A Study of Leptin, Biochemical and physiological analysis based on BMI in medical students

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ABSTRACT

Aim: The purpose of this study is to investigate the changes in the levels of Leptin in medical students based on BMI. Leptin is a 16-kDa protein hormone that plays a key role in regulating energy intake and energy expenditure, including appetite/hunger and metabolism. It is one of the most important adipose-derived hormones.

Methods: BMI was studied in four groups namely normal BMI, Increased BMI, Obesity-I, Obesity – II.

Results: The levels of Leptin, biochemical and physiological were found to be increased in the Increased BMI, Obesity-I, Obesity – II medical students when compared with control Normal BMI medical students.

Conclusions: The leptin - endocrine systems in obese subjects are characterized by changes consistent with secondary hyperparathyroidism and its serum concentrations in healthy individuals positively correlate with body fat content.

Introduction

The body mass index (BMI), or Quetelet index, is a measure of relative weight based on an individual’s mass and height. Devised between 1830 and 1850 by the Belgian polymath Adolphe Quetelet during the course of developing “social physics” it is defined as the individual’s body mass divided by the square of their height – with the value universally being given in units of kg/m². A large amount of research has been conducted on leptin since its discovery in 1994 and it is now possible to evaluate the physiological significance of leptin. Leptin acts as a metabolic hormone in a wide range of processes by binding to receptors in the brain. Leptin functions primarily as an anti-obesity hormone. Its serum concentrations in healthy individuals positively correlate with body fat content but it correlates negatively when energy intake is reduced and energy stores in fat are declining.

Menendez et al, 2001 found that leptin secretion by human adipose tissue is negatively and powerfully controlled by 25-OH-VitD.

Materials and Methods

Chemicals:
Leptin kits were purchased from immune Diagnostic kits, USA. All the other chemicals used were of analytical grade.

Experimental Design

Out of 100 Medical students were divided in to four groups. Group I – Normal BMI (24 Students), Group-II – Increased BMI (16 Students), Group-III- Obesity-I (28 Students) and Group-IV (32 Students). The study was conducted during the period of May 2013 to July 2014 in department of clinical biochemistry, Meenakshi Medical College Hospital And Research Institute, Kanchipuram, Tamil Nadu.

ETICAL CONCERN

Ethical clearance was obtained from the Ethical committee meeting conducted at Meenakshi Medical College and Hospital on January 29 th 2013. 100 randomly selected gender matched medical students and grouped according to BMI as normal with increased BMI from gender matched medical students.
students were enrolled in the study after getting an informed consent. The study parameters were estimated in the medical students with increased BMI and compared with the gender matched students of normal BMI.

INFORMED CONSENT
An informed consent was obtained from all the subjects participating in the present study. The participants were 100 medical students studying MBBS in Meenakshi Medical College. The students belong to different socioeconomic and religious backgrounds.

INCLUSION CRITERIA
1. Age group of 19-21 years
2. Both sex

EXCLUSION CRITERIA
1. Age <19 and > 23 years
2. Diabetes mellitus
3. Renal disorders
4. Liver pathology
5. Vitamin D supplemented individuals.
6. Any chronic illness necessitating the intake of hormones and drugs.

ANTHROPOMETRY
CALCULATION OF BMI
After removal of their footwear subjects' weight were measured with a beam balance scale, height was measured in a stadiometer to the nearest 0.5 cm. Their BMI was calculated using the formula

\[ BMI = \frac{weight \text{ in kg}}{height \text{ in m}^2} \]

Waist circumference (cm) was taken with a tape measure as the point midway between the costal margin and iliac crest in the mid-axillary line, with the subject standing and breathing normally. Hip circumference (cm) was measured at the widest point around the greater trochanter. The waist-to-hip ratio was calculated as the waist measurement divided by the hip measurement.

BIOCHEMICAL PARAMETERS
Serum leptin, lipid profile were the biochemical and physiological parameters estimated in the study population.

COLLECTION OF BLOOD SAMPLE
3ml of blood was collected for the estimation of biochemical parameters parameters. The blood drawn was allowed to coagulate and the serum was separated by centrifuging and stored at -20°C until assayed.

Results
Prevalence of BMI in Medical Students:
The prevalence of BMI was studied in four groups namely normal BMI (18.5 – 24.9), Increased BMI (25.0 – 29.9), Obesity-I (30.0 – 34.9), Obesity – II (35.0 – 39.9). Out of 100 Medical students 16 had increased BMI, 28 belonged to Obesity –I group and 32 belonged to obesity-II group while 24 had normal BMI. The percentage prevalence of BMI in normal, Increased BMI, Obesity-I and Obesity II levels medical students is shown as a pie chart in Chart 1.

The percentage of normal, Increased BMI, Obesity-I and Obesity II levels in the groups are 24%, 16%, 28% and 32% respectively and BMI levels are 21.38, 27.52, 33.21 and 38.54 respectively. In our study, BMI was estimated in medical students of 19-21 years without any history of signs and symptoms of clinical diseases, studying in Meenakshi Medical College, Enathur, Kanchipuram.

BMI WITH LEPTIN:
In our study, the four categories of Leptin levels were classified. The observed mean Leptin values of Normal BMI, Increased BMI, Obese-I and Obese-II students were 8.22±0.85, 16.45±1.6, 20.84±2.10 and 24.54±2.70 respectively as shown in figure.1

BMI WITH BLOOD GLUCOSE
Figure 2 shows the relation between BMI with blood glucose levels in medical students. The blood levels of fasting glucose were estimated in four groups of medical students. The fasting glucose levels were significantly elevated in Obesity-I and Obesity- II groups (P<0.05) when compared with normal BMI group whereas there is no significant elevation in increased BMI versus normal BMI group.

BMI AND LIPID PROFILE
Figure 3 illustrates the levels of Total Cholesterol (TC), Triglycerides (TGL) and High Density Lipoprotein (HDL) in Medical students based on BMI. The levels of TC and TGL were found to be significantly positively correlated (p<0.001) with BMI. HDL was found to be significantly decreased (P<0.001) in increased BMI and Obese-I and Obese-II medical students compared to normal BMI medical students.

BMI AND BLOOD PRESSURE
Figure 4 shows the relation between the blood pressure levels in medical students based on BMI. The levels of systolic and diastolic blood pressure
Figure 1: Relation between BMI and Leptin

Each value is expressed as mean ± SD for hundred medical students.

- a*: as compared with Normal BMI Group
- b*: as compared with Normal BMI Group
- c*: as compared with Normal BMI Group

Statistical significance: *p<0.001 @ p<0.01 #p<0.05, NS - Not significant

Figure 2: Relation between BMI and blood glucose

Each value is expressed as mean ± SD for hundred medical students.

- a*: as compared with Normal BMI Group
- b*: as compared with Normal BMI Group
- c*: as compared with Normal BMI Group

Statistical significance: *p<0.001 @ p<0.01 #p<0.05, NS - Not significant
were observed in four groups. The mean SBP and DBP for the study participants with normal BMI were 120.4±12.18 and 80.9±9.44 mmHg and with increased BMI it was 122.26±18.10 and 80.9±9.9 in mmHg. In medical students who belong to obesity - I group the mean SBP and DBP were 122.63±13.17and 82.98±10.26 and in students who belong to obesity -II group the mean SBP and DBP were 128.09±18.92 and 86.26±12.80. The observed results show that the blood pressure was found to be significantly (p <0.05) increased in obese medical students when compared to students with normal BMI.

**RELATION BETWEEN BMI AND WAIST TO HIP-RATIO**

Figure 1 and 2 shows the relationship between BMI and waist to hip ratio in medical students. Waist to hip ratio was observed in four groups. In students with normal BMI it was 0.78±0.05 in students with increased BMI it was 0.82±0.06 in obese students [group-I] it was 0.91±0.08 in obese students [group-2] it was 0.93±0.09.

The observed results clearly shows that waist to hip ratio was found to be significantly (p <0.05) increased in obese medical students when compared to students with normal BMI.

**Discussion**

Leptin is a 16-kDa protein hormone that plays a key role in regulating energy intake and energy expenditure, including appetite/hunger and metabolism. It is one of the most important adipose-derived hormones (Brennan and Mantzoros, 2006). Leptin has many additional effects that include angiogen­esis, hematopoiesis, lipid and carbohy­drate metabo­lism and effects on the repro­ductive, cardio­vascular and immune systems. In obese humans, an increased fat mass correlates with increased plasma leptin levels (Considine et al., 1996).

Leptin acts as a metabolic hormone in a wide range of processes by binding to receptors in the brain (Holick, 2005). Leptin functions primarily as an anti-obesity hormone, based on the hypothalamic nuclei, leptin decreases food intake, and increases energy expenditure through sympathetic activation, which consequently decreases adipose tissue mass and body weight. The hormone levels are decreased during fasting and increased after several days of overfeeding as an effort to help regulate energy balance in humans.

The significantly higher leptin concentrations in overweight or obese compared with lean or normal-weight people suggest that the effect of leptin on appetite control is diminished or absent. This is compatible with animal studies in which the administration of leptin decreases food intake, adiposity and body weight in leptin-deficient ob/ob mice but not in leptin insensitive db/db mice.

**PREVALENCE OF BMI IN MEDICAL STUDENTS**

The body mass index (BMI) or Quetelet index, is a measure of relative weight based on an individual’s mass and height. It is defined as the individual’s body mass divided by the square of their height – with the value universally being given in units of kg/m².

In our study we observed that out of 100 Medical students 16 had increased BMI, 28 belonged to Obesity –I group and 32 belonged to obesity-II group while 24 had normal BMI. The percentage of normal, Increased BMI, Obesity-I and Obesity II levels in the groups are 24%, 16%, 28% and 32% respectively and BMI levels are 21.38, 27.52, 33.21 and 38.54 respectively.

The prevalence of overweight and obesity among the medical students in the present study was similar to that of the general population in India. In our study, 71.7% of undergraduate medical students were obese which was almost similar to study conducted in West Bengal in India among undergraduate medical students (Park K. Text book of preventive and social Medicine 19th edition page 335).

The international diabetes foundation has accepted BMI > 25kg/m² and >23kg/m² as cut off value for obesity for Asian men & women respectiv­ely and according to this the prevalence of Obesity among males was 32% and among females was 52% which was alarming.

**LEPTIN AND BMI**

In our study leptin levels were measured in the study group. Leptin levels were found to be from 8.22 to 9.07 ng/ml in normal BMI group, 16.45 to 18.00 ng/ml in increased BMI group, 20.84 to 22.94 ng/ml in obesity I group ,24.54 to 27.20 ng/ml in obesity II group.

These results show that there is an increase in leptin levels with the increase in the BMI which was similar with the previous studies conducted by (Chow and Phtoon, 2003).

Leptin is secreted as a hormone mainly from white adipose tissue and serves as a signal for the brain of the body’s energy stores.

By reducing food intake and increasing thermogenesis, leptin controls body fat tissue and, hence, body weight (Halaas et al., 1996). Studies of its physiologic action in humans have shown a strong positive correlation between serum leptin concentrations and the percentage of body fat (Considine et al., 1996; Hassinik et al., 1996).

The significantly higher leptin concentrations in overweight or obese compared with lean or normal-weight people suggest that the effect of leptin on appetite control is diminished or absent. This is compatible with animal studies in which the administration of leptin decreases food intake, adiposity and body weight in leptin-deficient ob/ob mice but not in leptin insensitive db/db mice.

Acting on the hypothalamic nuclei, leptin decreases appetite, and increases energy expenditure through sympathetic activation, which consequently decreases adipose tissue mass and body weight. The hormone levels are decreased during fasting and increased after several days of overfeeding as an effort to help regulate energy balance in humans.

Due to latter homeostatic control mechanism, leptin is an anti-obesity hormone, based on the hypothetical fact that high leptin levels would prevent the occurrence of obesity. Unfortunately, this is not the case, and so the strong correlation between serum leptin levels and body fat mass found in obese individuals now suggests the existence of an endogenous leptin-resistant mechanism in obesity.
It has been postulated that the apparent loss of the anorexic and weight-reducing effects of leptin in obesity, is a result of a leptin-resistance mechanism. Nevertheless, obesity is associated with increased sympathetic nerve activity, and leptin has been proven to participate in autonomic nervous system control, by increasing renal sympathetic nerve activity (RSNA). Therefore, it is contradictory that, in the presence of a leptin resistance state, the hormone can contribute to the sympathetic activation seen in obesity. This has led to the novel concept of selective leptin resistance, in which resistance appears to be primarily limited to the metabolic (satiety and weight-reducing) actions of leptin, sparing the renal sympathetic activation effects. This concept has emerged from observations made first in agouti yellow obese (Ay) mice and corroborated recently in a diet-induced obesity model (Rahmouni et al., 2005).

In these studies, leptin administered peripherally produced increase in RSNA in both obese and lean mice, but failed to decrease food intake and body weight in the obese mice to a similar degree as it did in their lean littermates.

Interestingly, this same effect was observed when leptin was injected into the lateral ventricle of the brain. Here, leptin increased RSNA again, without changing significantly food intake and body weight in Ay and diet-induced obese mice, as compared with their respective lean littermates.

These latter studies also served to demonstrate that is unlikely that leptin resistance is due to an impaired leptin transport mechanism across the blood–brain barrier as intracerebroventricular administration of the hormone also failed to enhance food intake and weight loss. Moreover, the increased RSNA achieved by central leptin administration was not accompanied by changes in plasma leptin levels, suggesting that leptin-induced RSNA was centrally-mediated.

The mechanism by which the increase in body fat is translated into an increase in serum leptin appears to involve induction of the ob gene. There is a significantly greater amount of ob mRNA in adipocytes from obese subjects than in those from normal-weight subjects. The fact that in obese subjects serum leptin increases significantly suggests that hypertrophy of adipocytes leads to an increase in leptin production by individual cells, to approximately twice the initial value. Recent studies in humans and rodents support the concept that serum leptin concentrations are regulated by direct changes in the expression of the ob gene. It appears therefore that changes in body fat are translated into changes in serum leptin at the level of ob gene expression.

**BMI AND BLOOD PRESSURE**

In our study both systolic and diastolic blood pressure were observed in the normal BMI group, increased BMI group, obesity- I group and obesity- II group. The observed results show that the blood pressure was found to be significantly (p <0.05) increased in obese medical students when compared to students with normal BMI.

The result obtained in our study was similar with the previous study done by Jayet al. (1997). A number of metabolic consequences of obesity have been proposed as the blood pressure–elevating mechanism (Hall et al., 1994) Increasing weight has been shown to increase salt retention (Rochini et al., 1989; Cooper et al., 1984) and insulin resistance is proposed by some to be a cause of hypertension. Weight gain is recognized to be an important contributor to essential hypertension. In obese dogs and humans, the shift of pressure natriuresis to higher blood pressures appears to be due mainly to increased tubular reabsorption, as glomerular filtration rate and renal plasma flow are increased compared with normal.

Multiple causes of increased tubular reabsorption and hypertension in obesity have been postulated.
Figure - 3: Relation between BMI and lipid profile

Each value is expressed as mean ± SD for Hundred students
a : as compared with Normal Group (Control Group)
Statistical significance: *p<0.001 @ p<0.01 #p<0.05, NS - Not significant

Figure - 4: Relation between BMI and blood pressure

Each value is expressed as mean ± SD for Hundred students
a : as compared with Normal Group (Control Group)
Statistical significance: *p<0.001 @ p<0.01 #p<0.05, NS - Not significant

Figure - 5: Relation between BMI and obesity

Each value is expressed as mean ± SD for Hundred students
a : as compared with Normal Group (Control Group)
Statistical significance: *p<0.001 @ p<0.01 #p<0.05, NS - Not significant
including insulin resistance and hyperinsulinemia, activation of the sympathetic nervous and renin-angiotensin systems, and physical changes within the kidney itself.

Support for the insulin resistance-hyperinsulinemia link between obesity and hypertension has been inferred mainly from acute and epidemiologic studies showing a correlation between insulin and blood pressure (Hall et al., 1994).

Recent studies suggest that chronic hyperinsulinemia, comparable to that found in obesity, cannot account for obesity hypertension in dogs or humans. Activation of the sympathetic nervous system may play a role in obesity-induced hypertension, and there is evidence for a role of altered intrarenal physical forces caused by histological changes within the renal medulla.

**BMI AND WAIST TO HIP RATIO**

In our study waist to hip ratio was measured in the normal BMI group, increased BMI group, obesity-I group and obesity-II group. The results obtained showed that there is an increase in waist to hip ratio with an increase in BMI. Our finding was supported by previous work done by Sukhpal and Indarjit (2007).

Over weight and obesity are common health conditions. Body mass index, waist circumference are the commonly used parameters to evaluate obesity. Waist circumference has become the preferred measure for abdominal obesity. Han has also reported that the larger waist circumference helps in identification of people at increased cardiovascular risks (WHO, 1998).

In the Inter heart study, it was very clear that out of different anthropometric measures waist-hip ratio shows the strongest relation with the risk of myocardial infarction. One more study also confirmed waist hip ratio as an important risk factor for death from coronary heart diseases.

**Statistical analysis**

For statistical analysis, one way analysis of Variance (ANOVA) was used, followed by the Newman-Keuls Multiple Comparison test.

**Conclusion**

From the present study, normal BMI, Increased BMI, Obesity-I, Obesity – II. Leptin, biochemical and physiological analyses were significantly increased in increased BMI, Obesity-I & II in when compared with other normal BMI medical students.

**References**


Brennan AM, Mantzoros CS “Drug Insight: the role of leptin in human physiology and pathophysiology—emerging clinical applications”.


