PEFR with respect to weight and chest circumference (Tables 2a, 2b and 2c). There were also fluctuations in PEFR with respect to height, weight and chest circumference in the adult females (Tables 3a, 3b and 3c). A summary of the ranges for the anthropometric measurements is shown in table 4. The ranges of the various parameters were comparable from one group to another.

***Table 2a:** Variations of PEFR with height in normal older adult males*

Height (cm)	No. of persons	PEFR (Mean ± S.D) L/min
156 – 160	4	545.0 ± 40.0
161 – 165	22	496.67 ± 44.78
166 – 170	6	520.0 ± 59.58
171 – 175	22	527.27 ± 122.01
176 – 180	2	577.86 ± 53.11
181 – 185	6	505.0 ± 124.16
186 – 190	2	670.0

Correlation coefficient (r) = 0.68

P<0.05

***Table 2b:** Variations of PEFR with weight in normal older adult males*

Weight (kg)	No. of person s	PEFR (Mean ± S.D) L/min
46 – 50	2	585.0
51 – 55	2	630.0
56 – 60	22	539.55 ± 82.78
61 – 65	14	569.29 ± 79.17
66 – 70	12	530.0 ± 54.92
71 – 75	4	495.0 ± 140.0
76 – 80	2	535.0
81 – 85	2	330.0
86 – 90	-	-
91 – 95	2	670.0
96 – 100	-	-
101 – 105	2	370.0

Correlation coefficient (r) = 0.4
P>0.05
(uneven distribution of subjects).

***Table 2c:** Variations of PEFR with chest circumference in normal older adult males*

Chest Circumference (cm)	No. of person s	PEFR (Mean ± S.D) L/Min
71 – 75	4	422.50 ± 67.50
76 – 80	4	515.0 ± 65.0
81 – 85	6	645.0 ± 42.43
86 – 90	14	558.33 ± 52.97
91 – 95	16	585.63 ± 59.02
96 – 100	8	532.50 ± 71.89
101 – 105	2	535.0
106 – 110	2	670.0
111 – 115	-	-
116 - 120	8	425.0 ± 32.21

Correlation coefficient (r) = 0.65
P<0.05

Table 3a: Variations of PEFR with height in normal adult females

Height (cm)	No. of persons	PEFR (Mean ± S.D) L/min
156 – 160	18	428.75 ± 26.55
161 – 165	18	390.56 ± 114.20
166 – 170	22	335.46 ± 116.12
171 – 175	6	291.67 ± 52.02
176 – 180	-	
181 – 185	-	
186 – 190	-	

Correlation coefficient (r) = -0.76
P<0.05)

Table 3b: *Variations of PEFR with weight in normal adult females*

Weight (kg)	No. of persons	PEFR (Mean ± S.D) L/min
46 – 50	10	170.0 ± 10.20
51 – 55	10	430.0 ± 20.98
56 – 60	-	-
61 – 65	16	291.67 ± 52.02
66 – 70	-	-
71 – 75	4	425.0 ± 21.51
76 – 80	4	492.50 ± 2.50

Correlation coefficient (r) = 0.6
P<0.05

Table 3c: Variations of PEFR with chest circumference in normal adult females

Chest Circumference (cm)	No. of persons	PEFR (Mean ± S.D) L/min
71 – 75	-	-
76 – 80	-	-
81 – 85	10	323.0 ± 110.71
86 – 90	6	425.0 ± 42.62
91 – 95	-	-
96 – 100	18	346.25 ± 92.15
101 – 105	10	446.0 ± 38.91
106 – 110	8	456.25 ± 54.
111 – 115	12	244.17 ± 71.56

Correlation coefficient (r) = 0.54
P<0.05

Table 4: Summary of Anthropometric Measurements

Groups	A	B	C
No. of subjects	172	64	64
Ages (years)	18 – 30	30 – 46	30 – 46
Height (cm)	157 – 189	157 – 187	156 – 175
Weight (kg)	46 – 80	48 – 104	46 – 80
Chest circumference (cm)	71 – 105	71 – 118	81 – 115

KEY TO GROUPS
A - Normal young adult males
B - Normal older adult males
C - Normal adult females

Discussion

The values of PEFR obtained in this study all fell within the ranges for the general, normal adult male (360 – 900 L/min) and female (168 – 600 L/min) populations. There are racial differences in thoracic cage size or shape (Cotes, 1993). The racial differences in ventilatory capacity necessitate the calculation of different standard values for the various races. It is well known that values for lung volumes obtained for Africans are lower when compared with values for Caucasians (Cotes, 1993). This may account for the PEFR values obtained in this study, which tilt more towards the region of the middle to the lower limits of the normal range for the general male and female populations.

Overall, the study showed that in healthy young adult males, PEFR significantly (P<0.05) increases with height, weight and chest circumference, which is in agreement with the reports of other investigators (Onadeko *et al*, 1976; Jaja and Ojo, 1983). A similar observation has been reported in healthy Nigerian children. (Azah *et al*, 2002). These observations do not necessarily apply to healthy older adult males and females (i.e. those above thirty years old) as seen from our study, as these parameters fluctuated considerably in these individuals. There were too few healthy young adult female volunteers and so their results were not included in the analysis

In order to establish standard values for certain physiological parameters or collect reference data that would enable the physiologist to have a framework on which to base his future findings, such data are best collected in healthy young adult males. Their responses when subjected to various conditions, and hence results collected from them, are more likely to tend towards what the true results should really be, if the investigator were to use the “ideal” individuals. In other words, such young adults are more likely to be healthier than the older adults, because after the age of 30 years, several other factors may come into play to preclude what the real responses should have been. Such factors may include prolonged exposure of the airways and lung tissues to insults, environmental hazards and stresses and so forth, resulting in loss of muscle elasticity, increase in body fat content in relation to protein, increase in reaction time to stimuli and so on. The fluctuations in PEFR in relation to the anthropometric determinants observed in older adults used in this study, as compared to the young adult males may have been consequent on the foregoing factors in addition to the uneven distribution of subjects in the age groups.

It is concluded that PEFR not only increases with anthropometric determinants, but that the increases correlate significantly in healthy young adult males, especially adults below the age of thirty years. Also, in as much as separate standards must be constructed for men and women, and the possible influence of body size, nutrition, socio-economic status and smoking habit taken into consideration as has been done in this study, the age of the individual plays an important role in determining the final responses, even amongst apparently healthy adults. So, for determinations of normal lung function, healthy young adults below the age of thirty are ideal subjects.

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