Research Article

Relationship between leptin and indices of obesity among apparently healthy adults in Kano, Northwestern Nigeria

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Abstract

Background: Leptin secretion has been reported to be highly correlated with body fat. However, measurement of serum leptin levels is cost intensive and requires sophisticated equipment.

Objective: To determine the relationship between serum leptin levels and indices of obesity among Nigerians.

Materials and Methods: A random sample of 96 apparently healthy adults was studied. Anthropometric parameters and serum leptin levels were measured. Data were analyzed using Minitab statistical software.

Results: The male:female ratio of the subjects was 1.28:1; their ages ranged from 30 to 85 years with a mean ± SD of 50.27 ± 1.42 years. The means of weight (% difference 11.6, $p = 0.09$), height (% difference 6.0, $p = 0.001$) and waist–hip ratio (% difference 6.4, $p = 0.001$) were higher in male subjects. The mean ± SD of serum leptin (ng/mL) for the male and female respondents were 4.23 ± 2.22 and 5.3 ± 2.59, respectively. A significant positive correlation between serum leptin levels and body mass index (BMI) was observed ($r = 0.48$, $p = 0.001$). Similarly, serum leptin levels were positively correlated with waist circumference ($r = 0.39$, $p = 0.001$). In a model of binary logistic regression, BMI was the only variable that emerged as the independent predictor of serum leptin level.

Conclusion: This study suggests that BMI can be used to project serum leptin levels. The finding is a clarion call on clinicians and researchers to further test the effectiveness of this relationship.

KEY WORDS: Serum leptin, indices of obesity, Nigeria, low-resource setting

Introduction

Leptin is an adipocyte hormone that consists of 167-amino acid protein transcribed from the obese (*ob*) gene.[1,2] The 16-kDA hormone was initially thought to be involved only in food intake and energy balance[3,4] but has now been found to have a crucial role in hormonal regulation and metabolism.[5] The expression and secretion of leptin has been reported to be highly correlated with body fat mass and adipocyte size.[6,7] Thus, females have higher concentration of the hormone than men.[8] Empirical evidence suggests that serum leptin can be considered as one of the best biological markers reflecting total body fat in both animals and humans.[3]

The change in dietary pattern and increased sedentary lifestyle from urbanization and industrialization is associated with the increasing prevalence of obesity worldwide. Data emerging over the past several years reported a worldwide increase in the number of obese people.[9] However, evidence abounds that people with obesity have higher chances of developing noncommunicable diseases such as type 2

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diabetes mellitus, hypertension, and other cardiovascular diseases.[10] Although physical exercise has proven a formidable approach to the control of body fat or weight, the practice has failed to be adopted as part of the traditional African culture where obesity is seen as a sign of affluence. Furthermore, the control of body weight or fat in low-resource setting, especially among the elderly and the sick people, continues to be a serious challenge. Interestingly, leptin has been shown to play a significant role in the pathophysiology of insulin resistance related to obesity because leptin replacement reverses insulin resistance and diabetes in mice homozygous for mutations of the *ob* gene.[11]

Measurement of serum leptin levels is cost intensive, requires sophisticated equipment, and, as such, is not accessible for routine health care, especially in low-resource setting. Body mass index (BMI), waist circumference (WC), and waist–hip ratio (WHR), on the other hand, are easily measured in this setting, and once proven effective in predicting, serum leptin level will be cost effective and appropriate for use in this setting. Furthermore, as there are little documentation describing the relationship between serum leptin and the indices of obesity, especially among Nigerian population, it is hoped that findings from this study will be useful to clinicians and researchers and will also add to the empirical literature. This study was, therefore, done to determine the relationship between serum leptin levels and indices of obesity (specifically BMI, WC, and WHR) among Nigerians.

Conceptual Framework

Leptin hormone exerts its effect in the hypothalamic area of the central nervous system. Its receptors are expressed in the hypothalamus and are important in regulating food intake and energy expenditure, in addition to body temperature and metabolic and endocrine functions. The hormone signals the brain about the quantity of stored fat in the body. When there is increase in adipose tissue as indicated by weight gain, leptin signals the brain through the receptors in the hypothalamus to reduce food intake and increase energy expenditure and sympathetic activity. Similarly, when there is decrease in adipose tissue as indicated by weight loss, leptin signals the brain to increase food intake and parasympathetic activity and to reduce energy expenditure and reproductive function.

Materials and Methods

The study was conducted in Murtala Muhammed Specialist Hospital (MMSH), Kano State, in northwestern Nigeria. MMSH has the largest turnover of patients in Kano State. The hospital is attended by patients from all over the northwestern states and the neighboring Niger Republic. Majority of the people attending the hospital are the Hausa and Fulani and other ethnic groups such as Yoruba, Igbo, Kanuri, Igala, and Egbira, who are resident in the area.

We used a descriptive cross-sectional design to study a random sample of 96 apparently healthy relatives of patients attending the medical outpatient clinic of the hospital. Those with hypertension, diabetes, or signs of endocrine disorders and chronic illnesses were excluded from the study.

Anthropometric parameters (weight, height, BMI, WC, hip circumference, and WHR) and serum leptin levels were measured for all the subjects. A bathroom scale was used for measuring weight of the subjects while a standiometer was used to measure their height. A measuring tape was used to measure their waist and hip circumferences. Serum leptin levels were estimated using enzyme-linked immunosorbent assay kits, and spectrophotometer (EX Labsystem) was used to measure the absorbance of the samples. Data were analyzed using Minitab statistical software. Mean and standard deviation were used to summarize quantitative variables. BMI was calculated as weight in kilograms divided by the square of the height in meters. WHR was estimated as the ratio of circumference of the waist to that of the hip. BMI of less than 18 kg/m^2 was adjudged as underweight, between 18 and 24.99 kg/m^2 as normal, between 25 and 29.99 kg/m^2 as overweight, and >30 kg/m^2 as obese. WC of less than 94 cm in men and less than 80 cm in wo was adjudged to be normal. Similarly, WHR of less than 0.9 cm in men and 0.85 cm in women was adjudged to be normal.[12] Student's *t* test and Pearson correlation were used to test for statistical significance. BMI, abdominal circumference, and WHR were correlated with serum leptin using Pearson correlation, and Student's *t* test was used to compare mean values of all quantitative parameters between the males and female subjects. The *p* value of ≤ 0.05 was considered as significant.

Ethical clearance and permission for the study were sought and obtained from the Ethical committee of Aminu Kano Teaching Hospital and Kano State Hospitals Management Board, respectively, while informed consent was obtained from each participant before enrolling for the study.

Results

Age and Sex Distribution

Ninety-six apparently healthy adults participated in the study; 56.2% were men and 43.7% women, with a male-to-female ratio of 1.28:1. The subjects were aged between 30 and 85 years with a mean ± SD of 50.27 ± 1.42 years. The mean age ± SD of the male and female subjects in the group was 50.54 ± 1.91 years and 49.93 ± 2.15 years, respectively. The means of the respective age groups of the subjects by sex are given in Table 1.

Indices of Obesity

Table 2 highlights the weight, height, BMI, WC, hip circumference, and WHR of the respondents. The means of weight (% difference 11.6, $p = 0.09$), height (% difference 6.0, $p = 0.001$), and WHR (% difference 6.4, $p = 0.001$) were significantly higher in male subjects.

Serum Leptin Levels of the Subjects

The mean ± SD of serum leptin levels of all the respondents were 4.70 ± 2.44 ng/mL. Further analysis of the mean

Table 1: Age and sex distribution of the respondents

Age group (years)	Male, mean ± SD	*n*	Female, mean ± SD	*n*
30–37	35.00 ± 2.49	11	34.70 ± 2.16	10
38–45	40.55 ± 2.54	11	41.30 ± 2.83	10
46–53	49.93 ± 2.15	15	48.40 ± 1.52	5
54–61	58.50 ± 2.29	6	57.22 ± 1.92	9
62–69	62.50 ± 1.50	4	65.00 ± 0.00	1
70–77	73.00 ± 2.65	3	72.50 ± 274	6
78–85	82.00 ± 3.56	4	80.00 ± 0.00	1
Total		54		42

Table 2: Weight (kg), height (m), body mass index, hip circumference (cm), waist circumference (cm), and waist–hip ratio in male and female subjects

Parameter	Male (*n* = 54), mean ± SD	Female (*n* = 42), mean ± SD	% Difference
Weight (kg)	70.61 ± 14.87	62.45 ± 13.50	11.56*
Height (m)	1.67 ± 0.08	1.57 ± 0.07	5.99*
Body mass index	25.26 ± 5.00	25.33 ± 4.48	–0.28**
Waist circumference (cm)	83.24 ± 10.74	80.98 ± 10.59	3.19**
Hip circumference (cm)	90.22 ± 11.80	93.38 ± 14.40	–3.50**
Waist to hip ratio	0.96 ± 0.09	0.87 ± 0.78	6.45*

*$p \leq 0.05$, significant; **$p > 0.05$, not significant.

Table 3: Leptin levels by age group in male and female respondents

Age group (years)	Male, mean ± SD	*n*	Female, mean ± SD	*n*	% Difference
30–37	3.49 ± 2.41	11	5.21 ± 2.89	10	–49.28*
38–45	3.89 ± 1.93	11	5.58 ± 2.38	10	–43.44*
46–53	4.56 ± 2.37	15	6.34 ± 3.16	5	–39.04*
54–61	4.32 ± 2.22	6	4.94 ± 2.44	9	–14.35*
62–69	3.95 ± 2.76	4	2.28 ± 0.00	1	–42.28*
70–77	4.49 ± 2.22	3	4.56 ± 2.36	6	–1.56*
78–85	4.77 ± 2.90	4	9.00 ± 0.00	1	–88.68*
Total		54		42	

*$p > 0.05$, not significant.

and standard deviation of the leptin levels by sex revealed that the male and female respondents had means ± SD of 4.23 ± 2.22 and 5.3 ± 2.59 ng/mL, respectively. Considering the levels across the age groups by sex, it was observed that higher concentration of leptin was found in women than men, except for the age group 62 to 69 years, which was higher in the male subjects. However, the difference was not statistically significant, as depicted in Table 3.

Relationship Between Serum Leptin Levels and Indices of Obesity

This study observed a significant positive correlation between serum leptin levels and BMI ($r = 0.48$, $p = 0.001$) with a regression equation "$y = 0.2462x - 1.5263$." As serum leptin level increased, there was a corresponding increase in BMI as shown in Figure 1. Similarly, serum leptin levels were positively correlated with WC with a regression equation "$y = 1.6548x + 74.469$," as indicated by corresponding increase in WC as the serum leptin levels increased. The data from this assessment suggest that the relationship was statistically significant ($r = 0.39$, $p = 0.001$), as shown in Figure 2.

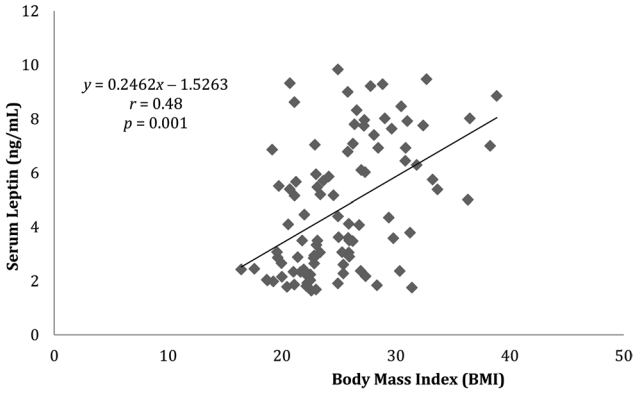

Figure 1: Relationship between leptin and BMI.

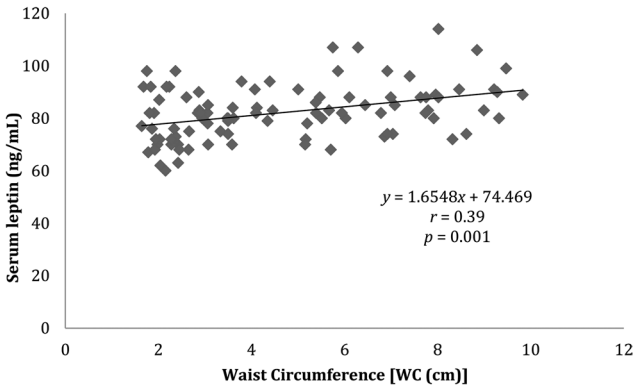

Figure 2: Relationship between leptin and WC.

The relationship between serum leptin levels and WHR is as depicted in Figure 3. WHR increased with increasing serum leptin concentration. However, the relationship was not statistically significant ($r = 0.10$, $p = 0.26$).

When the indices that turned out to be significantly correlated with serum leptin levels were considered in a model for multivariate analysis to identify independent predictors of serum leptin levels, it was observed that BMI was the only index that emerged as the independent predictor of serum leptin [Table 4].

Discussion

Leptin, an adipocyte hormone, is a product of human leptin gene. The concentration of the hormone is proportionate to body mass adiposity, with higher levels found in

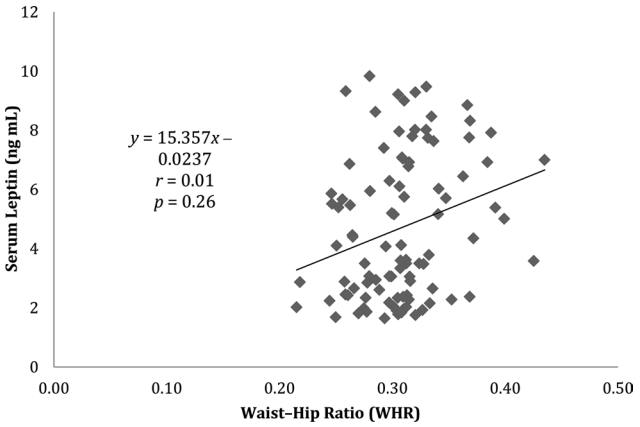

Figure 3: Relationship between leptin and waist–hip ratio.

Table 4: Indices of obesity that predict serum leptin levels

Parameter	Bivariate analysis		Multiple linear regression	
	r	*p*	*t* Test	*p*
Age	0.009	0.93**	–	–
BMI	0.48	0.001*	3.29	0.001*
WC	0.39	0.001*	0.81	0.42**
HC	0.29	0.004*	–0.03	0.99**
WHR	0.1	0.26**	–	–

*$p \leq 0.05$, significant; **$p > 0.05$, not significant.

individuals with obesity compared with lean weight healthy individuals.[13] Although leptin was originally recognized for its role as a satiety factor, it is now implicated in a wide variety of multisystem biological functions, playing a vital role in the pathogenesis of obesity.[14] Empirical evidence suggested that leptin hormone deficiency or leptin receptor resistance manifest with hyperphagia, obesity, type 2 diabetes, and neuroendocrine disorders.[15]

The mean weight and height of the subjects are higher in men than in women. Sex differences in body composition are chiefly attributable to the action of sex hormones, which lead to the dimorphisms during pubertal development. In men, a reduction in free testosterone levels is associated with an increase in fat mass and reduction in muscle mass, and both total and free testosterone levels are inversely associated with obesity.[16] This study observed greater WHR in the men than in the women, a finding that may not be unconnected with more accumulation of visceral adiposity in the men than in the women. It is on record that visceral adiposity represents approximately 10% and 6% of the total body fat in men and women, respectively.[17] Increase in visceral adipose tissue is associated with a range of metabolic abnormalities, including decreased glucose tolerance, reduced insulin sensitivity, and adverse lipids profile, which are risk factors for type 2 diabetes and cardiovascular disease. As a result, men have higher risk of developing these diseases than the women.[18]

This study observed low leptin levels compared with studies done among the whites. A comparative study by Lindeberg et al.[19] between westernized and nonwesternized populations reported higher serum leptin levels among the westernized population. This could be associated with higher adiposity and higher concentration of insulin levels found among the western population.[7] Similarly, Kazmi et al.[20] from Pakistan and Al-Shoumer et al.[21] from Saudi Arabia reported low leptin levels among their subjects. The low leptin levels observed in this study may be attributed to the lower body size of the African black population and, apparently, the low adipose tissue mass as reflected in the BMI of the subjects irrespective of the cause of the low adiposity.

This study also concurs with findings from Couillard et al.[8] where sex differences in leptin concentrations were observed with female subjects exhibiting higher leptin levels than male subjects. This may perhaps because of the effect of estrogen hormone, which is known to induce leptin synthesis and androgen, a potent leptin inhibitor. Kennedy et al.,[22] however, associated the higher leptin levels in female than male subjects of the same adipose tissue mass to the more leptin resistance in the female subjects.[22]

This study observed positive correlation between leptin and BMI among the subjects. Leptin, an adipocyte hormone, is mostly synthesized in the white adipose tissue, and the concentration of the hormone in blood correlates with body fat mass. It has been found that the higher the body mass, the higher the circulating leptin concentration.[7,23] This observation is consistent with findings of several studies conducted among different populations.[13,24] Since leptin levels increases with increase in BMI, it suggests that leptin levels can be projected from BMI using the trend line formula for the relationship ($y = 0.2462x - 1.5263$).

The observed correlation between leptin and WC among the subjects in this study suggest that the higher the WC, the greater the leptin concentration. This finding is expected because of the large deposits of white adipose tissue in the abdomen. Positive correlation between WC and leptin has also been reported from Saudi Arabia.[25] Similarly, another study on male and female teenagers in Gaza, Palestine, showed significant positive relationship between leptin and WC.[26] Furthermore, the Gaza study also observed increasing leptin concentration as WHR increases, although the relationship was not statistically significant. In addition, the finding of this study that BMI emerged as independent predictor of leptin concentration following multivariate analysis further corroborates the interactions between leptin hormone and BMI.

Conclusion

In summary, this study observed that serum leptin level among adults in Kano, Nigeria, is low. A positive correlation was seen between leptin and BMI, WC, and HC; of the indices of obesity examined, BMI was the only independent predictor of serum leptin levels. BMI may, therefore, be used as appropriate for projecting serum leptin levels in using the trend

line formula for the relationship ($y = 0.2462x - 1.5263$), where y = leptin concentration in ng/mL and x = BMI. This finding is a clarion call on clinicians and researchers to further test the effectiveness of this relationship.

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