

## OBESITY IN SAUDI FEMALE POPULATION

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### ABSTRACT

An interaction of genotype and environment results in obesity which leads to a complex multifactorial chronic disease. Obesity also involves the integration of various factors such as social, behavioral, cultural, physiological, metabolic and genetic. Contributing to the significant increase in morbidity and mortality, a prevalence of obesity is becoming an important public health problem.

The aim of this study is to understand obesity among Saudi female population belonging to Makkah community. Obesity has been studied by measuring leptin concentration, and other measurements like body mass index (BMI) and waist circumference (WC).

This study included 240 women aged between 18 and 65 and the participants were divided into three groups. The normal or control group whose BMI ranged from 18 to 29.9 comprised the first group, the obese characterized by the BMI  $\geq 30$  formed the second group and the obese diabetic group with body mass index (BMI)  $\geq 30$  formed the third group. The parameters collected included height, weight, and waist circumference and blood samples. Blood samples were later thawed.

Serum leptin levels in all the groups were detected using ELISA and their means found to be  $8.4 \pm 1.4$  in normal,  $56.3 \pm 18.8$  in obese and  $42 \pm 19.3$  in a diabetic obese group. In the normal group, the leptin levels were directly associated with BMI ( $r = 0.152$ ,  $p = 0.178$ ), and leptin levels showed strong positive correlation in obese and diabetic obese groups as the follow:  $r = 0.350$ ,  $p = 0.001$  and  $r = 0.355$ ,  $p = 0.001$ . Also, leptin concentrations were positively correlated with BMI and WC in obese and diabetic obese groups, showing high leptin concentration in both the groups.

It is understood that leptin hormone influences appetite and body weight, causing obesity. However, fasting, hypertension, practice physical activity, smoking or following special diet results in changes to serum leptin concentration.

**KEYWORDS:** *Obesity, Leptin, Genotype*

### INTRODUCTION

An abnormal or excessive accumulation of body fat in adipose tissue leads to obesity, impairing health (1). It is unhealthy to have excess weight. Hypertension, hypertriglyceridemia, hypercholesterolemia and high glucose level are all due to obesity. The interaction between genotype and the environment develops into obesity, a complex of multifactorial disease, involving the integration of various factors such as social, behavioral, cultural, physiological, metabolic, and genetic (2). Being a risk factor for metabolic syndrome, obesity is associated with T2DM,

hypertension, hypertriglyceridemia, hypercholesterolemia, which lead to heart disease (2). Therefore, obesity poses a real threat to health (3).

Among the Saudi population, obesity is considered a major health threat. According to a study, in an overall population aged 14-70 years, 13.05% of males and 20.26% of females were obese, which is higher than that reported in the United Kingdom, Australian, Americans and Italian populations (4).

### **Physiology of Obesity and Weight Loss Therapies**

The interaction of the feeding center, located in the lateral hypothalamic nucleus, and the satiety center, located in the ventromedial nucleus of the hypothalamus is key to the regulation of appetite. In response to signals from both adipose tissue and the gastrointestinal tract, the brain regulates energy homeostasis. It is necessary to arrive at a balance between the urge to eat and energy expenditure overtime so that the body weight remains stable (6). It is essential to understand the cause of obesity, the role of appetite as it relates to energy intake and weight gain so that efficacious weight-loss therapies are developed. Several compounds appear to play important role in the regulation of food intake, circulating nutrients (eg, glucose, amino acids, and fatty acids), metabolic compounds (eg, lactate, pyruvate, and ketone bodies), and hormones (eg, insulin, glucagon, cholecystokinin, leptin, and ghrelin) (7).

A peptide hormone secreted by adipose tissue, leptin (from the Greek word leptos, meaning thin) influences energy homeostasis, immune and neuroendocrine functions (8). It has been well established in humans that plasma leptin levels are directly proportional to body fat percentage. High concentration of leptin is very common among obese individuals, especially in their serum and plasma, exhibiting leptin resistance because of either decreased leptin transport into the central nervous system or downregulation of leptin receptors (9,10).

Waist circumference (WC) was not included in Preliminary data analysis of leptin concentration across the range of BMI. Furthermore, the relationship between leptin level and WC have not been assessed in a sample of adults with differences in age, fasting, physical activity and hypertension (12, 13).

The aim of this study was to evaluate the relationship of leptin with BMI and waist circumference in a random sample of adult women ranging from normal weight to severely obese. Through this study, a direct relationship of leptin with BMI and waist circumference was anticipated. The relationship of these hormones with diabetes, hypertension, and fasting was also studied.

### **MATERIALS AND METHODS**

Approved by the University of Umm-Alqura Institutional Review Board, this study obtained signed an informed consent form. The study was carried out at Umm AL-Quran University, AL-Noor Specialist Hospital (Diabetic Centre) and King Abdul-Aziz Hospital (AL-Zaher). All blood analyses were carried out in the University Physiology Department and Professor Sultan research laboratory at Umm AL-Qura University.

#### **Subjects**

The study participant included 240 women aged 18-65 and was divided into three groups (see below).

**First group: The Control group (normal) comprised 80 volunteers, with the BMI ranging from 18 to 29.99.**

**Second group: The obese group comprised 80 volunteers with the BMI of  $\geq 30$ .**

### First and Second Groups Met the Following Criteria

- Should not be on any diet or use any medication that can interfere with the result.
- Should not perform any physical activity interfering with the result.

**Third group: The Diabetic Obese Group Comprised** 80 volunteers with the BMI of  $\geq 30$ .

### Anthropometric Measurements

BMI is calculated as  $\text{kg/m}^2$ . Height was measured to the nearest centimeter using a Harpenden anthropometer (Holtain, Ltd, Crymych, UK). Weight was measured to the nearest 0.1 kg using a Scaletronix scale (Sharp Corp, Wheaton, IL, model 695, weighing to 364 kg). Subjects were divided based on five BMI categories as follows (2): normal weight,  $<25$ ; overweight, 25 to 29.9; obese I, 30 to 34.9; obese II, 35 to 39.9; severely obese,  $>40$ . The BMI of participants were not  $<18.5$ . Waist circumference was measured by locating the upper hip bone and placing a measuring tape around the abdomen (ensuring that the tape measure is horizontal) (14).

### Hormone Levels

Plasma obtained by centrifugation of blood samples collected after an overnight fast was stored at  $-70^\circ\text{C}$  in the Microbiology Department.

Using the enzyme-linked immunosorbent assay kit and once the samples thawed, leptin levels were measured in duplicate. Leptin kits were purchased from the Millipore Corporation Research Inc (St Charles, MO, U.S.A) and were used to test hormone levels at Professor Sultan Research Laboratory.

### Statistical Analysis

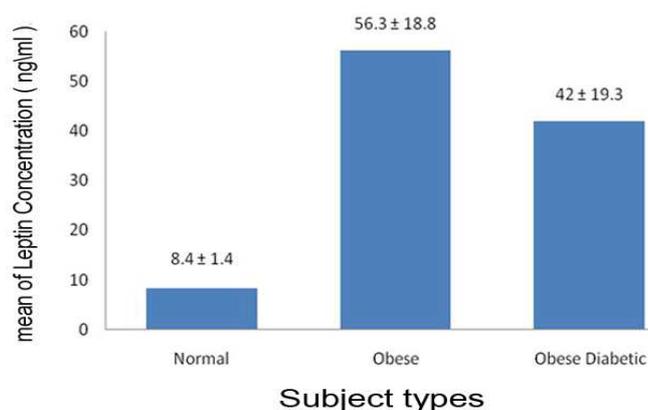
The SPSS software (version 11.5, 2002) was used for descriptive statistical analyses. For all analyses, the statistical significance was set at  $P = 0.05$ . The relationship of BMI, waist circumference with leptin concentrations in these subjects groups (normal, obese and obese diabetic) were determined using Pearson correlation coefficients. Correlation is defined as a measure of the strength of a linear relationship between two variables. The statistical measure of linear association is known as the correlation coefficient, denoted by the symbol  $r$ , which measures how close the points lie on a straight line, whose values always lie between  $-1$  and  $+1$ . The value  $+1$  indicates a perfect positive relationship between the two variables and  $-1$  indicates a perfect negative relationship. In addition, a  $p$ -value is the probability of getting the observed difference. If the  $p$ -value is greater than 0.05, then it can be concluded that the observed difference could have occurred by chance and there is no statistically significant evidence (at the 5% level) for a difference between the groups in the population.

### Result

The study samples were 240 women aged between 17 and 65 years, with a mean age of  $32.7 \pm 13.75$  years, height  $1.54 \pm 6.3$  m, and weight  $74.9 \pm 17.5$  kg (see table 1).

**Table 1: Summary of Characteristic Feature of All Volunteers in All Groups Such as Age, BMI, WC, Weight, Height, and Leptin Concentration**

Character		Normal	Obese	Obese Diabetic
Age	Range	18-38	18-55	20-58
BMI		18-29.9	30-53	30-53.6
WC		60-100	77-149	90-192
Age (years)	mean±std	20.1±2.3	31.4±12.1	46.6±7.9
Height (m)		1.55±6.4	1.556±6.4	1.529±6.00
Weight (Kg)		55.61±7.9	86.5±13.7	82.7±10.2
BMI		22.7±2.6	35.7±5.2	35.4±4.3
WC (cm)		72.9±7.5	101.6±12	106.6±12.4
Leptin Concentration (ng/mL)		8.4±1.4	56.3±18.8	42 ±19.3
		Max.	10.99	99.60
	Min.	5.12	8.21	12.71



**Figure 1: Mean ± Standard Deviation for Leptin Concentration**

### Leptin Concentration

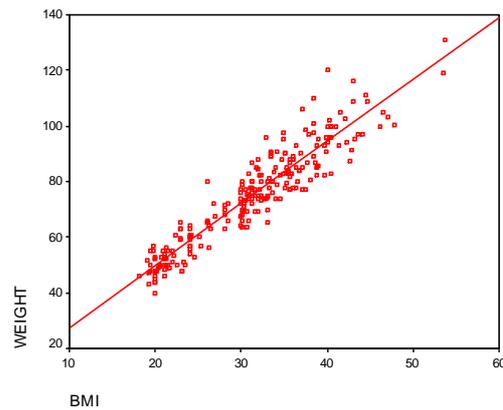
In all three groups, the Mean of leptin concentrations was 8.4 ng/ml ( $\pm 1.4$ ) in normal, 56.3 ( $\pm 18.8$ ) in obese and 42 ( $\pm 19.3$ ) in the diabetic obese group (see table 1 and figure 1).

### BMI and Weight

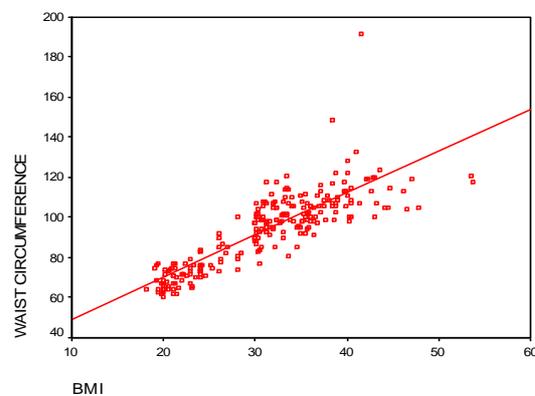
Directly associated with weight, BMI showed a strong positive relation ( $r = 0.935$ ,  $P = 0.000$ ) (See figure 2).

### BMI and Waist Circumference

Directly associated with waist circumference, BMI demonstrated a strong positive relation ( $r = 0.840$ ,  $P = 0.000$ ) (See figure 3).



**Figure 2: Correlation between Weight and BMI**



**Figure 3: Correlation between Waist Circumference and BMI**

### **Leptin Concentration and BMI in Various Groups**

#### **In Normal Subjects**

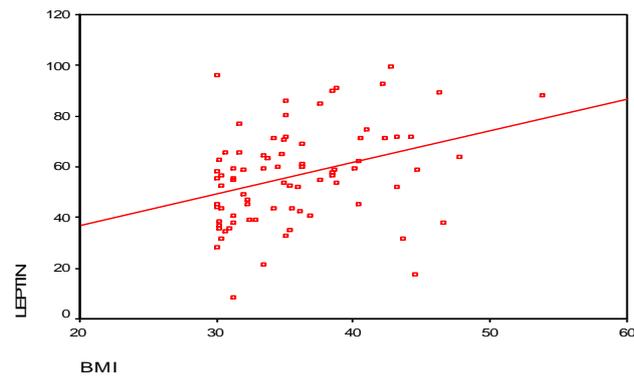
Leptin concentration and BMI showed a linear correlation ( $r = 0.152$ ,  $p = 0.178$ ) (data not shown).

#### **In Obese Subjects**

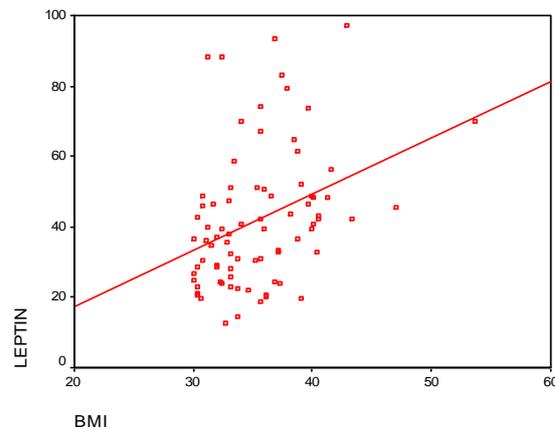
Directly associated with BMI, demonstrating a strong positive relation ( $r = 0.350$ ,  $p = 0.001$ ) (See figure 4).

#### **In Diabetic Obese Subjects**

Directly associated with body mass index, leptin concentration showed a strong positive correlation ( $r = 0.355$ ,  $p = 0.001$ ) (See figure 5).



**Figure 4: Correlation between Leptin Concentration and BMI in Obese Subjects**



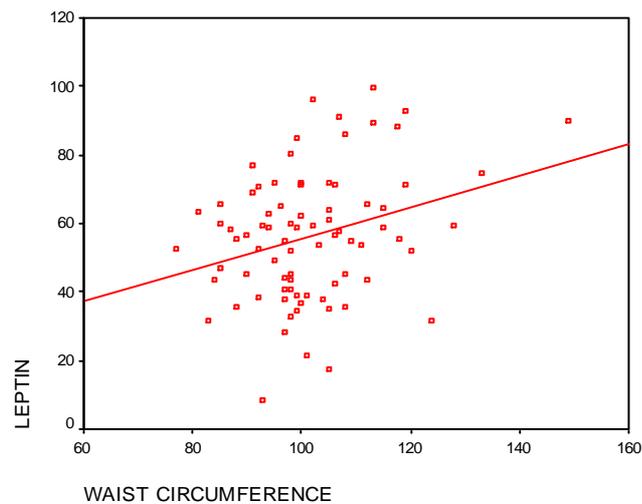
**Figure 5: Correlation between Leptin Concentration and BMI in Obese Diabetic Subjects**

#### **Leptin Concentration and WC in Various Subject Groups**

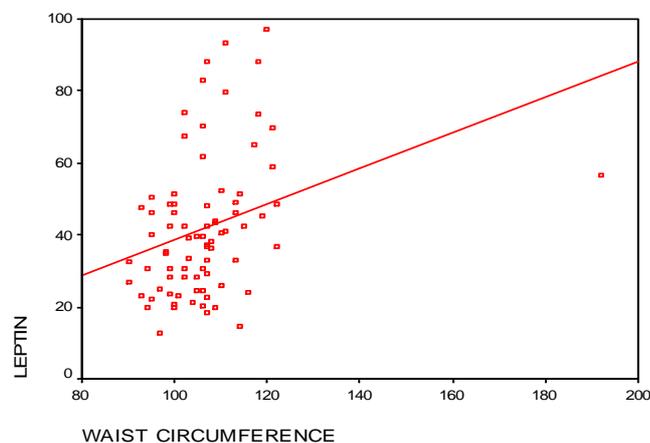
**In Normal Subjects,** No obvious correlation between leptin concentration and WC ( $r = 0.115$ ,  $p = 0.310$ ) (data not shown) was found.

**In Obese Subjects,** leptin concentrations were directly associated with WC with a positive correlation ( $r = 0.299$ ,  $p = 0.007$ ) (See figure 7).

**In Diabetic Obese Subjects,** leptin concentrations were directly associated with WC and demonstrated a strong positive correlation ( $r = 0.316$ ,  $p = 0.004$ ) (See figure 8).



**Figure 6: Correlation between Leptin Concentrations with WC in Obese Subjects**



**Figure 7: Correlation between Leptin Concentrations and WC in Obese Diabetics**

## DISCUSSIONS

The objective of this study was to measure the relation between BMI, WC and leptin concentration to understand obesity in the Saudi female population. BMI and WC were directly associated with leptin levels, showing a significant positive correlation between leptin and BMI categories.

Due to both increased fat cell number (hyperplasia) and increased fat cell size (15), obesity is characterized by increased adipose tissue mass. As the most significant contributor to ill health, obesity is now very common in the world's population, which is also replacing under nutrition and infectious diseases. In the United States, obesity currently affects 30% of the adult population and in KSA it affects 35.5% (16).

As the anthropometric measurement for obesity and fat content, the current study used BMI and WC. Many studies confirmed the association of BMI and WC with obesity and fat content. Correlating strongly with fat mass measurement is BMI, though it is unable to distinguish to fat mass from lean mass (17). On the contrary, a patient's abdominal fat content can be measured based on waist circumference, which is clinically acceptable (18).

## Obesity and leptin Concentration

The uniqueness of this study is that in adult Saudi women leptin concentrations were assessed for all BMI range, considering various risk factors such as waist circumference, age diabetes, and physical activity.

According to previous studies, in the healthy communities, based on the nationality, there is only little variation in leptin concentrations. A recent study indicated that leptin concentrations in Omani control subjects were 10.6 ( $\pm$  4.2) ng/ml (19) and in American control subjects, it was 7.8 ( $\pm$  0.7) ng/ml (20). Based on this study, the normal mean leptin concentration was 8.4 ( $\pm$ 1.4) ng/ml in Saudi women.

Various studies reported leptin levels were higher in obese individuals compared to normal weight individuals (21,22). In both obese and non-obese subjects, leptin seems to correlate better with subcutaneous fat compared with visceral fat, irrespective of the weight (23, 24). It has been understood that leptin concentrations are higher in obese subjects (see table 1), mainly because of a diminished response by the leptin receptor signaling pathway, leptin's poor penetration of the blood-brain barrier, or the presence of less active molecular forms of leptin (25). Leptin deficiency in normal subjects compared to obese subjects can be a likely target for leptin therapy, but an obese subject with high levels of leptin are likely to be resistant to leptin therapy (26). Obesity can lead to leptin resistance, which may also be due to a lack of sensitivity to circulating leptin contributing to the etiology of obesity (27).

There is an increased concentration of serum leptin -based on increased body fat content. The increased release of leptin from large fat cells is the proof for the positive correlation between body fat and serum leptin. In addition, fat content can be assessed based on the serum leptin levels, whose level may decrease by reduction of body fat, maintaining the BMI values (28).

Although insulin levels are not assessed, previous studies proved that leptin is directly associated with insulin resistance (29,30). However, in the diabetic obese group, leptin concentrations were lower compared to those in the obese group but still higher compared to the normal group (31). The differences in fat distribution between the obese diabetic and the obese nondiabetic groups may be the reason for this. Studies have demonstrated that subcutaneous fat produces more leptin compared to visceral fat. diabetics subjects have more visceral fat and less subcutaneous fat because insulin is an important stimulator of leptin production (31).

Profound insulin deficiency leads to uncontrolled diabetes which in turn is realized by behavioral markers and metabolic concerns, such as severe hyperglycemia, depletion of body fat mass, and reduced circulating leptin levels that stimulate food intake (32). It is essential to understand whether the subcellular and tissue distribution of leptin are different in human adipocytes obtained from lean and diabetic obese individuals and whether it can be altered by effectors such as insulin (33).

In spite of controlling the glucose level, high levels of leptin are observed in diabetic obesity, as leptin antagonizes insulin's action in the liver, which is influenced by the changes in intrahepatic glucose with increased gluconeogenesis and decreased glycogenolysis. It is likely that these leptin's metabolic effects regulate hepatic glucose metabolism under physiological conditions (34).

## Obesity and Anthropometric Measurements

As demonstrated by this study, BMI and WC correlate well with leptin concentration in all subject groups. This is achieved by the close relation of BMI, WC and body fat content along with the role of visceral and subcutaneous fat for producing leptin (35,36).

In our study, the mean BMI in normal obese and diabetic obese groups were, respectively, 22.7 ( $\pm$  2.8), 35.7 ( $\pm$  5.2) and 35.4 ( $\pm$  4.3)[AQ: three set of values are provided for two parameters. Please check and edit as necessary.]. BMI and body weight are correlated,. Based on the reported data, BMI and leptin concentrations were higher in obese women compared to other groups. The WC mean in the normal, obese and diabetic obese groups were 72.9 ( $\pm$  7.5), 101.6 ( $\pm$ 12) and 106.6 ( $\pm$ 12.4), indicating that the high WC was found in the obese and diabetic obese compared to the normal group.

According to the findings of the current study, there is a positive relationship between BMI and WC, demonstrating that increase in BMI will in turn cause increase in WC and leptin concentration (See figure 3).

## CONCLUSIONS

A Middle Eastern country with approximately 23 million populations, Saudi Arabia has shown significant economic and cultural changes over the past thirty years. Approximately 60% of the population is urbanized and have adopted lifestyle according to their diet and physical activity.

In today's world, obesity has become a major health issue as it is linked to hypertension, dyslipidemia, and diabetes and insulin resistance syndrome. Over the past several years, Data have shown a worldwide increase in the number of obese people. In Saudi Arabia, the prevalence of obesity among female and, to a lesser extent, male adults has reached epidemic proportions.

Based on the findings of this study and other studies, obesity and being overweight are the major public health issues of women in Saudi Arabia.

In Saudi Arabia, limited physical activity, limited availability of exercise facilities for women and limited awareness of obesity-related health risks among the population are the reasons for the prevalence of obesity among Saudi women.

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