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Original Article

Physiology Section

Correlation of Sagittal Abdominal Diameter and Other Anthropometric Parameters with Serum Leptin Levels in Young Adults- A Cross-sectional Study

PRAVESH KUMAR[1], RAHUL[2], ANUBHAV DWIVEDI[3], MAYANK AGARWAL[4], NARSINGH VERMA[5], SHIVANI PANDEY[6]

ABSTRACT

Introduction: Leptin is secreted in concentrations proportional to body fat mass. The anthropometric parameter among Sagittal Abdominal Diameter (SAD), Body Mass Index (BMI), Hip Circumference (HC), Waist Circumference (WC), Waist-Hip Ratio (WHR), and Waist-Height Ratio (WHtR) that correlates maximally with serum leptin levels could be used preferably to assess adiposity.

Aim: The present study aims to correlate serum leptin levels with SAD, BMI, HC, WC, WHR and WHtR in young and healthy North Indian adults.

Materials and Methods: The present cross-sectional study was conducted jointly in the Department of Physiology and Biochemistry at the King George's Medical University, Lucknow, Uttar Pradesh, India from September 2015 to August 2016 and it included apparently healthy individuals, aged 18-25 years, native to North India, after obtaining an informed consent. A convenient sample size of 100 was taken. One investigator took all anthropometric measurements. (SAD, BMI, HC, WC, WHR and WHtR) RayBio human leptin ELISA kit was used for the estimation of leptin level. For statistical analysis, Pearson's correlation coefficient was used. P<0.05 was considered significant.

Results: The study involved 55 males and 45 females aged 21.4±1.5 years with BMI 22.7±2.7 kg/m^2, HC 91.5±6.9 cm, WC 81.9±7.9 cm, WHR 0.9±0.1, WHtR 0.50±0.04, SAD 20.8±3.1 cm and serum leptin level 389.6±102.7 pg. Serum leptin level correlated significantly with HC (r=0.23, p=0.02), WC (r=0.29, p=0.003), WHtR (r=0.36, p<0.001), and SAD (r=0.56, p<0.001). A non significant correlation was obtained with BMI (r=0.15, p=0.12) and WHR (r=0.11, p=0.26).

Conclusion: SAD is a better predictor of body fat and hence, cardiometabolic health than other anthropometric parameters in the present study, as it correlated most strongly with serum leptin levels.

Keywords: Adiposity, Body mass index, Waist circumference, Waist-hip ratio, Waist-height ratio

INTRODUCTION

The visceral fat accumulation leads to the activation of various inflammatory pathways causing the development of cardiovascular and metabolic disorders [1]. Accurate quantification of adipose tissues requires imaging techniques such as Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) [2]. However, these imaging techniques are expensive and not readily available, thus impractical for primary healthcare setup.

Traditionally, primary care physicians use BMI or Quetelet index to assess adiposity [3]. However, it has been established that the Asian populations develop cardiometabolic complications at a lower BMI than western populations due to the difference in body fat distribution [4]. Hence, BMI is not an accurate indicator of body fat percentage, and therefore other clinical anthropometric measurements, such as WC, WHR, and WHtR, came into existence [5,6]. Nevertheless, another anthropometric marker of metabolic syndrome and visceral obesity is the SAD [7,8]. SAD is a measure of the anteroposterior diameter of the abdomen in a supine position that can be measured using a sliding beam abdominal calliper. Previous studies involving populations of different ethnicity, age and BMI have identified SAD as a better predictor of cardiovascular and metabolic health [9-11]. Leptin is a vital adipokine that plays a crucial role in the metabolic homeostasis of the body. Leptin causes satiety, i.e., lowers food intake, increases energy expenditure, and maintains average body weight [12]. Leptin is not only an established biomarker of body fat mass in the general population, but also high leptin level is associated with poor cardiometabolic health [13,14].

Few previous studies have correlated serum leptin levels with different anthropometric measurements [15-17]. The anthropometric parameter that maximally correlates with serum leptin levels could be used preferably to assess adiposity and cardiometabolic health. Therefore, the present study aimed to correlate serum leptin levels with SAD, BMI, HC, WC, WHR and WHtR in young and healthy North Indian adults.

The null hypothesis assumed no correlation exists between serum leptin level and SAD. In contrast, the alternate hypothesis stated that the serum leptin level increases with an increase in SAD.

MATERIALS AND METHODS

The present cross-sectional study was conducted jointly in the Department of Physiology and Biochemistry at the King George's Medical University (KGMU), Lucknow, Uttar Pradesh, India. Institutional ethical clearance (64 ECM II-B/P3) was obtained to conduct the study from September 2015 to August 2016. A structured general and systemic examination was conducted to know the health status of the subjects.

Inclusion criteria: Apparently healthy individuals, aged 18-25 years, native to North India, were recruited for the study irrespective of gender after obtaining informed written consent.

Exclusion criteria: Subjects in which any abnormality was detected during the examination; positive history of substance abuse; history of drug use that interferes with glucose metabolism; family history positive for metabolic diseases, cardiovascular diseases, autoimmune diseases, psychosomatic disorders, or neurological disorders were excluded from the study.

Sample size calculation: A convenient sample size of 100 was taken for the study. G*power v3.1.9.7 determined that at a permissible 5% alpha error, 80% power of the study, and sample size of 100, a correlation coefficient (r) of more than 0.246 in a one-tailed bivariate normal model correlation test would prove the alternate hypothesis [18].

Study Procedure

One investigator took all anthropometric measurements. First, weight was measured using a locally available electronic weighing scale (Omron HBF 212) to the nearest 0.1 kg. For weight measurement, the subject wore light clothing and no shoes, and their feet were placed in the center of the scale. Next, height was measured to the nearest 0.1 cm when the participant stood barefoot on the platform of a locally available rigid stadiometer (model SECA 213). While measuring the participant's height- shoulder blades, buttocks, and heels touched the back of the stadiometer, legs were straight, knees and heels were together, toes pointed outwards at approximately 60° angle, the head was in the Frankfort plane, arms were hanging at the sides with palms supine, breath was held in deep inhalation to straighten the spine, and hair was compressed to the crown of the head by the horizontal bar of the stadiometer. Finally, BMI was calculated by Quetelet's index, i.e., weight (in kilograms) divided by the square of height (in meters) [3].

WC was measured to the nearest 0.1 cm with a flexible and inelastic measuring tape when the participant stood in an end-expiration state with both feet together and arms placed on the contralateral shoulders. The measuring tape was snugly wrapped horizontally around the lateral aspect of each ilium at the mid-axillary line while taking the precaution of not compressing the underlying tissues. HC was measured at the widest part of the hip when the subject stood in a posture similar to the WC measurement. WHR was calculated by dividing WC by HC. WHtR was calculated by dividing WC by height. The SAD was recorded in the supine position with knees bent at approximately 90° angle, feet resting flat on the table, and arms crossed over the chest. The measuring tape was snugly wrapped horizontally around the uppermost lateral aspect of each ilium at the mid-axillary line. A horizontal line is drawn from the umbilicus to the lateral side with a cosmetic pencil on the border of the measuring tape towards the participant's head end. A locally available sliding beam abdominal calliper's lower arm was inserted beneath the back of the participant such that the calliper's arm remained in touch with the subject's back. The shaft of the calliper was adjusted in a vertical position. The participant was instructed to hold their breath in an end-expiratory position. The calliper's upper arm was slid over the line drawn previously, taking care not to compress the abdomen. The average of two measurements was taken as the final [19].

For serum leptin level estimation, a trained phlebotomist drew 5mL of blood after overnight fasting in a vacutainer tube from the superficial vein of the arm of participants under all aseptic conditions. The vacutainer tube containing the blood sample was left undisturbed at room temperature for an hour; after that, the serum was separated from the plasma by centrifugation at 3000 Revolutions Per Minute (RPM). The serum was stored in cryovials at -80° celsius. RayBio human leptin Enzyme-Linked Immunosorbent Assay (ELISA) kit was used to determine the concentration of leptin in serum. Serum leptin levels vary with the fat content of the body and there is a paucity of data regarding normal serum leptin levels in healthy Indian adults. However, data from the Chinese population indicates that serum leptin levels of 0.33-19.85 ng/mL for males and 3.60–54.86 ng/mL for females should be considered normal and this was considered as a reference here in this study as corresponding data from Indian population is not well documented [20].

STATISTICAL ANALYSIS

International Business Machines (IBM) Statistical Package for Social Sciences (SPSS) Statistics for windows version 25.0 was used to conduct the statistical analysis after entering the initial data in Microsoft Excel 2019 software. Data are presented as mean±standard deviation and rounded off to either one or two decimal places. Pearson's correlation coefficient was used to correlate serum leptin with HC, WC, WHR, WHtR, BMI, and SAD. The confidence interval was 95%. $p<0.05$ was considered significant.

RESULTS

[Table/Fig-1] shows the characteristics of the participants, anthropometric measurements, and serum leptin level.

Anthropometric parameters (n=100)	(Mean±SD)
Age	21.4±1.5
Male:Female	55:45
Height (cm)	163.1±7.2
Weight (kg)	60.5±8.7
BMI (kg/m²)	22.7±2.7
HC (cm)	91.5±6.9
WC (cm)	81.9±7.9
WHR	0.9±0.1
WHtR	0.50±0.04
SAD (cm)	20.8±3.1
Serum leptin (pg)	389.6±102.7

[Table/Fig-1]: Participant characteristics, anthropometric measurements and serum leptin level.

[Table/Fig-2] shows a positive, strong, statistically significant correlation between serum leptin level and SAD. Hence, the alternate hypothesis was proved. HC, WC, and WtHR were also positively and significantly correlated with leptin levels. Serum leptin does not show a significant correlation with BMI and WHR.

Parameter	r	p
BMI (kg/m²)	0.15	0.12
HC (cm)	0.23	**0.02**
WC (cm)	**0.29**	**0.003**
WHR	0.11	0.26
WHtR	**0.36**	**<0.001**
SAD (cm)	**0.56**	**<0.001**

[Table/Fig-2]: Correlation between anthropometric parameters and serum leptin (pg).
Pearson correlation coefficient was used; p<0.05 was considered significant.

[Table/Fig-3] shows that BMI and SAD were significantly ($p<0.001$) associated with serum leptin levels in the multivariate linear regression analysis among the males, i.e., if the BMI and SAD will increase, the serum leptin level will also increase in males. However, only SAD was positively and significantly ($p<0.001$) associated with the level of serum leptin among females.

Anthropometric parameters	Beta coefficient	p-value
Male		
BMI (kg/m²)	11.97	0.001
HC (cm)	-17.93	0.112
WC (cm)	12.99	0.276
WHR	-923.44	0.325
WHtR	518.79	0.172
SAD (cm)	15.22	<0.001
Constant	948.14	0.326
Female		
BMI (kg/m²)	2.31	0.626
HC (cm)	-5.54	0.560
WC (cm)	6.63	0.579

WHR	-305.70	0.776
WHtR	49.77	0.933
SAD (cm)	23.47	<0.001
Constant	156.76	0.864

[Table/Fig-3]: Multivariate linear regression analysis of anthropometric parameters and serum leptin (pg).
Multivariate linear regression analysis was used. p<0.05 was considered significant

DISCUSSION

Leptin, a polypeptide hormone, is secreted from the adipose tissue that has complex and multidirectional actions in the metabolic homeostasis of the body. Leptin is secreted in concentrations proportional to body fat mass, and its increased level is associated with metabolic syndrome and cardiovascular diseases [21]. Previous studies have also indicated that SAD is a better indicator of cardiometabolic health than the widely used BMI for assessing adiposity [9-11,22].

The present cross-sectional study involved 100 young and healthy North Indian males and females. Serum leptin levels were correlated with various anthropometric measurements. The study's main finding was that SAD shows a strong and statistically significant correlation with serum leptin levels in both males and females. The result of the present study is similar to the previous study done by Yadav A et al., which reported a significant and positive correlation of HC and WC with serum leptin levels. Also, similar to the present study results, WHR showed no significant correlation with serum leptin levels in the North Indian healthy adult age group subjects that included both males and females. However, Yadav A et al., reported a positive and significant correlation between BMI and serum leptin level, while in the present study non significant correlation was established [23]. Similar results were reported by Ayina CN et al., in the sub-Saharan African population [24]. In addition, Ugrinska A et al., reported a significant and positive correlation of serum leptin levels with WC, HC, and BMI in 50 obese women [25].

Agbogu-Ike OU et al., reported that leptin level significantly correlates with BMI in males, but a non significant correlation was obtained for non diabetic Nigerian African females [26]. Stępień M et al., reported a non significant correlation of BMI with serum leptin in elderly, obese, non diabetic, and hypertensive patients [27]. Abd Elhafeez MA et al., reported a negative and non significant correlation of BMI with serum leptin levels in multiple sclerosis patients [28]. Recently, Abdalla MMI, Soon SC reported a lack of association between serum leptin levels and BMI in normal and obese males [15]. A considerable variation in the correlation of BMI with serum leptin levels has been reported in previous studies. The reason for this variation could be different population characteristics. In the present study, SAD correlated more strongly with serum leptin levels than WC, HC, and WHtR, while a non significant correlation was obtained for BMI and WHR. Thus, it can be said that SAD is a better predictor of cardiometabolic health than other anthropometric parameters involved in the present study. Contrary to the present study results, Al-Attas OS et al., reported that BMI correlates more strongly with leptin levels than SAD. Al-Attas OS et al., concluded that BMI is a better predictor of cardiometabolic risk factors than SAD [8]. SAD could be the best noninvasive surrogate marker for raised serum leptin levels that can be easily measured at a primary care setup without any cost to alert patients of future risk of metabolic syndrome.

Limitation(s)

The present study had a few limitations, including the involvement of only young and healthy individuals; hence, the results might not apply to the general population. A large and diverse population is required to firmly establish the correlation between serum leptin levels and anthropometric measurements.

CONCLUSION(S)

The study concluded that serum leptin levels in young Indian adults significantly and positively correlated with WHtR, WC, and SAD. In addition, SAD showed the strongest correlation with serum leptin levels. Therefore, primary care physicians should consider including SAD in routine examinations to delineate the patients with a high risk of developing cardiometabolic disorders.

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PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of Physiology, Autonomous State Medical College, Hardoi, Uttar Pradesh, India.
2. Associate Professor, Department of Physiology, Autonomous State Medical College, Pratapgarh, Uttar Pradesh, India.
3. Associate Professor, Department of Physiology, Autonomous State Medical College, Fatehpur, Uttar Pradesh, India.
4. Assistant Professor, Department of Physiology, All India Institute of Medical Sciences, Raebareli, Uttar Pradesh, India.
5. Professor and Head, Department of Physiology, King George Medical University, Lucknow, Uttar Pradesh, India.
6. Professor, Department of Biochemistry, King George Medical University, Lucknow, Uttar Pradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Mayank Agarwal,
Assistant Professor, Department of Physiology, All India Institute of Medical Sciences, Raebareli, Uttar Pradesh, India.
E-mail: mayankphysiology@gmail.com

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