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# Ventilatory pulmonary function study in healthy young Nigerian adults

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**Summary**

Ventilatory pulmonary function was studied in 108 healthy young Nigerian adults using an electronic spirometer, with a view to determining the normal values of function for healthy Nigerians. The measured values of forced vital capacity, forced expiratory volume in 1 sec, maximum voluntary ventilation, and peak flow rate were compared with those obtained from similar studies on Nigerians and the predicted values for Caucasians. Higher values of function were obtained in Nigerian males than in the females. Nigerian males, however, showed lower values when compared with Caucasians of similar anthropometric measurements; there was no difference between the females in this study and their Caucasian counterparts. There were also some similarities and differences between the values obtained in this study and those of similar studies in Nigerians of different socio-ethnic backgrounds. The results emphasize the necessity for a ventilatory normogram for each socio-economic or ethnic grouping of individuals.

**Résumé**

Utilisant un spiromètre électronique, la fonction ventilatoire pulmonaire était étudiée dans 108 jeunes Nigérians adultes en bonne santé, envisagant à déterminer les valeurs normales de la fonction pour des Nigérians en bonne santé. Mêmes études faites, dans les valeurs mesurées, de la capacité forcée vitale, du volume forcé expiratoire dans 1 sec, de la ventilation volontaire au maximum, et le plus haut haut degré d'écoulement étaient comparées avec celles obtenues des mêmes études sur des Nigérians et les valeurs prédéterminées pour des Caucasians. Des valeurs de fonction plus élevées, ont été obtenues dans des mâles que dans les femelles. Des mâles Nigérians, pourtant, avaient mis en évidence des valeurs moins élevées en étant comparés avec des Caucasians d'autres côtés. Il y avait aussi quelques similitudes et quelques différences entre les valeurs obtenues dans cette étude et celles des études similaires dans des Nigérians des arrières-plans socio-éthniques différents. Les résultats accentuent la nécessité d'un normogram ventilataire pour chaque groupe d'individus socio-économique ou ethnique.

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## Introduction

Measurement of pulmonary function is an important procedure in the assessment of physical ability of a healthy individual, or of a patient with cardiorespiratory disease. The results of pulmonary function testing are so variable that it becomes desirable that each institution should establish its own 'normal' levels [1,2]. Normograms of pulmonary functions based on studies on Caucasians in temperate countries should not be applied to other racial or ethnic groups such as Nigerians. Studies in Western Nigeria [3–6] and in Northern Nigeria [7,8] have rightly aimed at establishing 'normal' standard values for Nigerians. The studies have also revealed interesting differences in the pulmonary function of healthy Nigerians when compared with those of Caucasians. The aim of the present study is to determine, with the use of a simple electronic spirometer, the basic ventilatory functions of healthy young Nigerians in the eastern part of the country and thereby contribute figures that could be useful in providing a suitable normogram of pulmonary function for Nigerians.

## Subjects and methods

The subjects were healthy indigenous adult Nigerians studying or working in Enugu in the eastern part of Nigeria. Each subject was screened by either of us and any subject with previous or current history of cardiorespiratory disease (such as bronchial asthma, bronchiectasis, pneumonia or chest injury) or history of cigarette smoking was eliminated from the study. Clinical examination to detect any latent cardiopulmonary disease was performed and any subject with significant abnormality was rejected from the study. The subject was then taught, with demonstrations and trial tests, how to breathe through the spirometer (Monaghan 403 Electronic Spirometer, Monaghan Co., Denver, U.S.A.). The weight (with simple clothing) and height of the subject were measured. With the subject sitting in a room with minimal air movement, he/she performed each breathing test at least three times through the electronic spirometer shown in Fig. 1, which gives digital displays of forced vital capacity (FVC), forced vital capacity in 1 sec ($FEV_1$), the peak flow rate (PFR) and the maximum voluntary ventilation (MVV). The average of the three readings of each function was calculated and recorded.

**Fig. 1.** The Monaghan 403 electronic spirometer in use.

Statistical analyses of the readings were made using the *Z*-test for significance. The predicted values for the subjects were calculated from the formulae which had been designed for corresponding Caucasians by Kory *et al.* [9] for FVC, $FEV_1$, MVV, in males; Lindall *et al.* [10] for females; and Leiner *et al.* [11] for PFR in both sexes. The means and standard deviations (s.d.) of the ventilatory function readings were determined for males and females.

## Results

A total of 108 adults (70 males and 38 females) were studied. The range, means and standard deviations for the anthropometric and ventilatory function values for males and females are shown in Tables 1 and 2 respectively. Table 3 compares the means and standard deviations of the values in males and females and confirms significantly higher values in males than in females.

Tables 4 and 5 compare the measured ventilatory function values with the predicted values in males and females respectively, and confirms significantly lower values in Nigerian males than in Caucasian males of similar age, height and weight, but similar values in the females of both racial origins. When the values in the present study were compared with the values obtained by other workers on Nigerian subjects (Table 6), there were some significant similarities

**Table 1.** Range, mean values and s.d. of anthropometric and ventilatory function tests in males

| | Range | Mean | s.d. |
|---|---|---|---|
| Age (years) | 21–46 | 26.14 | 5.43 |
| Height (m) | 1.29–1.92 | 1.73 | 0.08 |
| Weight (kg) | 32–92 | 66.11 | 8.98 |
| FVC (l) | 2.09–3.77 | 3.62 | 0.20 |
| $FEV_1$ (l) | 1.77–3.75 | 3.30 | 0.58 |
| MVV (l/min) | 74–265 | 175.16 | 41.15 |
| PFR (l/min) | 311–707 | 548.60 | 141.25 |
| $FEV_1$/FVC (%) | 53.6–100 | 92.25 | 12.29 |

**Table 2.** Range, mean values and s.d. of anthropometric and ventilatory function tests in females

| | Range | Mean | s.d. |
|---|---|---|---|
| Age (years) | 21–44 | 23.92 | 7.46 |
| Height (m) | 1.51–1.76 | 1.63 | 0.06 |
| Weight (kg) | 45–80 | 59.79 | 8.36 |
| FVC (l) | 2.57–3.74 | 3.45 | 0.33 |
| $FEV_1$ (l) | 1.78–3.58 | 3.01 | 0.47 |
| MVV (l/min) | 57–172 | 120.60 | 26.53 |
| PFR (l/min) | 204–647 | 403.58 | 110.70 |
| $FEV_1$/FVC (%) | 62–100 | 86.29 | 9.27 |

**Table 3.** Comparison of mean and s.d. of the anthropometric and ventilatory function values in males and females

| | Males | Females |
|---|---|---|
| Age (years) | 26.14 ± 5.43 | 23.92 ± 7.46 |
| Height (m) | 1.73 ± 0.09 | 1.63 ± 0.06 |
| Weight (kg) | 66.11 ± 8.98 | 59.79 ± 8.36 |
| FVC (l) | 3.62 ± 0.20 | 3.45 ± 0.33 |
| $FEV_1$ (l) | 3.30 ± 0.58 | 3.02 ± 0.47 |
| MVV (l/min) | 175.16 ± 41.15 | 120.60 ± 26.53 |
| PFR (l/min) | 548.60 ± 141.25 | 403.56 ± 110.69 |
| $FEV_1$/FVC (%) | 92.25 ± 12.30 | 86.29 ± 9.27 |

**Table 4.** Measured and predicted (using formulae for Caucasians) values in Nigerian males

| | Measured | | | Predicted | | |
|---|---|---|---|---|---|---|
| | Range | Mean | s.d. | Range | Mean | s.d. |
| FVC (l) | 2.09–3.77 | 3.62 | 0.20 | 2.92–6.18 | 5.05 | 0.50 |
| $FEV_1$ (l) | 1.77–3.75 | 3.30 | 0.58 | 2.75–4.65 | 3.93 | 0.37 |
| MVV (l/min) | 74–265 | 175.16 | 41.15 | 146–226 | 192.81 | 16.04 |
| PFR (l/min) | 311–707 | 548.60 | 141.25 | 454–707 | 617.32 | 39.43 |

and differences. In the males of comparable anthropometric measurements, the values for FVC and $FEV_1$ obtained by the different authors were similar. The mean PFR of our subjects was similar to that of Ahuja and Ahuja [7], but higher than the values obtained by Ali [8] whose values for MVV were also significantly lower than the value of our subjects.

In the females, our values for FVC, $FEV_1$, MVV and PFR were significantly higher than those obtained by other Nigerian authors (Table 6).

## Discussion

Pulmonary function tests have been found useful in the assessment of physical ability of

**Table 5.** Measured and predicted (using formulae for Caucasians) values in Nigerian females

| | Measured | | | Predicted | | |
|---|---|---|---|---|---|---|
| | Range | Mean | s.d. | Range | Mean | s.d. |
| FVC (l) | 2.57–3.74 | 3.45 | 0.33 | 2.74–4.03 | 3.38 | 0.27 |
| $FEV_1$ (l) | 1.78–3.58 | 3.02 | 0.47 | 2.18–3.38 | 2.81 | 0.25 |
| MVV (l/min) | 57–172 | 120.60 | 26.53 | 111–145 | 127.05 | 6.13 |
| PFR (l/min) | 204–647 | 403.58 | 110.70 | 413–496 | 448.97 | 20.53 |

**Table 6.** Comparison of ventilatory values (means) from different Nigerian authors

| Authors (reference number) | 2 | 5 | 6 | 7 | 8 | Present study |
|---|---|---|---|---|---|---|
| Males | | | | | | |
| Age (years) | 34.5 | 19.20 | 22.5 | 16.30 | 24.35 | 26.14 |
| Height (cm) | 168.2 | 170.38 | 170.5 | ? | 168.66 | 173.0 |
| Weight (kg) | 65.8 | 55.13 | ? | ? | 60.92 | 66.11 |
| FVC (l) | 3.41* | 3.24 | 4.18 | 3.80 | 3.64 | 3.62 |
| $FEV_1$ (l) | 2.70 | 2.79 | 3.53 | 3.34 | 2.97 | 3.30 |
| MVV (l/min) | ? | ? | ? | ? | 111.24 | 175.16 |
| PFR (l/min) | ? | ? | ? | 546.88 | 485.36 | 548.10 |
| $FEV_1$ (%) | 79.3 | ? | 84.4 | 87.87 | ? | 92.25 |
| Females | | | | | | |
| Age (years) | 29.4 | 15.17 | | | 26.60 | 23.92 |
| Height (cm) | 161.1 | 161.90 | | | 158.24 | 163.0 |
| Weight (kg) | 62.2 | 50.32 | | | 58.05 | 59.79 |
| FVC (l) | 5.55* | 2.35 | | | 2.78 | 3.45 |
| $FEV_1$ (l) | 2.0 | 2.12 | | | 2.37 | 3.02 |
| MVV (l/min) | ? | ? | | | 89.45 | 120.60 |
| PFR (l/min) | ? | ? | | | 382.29 | 403.58 |
| $FEV_1$ (%) | 80 | ? | | | ? | 86.29 |

*Values for VC which closely 'corresponded' with values for FVC.

healthy individuals (e.g. sportsmen) and also in the diagnosis and treatment of cardiorespiratory diseases. The testing of the pulmonary function has progressed immensely from the Snider match test [12], which was found to be valuable in the pre-operative assessment of patients, to the use of intricate and fascinating equipment which is often beyond the means of most developing countries. As several factors including age, race or ethnic group, socio-economic class and urban/rural residence affect the results of pulmonary function tests, it is necessary for each reference centre to have its own reference 'normogram' of pulmonary functions. As clinical pulmonary function testing is largely an art rather than a science [13], and in view of the problems of acquisition and maintenance of sophisticated equipment, the simplest tests using the simplest equipment are recommended for a technologically developing country like Nigeria. We have therefore used an electronic spirometer which is simple to operate and does not require a trained technician for its use; the spirometer is also not affected by ambient temperature. The parameters chosen by us, i.e. FVC, $FEV_1$, MVV and PER, have been found to be most useful investigations [14], with FVC and $FEV_1$ being the most

reproducible and with the least intra-subject variability [15]. All studies on Nigerians, including the present study but excluding that of Femi-Pearse and Elebute [2] were made on young Nigerian adults. Though the results may not appear to be representative of all subjects in the reference group, it has been confirmed [16] that measurements of respiratory function reach optimum values in the early twenties and change minimally during the remainder of that decade. Therefore, the results we obtained from our healthy subjects can be regarded as the normal values for healthy adult Nigerians in the Enugu environment.

When compared with the normal values obtained from the studies in other parts of the country, the FVC, $FEV_1$ and PFR in our male subjects show significant similarities. However, the values in our female subjects are significantly higher than those of other authors despite similar anthropometric measurements. This difference can be attributed to greater accuracy of the electronic spirometer which, as much as possible, eliminates human errors. Our results also confirm the findings of others [1,5,8] who obtained higher values of pulmonary function in males than in females.

Physical factors, other than anthropometric features could explain the sex differences in pulmonary functions [2]. The greater size of the lungs, combined with the greater muscle strength and larger vital capacity of young men when compared with young women, account for the larger ventilatory capacity in the males [17]. The ventilatory values of our male (Negroid) subjects are significantly lower than the predicted values using the formulae based on Caucasians. This is in agreement with the findings of several authors [1,2,8,18]; these racial differences are supposed to be due to differences in chest sizes and lung volumes, though differences in physical activities may be a significant factor. The reason for the similarity of the ventilatory function values of our female subjects to the predicted values (for Caucasians) cannot be easily explained; the lung volumes and the physical activities of our females may be similar to those of the average Caucasian female.

Though the number of subjects in our present study is relatively limited, the results we obtained are contributory to a possible 'normogram' of ventilatory function for Nigerian adults.

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