# Variations In Body Mass Indices Among Post-Pubertal Nigerian Subjects With Correlation To Cormic Indices, Mid-Arm Circumferences And Waist Circumferences

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**Abstract**

Overweight and obesity are the leading nutrition-related disorders of clinical and public health concern. Assessment and classification of these conditions are dependent on specific body mass index (BMI) cut-off points. A study of BMI with correlation to Cormic index (CI, sitting height /stature ratio), mid-arm circumference (MAC), waist circumference (WC) and lower limb length (LLL), was carried out on post-pubertal Nigerian subjects within Ilorin Metropolis. The subjects considered were randomly selected from some of the major converging centres within the metropolis. The height, weight, MAC waist circumference and lower limb length of 400 volunteers (200 males; 200 females) were measured. Their BMIs were calculated from the heights and body weights. The results obtained showed a mean BMI of 21.33 ± 0.328 and 21.83 ± 0.443 for the post-pubertal male and female population respectively. The mean MAC and waist circumference respectively were found to be 27.14 ± 0.380 and 77.80 ± 0.885 for the post-pubertal male population and 26.94 ± 0.376 and 75.44 ± 0.914 for the post-pubertal female population. The values obtained for the correlation coefficient (rXY) of the BMI to MAC and waist circumference were close to +1 for all the groups under study. This implies that there is a significant positive correlation between the BMIs and other parameters considered.

## INTRODUCTION

Body mass index (BMI) or Quetelet Index is a statistical measure of the weight of a person scaled according to height. It was invented between 1830 and 1850 by the Belgian polymath Adolphe Quetelet during the course of developing “social physics”. It is a practical anthropometric parameter generally accepted as the most useful way to measure the body fat in adult below the age of 70years and it is defined as the individual's body weight divided by the square of their height. The formula universally used in medicine produce a unit of measure of kg/m $^2$ . Body mass index can be accurately calculated using the formula below.

**Figure 1**

$$\mathrm{BMI} = \frac{weight\ (\mathrm{kg})}{height^2(\mathrm{m}^2)}$$

As a measure, BMI became popular during the early 1980s as obesity started to become a discernible issue in prosperous Western society. BMI provided a simple numeric measure of a person's “fatness” or “thinness”, allowing health professionals to discuss over- and under-weight problems more objectively with their patients. However, BMI has become controversial because many people, including physicians, have come to rely on its apparent numerical “authority” for medical diagnosis – but that has never been the BMI's purpose. It is meant to be used as a simple means of classifying sedentary (physically inactive) individuals with an average body composition (WHO Technical Report Series, 1995) For these individuals, the current value settings are as follows: a BMI of 18.5 to 25 may indicate optimal weight; a BMI lower than 18.5 suggests the person is underweight while a number above 25 may indicate the person is overweight; a BMI below 17.5 may indicate the person has anorexia or a related disorder; a number above 30 suggests the person is obese (over 40, morbidly obese). Tanphaichitr and Leelahagul, 1995 reported the use of BMI to assess protein and energy status of adult individual. Keys et al., 1992 found a correlation

between the BMI and the skin fold thickness of Japanese farmers (r = 0.611) and of Minnesota students (r = 0.850). Durnin and Wormersy, 1974 also found the correlation between BMI and percentage of body fat measured by densitometry.

The cormic index (sitting height/stature ratio) is the most common bi-variate index of shape. It is a measure of the relative length of trunk and lower limb and it varies between individuals and group. There is a racial or ethnic variation in the mean cormic index; for the European and Indio-Mediterranean population, it is about 52% (0.52). Africans have proportionally longer legs in general with cormic index value around 51% (0.51). Asian and far Eastern population have proportionally shorter legs with cormic index of 53-54% (Pheasant, 1986). The relationship between BMI and cormic index has been shown by the report of the research carried out on 158 samples of rural non Europeans (95men and 63women) by pleasant in 1986. In this research, the BMI and cormic index were significantly correlated with r = 0.45 (P < 0.001) for the men and r = 0.56 (P<0.001) for the women. Also, in the experiment carried out on 349 adult (187 males and 152 females) Australian Aborigine reported by Norgan in 1994, the BMI and sitting height ratio were significantly correlated. The correlation coefficient r obtained was 0.43 (P > 0.001) for males while the value obtained for females was r = 0.37 (P<0.001). These Australian Aborigines exhibited low mean sitting height/stature ratio of 0.48 ± 0.02 (48%) ranging from 0.41 – 0.54 (41 – 54%) that is they are relatively long legged.

## MATERIALS AND METHODS

### SAMPLE

The study was undertaken in Ilorin metropolis located in the north central geopolitical zone of Nigeria. Anthropometric measurements were taken from adult male and female individuals aged between 15 and 56 years. A total of four hundred healthy adult individuals (200 males and 200 females) were selected at random from institutions of learning (secondary and tertiary) and religion which are part of the major converging centres that allow individual of diverse ethnic group to be represented in the study. The information regarding the age was confirmed from the school register and related individuals were excluded from the study. Written consent was obtained from the principal of the secondary schools location before the work commenced.

### ANTHROPOMETRIC MEASUREMENTS

All anthropometric measurements were done by one of us (to ensure consistency). Standard technique of anthropometric measurements recommended by Lohman et al., 1988 was adopted for accuracy. Bare footed standing heights were measured to the nearest centimetre using Seca stadiometer-model 216. To measure the height, the subjects stood erect with their backs touching the stadiometer, their arms held laterally by their sides and their two feet closely apposed. The weight of each subject was measured to the nearest kilograms using bathroom scale. Sitting heights (SH) were measured after sitting on a standard laboratory stool of a known height placed against the stadiometer. Each of the subjects was made to sit upright with their head at eye-ear plane. The sitting height was then obtained by subtracting the height of the stool from the reading on the stadiometer. The mid-arm and waist circumferences were measured to the nearest centimetre using tape rule. The mid point of the arm was taken to be the middle of the distance between the acromion of the scapula and the olecranon process of ulna, and the circumference of the arm at this point was measured with the arm fully extended. The circumference of the waist at the level of iliac crest was also measured while the subject is standing erect. The lower limb length was measured from the iliac crest to the foot. The body mass index (BMI) was calculated from the height and weight [weight/ height $^2$ ] while the cormic index was calculated from the sitting and standing heights [sitting height/standing height×100].

### STATISTICAL ANALYSIS

The data were analysed using descriptive and inferential statistics for anthropometric variables. The significance of differences in the means of the parameters and indices reported was determined using paired sample student t- test and a p value of <0.05 (two tailed) was considered as significant. On the other hand, Pearson correlation coefficient (r) was analysed for understanding the overall relationship between the anthropometric variables (BMI, CI, MAC, WC and LLL).

### RESULTS

The mean values of the anthropometric measurements and indices of post pubertal male and female Population are represented in tables 1 below.

### Figure 2

Table 1

| | Height (m) | Weight (kg) | BMI Kg/m² | SH (cm) | CI (%) | WC (cm) | MAC (cm) | LLL (cm) |
|---|---|---|---|---|---|---|---|---|
| **Males** | 1.73 ± 0.010 | 63.92 ± 1.407 | 21.33 ± 0.238 | 0.86 ± 0.006 | 49.86 ± 0.242 | 77.8 ± 0.885 | 27.14 ± 0.380 | 105.38 ± 0.732 |
| **Females** | 1.60 ± 0.010* | 55.64 ± 0.195* | 21.83 ± 0.443 | 0.80 ± 0.006* | 50.45 ± 0.245 | 75.44 ± 0.914 | 26.94 ± 0.376 | 96.88 ± 0.804* |

Table 1 shows that there exist no statistically significant differences ($p>0.05$) in the mean value of BMI, Cormic index, waist circumference and mid arm circumference obtained for the post pubertal male and female populations; although a significance difference ($p<0.05$) exist between the mean of other parameters as shown in the table.

### Figure 3

Table 2: Correlation between BMI and Cormic Index

| | Post Pubertal Males | | Post Pubertal Females | |
|---|---|---|---|---|
| | BMI (kg/m²) | Cormic Index (%) | BMI (kg/m²) | Cormic Index (%) |
| **Mean** | 21.33 | 49.86 | 21.83 | 50.45 |
| **SEM** | 0.328 | 0.242 | 0.443 | 0.245 |
| **Correlation coefficient** | +0.341* | | +0.560* | |

### Figure 4

Table 3: Correlation between BMI and Mid-arm Circumference (MAC)

| | Post Pubertal Males | | Post Pubertal Females | |
|---|---|---|---|---|
| | BMI (kg/m²) | Mid-arm Circumference (cm) | BMI (kg/m²) | Mid-arm Circumference (cm) |
| Mean | 21.33 | 27.14 | 21.83 | 26.94 |
| SEM | 0.328 | 0.380 | 0.443 | 0.376 |
| Correlation coefficient | +0.88* | | +0.92* | |

### Figure 5

Table 4: Correlation between BMI and Waist Circumference (WC)

| | Post Pubertal Males | | Post Pubertal Females | |
|---|---|---|---|---|
| | BMI (kg/m²) | Waist Circumference (cm) | BMI (kg/m²) | Waist Circumference (cm) |
| Mean | 21.33 | 77.8 | 21.83 | 75.44 |
| SEM | 0.328 | 0.885 | 0.443 | 0.914 |
| Correlation coefficient | +0.67* | | +0.74* | |

### Figure 6

Table 5: Correlation between BMI and Lower limb length (LLL)

| | Post Pubertal Males | | Post Pubertal Females | |
|---|---|---|---|---|
| | BMI (kg/m²) | Lower limb length (cm) | BMI (kg/m²) | Lower limb length (cm) |
| Mean | 21.33 | 105.38 | 21.83 | 96.88 |
| SEM | 0.328 | 0.732 | 0.443 | 0.804 |
| Correlation coefficient | - 0.92* | | - 0.84* | |

Examination on Pearson correlation coefficient revealed significant ($p<0.05$) positive correlation between BMI and cormic index in male ($r = 0.341$) and female ($r = 0.560$) populations as shown in table 3. Table 4 also shows that there is a significant ($p<0.05$) positive correlation between BMI and MAC in male ($r = 0.88$) and female ($r = 0.92$) populations. Table 5 also shows that a statistically significant ($p<0.05$) correlation exist between BMI and WC ($r = 0.67$ and 0.74) in post-pubertal male and female population respectively.

### Figure 7

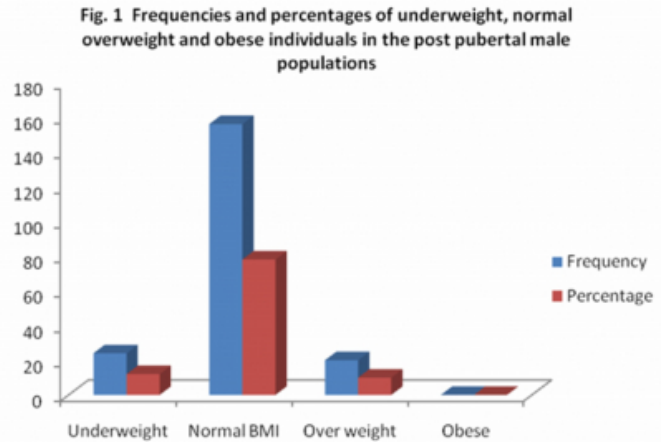
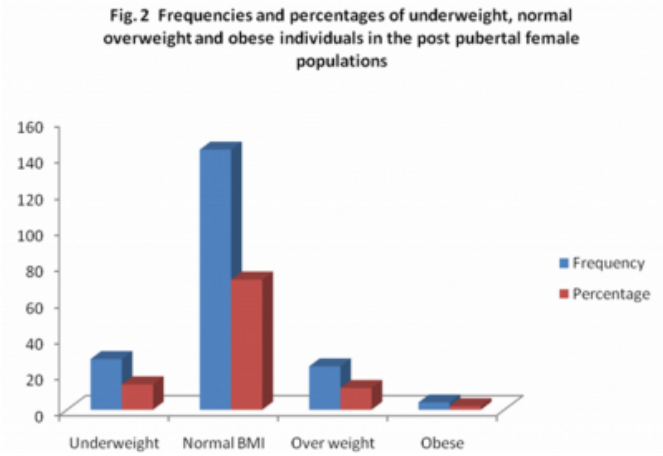


**Figure 8**




## DISCUSSION

The body mass index and the cormic index which are the major and the most common bivariate indices of shape (Norgan, 1994) and the most common body size descriptor, have been shown by several authors to have sexual and age differences. It has been noted in the past that the normal body mass index ranges between 18.5kg/m $^2$ – 23.5kg/m $^2$ in the post pubertal female population while in post-pubertal males it ranged between 20kg/m $^2$ – 25kg/m $^2$ .

The result of the present study shows that majority of the Nigerian post-pubertal males (about 78%) fall within the normal range of weight for height ratio (which is between 18.5kg/m $^2$ – 25kg/m $^2$ ), about 12% of them are underweight (i.e. they have a BMI value below 18.5kg/m $^2$ ) while the remaining 10% are overweight having a BMI value above 25kg/m $^2$ . Also, for the post-pubertal female population, majority (about 72%) are within the normal BMI range, 14% are underweight, 12% are overweight while the remaining 2% are obese. The result also shows that the mean values of all the anthropometric parameter obtained for the post-pubertal males are greater than that obtained for the post-pubertal females while the indices calculated from these parameters have a higher mean value in post-pubertal females than males (i.e. the mean of the value of BMI obtained for the post pubertal males was 21.33 ± 0.328kg/m $^2$ while that of the post pubertal female was 21.38 ± 0.443kg/m $^2$ ; also, the mean cormic index obtained for the post pubertal males was 49.86% while that of the females 50.45%.) The relationship between the body mass index and cormic index obtained for the post pubertal Nigerian male and female according to the report of this study agrees closely with the work of Norgan (1994) in which correlation coefficient r of BMI with cormic index for both male and female are 0.43 and 0.37 respectively.

This present study shows that it is the size of the trunk that mainly determined the body weight and not the lower limb. People with relatively long lower limbs tend to have low BMI value. This accounts for the reason why the mean value of BMI of the females is higher than that of the males in the post-pubertal population despite the fact that the mean weight and the mean sitting height for the post-pubertal male population are significantly higher that of the females of the same pubertal status. The result of the present study also shows that there is a positive correlation between the body mass index and the cormic index of the post-pubertal Nigerian male and female subjects. This correlation is relatively weak for the post-pubertal males according to the result (i.e. r = 0.314). The t-test conducted to test the significance of the difference between the mean of anthropometric indices (BMI and CI) of the post pubertal male and female population shows that there is no statistically significant difference between the two means ($p>0.05$). Also a strong positive correlation exists between the body mass index and mid-arm and waist circumferences obtained for the post-pubertal male and female population. This implies that these parameters (i.e. waist circumference and mid arm circumference) are part of the major determinant of the BMI of an individual i.e. the BMI increases with an increase in the waist circumference and mid arm circumference. However, strong negative correlations exist between the BMI and the lower limb length of the both male and female population (i.e. the BMI decreases with increase in the lower limb length)

In conclusion, the results of this study shows that it is the size of the trunk that majority accounts for the body weight and not the length of the lower limb due to the fact that a strong positive correlation exist between the BMI and cormic index (which is a variable derived from the sitting height which measures the length of the trunk and the head) which implies that the BMI increases with an increase in the cormic index.

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