ORIGINAL ARTICLE

Indices of Obesity Derived from Height and Weight in a Nigerian Adult Population

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ABSTRACT

***Background**: Obesity is a rapidly growing health risk all over the world. Even in mild degrees, it has serious adverse effects and is associated with diminished life span. The study was aimed at determining the most suitable obesity index derived from height and weight in a young adult Nigerian population.*

***Methods**: A cross-sectional study of students of University of Nigeria Enugu Campus was done. Heights and weights of 402 males and 268 females aged between 20 and 28 were measured. Weight-height ratio (W/H), body mass index (W/H^2), Rohrer's index (W/H^3) and ponderal index ($H/W^{1/3}$) were calculated.*

***Results:** Zero-order correlation coefficients of these indices with height and weight showed that body mass index was the only index not significantly correlated with height in both sexes. Weight-height ratio and Rohrer's index underestimated the degree of obesity in short subjects and overestimated it in tall subjects. The reverse was the case for ponderal index.*

***Conclusions**: Body mass index (W/H^2) is the most suitable index derived from height and weight for the assessment of obesity in our study population. We recommend its use in busy clinical practice and epidemiological studies.*

KEYWORDS: Height; Weight; Obesity indices.

Paper accepted for publication 30th May 2006

INTRODUCTION

Obesity is widely recognized as a rapidly growing health risk all over the world[1]. Remarkable increases in obesity have occurred in both higher and lower income countries, particularly during the 1990's. Overweight and obesity, defined as a BMI >25 and 30 kg/m^2 respectively, now often affect an alarming 50-65 % of a nation's population, not only in the USA, Europe, and Australia, but also in countries as varied as Mexico, Egypt, and the black population of South Africa. The highest concentration of obesity is now found in some of the Pacific Islands, and in parts of the Middle East. Even in mild degrees, obesity has serious adverse effects on health and is associated with diminished life span[2]. It is a risk factor for a number of diseases including diabetes mellitus, heart disease, high blood cholesterol, high blood pressure, and stroke as well as for certain malignancies. Obese women are more likely than non-obese women to die from cancer of the gallbladder, breast, uterus, cervix and ovaries[3].

Recent epidemiological and nutritional studies have directed attention towards the relative merits of various obesity indices for the assessment of obesity in different population groups[4]. Zinyowera and Msamati[5] noted population differences in the suitability of different obesity indices and emphasized the need for appropriate indices of obesity to be derived for use in each population. Deurenberg-Yap *et al*.[6] have advocated that the WHO cut-off values for the various indices of obesity be revised in respect of different populations. Ideally, obesity should be assessed by direct measurement of the degree of fatness using techniques such as water immersion, skin fold thickness measurements and somatotyping. However, these direct measurements are too laborious and time consuming to be useful in usually busy clinical practice or in epidemiological studies. Consequently, in these situations, indirect estimates obtained from weight and height formulae are routinely used for the assessment of obesity. Indirect measurements are not only easily obtainable; they have been shown to be reasonably accurate[7].

Commonly used weight and height obesity indices include weight-height ratio (W/H), body mass index (W/H^2), Rohrer's index (W/H^3) and ponderal index ($H/W^{1/3}$). Data on the suitability of these indices for Caucasian populations abound in the literature. However, the same cannot be said for other populations. The paucity of such data for Nigerians necessitated the present study.

SUBJECTS AND METHODS

A total of 402 male and 269 female, 20-28 year old students of the University of Nigeria, Enugu Campus participated in the study which was conducted in 1990. Most of the subjects were Igbo but small numbers of members of other Southern ethnic groups were included in the study sample. The selection was by simple random sampling. Their heights and weights were obtained by the same investigator for consistency using a fixed wall ruler with a spirit level as bar for the

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height, and a beam balance for the weight. Heights were recorded to the nearest 0.1 cm. Weight was measured to the nearest 0.1 kg with subjects lightly clothed. All anthropometric measurements were made according to previously described standard procedures[8]. Weight-height ratio (W/H), body mass index (W/H^2), Rohrer's index (W/H^3) and ponderal index ($H/W^{1/3}$) were calculated.

RESULTS

As shown in Table I, mean heights were 174.9 cm for males and 165.0 cm for females. The corresponding weights were 65.9 kg and 58.3 kg, respectively. As expected, males were significantly taller and heavier than females ($p<0.001$). Males had significantly higher weight-height (W/H) and ponderal ($H/W^{1/3}$) indices than females ($p<0.001$) while females had significantly higher Rohrer's (W/H^3) index than males ($p<0.001$). There was no significant sex difference for body mass index (W/H^2). Table II shows that weight-height ratio and ponderal index increased with weight in both sexes. The converse was the case for Rohrer's index. Body mass index showed a strong positive correlation with weight and was the only index not significantly correlated with height (Table III) in both sexes. Although weight-height ratio had the strongest correlation with weight, it was also significantly correlated with height. Ponderal index was negatively correlated with weight ($p<0.001$). Comparative data on the relative merits of all the obesity indices studied are shown in Tables IV and V.

Table I. Heights, Weights and Weight-Height Indices of Males and Females

	Ht (cm)		Wt (kg)		W/H		W/H^2		W/H^3		$H/W^{1/3}$	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Males	174.9	7.0	65.9	7.9	0.38	0.04	21.5	2.0	123.2	12.4	43.4	1.5
Females	165.0	5.6	58.3	7.7	0.35	0.04	21.4	2.6	130.0	16.7	42.7	1.8

Table II. Weight-Height Indices of Males and Females by Height Groups

	Height (cm)		Weight	W/H	W/H^2	W/H^3	$H/W^{1/3}$
	Group	No.	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD
	160-169	83	59.4 4.6	0.36 0.03	21.4 1.6	128.2 10.3	42.8 1.1
MALES	170-179	229	65.6 6.2	0.38 0.03	21.6 2.0	123.9 11.7	43.3 1.3
	e180	90	71.9 7.1	0.39 0.04	21.2 1.9	115.3 10.9	44.4 1.4
	<160	47	52.1 5.3	0.33 0.03	21.2 2.0	135.3 12.7	42.1 1.3
	160-169	159	58.4 7.0	0.36 0.04	21.6 2.6	131.6 15.9	42.5 1.6
FEMALES	170-179	60	61.5 6.6	0.36 0.04	20.8 2.2	120.8 13.2	43.7 1.6
	e180	2	71.3 1.2	0.39 0.01	21.8 0.7	120.7 4.6	43.6 0.6

Table III. Zero-order Correlation Coefficients of Obesity Indices of Males a nd Females by Weight and Height

	Age (yr)	W/H		W/H^2		W/H^3		$H/W^{1/3}$	
		W	H	W	H	W	H	W	H
MALES	20-28	0.957	0.346	0.785	0.019*	0.510	-0.380	-0.490	0.400
FEMALES	20-28	0.970	0.170	0.860	0.014*	0.400	0.230	-0.510	0.310

* Not statistically significant at $p<0.05$

Table IV. Comparative Data on Zero-order Correlation Coefficients of Obesity Indices of Males by Weight and Height.

Country/ People	Age (yr)	Authors	W/H		W/H^2		W/H^3		$H/W^{1/3}$	
			W	H	W	H	W	H	W	H
British	Adult	Florey[12]	0.96	0.22	0.83	-0.08	-	-	-0.64	0.36
British	20-24	Khosla & Lowe[7]	0.97	0.28	0.84	-0.02	0.63	-0.32	-	-
Caucasian Americans	18	Lee et al.[4]	0.96	0.21	0.81	-0.12	0.59	-0.41	-0.60	0.39
Japanese Americans	18	Ditto	0.97	0.30	0.85	-0.01	0.64	-0.30	-0.64	0.28
Israel	Adult	Goldbourt & Medalie[13]	0.96	0.28	0.83	-0.03	-	-	-0.64	0.31
New Zealand	Adult	Watson et al.[11]	0.95	0.13	0.80	-0.20	0.58	-0.47	-0.61	0.44
Nigerians	20-28	Present study	0.96	0.35	0.79	0.02	0.51	-0.38	-0.49	0.40

Table V. Comparative Data on Zero-order Correlation Coefficients of Obesity Indices of Females by Weight and Height

Country/ People	Age (yr)	Authors	W/H		W/H^2		W/H^3		$H/W^{1/3}$	
			W	H	W	H	W	H	W	H
British	Adult	Florey[12]	0.97	0.03	0.90	-0.20	-	-	-0.77	0.41
Caucasian Americans	18	Lee et al.[4]	0.97	0.04	0.88	-0.20	0.76	-0.40	-0.73	0.42
Japanese Americans	18	Ditto	0.96	0.10	0.85	-0.18	0.68	-0.43	-0.69	0.41
New Zealand	Adult	Watson et al.[11]	0.98	0.01	0.93	-0.17	0.84	-0.35	-0.82	0.36
Nigerians	20-28	Present study	0.97	0.17	0.86	0.10	0.40	-0.23	-0.51	0.31

DISCUSSION

A most appropriate obesity index derived from weight and height is one that is most strongly, positively correlated with weight and minimally correlated with height. It ought to be independent of height[4]. Our data show that Rohrer's index (W/H^3) and ponderal index ($H/W^{1/3}$) are not suitable obesity indices because they were significantly correlated with height and only

moderately correlated with weight. Ponderal index had the additional disadvantage of being negatively correlated with weight. Rohrer's index underestimated the degree of obesity in short subjects and overestimated it in tall subjects. The converse was the case for ponderal index. Although weight-height ratio (W/H) had the strongest positive correlation with weight, it is not a suitable obesity index because it was also significantly correlated with height and it underestimated the degree of obesity in short- and overestimated it in tall subjects.

Body mass index (W/H^2) was the only index not significantly correlated with height in both sexes while being strongly, positively correlated with weight. Thus, it is the most suitable index of obesity for our study population. Our findings are in keeping with those of Evans and Prior[9] and Bjelke[10]. These authors found body mass index to be the least height biased obesity index in both sexes. Watson et al.[11] reported that although weight-height ratio and body mass index were almost equally comparable for the prediction of body fat, body mass index was slightly better for men while weight-height ratio was preferable for women. Florey[12] (Britons) and Lee *et al*.[4] (Caucasian Americans) found body mass index to be the least height biased index in males, and weight-height ratio the least height biased in females. In studies done on British (Khosla and Lowe[7]) and Israeli subjects (Goldbourt and Mendalie[13]), body mass index was found least correlated with height in males. These authors did not study females.

The present study has shown body mass index (W/H^2) to be the most suitable index derived from weight and height for the assessment of obesity in our Nigerian population. Sarria *et al*.[14] studied the sensitivity and specificity of body mass ratio as a predictor of percentage total body fat (TBF %) obtained from underwater weighing and found that it predicted TBF % quite well. We propose the use of body mass index for the assessment of obesity in our Nigerian population both in clinical practice and in epidemiological screening.

ACKNOWLEDGEMENT

We wish to express our gratitude to Mr. U. Aligwekwe and Dr. (Mrs) T. B. Ekanem of the University of Calabar for their assistance. Prof. P. O. Okonkwo of the University of Nigeria, Enugu Campus provided some materials for our study.

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