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CORRELATION OF SERUM LEPTIN WITH ANTHROPOMETRIC PARAMETERS AND ABDOMINAL FAT DEPOTS DETERMINED BY ULTRASONOGRAPHY IN OVERWEIGHT AND OBESE WOMEN

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Abstract

Leptin is an adipocytokine that has an important role in energy homeostasis and therefore in the pathophysiology of obesity. Leptin levels are influenced by many factors such as gender, race, energy intake, fat mass, etc.

The aim of our study is to investigate the relationship of circulating leptin levels to anthropometric parameters and to the subcutaneous and visceral fat tissue determined by ultrasonography in healthy overweight and obese women.

The study included 50 healthy women, with body mass index (BMI) above 25 kg/m^2. Measurements of anthropometric parameters were performed with a standardized technique. The subcutaneous and visceral fat tissue was measured with ultrasound 1 cm above the umbilicus. Leptin was determined by radioimmunoassay.

The serum leptin levels presented a positive correlation between the levels of leptin and BMI (r-0.73, $p < 0.05$) waist circumference (r-0.73, $p < 0.05$) hip circumference (r-0.74, $p < 0.05$), thigh circumference (r-0.56, $p < 0.05$) and abdominal subcutaneous fat tissue (r- 0.46, $p < 0.05$). There was no correlation between leptin and visceral fat tissue, waist to hip and waist to thigh ratio.

The results of our study confirmed the correlation between leptin and BMI. The correlation between leptin and all measured circumferences cannot be attributed to a particular fat depot, but rather reflect the correlation between this adipocytokine and the total body fat. The subcutaneous fat depot determined by ultrasound showed a correlation with leptin, while this kind of connection was not established for the visceral fat tissue.

Key words: Leptin, abdominal subcutaneous fat, abdominal visceral fat.

Introduction

Leptin is an adipocytokine secreted by the white fat tissue that plays a very important role in energy homeostasis by regulating both energy intake and energy expenditure. Therefore this adipocytokine has a very important role in the development of obesity, but has also proved to be very important in the pathophysiology of conditions such as diabetes, hypertension and cardiovascular diseases [1–3]. The serum concentration of leptin is influenced by many factors. Leptin is gender dependent, with values in the higher range reported in women [4–6]. Also some investigators report different leptin values related to race and ethnic origin [7]. Acute changes in the energy intake influence the variations in the concentrations of serum leptin [8]. In addition to the energy intake, body mass index (BMI) and the amount of fat in the body are reported as determinants of the serum leptin concentrations in most studies [9–11]. The pattern of body fat distribution is also important. The majority of studies recognize the subcutaneous fat tissue as a leptin production site in lean and obese subjects, although there are studies that report correlation of leptin with both fat depots, the subcutaneous and the visceral fat depot [12, 13].

The aim of this study is to evaluate the correlation between serum leptin and anthropometric parameters, subcutaneous abdominal fat tissue (SFT) and visceral fat tissue (VFT) in overweight and obese women.

Material and methods

The study included 50 overweight and obese women, aged 20–60 years. The study group was selected from the participants in the MONODIET project at the Institute of Pathophysiology and Nuclear Medicine at the medical faculty in Skopje. The presence of endocrinological disorder, pregnancy, lactation, hormonal or antilipidemic drugs were exclusion criteria.

The weight of the participants was obtained with a digital scale with a precision of 0.1 kg, with light indoor clothes, without shoes. The height was measured with a stadiometer to the nearest 0.5 cm. Waist circumference was measured with a nonelastic plastic band over the umbilicus with subjects in a standing position. Hip circumference was measured between the anterior iliac spine and the major trochanters. The thigh circumference was measured at the proximal end at the level that showed the largest circumference. The circumferences were measured to the nearest 0.5 cm. Waist to hip ratio (W/H ratio) and waist to thigh ratio (W/T ratio) were calculated from the results of the measured circumferences, and body mass index (BMI) from the height and weight.

The ultrasound measurements were performed at the University Gastroenterohepathology Clinic at the Medical Faculty in Skopje. The measurements were performed with a 3.5 MHz ultrasound probe one centimetre above the umbilicus without applying pressure to the abdominal wall. The distance between the aorta and the interior wall of the *musculus rectus abdominis* was defined as representative of the amount of VFT, while the distance from the skin to the exterior wall of the *m. rectis abdominis* was defined as SFT.

According to the BMI, the subjects were divided into two groups. Group A consisted of women with a BMI below 30 kg/m^2 and Group B of women with a BMI greater than 30 kg/m^2.

Considering the circadian variations of leptin levels, blood samples were collected in the morning in the fasting state for the assessment of leptin levels. Leptin was determined by competitive radioimmunoassay in duplicate samples with a commercially available kit (Mediagnost, Germany) with inter- and intra-assay variance < 8%.

The statistical analysis of the data was performed using the Spearman rank correlation and the Mann Whitney U test. The probability level < 0.05 was considered statistically significant.

The study was approved by the ethical committee of the Medical Faculty at the SS Cyril and Methodius University in Skopje.

Results

The analysed group consisted of 50 women aged from 20 to 60 years (mean 42 ± 9.78). The mean value for BMI ranged from 25.3 to 52.6 kg/m^2 (mean 33.3 ± 6.2 kg/m^2). The values of the anthropometric parameters are presented in Table 1.

Leptin levels ranged from 8.37 ng/ml to 58.8 ng/ml (mean 24.7 ± 11.2 ng/ml). The mean value of leptin in group A was 15.9 ± 8.37 ng/ml, and in group B it was 30.1 ± 15.38. The Mann Whitney U test showed a significant difference between the groups A and B in regard to the leptin values ($p < 0.01$).

Table 1

Mean values for age, anthropometric parameters and abdominal fat depots

	Mean	Minimum	Maximum	Std. Dev.
Age	42.0800	20.0	60.0	9.78512
Weight	88.2429	65.0	128.0	16.21166
BMI	33.3108	25.3	52.6	6.20924
Waist circumference	103.3571	82.0	133.0	11.10931
Hip circumference	116.0816	98.0	142.0	11.68927
Thigh circumference	66.5918	53.0	87.0	7.85856
W/H ratio	0.8901	0.78	1.04	0.05282
W/T ratio	1.5626	1.24	2.04	0.16578
SFT	2.6571	0.8	5.8	1.14661
VFT	5.2214	2.2	9.7	1.83377
SFT/VFT	0.6286	0.13	2.64	0.46795

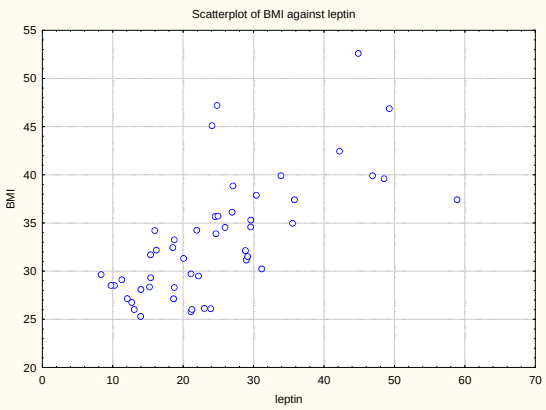
Spearman rank order correlation analysis was performed to assess the correlations between leptin and various anthropometric indices. A significant correlation was found between the levels of leptin and BMI, waist circumference, hip circumference, thigh circumference and abdominal subcutaneous fat tissue. The values for Spearman r are presented in Table 2.

Table 2

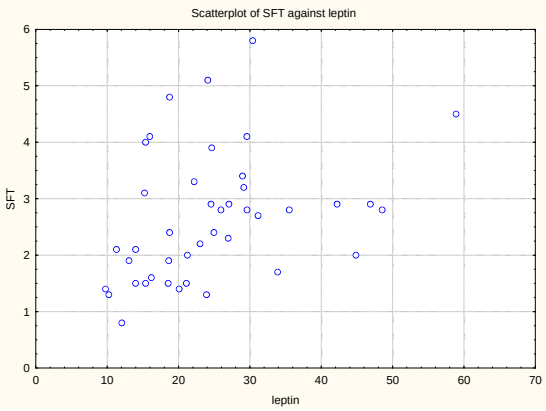
Spearman Rank Order Correlations for leptin with anthropometric parameters. Marked correlations are significant at p < 0,05

	Leptin
Weight	**0.733609**
BMI	**0.733943**
Waist circumference	**0.748820**
Hip circumference	**0.759051**
Thigh circumference	**0.564957**
W/H ratio	-0.070676
W/T ratio	0.047675
SFT	**0.465328**
VFT	0.300073
SFT/VFT ratio	0.087549

The scatterplots for the correlation between leptin and BMI and SFT are presented in Graphs1 and 2 respectively.



Graph 1 – Soatterplot of BMI against leptin



Graph 2 – Soatterplot of SFT against leptin

Discussion

The influence of different factors on the level of circulating leptin has been investigated in many studies during the past years. Almost all studies report a high correlation between BMI and leptin levels [14–16, 6, 17]. Our study confirmed the results of other investigators. The BMI showed a high correlation with leptin levels (r- 0.73, p < 0.01).

Waist circumference, hip and thigh circumference also presented with a statistically significant correlation with leptin levels. Our results are in concordance with the results from a NHANES survey conducted in the USA. This study examined the leptin concentrations in a sample of USA population consisting of 6,303 men and women in relation to anthropometric and demographic parameters. In this study both waist and hip circumference were correlated with leptin concentrations. This study also reported a very high correlation of leptin with triceps skinfold thickness [16]. The study by Bennett et al. that included 375 subjects did not report a correlation between leptin and waist circumference. This study reports a significant correlation only with hip circumference [18]. There are other studies that also confirm the association of leptin with hip circumference in women [10, 19].

Waist circumference is usually perceived as an estimation of abdominal visceral fat, while hip circumference in women is an estimation of peripheral fat tissue. In our study both circumferences correlated with leptin concentrations. Few studies have investigated the association between thigh circumference and leptin. The study by Garaulet et al. conducted on 84 obese subjects did not find any correlation between thigh circumference, or W/T ratio and leptin [12]. According to our knowledge our study is the first that reports a correlation between thigh circumference and leptin levels. Our assumption is that the positive correlation with all measured circumferences in our subjects represents an estimation of total adiposity, rather than an association with particular fat depots. There is a possibility, though, that these findings reflect the association of leptin with peripheral subcutaneous fat tissue. This observation is further confirmed with the absence of correlation between leptin and W/H ratio and W/T ratio. These ratios are used for estimation of visceral fat tissue. Also our study did not find any correlation between leptin and visceral fat tissue measured by ultrasonography. Our study confirms the reports of other investigators [5]. However, there are reports that report an association between leptin and both fat depots. The study by Mahabir et al. that included 51 postmenopausal women reports a high correlation for subcutaneous and visceral fat tissue measured by DEXA and leptin concentrations [13]. The difference in results might be explained by the selection of the study group. Most of our subjects were

women in the reproductive period while the subjects in the study of Mahabir et al. were postmenopausal women. Other investigators report an inverse correlation of W/H ratio with leptin levels. The study by Liuzzi et al. that included 400 subjects reports an inverse correlation between visceral fat tissue and leptin levels, a relation that was observed by the authors as a metabolic profile with an increased cardiovascular risk [6].

The peripheral fat tissue in our study was estimated by abdominal subcutaneous fat tissue measured by ultrasonography. The abdominal SFT showed a statistically significant correlation with leptin. Our results are in agreement with the results of many studies that report the correlation between leptin and peripheral fat depots [12, 5, 13, 20]. These results are explained with studies that report a greater expression of ob mRNA in subcutaneous than in omental adipose tissue [21, 22]. These results point to the subcutaneous fat tissue as a main site of leptin synthesis.

Conclusion

The results of our study showed that leptin levels in overweight and obese women are influenced by BMI, waist, hip and thigh circumference and the amount of abdominal subcutaneous fat tissue. The measures of central obesity W/H ratio, W/T ratio and visceral fat tissue did not correlate with leptin levels in our study.

REFERENCES

1. Ahima RS, Osei SY. Adipokines in obesity. Frontiers of hormone research. 2008 Jan; 36: 182–97.
2. Tune JD, Considine R V. Effects of leptin on cardiovascular physiology. Journal of the American Society of Hypertension: JASH. 2007 Jan; 1(4): 231–41.
3. Considine RV. Human leptin: an adipocyte hormone with weight-regulatory and endocrine functions. Seminars in vascular medicine. 2005 Mar; 5(1): 15–24.
4. Magni P, Liuzzi A, Ruscica M, Dozio E, Ferrario S, Bussi I, et al. Free and bound plasma leptin in normal weight and obese men and women: relationship with body composition, resting energy expenditure, insulin-sensitivity, lipid profile and macronutrient preference. Clinical endocrinology]. 2005 Feb; 62(2): 189–96.
5. Minocci A, Savia G, Lucantoni R, Berselli ME, Tagliaferri M, Calò G, et al. Leptin plasma concentrations are dependent on body fat distribution in obese patients. International journal of obesity and related metabolic disorders: journal of the International Association for the Study of Obesity. 2000 Sep; 24(9): 1139–44.
6. Liuzzi A, Savia G, Tagliaferri M, Lucantoni R, Berselli ME, Petroni ML, et al. Serum leptin concentration in moderate and severe obesity: relationship with clinical, anthropometric and metabolic factors. International journal of obesity and related metabolic disorders: journal of the International Association for the Study of Obesity. 1999 Oct; 23(10): 1066–73.
7. Azrad M, Gower BA, Hunter GR, Nagy TR. Racial differences in adiponectin and leptin in healthy premenopausal women. Endocrine. 2012 Sep 15.
8. Chan JL, Heist K, DePaoli AM, Veldhuis JD, Mantzoros CS. The role of falling leptin levels in the neuroendocrine and metabolic adaptation to short-term starvation in healthy men. The Journal of clinical investigation. 2003 May; 111(9): 1409–21.
9. Ruhl CE, Everhart JE, Ding J, Goodpaster BH, Kanaya AM, Simonsick EM, et al. Serum leptin concentrations and body adipose measures in older black and white adults. The American journal of clinical nutrition. 2004 Sep; 80(3): 576–83.
10. Al-Sultan AI, Al-Elq AH. Leptin levels in normal weight and obese saudi adults. Journal of family & community medicine. 2006 Sep; 13(3): 97–102.
11. Ahima RS. Adipose tissue as an endocrine organ. Obesity (Silver Spring, Md.). 2006 Aug; 14 Suppl 5: 242S–249S.
12. Garaulet M, Pérex-Llamas F, Fuente T, Zamora S, Tebar FJ. Anthropometric, computed tomography and fat cell data in an obese population: relationship with insulin, leptin, tumor necrosis factor-alpha, sex hormone-binding globulin and sex hormones. European journal of endocrinology / European Federation of Endocrine Societies. 2000 Nov; 143(5): 657–66.
13. Mahabir S, Baer D, Johnson LL, Roth M, Campbell W, Clevidence B, et al. Body Mass Index, percent body fat, and regional body fat distribution in relation to leptin concentrations in healthy, non-smoking postmenopausal women in a feeding study. Nutrition journal. 2007 Jan; 6: 3.
14. Havel PJ, Kasim-Karakas S, Mueller W, Johnson PR, Gingerich RL, Stern JS. Relationship of plasma leptin to plasma insulin and adiposity in normal weight and overweight women: effects of dietary fat content and sustained weight loss. The Journal of clinical endocrinology and metabolism. 1996 Dec; 81(12): 4406–13.
15. Al-Daghri NM, Al-Attas OS, Alokail MS, Alkharfy KM, Charalampidis P, Livadas S, et al. Visceral adiposity index is highly associated with adiponectin values and glycaemic disturbances. European journal of clinical investigation. 2013 Feb; 43(2): 183–9.
16. Ruhl CE, Everhart JE. Leptin concentrations in the United States: relations with demographic and anthropometric measures. The American journal of clinical nutrition. 2001 Sep; 74(3): 295–301.
17. Ahima RS. Digging deeper into obesity. The Journal of clinical investigation. 2011 Jun; 121(6): 2076–9.
18. Bennett FI, McFarlane-Anderson N, Wilks R, Luke A, Cooper RS, Forrester TE. Leptin concentration in women is influenced by regional distribution of adipose tissue. The American journal of clinical nutrition. 1997 Dec; 66(6): 1340–4.
19. Rissanen P, Mäkimattila S, Vehmas T, Taavitsainen M, Rissanen A. Effect of weight loss and regional fat distribution on plasma leptin concentration in obese women. International journal of obesity and related metabolic disorders: journal of the Interna-

tional Association for the Study of Obesity. 1999 Jun; 23(6): 645–9.
20. Mazzali G, Di Francesco V, Zoico E, Fantin F, Zamboni G, Benati C, et al. Interrelations between fat distribution, muscle lipid content, adipocytokines, and insulin resistance: effect of moderate weight loss in older women. The American journal of clinical nutrition. 2006 Nov; 84(5): 1193–9.
21. Van Harmelen V, Reynisdottir S, Eriksson P, Thörne A, Hoffstedt J, Lönnqvist F, et al. Leptin secretion from subcutaneous and visceral adipose tissue in women. Diabetes. 1998 Jun; 47(6): 913–7.
22. Hube F, Lietz U, Igel M, Jensen PB, Tornqvist H, Joost HG, et al. Difference in leptin mRNA levels between omental and subcutaneous abdominal adipose tissue from obese humans. Hormone and metabolic research. 1996 Dec; 28(12): 690–3.

Резиме

КОРЕЛАЦИЈА НА СЕРУМСКИОТ ЛЕПТИН СО АНТРОПОМЕТРИСКИТЕ ПАРАМЕТРИ И АБДОМИНАЛНИТЕ МАСНИ ДЕПОА ОДРЕДЕНИ СО УЛТРАЗВУК КАЈ НАТХРАНЕТИ И ОБЕЗНИ ЖЕНИ

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Лептинот е адипоцитокин кој има значајна улога во енергетската хомеостаза, заради што игра важна улога во патофизиологијата на дебелината. Нивото на лептин е условено од многу фактори меѓу кои и пол, раса, енергетски внес, масните депоа и др.

Целта на нашата студија е да ја проучи врската помеѓу нивото на циркулирачкиот лептин со антропометриските параметри и субкутаното и висцералното масно ткиво одредено со ултразвук кај здрави натхранети и обезни жени.

Во студијата беа вклучени 50 здрави жени со телесен масен индекс (ТМИ) над 25 kg/. Стандардизирани техники беа употребени при мерењето на антропометриските параметри. Субкутаното и висцералното масно ткиво беа мерени со ултразвук 1 см над папокот. Лептинот беше одреден со радиоимуноесеј.

Нивото на лептинот во серумот покажа позитивна корелација со ТМИ (r-0,73, $p < 0,05$), обемот на стомакот (r-0,73, $p < 0,05$), обемот на колковите (r-0,74, $p < 0,05$), обемот на натколеницата (r-0,56, $p < 0,05$) и субкутаното масно ткиво (r-0,46, $p < 0,05$). Не беше најдена статистички сигнификантна корелација помеѓу лептинот со висцералното масно ткиво, соодносот стомак/колкови и соодносот стомак/натколеница.

Резултатите од нашата студија ја потврдија поврзаноста помеѓу лептинот и ТМИ. Корелацијата помеѓу лептинот и сите мерени обеми не може да се припише на поврзаност со одредено депо на масно ткиво, туку пред сè како корелација помеѓу лептинот и вкупната маса на масти во организмот. Субкутаното масно ткиво одредено со ултразвук покажа корелација со лептинот. Ваква поврзаност не се утврди за висцералното масно ткиво.

Клучни зборови: лептин, абдоминално субкутано масно ткиво, абдоминално висцерално масно ткиво.