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Relationship between neck circumference, waist circumference, body mass index, arm circumference and waist hip ratio as predictors of cardiovascular risk factors

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ABSTRACT

Neck circumference (NC), as an upper body obesity index, is a simple screening measure for identifying overweight and obese patients. Based on the clinical significance of body mass index (BMI), waist circumference (WC), hip circumference (HC) and waist hip ratio (WHR), this study examines a relationship between changes in BMI, WC, WHR and Neck circumference.

In a random sample cohort study the study group was comprised of 218 subjects (Male) with no known major medical conditions who were not receiving any medication therapy. With age (17-34), divided in two age groups (17-25 and 26-34) with mean values (77.06 ± 0.56 and 82.97 ± 1.5 respectively) showed a significant difference ($P < 0.05$). Main indicators studied included NC, WC, WHR and BMI.

Pearson's correlation coefficients indicated a significant association between changes in WC and changes in NC ($r= 0.46$ each, $P < 0.0001$) BMI and NC, ($r = 0.51$ each, $P< 0.0001$), Age and NC ($r=.127$ each, $P<0.05$) but was insignificant for WHR and NC, ($r= 0.1$, each, $P<0.07$).

Changes in WC, BMI, and Age, correlated positively with changes in NC but negatively with changes in WHR and the NC was revealed to be double the WC.

This might be used as a reliable, simple, quick and cheap method for predicting cardiovascular risk factors for coronary heart diseases and can possibly provide a very useful criterion for fashion designers for predicting waist circumference if a simple measurement of neck circumference is employed.

Key words: predictors. cardiovascular risk factors. Neck circumference. Waist circumference. Body mass index. Waist hip ratio. Age

INTRODUCTION

In clinical settings Age, tribe, body mass index (BMI), waist circumference (WC), hip circumference, waist hip ratio (WHR) and Arm circumference are of health significance to coronary heart diseases. Overweight is defined as a body mass index (BMI) between 25 and 29.9 kg/m^2 and obesity is defined as a BMI of 30 kg/m^2 or higher. These conditions pose a major public health problem because they are associated with various chronic diseases (Expert panel on the identification evaluation and treatment of overweight in adults, 1998). It is estimated that more than one-half of adults, 35 to 65 years of age, living in Europe are either obese or overweight. The prevalence of

obesity in Europe is estimated to be 10% to 20% of adult men and 15% to 25% of adult women. These figures seem to be increasing (Seidell, 1997). In the United States, the crude prevalence of overweight and obesity (BMI > 25 kg/m^2) for age ≥ 20 was 59.4% for men, 50.7% for women, and 54.9% overall between 1988 and 1994. The prevalence of obesity (BMI≥ 30 kg/m^2) is also on the increase; it was estimated to be 14.5% between 1976 and 1980, and 22.5% between 1988 and 1994 (Flagal 1998).

There are numerous methods of assessing overweight and obesity. Some techniques are applicable at primary care facilities, such as measurements of weight, height, abdominal sagittal diameter, abdominal and hip circumferences, and calculations of waist: hip ratio and BMI. It is not always practical to use these techniques, especially in winter, in busy, everyday primary care practice. Other procedures, such as ultrasound, computed tomography and magnetic resonance imaging are expensive and are primarily used for research purposes. As a first step to achieve obesity control, it is important to develop a reliable, simple, quick method for the assessment of obesity in primary care clinics.

Recently, data clarifying whether or not obesity-related comorbid conditions occur at different levels of (BMI) (weight (kg)/height (m) ^{2}) in different ethnic groups amongst the Caucasians has been documented (Colin et al, 2002). In his study higher BMI was associated with a higher prevalence of hypertension in all ethnic groups. However, at BMI levels less than 25, prevalence difference figures suggested a stronger association between BMI and hypertension in Chinese men and women but not in Filipino women, compared with non-Hispanic Whites. Non-Hispanic Blacks and Filipino women had a higher prevalence of hypertension at every level of BMI compared with non-Hispanic Whites and Mexican Americans. Valsamarkis (2003) in his heavily reach work on modest weight loss and reductions in waist circumference after medical treatment are associated with favourable changes in serum adipocytokines. Concluded that modest weight loss (>5%) after medical treatment in a routine obesity hospital clinic is as Body mass index (BMI) (weight (kg)/height (m)^2) is positively and independently associated with morbidity and mortality from hypertension, cardiovascular disease, type II diabetes mellitus, and other chronic diseases(Sunyer,1993). In Caucasian populations, the association between BMI and S25 (Hoffmans et al, 1988, and Stevens et al, 1998). On the basis of this association, the World Health Organization has devised a classification wherein persons with BMIs below 18.5–24.9 are considered underweight, those with BMIs above this range are considered overweight or "at risk," and those with BMIs greater than or equal to 30 are considered obese (WHO, 1998 and WHO, 1955). Valsamakis (2003) in his cited article concluded that modest weight loss (>5%) after medical treatment in a routine obesity hospital clinic is associated with improvements in insulin sensitivity and lipid profile. Modest weight loss is also associated with potentially favourably changes in serum adipocytokines, particularly in a rise of serum adiponectin while reduction of waist circumference is associated with a change in serum resistin. George Lunberg (2002) in his detailed work titled "is there a relationship between waist circumference and morality"? Documented that even in persons with a normal body mass index, and unrelated to prevalent diseases, smoking status, and ethnic/racial groupings, a large waist circumference conveyed 20% increase in mortality risk. And suggested that a need for intervention seems pretty obvious. Jean Vague was the first researcher to realize that different body morphology or types of fat distribution are related to the health risks associated with obesity. He used a neck skinfold in his index of masculine differentiation to assess upper-body fat distribution (Vague, 1956). Although obesity results in metabolic abnormalities, upper-body obesity is more strongly associated with glucose intolerance, hyperinsulinemia, diabetes, hypertriglyceridemia, gout, and uric calculous disease than is lower-body obesity (Vague,1956 and Kissebach *et al,* 1982). NC, as an index of upper-body subcutaneous adipose tissue distribution, was evaluated in relation to cardiovascular risk factors by (Sjöström *et al,* 1995). In addition, relationships were examined between changes in body composition, including the neck girth, and

changes in cardiovascular risk factors (Sjostrom *et al*, 1997). Furthermore, the free fatty acid release from upper-body subcutaneous fat was found to be larger than that from lower-body subcutaneous fat (Jenson, 1997), a fact that further strengthens the relevance of measuring upper-body subcutaneous adipose tissue depots. These observations indicate that NC as an index of upper body fat distribution can be used to identify overweight and obese patients. (Mavandre et al, 2002) in his study on Relationship between waist circumference/ body mass index, and Medical care costs suggested that abdominal adiposity as assessed by WC is associated with increased total health care charges and may be a better predictor of health care charges than the more widely used BMI. They concluded that waist circumference (WC) provides information about regional adiposity and may correlate with health care costs better than body weight or BMI. Chaoyang et al (1998) in his work on Recent trends in waist circumference and waist height ratio among US children and adolescents reported that Mean waist circumference and waist-height ratio and the prevalence of abdominal obesity among US children and adolescents greatly increased between 1988–1994 and 1999–2004. Tsutomu et al (2002) in his study on Relationship between of upper body obesity to menstrual disorder. Reported that Upper body, but not lower body, obesity is associated with menstrual disorders. Dalton et al (2008) in his highly reference research on waist circumference, waist hip ratio and body mass index and their correlation with cardiovascular disease risk factors in Australian suggested that given appropriate cut-off points, WHR is the most useful measure of obesity to identify individuals with CVD risk factors. Though undocumented NC as been said to have a positive correlation with WC and is used in determination of waist size for skirts and trousers.

The above study has examined NC, WC, BMI, and WHR as it relates to cardiovascular risk factors and its significance to health. But this present study aims at investigating the relationship between NC, WC, BMI, AC and WHR as simple, cheap, and fast predictors for cardiovascular risk factors. Secondly; to scientifically evaluate if neck circumference can be a criterion for selection of skirts and trouser sizes.

Objectives

The aim of this study was to determine whether a single measure of NC might be used to identify waist circumference and to define NC cut-off levels for waist circumference, body mass index, Arm circumference, and waist hip ratio and according to existing age.

Research methods and procedures

The entire cohort studied comprised of 218 Nigeria male undergraduate students within university of Benin, Benin-city, Nigeria. Age range (17-34yrs). The sampling method employed was the single-phase random sampling technique. Major converging centres were various departments in university of Benin. Ages and tribe of individuals was determined through oral communication. Major attributes collected and measured (Table 1).

Anthropometry

All measurements were made by standard techniques (WHO, 1989): weight by digital scales (HANSON, Watford, Hertforshire, England) to within 100 g, without heavy clothing; height barefoot by portable stadiometer (Holtain, Crymmych, Wales) to within 0.5 cm; waist and hip circumferences were calibrated weekly to within 1 mm, using plastic tapes. The waist was measured at the end of a gentle expiration midway between the lowest rib and iliac crest, with the patient standing, and the hips were measured at the greater trochanter. NC was measured in the midway of the neck, between midcervical spine and midanterior neck, to within 1 mm, with plastic tape calibrated weekly. In men with a laryngeal prominence (Adam's apple), it was measured just below the prominence. All circumferences were taken with the subjects standing upright, with the face directed toward L.B.-N., and shoulders relaxed.

Definitions

Low BMI was defined as <25 kg/m^2. High BMI was defined at two levels as ≥25 or ≥ 30 kg/m^2 . for both men and women (WHO, 1989). Waist circumference was defined as low: <94 cm for men and <80 cm for women (Lean *et al*, 1995). High waist circumference was defined at two levels as

described previously (Lean *et al,* 1995), with slight changes, as 94 to 102 cm for men and 80 to 88 cm for women or >102 cm for men and >88 cm for women. Waist: hip ratio was defined as low <0.95 for men and <0.80 for women and high as 0.95 for men and 0.80 for women (Kanaley *et al*, 1993). For this work, only definitions applicable to men were employed.

Statistical analysis

To check for the inter-relationships between NC and Age as dependent variables on WC, BMI and AC as independent variables we made use of the Linear Multiple Regression Model to check for any significant relationship, in it we calculated the Multiple regression Coefficient R = X for age and R = Y for the NC which indicated a significant relationship between the dependent variables and the predictors (Attributes).

To get the pair relationships between any of the two dependent variables (Age and NC) we ran a simple Linear Regression Model which gave us the Pearson correlation coefficient and the P-value at which there is a significant relationship. Also this model gave us an equation wherein we can forecast a cut-off, of which given the value of any of the attributes we can get a corresponding value of the Age or NC.

To further show relationship, the samples were broken into two different age groups (17-25yrs and 26-35yrs) and the mean values were computed and using a t-test we were able to get the significance in the mean values.

To check for the inter-relationships between NC and Age as dependent variables on WC, BMI and AC as independent variables we made use of the Linear Multiple Regression Model to check for any significant relationship, in it we calculated the Multiple regression Coefficient R = 0.380 for age and R = 0.464 for the NC which indicated a significant relationship between the dependent variables and the predictors (Attributes).

RESULTS

The Pearson's correlation (Table 2) showed that there is a significant positive relationship of r = 0.307 between NC and WC , r=0.345 between NC and BMI and r =0.415 between NC and AC all at P < 0.001. This shows that an increase in NC will cause a significant increase in the three (3) different attributes, (WC, BMI & AC)

To check if there was a significant difference in the mean a t-test was done (Table 3) and it showed that there was significant difference in the mean values of the BMI. That is as age increase WC and AC increase but this correlation was negative for BMI (Table 4).

WHR &WC, WC Pearson's correlation was

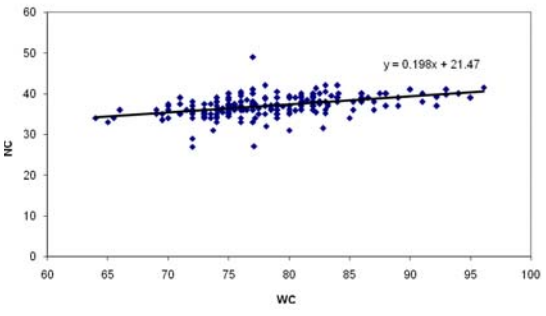

Fig. 1: Correlation between neck circumference (NC; centimetres) and waist circumference (WC; centimetres) for 218 male subjects (r= 0.46, P<0.0001)

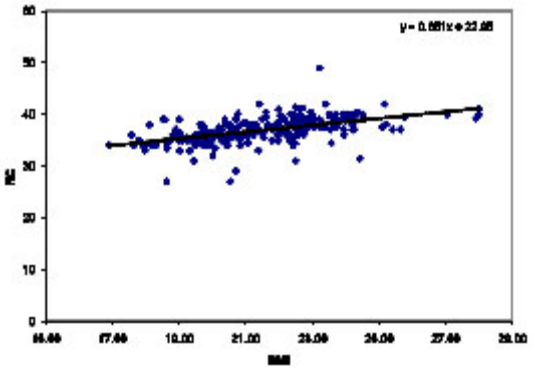

Fig. 2: Correlation between neck circumference (NC; centimetres) and waist circumference (WC; centimetres) for 218 male subjects (r= 0.23, P<0.0001)

Table 1: Showing major attributes collected and measured

S. No.	Sex	Age (Yrs)	Tribe	NC (CM)	WC (CM)	BMI (Kg/m²)	HC (cm)	WHR	Weight (Kg)	AC (cm)	Height (cm)	Height (m²)
1	Male	17	Bini	35	79	19.84	88.00	0.90	58	25.5	171	29241
2	Male	17	Bini	34.5	74	22.48	87.00	0.85	59	25	162	26244
3	Male	18	Owan	34	65.5	16.90	82.00	0.80	49	23	167	27889
4	Male	18	Ikwele	36	70	17.58	88.00	0.80	52	25	172	29584
5	Male	18	Urhobo	27	72	18.61	89.00	0.81	57	25	175	30625
6	Male	18	Idoma	36	72	18.81	85.00	0.85	55	26	171	29241
7	Male	18	Igbo	35	73	19.00	85.00	0.86	55	26	170	28900
8	Male	18	Igbo	35	77.5	19.23	86.50	0.90	63	25.5	181	32761
9	Male	18	Bini	37	78	19.74	95.00	0.82	72	28	191	36481
10	male	18	efik	33.5	69.5	20.08	80.00	0.87	54	24.5	164	26896
11	male	18	ijaw	36	70	20.99	86.00	0.81	55	26	162	26244
12	male	18	esan	36.4	77.5	22.23	87.50	0.89	65	28.5	171	29241
13	male	18	esan	36	87	22.34	100.20	0.87	70	30	177	31329
14	male	18	esan	40	75	24.50	94.00	0.80	75	29	175	30625
15	male	18	ijaw	38	74	58.82	90.00	0.82	170	31.5	170	28900
16	male	19	ibo	33	74	17.96	86.00	0.86	55	23	175	30625
17	male	19	yoruba	38	74	18.11	88.00	0.84	61	26	183.5	33672.25
18	male	19	bini	34	73.5	18.61	87.50	0.84	57	26.3	175	30625
19	male	19	bini	35	71	18.72	85.00	0.84	58	24	176	30976
20	male	19	owan	36	82	18.90	95.20	0.86	64	28.5	184.2	33929.64
21	male	19	yoruba	35	72	19.38	87.00	0.83	58	26.5	173	29929
22	male	19	bini	35	73.5	19.97	92.00	0.80	64	25	179	32041
23	male	19	itsekiri	35	79	20.29	98.00	0.81	65	28	179	32041
24	male	19	bini	38	76	20.53	97.00	0.78	68	28	182	33124
25	male	19	igbo	36	78.5	20.81	90.50	0.87	63	25.5	174	30276
26	male	19	bini	35	80	21.77	93.00	0.86	60	29	166	27556
27	male	19	akwa ibom	38	76	21.97	90.00	0.84	65	28	172	29584
28	male	19	itsekiri	36	83	22.23	95.00	0.87	65	31	171	29241
29	male	19	bini	38	77	22.31	92.00	0.84	66	31	172	29584
30	male	19	asaba	38	74	22.44	92.00	0.80	65	27	170.2	28968.04
31	male	19	esan	38	84	23.24	101.00	0.83	77	30	182	33124
32	male	19	igbo	37	89	24.20	101.00	0.88	70	30.5	170	28900
33	male	19	esan	40.5	79	24.34	95.00	0.83	78	33.5	179	32041
34	male	19	igbo	40	86	28.00	110.00	0.78	82	38	171	29241
35	male	20	owan	34	64	17.92	81.50	0.79	53	24.5	172	29584
36	male	20	bini	33.5	69.5	18.64	81.00	0.86	52	26	167	27889
37	male	20	esan	39	80	19.00	92.50	0.86	70	27.5	182	33124
38	male	20	isoko	36	73	19.49	86.00	0.85	59	25	174	30276
39	male	20	bini	36	77	19.66	93.00	0.83	63	26	179	32041
40	male	20	bini	37	70	20.20	85.00	0.82	64	24	178	31684
41	male	20	igbo	37.5	73	20.20	85.00	0.86	64	23	178	31684
42	male	20	ibo	36	76	20.24	91.00	0.84	62	26	175	30625
43	male	20	yoruba	37	70	20.28	86.00	0.81	60	26.5	172	29584
44	male	20	bini	35.4	82.2	20.30	96.70	0.85	68	30.5	183	33489

45	malE	20	Igbo	38	81.1	20.40	95.00	0.85	69	28.5	187	34969
46	Male	20	Owan	36	81	20.42	93.00	0.87	59	27	170	28900
47	Male	20	Ndokwa	35	69	20.45	85.00	0.81	53	26	161	25921
48	Male	20	Ikwale	34	72	20.83	87.00	0.83	52	27	158	24964
49	Male	20	Ikwale	38	76	21.03	88.00	0.86	65	27	176	30976
50	Male	20	Esan	37	77	21.80	96.00	0.80	66	31	174	30276
51	Male	20	Esan	41	90	21.98	100.00	0.90	72	35	181	32761
52	Male	20	Niger Delta	37.5	79	22.45	85.50	0.92	64	30	169	28561
53	Male	20	Ibo	36	72	22.50	92.00	0.78	69	29	175	30625
54	Male	20	Isoko	39	79	22.60	97.00	0.81	70	30	176	30976
55	Male	20	Igbo	37.5	75.5	23.03	8.00	9.44	65	31	168	28224
56	Male	20	Ndokwa	37	78	23.94	93.00	0.84	70	29.5	171	29241
57	Male	20	Esan	37	82	24.26	102.00	0.80	76	30	177	31329
58	Male	21	Aniocha	39	71	18.51	90.00	0.79	58	26	177	31329
59	Male	21	Owan	37	72	18.90	88.00	0.82	60	25.9	178	31684
60	Male	21	Ibibio	33	65	19.00	82.00	0.79	53	25.5	167	27889
61	Male	21	Bini	36	66	19.03	86.00	0.77	55	24	170	28900
62	Male	21	Igbo	35	74	19.08	87.00	0.85	66	27	186	34596
63	Male	21	Ika	38	74	19.62	92.00	0.80	65	28.5	182	33124
64	Male	21	Bini	38	87	19.70	94.00	0.93	69	28	187	34969
65	Male	21	Esan	37.5	75	19.75	89.00	0.84	64	26.5	180	32400
66	Male	21	Igbira	36	76	20.16	90.00	0.84	69	27.5	185	34225
67	Male	21	Igbo	35.5	74.5	20.60	90.00	0.83	69	26.5	183	33489
68	Male	21	Igbo	37.5	71	20.75	90.00	0.79	65	26	177	31329
69	Male	21	AniocHa	35.5	80	20.80	95.00	0.84	69	29	182	33124
70	Male	21	Igbo	35	69.5	20.81	88.00	0.79	63	27.5	174	30276
71	Male	21	Bini	38.2	82.5	20.91	94.00	0.88	64	28.5	125	15625
72	Male	21	Igbo	38.5	75	21.01	92.50	0.81	60	29	169	28561
73	Male	21	Esan	36	71.5	21.06	91.00	0.79	69	29.5	181	32761
74	Male	21	Bini	37.5	77	22.00	93.10	0.83	60	30.5	165	27225
75	Male	21	Urhobo	38	81	22.30	91.00	0.89	69	29.8	170	28900
76	Male	21	Urhobo	37	80	22.53	94.00	0.85	69	26.5	175	30625
77	Male	21	Agbor	37	79	22.60	93.00	0.85	70	30	176	30976
78	Male	21	Igarra	41	77	22.60	91.00	0.85	64	26.2	168	28224
79	Male	21	Bini	38	82	22.80	96.00	0.85	66	29	170	28900
80	Male	21	Igarra	39	81	22.86	94.20	0.86	70	28	175	30625
81	Male	21	Aniocha	49	77	23.20	95.00	0.81	76	30.1	181	32761
82	Male	21	Etsako	39	81	23.71	94.00	0.86	76	29	179	32041
83	Male	21	Bini	37.5	77	23.72	94.00	0.82	71	31	173	29929
84	Male	21	Bini	39	80.5	23.85	100.00	0.81	79	29	182	33124
85	Male	21	Esan	38.7	78	24.00	97.50	0.80	71	28.5	172	29584
86	Male	21	Bini	40	76	24.06	98.00	0.78	72	32	173	29929
87	Male	21	Igbo	39.5	76	24.16	93.00	0.82	74	30.5	175	30625
88	Male	22	Ibo	35	74	17.80	84.00	0.88	59	26	182	33124
89	Male	22	Urhobo	34	70	18.30	83.00	0.84	54	22	171.5	29412.25
90	Male	22	Urhobo	36	69	19.70	87.00	0.79	57	25	1700	2890000
91	Male	22	Yoruba	36	74.2	19.71	93.20	0.80	66	27.5	183	33489
92	Male	22	Ika	34	74	19.84	88.00	0.84	65	27	181	32761
93	Male	22	Ibo	32	78.1	20.00	92.50	0.84	54	26	164.2	26961.64

94	Male	22	Esan	35.5	74.5	20.24	89.00	0.84	62	27	175	30625
95	Male	22	Owan	36.2	80	20.28	87.40	0.92	60	30	172	29584
96	Male	22	Bini	35	71	20.31	85.00	0.84	58	29	169	28561
97	Male	22	Ijaw	35	79	20.38	92.00	0.86	69	26	184	33856
98	Male	22	Ora	37	82	20.56	100.00	0.82	75	27	191	36481
99	Male	22	Igbanke	36	74	20.60	87.00	0.85	66	24	179	32041
100	Male	22	Ibo	40.1	84.1	20.76	96.50	0.87	68	30.5	181	32761
101	Male	22	Igbo	37.5	70	20.76	86.00	0.81	60	27	170	28900
102	Male	22	Urhobo	38	85.3	21.19	100.10	0.85	66	32.1	176.5	31152.25
103	Male	22	Bini	36	73	21.20	88.00	0.83	62	27	171	29241
104	Male	22	Delta	36	76	21.50	90.00	0.84	60	27.5	167	27889
105	Male	22	Egun	37	79	21.60	93.00	0.85	70	27.5	180	32400
106	Male	22	Urhobo	35	73	21.97	86.00	0.85	65	27	172	29584
107	Male	22	Ika	37	81	22.09	97.00	0.84	70	29	178	31684
108	Male	22	Ogoja	39	86.5	22.15	94.00	0.92	70	32.5	178	31684
109	Male	22	Esan	37	81	22.22	90.00	0.90	68	29	175	30625
110	Male	22	Ibo	34	85	22.41	95.00	0.89	64	29	169	28561
111	Male	22	Etsako	41.3	82.2	22.70	94.10	0.87	68	30	173.5	30102.25
112	Male	22	Edo	39.5	76	22.70	89.50	0.85	61	28	164	26896
113	Male	22	Bini	37.5	77	23.38	92.00	0.84	69	30.8	172	29584
114	Male	22	Hausa	36	85.3	23.94	99.00	0.86	75	31.9	177	31329
115	Male	22	Igbo	40	88	24.30	103.20	0.85	79	31.9	180	32400
116	Male	22	Etsako	39	84	24.52	99.00	0.85	83	29	184	33856
117	Male	22	Urhobo	39.5	82	25.76	98.00	0.84	78	31.5	174	30276
118	Male	23	Etsako	36	72	18.90	88.00	0.82	64	25	184	33856
119	Male	23	Etsako	36.5	76	18.99	86.00	0.88	65	28	185	34225
120	Male	23	Esan	35.5	73	19.23	89.00	0.82	68	26.5	188	35344
121	Male	23	Esan	31	73.7	19.44	84.00	0.88	53	24.8	165.1	27258.01
122	Male	23	Ndokwa	34	74	19.48	81.00	0.91	55	27	168	28224
123	Male	23	Isoko	35	75	19.60	93.00	0.81	70	24	189	35721
124	Male	23	Ondo	37.5	75.5	19.66	91.00	0.83	63	25.5	179	32041
125	Male	23	Yoruba	36.5	74.5	19.66	91.50	0.81	63	27.5	179	32041
126	Male	23	Igbo	34	76	19.71	90.10	0.84	59	27	173	29929
127	Male	23	Ibo	36	74	19.83	96.00	0.77	59	27	172.5	29756.25
128	Male	23	Igbo	36	76	19.88	87.00	0.87	63	24	178	31684
129	Male	23	Itsekiri	34	70	19.96	85.00	0.82	55	27	166	27556
130	Male	23	Urhobo	35.5	72	20.01	86.00	0.84	67	28	183	33489
131	Male	23	Bini	39	80	20.37	94.00	0.85	72	27.5	139	19321
132	Male	23	Ika	34	73	20.43	84.00	0.87	51	26	158	24964
133	Male	23	Esan	37	76	21.10	92.00	0.83	69	27	181	32761
134	Male	23	Bini	37.5	73.5	21.15	89.00	0.83	67	28	178	31684
135	Male	23	Owan	37	78	21.38	95.00	0.82	67	28	177	31329
136	Male	23	Igbanke	33	77	21.39	100.20	0.77	60	27	167.5	28056.25
137	Male	23	Ibo	42	78	21.40	95.00	0.82	67	30	177	31329
138	Male	23	Uromi	35.5	75	21.51	86.00	0.87	60	27	167	27889
139	Male	23	Yoruba	40.5	76	21.60	90.50	0.84	70	30	180	32400
140	Male	23	Esan	38	72	21.66	88.00	0.82	65	29	176	30976
141	Male	23	Etsako	37.2	78.5	21.74	91.00	0.86	72	29	182	33124
142	Male	23	Benin	37.5	77	21.77	91.00	0.85	69	28	178	31684
143	Male	23	Owan	36	76.5	21.97	93.00	0.82	65	27.5	172	29584

144	Male	23	Igbo	40	77	22.34	95.00	0.81	70	29	177	31329
145	Male	23	Ibo	35.2	83	22.40	93.80	0.88	65	30	170.5	29070.25
146	Male	23	Bini	38	83	22.47	98.00	0.85	72	29	179	32041
147	Male	23	Igbo	38.5	76.5	22.60	94.00	0.81	70	28	176	30976
148	Male	23	Aniocha	39	74	22.72	96.00	0.77	72	30	178	31684
149	Male	23	Ika	39	82	22.79	98.00	0.84	69	31.6	174	30276
150	Male	23	Ika	39	95	23.21	115.00	0.83	65	38.5	168	28224
151	Male	23	Ibo	40	86	23.50	97.00	0.89	68	32	170	28900
152	Male	23	Ika	39.5	81	24.00	96.10	0.84	71	28	172	29584
153	Male	23	Igbo	31.5	82.8	24.42	97.50	0.85	80	32.7	181	32761
154	Male	23	Ibo	38	82	25.20	100.00	0.82	79	32	177	31329
155	Male	23	Ijaw	39.2	92.2	27.91	108.00	0.85	85	38.2	174.5	30450.25
156	Male	24	Igbo	37	75	23.53	86.50	0.87	61	29	161	25921
157	Male	24	Esan	35.8	80.5	19.47	93.00	0.87	61	27.1	177	31329
158	Male	24	Ijaw	36	76.2	19.60	96.20	0.79	60	27	175	30625
159	Male	24	Esan	36.5	75.1	19.90	92.00	0.82	66	29.1	182	33124
160	Male	24	Bini	37.5	75.5	20.20	89.00	0.85	64	29	178	31684
161	Male	24	Esan	37.5	77.2	20.76	88.90	0.87	60	30	170	28900
162	Male	24	Auchi	36	75	20.89	88.00	0.85	64	26.5	175	30625
163	Male	24	Esan	36	74	21.22	93.00	0.80	68	30	179	32041
164	Male	24	Esan	37	75.5	21.32	91.50	0.83	73	31.5	185	34225
165	Male	24	Igbo	37	75	22.23	90.50	0.83	65	39.5	171	29241
166	Male	24	Lagos	38	76	22.28	94.00	0.81	73	29	181	32761
167	Male	24	Esan	39	80	22.45	93.00	0.86	76	32	184	33856
168	Male	24	Isoko	36	79	22.72	91.00	0.87	68	29	173	29929
169	Male	24	Igara	37	77	22.79	92.00	0.84	69	30	174	30276
170	Male	24	Bini	38	77	22.92	92.00	0.84	71	28.5	176	30976
171	Male	24	Yoruba	42	84	23.40	99.00	0.85	71	32	174	30276
172	Male	24	Igbo	40	82.5	23.92	100.00	0.83	81	33.5	184	33856
173	Male	24	Esan	39	75	23.94	90.00	0.83	70	30	171	29241
174	Male	24	Igbo	40	87.5	24.21	100.50	0.87	75	30.8	176	30976
175	Male	24	Igbo	39	86	24.54	95.00	0.91	76	29	176	30976
176	Male	24	Yoruba	42	83	25.16	96.00	0.86	71	30	168	28224
177	Male	25	Urhobo	34	70	17.63	81.00	0.86	54	25.5	175	30625
178	Male	25	Esan	39	78	18.56	89.50	0.87	67	28.5	190	36100
179	Male	25	Etsako	36	75.5	19.83	88.00	0.86	54	25	165	27225
180	Male	25	Bini	36.5	78.5	20.00	86.00	0.91	59	28.1	171.5	29412.25
181	Male	25	Esan	34	79	20.44	89.00	0.89	52	25.2	159.5	25440.25
182	Male	25	Ijaw	27.1	77.1	20.54	96.00	0.80	60	36	171	29241
183	Male	25	Urhobo	38	91	21.30	99.00	0.92	69	32	180	32400
184	Male	25	Urhobo	37	76	21.38	90.00	0.84	67	27	177	31329
185	Male	25	Igarra	39.1	84	21.51	97.10	0.87	71	31.1	182	33124
186	Male	25	Ibibio	35	78	22.31	86.00	0.91	66	29	172	29584
187	Male	25	Urhobo	40	88	22.41	99.00	0.89	64	31	169	28561
188	Male	25	Ijaw	36.2	81	22.60	98.00	0.83	55	28	156	24336
189	Male	25	Izon	40	91	22.99	95.60	0.95	68	32	172	29584
190	Male	25	Ijaw	39	89	23.03	95.00	0.94	65	31	168	28224
191	Male	25	Igbo	37.5	82.5	23.26	93.00	0.89	68	30.5	171	29241
192	Male	25	Bini	39.5	80	23.54	100.00	0.80	78	31	182	33124
193	Male	25	Asama	37.5	83.2	25.10	101.00	0.82	70	30.1	167	27889

194	Male	26	Isoko	39	74	20.70	88.00	0.84	65	26	177	31329
195	Male	26	Ijaw	34.5	73	21.06	90.00	0.81	57	26.8	164.5	27060.25
196	Male	26	Igbo	38.5	81.5	21.95	97.00	0.84	68	32.5	176	30976
197	Male	26	Esan	37	74	22.58	96.00	0.77	74	30.5	181	32761
198	Male	26	Bini	40.5	83	22.94	96.00	0.86	76	30.5	182	33124
199	Male	26	Ogoni	39	84	23.70	98.40	0.85	70	29.5	172	29584
200	Male	26	Ijaw	37	92.2	25.65	101.00	0.91	79	34.8	175.5	30800.25
201	Male	27	Ijaw	29	72	20.70	90.00	0.80	60	34	170	28900
202	Male	27	Esan	40	82	22.60	96.00	0.85	70	28	176	30976
203	Male	27	Ijaw	34.5	75	23.57	98.00	0.77	66	29	168	28224
204	Male	27	Esan	40	81	23.71	101.00	0.80	76	31	179	32041
205	Male	27	Ibo	41	93	27.99	104.00	0.89	79	32	168	28224
206	Male	28	Ijaw	34	77.2	18.18	87.50	0.88	60	26.8	182.5	33306.25
207	Male	28	Ika	33	76	19.30	84.00	0.90	58	27	173	29929
208	Male	28	Bini	39.8	93	22.04	101.00	0.92	60	31.1	165	27225
209	Male	28	Isoko	40	94	24.51	99.00	0.95	70	32	169	28561
210	Male	28	Ijaw	37	88	25.40	107.00	0.82	57	32	175	30625
211	Male	29	Urhobo	31	80	22.48	94.00	0.85	54	27.5	155	24025
212	Male	30	Ibo	38	86	21.88	94.00	0.91	56	30	160	25600
213	Male	30	Ibo	40	94	27.04	113.00	0.83	80	36	172	29584
214	Male	31	Isoko	36	79	20.45	92.00	0.86	67	29	181	32761
215	Male	31	Ijaw	37	83.2	22.60	93.00	0.89	66	31.8	171.5	29412.25
216	Male	32	Ijaw	39.5	83.5	21.60	97.20	0.86	70	30.8	180	32400
217	Male	32	Ijaw	41.5	96.1	22.48	107.00	0.90	82	35.5	191	36481
218	Male	34	Ijaw	36.9	79.5	21.29	94.00	0.85	69	31.5	180	32400

Table 2: Showing the mean and standard deviations of attribute

Attributes	Mean	Std. Deviation
Neck Circumference (Nc)	36.97	2.53
Waist Circumference (Wc)	77.73	7.92
Body Mass Index (Bmi)	21.69	3.23
Arm Circumference (Ac)	28.69	2.91

statistically significant when the following attributes were compared;& NC, WHR & h, WHR &AC, Age & AC, Age & NC, Age &WC, Age & BMI, Age & HC, age & H, Age & Wt, age & AC, Age & WHR, all showed a statistical significant at P <0.001/ P< 0.0001 (Table 5). On the other hand Pearson's correlation was statistically insignificant when the following attributes were compared; WHR & NC, WHR &BMI, WHR & HC, WHR & WT, Age & HT.

Table 3: Showing the descriptive statistics of the age group and different attributes

	Age Group	Mean	Std. Deviation	Std. Error Mean
Waist Circumference	17 - 25yrs	77.05	7.747	0.558
	26 - 34yrs	82.97	7.381	1.476
Bmi	17 - 25yrs	21.5687	3.31797	0.23883
	26 - 34yrs	22.6559	2.25103	0.45021
Arm Circumference	17 - 25yrs	28.434	2.8366	0.2042
	26 - 34yrs	30.624	2.7434	0.5487

The above table shows the descriptive statistics of the age group and the different attributes. to check if there is a significant difference in the mean a t-test was done

Table 4: T-showing test for the attributes

	T	P-value	Mean Difference
Waist Circumference	-3.611	0.000	5.916±1.638
Bmi	-1.590	0.113	1.08720±0.68379
Arm Circumference	-3.645	0.000	2.1898±0.6008

Mean Difference Is Expressed As Mean ± Sem.

The t-test shows that there was significant difference in the mean values of the two age groups for wc and ac but no significant difference in the mean values of the bmi. That is as age increase wc and ac increase but this correlation is not shown for bmi.

Table 5: Showing pearson's correlation and student t-test for attributes compared

Attributes Studied	R	P Value
Whr And Wc	0.54	P<0.0001
Wc And Nc	0.46	P<0.0001
Whr And Nc	0.1	P>0.05*
Whr And Bmi	0.074	P >0.05*
Whr And Hc	-0.06	P>0.05*
Whr And Height	-0.112	P<0.05
Whr And Weight	0.004	P>0.05*
Whr And Ac	0.14	P<0.05
Age And Ac	0.345	P<0.0001
Age And Nc	0.127	P< 0.05
Age And Wc	0.373	P< 0.0001
Age And Bmi	0.23	P<0.0001
Age And Height	0.01	P=0.439*
Age And Weight	0.16	P<0.001
Age And Ac	0.345	P<0.0001
Age And Whr	0.215	P<0.001
Age And Hc	0.029	P<0.0001

*= Not Significant

The scattered diagram of NC and WC was employed as to show the correlation between the two attributes using the regression line equation and the pearson's correlation coefficient (Fig. 1). The regression line was given as NC=0.098WC + 29.35 which imply that at a particular value of WC we can get the NC. For correlation between MBI and AC, the regression line was given as NC = 0.270BMI +31.11. This implies that at a particular value of AC we can get the BMI (Fig. 2).

For correlation between NC and AC, the regression line was given as NC= 0.361AC + 26.59, which implies that at a particular value of AC we can get the NC (Fig. 3).

For correlation between age and WC, the regression line was given as Age = 0.094WC +15.08, this implies that at a particular age we can get the WC (Fig. 4).

For correlation between age and BMI, the regression line was given as Age= 0.063BMI +

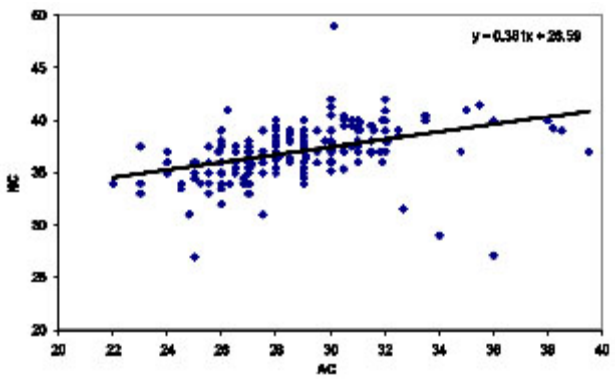

Fig. 3: Correlation between neck circumference (NC; centimetres) and waist circumference (WC; centimetres) for 218 male subjects (r= 0.345, P<0.0001)

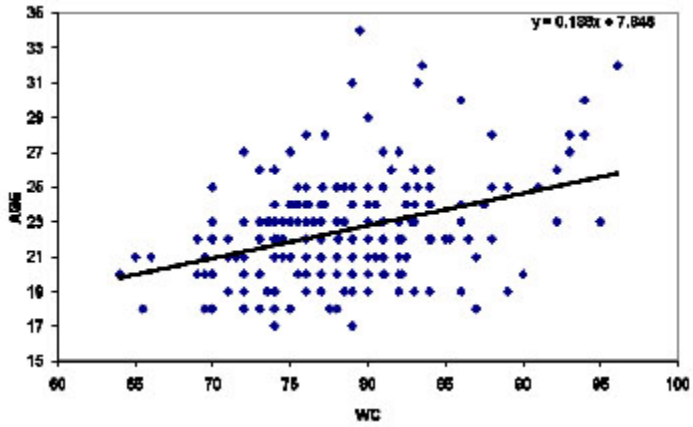

Fig. 4: Correlation between neck circumference (NC; centimetres) and waist circumference (WC; centimetres) for 218 male subjects (r= 0.373, P<0.0001)

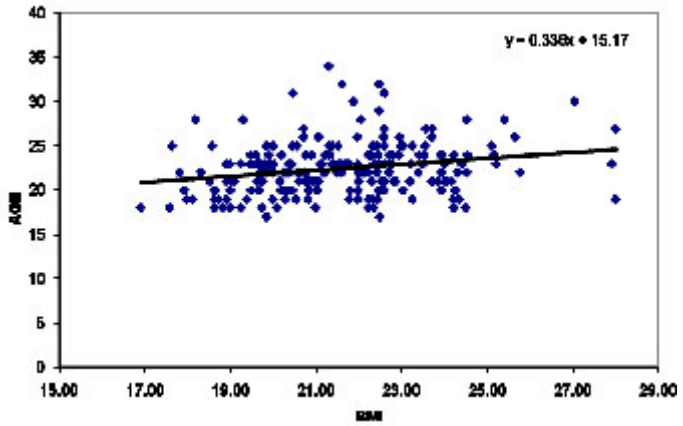

Fig. 5: Correlation between neck circumference (NC; centimetres) and waist circumference (WC; centimetres) for 218 male subjects (r= 0.23; P<0.0001)

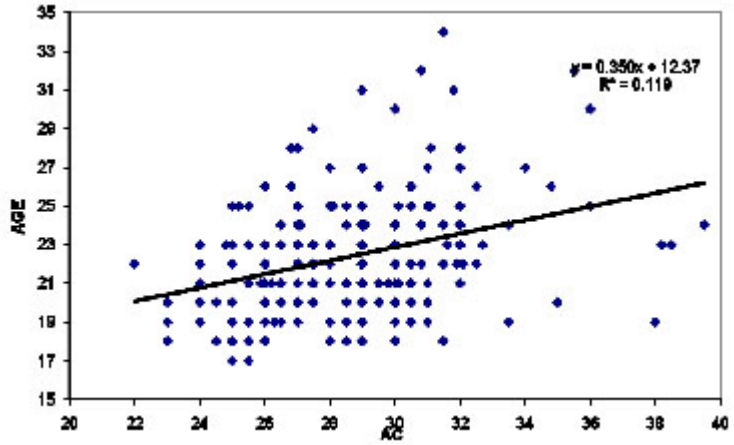

Fig. 6: Correlation between neck circumference (NC; centimetres) and waist circumference (WC; centimetres) for 218 male subjects (r= 0.345, P<0.0001)

21.03, which implies that at a given age we can get the BMI (Fig. 5).

For correlation between age and AC, the regression line was given as Age= 0.350X + 12.37, which implies that at a given age we can get the AC (Fig. 6).

DISCUSSION

This present study was performed to examine the relationship between NC, WC, WHR, AC, BMI, HT, WT and age as to determine if they could be of clinical relevance in predicting cardiovascular risk factors. A number of conclusions can be drawn from this study. First, prevalence of obesity among the study age group is not a common feature amongst the south-south and south-east Nigerians. As was evident by 2.3% of the entire cohort presenting with overweight (BMI) between 25 and 29.9kg/m^2 while there was no case of obesity among the entire cohort studied BMI of 30kg/m^2 or higher (Table 1). Compare with the report by Seidell (1997) it shows that Caucasians have high prevalence of obesity when compared to the Negros. However, this is in agreement with the report by Dicker et al (2008) that the high incidence of overweight and obesity amongst the Caucasians is mainly due to diet type. Secondly, WC showed a positive and significant correlation with NC, WHR, and age, this shows that WC is of great clinical significance, a finding that agrees with a previous report that modest reduction in waist circumference (> 5%) after medical treatment in a routine obesity hospital clinic is as BMI [weight (kg) height (m^2)] is positively and independently associated with morbidity and mortality from hypertension, cardiovascular diseases, type ll diabetes mellitus and other chronic diseases (Valsamarkis,2003; Sunyer, 1993; and Stevens *et al*, 1998). He concluded that loss/gain in WC are associated with favourable changes in serum adipocytokines. Thirdly, (Figs. 1, 2,3,4,5, & 6) respectively, showed strong positive correlation between NC and WC, BMI and AC, NC and AC, Age & WC, Age and BMI, age and AC, (table 5). This however suggest that they can be use as a simple method to asses cardiovascular risk factors based on the evidence that NC, age and BMI has been documented to have a positive correlation with Cardiovascular risk factors in Caucasians (Liubov *et al,* 2001). Fourthly, this agrees with the findings by Dalton et al (2008) in his highly references article on WC, WHR and BMI and their correlation with cardiovascular risk factors in Australian suggested that given appropriate cut-off points, WHR is the most useful measure of obesity to identify individuals with cardiovascular disease risk factors. Fifthly, greater WC is associated with increased total health care charges and greater BMI is also associated with increased total health care charges although not statistically significant (Marc-Andre Cornier *et al,* 2002). Finally, this study has been able to indicate that NC can actually be use to determine WC (Y0.198X +21.47= WC) and as such can be use as a criterion by fashion designers to determine skirts and trouser size in normal subjects. Conclusively, it might be of good health value for every person to have a data on measurement of their NC, WC, WHR, AC and BMI as an aid to diagnose early unset of any possibly existing coronary heart diseases.

CONCLUSION

Base on the strong correlation evident among the attributes studied, we are of the opinion that NC could be use as a simple, quick, fast and cheap method for early prediction of cardiovascular risk factors and diseases.

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