

**Leptin and Serum Lipids among Sudanese Obese In Khartoum State**

**Maryam Suliman Mosamer <sup>1</sup>,**

**Salih Abdelgadir Elmahdi <sup>2</sup>,**

**Dalia Mursi<sup>3</sup>**

<sup>1,2</sup>Department of Clinical Chemistry. Faculty of Medical Labtotary Sciences,  
National Ribat University, Khartoum, Sudan <sup>3</sup> Department of Mulecular  
Biology, Central Laboratory, Ministry of Higher education and scientific research,  
Khartoum, Sudan

*Email: <sup>1</sup> [mimi.su1@hotmail.com](mailto:mimi.su1@hotmail.com),*

*<sup>2</sup> [drsalmhadi900@gmail.com](mailto:drsalmhadi900@gmail.com),*

*<sup>3</sup> [Dallosh25@yahoo.com](mailto:Dallosh25@yahoo.com)*

**Abstract** :Obesity epidemic is increasing worldwide at an alarming rate in particular in African countries .Obesity among females more than males and its associated with age, sex and blood pressure<sup>(1)</sup> .Overweight refers to an excess amount of body weight that may come from muscles, bone, fat, and water, while obesity refers to an excess amount of body fat and leads to morbidity and mortality due to hypertension, dyslipidemia, type 2 diabetes ,coronary heart disease, stroke, gallbladder disease, osteoarthritis, sleep apnea, respiratory problems and cancers.<sup>(2)</sup> ). The objective of this study is to assess the association of Cholesterol, Triglyceride and Leptin hormone Levels among Sudanese Obese Subjects in Khartoum state – Sudan. A case-control study was conducted during the period from January 2017 to August 2018. This study including 130 obese Sudanese individual and 50 ages matched apparently healthy volunteer as control. Total cholesterol and TRG were measured by (Mindary BS 380, China) ELISA method was used to measure level of leptin hormone. Data were analyzed by s (IBM, SPSS) version 21. T.test for means and standard deviation, while Pearson’s correlation between study variables. Mean level of BMI, T. cholesterol, TRG and leptin hormone were significantly increase among obese subjects rather than other control group, P value (0.000, 0.000, 0.000) respectively .There was no significant difference in mean of study parameters of the obese group according

# МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 11.79/2023

SJIF 2024 = 5.444

Том 2, Выпуск 5, 31 Май

to gender classification except leptin hormone was found significant increase among female group, P.value (0.005).The Correlation studies showed positive between BMI(T.CH,TRG,leptin) R.value( 0.352,0.373,0.452) P.value (0.034,0.032,0.004) respectively. This study conclude, significant increase in the serum lipids, of total cholesterol, triglycerides and leptin in obese subjects compare with control group, Positive correlation was observed between BMI and total cholesterol ,triglyceride and leptin hormone.

**Keywords**—obesity; cholesterol; triglyceride; BMI; leptin

## Лептин и сывороточные липиды среди суданцев, страдающих ожирением, в штате Хартум

**Аннотация:** Эпидемия ожирения растет во всем мире тревожными темпами, особенно в африканских странах. Ожирение среди женщин больше, чем среди мужчин, и оно связано с возрастом, полом и артериальным давлением (1). Избыточный вес означает избыточную массу тела, которая может быть вызвана мышцами, кости, жир и вода, тогда как ожирение относится к избыточному количеству жира в организме и приводит к заболеваемости и смертности из-за гипертонии, дислипидемии, диабета 2 типа, ишемической болезни сердца, инсульта, заболеваний желчного пузыря, остеоартрита, апноэ во сне, респираторных заболеваний. проблемы и рак.(2). Целью этого исследования является оценка связи уровней гормонов холестерина, триглицеридов и лептина среди суданских субъектов с ожирением в штате Хартум, Судан. Исследование «случай-контроль» проводилось в период с января 2017 года по август 2018 года. В этом исследовании приняли участие 130 суданцев, страдающих ожирением, и 50 возрастов, соответствующих внешне здоровым добровольцам, в качестве контроля. Общий холестерин и ТРГ измеряли с помощью (Mindary BS

380, Китай) для измерения уровня гормона лептина использовали метод ИФА. Данные были проанализированы с помощью программы s (IBM, SPSS) версии 21. T.test для средних и стандартного отклонения, а также корреляции Пирсона между переменными исследования. Средний уровень ИМТ, Т. холестерина, ТРГ и гормона лептина был значительно выше среди субъектов с ожирением, чем в другой контрольной группе, значение P (0,000, 0,000,

# МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 11.79/2023

SJIF 2024 = 5.444

Том 2, Выпуск 5, 31 Май

0,000) соответственно. Не было значительной разницы в средних значениях исследования.

параметры группы с ожирением в соответствии с гендерной классификацией, за исключением гормона лептина, было обнаружено значительное увеличение среди женской группы, значение  $P$  (0,005). Корреляционные исследования показали положительное значение между ИМТ (Т.СН, TRG, лептин)  $R$ .value (0,352,0,373). ,0,452)  $P$ .value (0,034,0032,0,004) соответственно. В этом исследовании делается вывод, что значительное увеличение сывороточных липидов, общего холестерина, триглицеридов и лептина у субъектов с ожирением по сравнению с контрольной группой. Положительная корреляция наблюдалась между ИМТ и общим холестерином, триглицеридами и гормоном лептином.

**Ключевые слова:** ожирение; холестерин; триглицерид; ИМТ; лептин

## **Xartum shtatidagi Sudan semizligi orasida leptin va sarum lipidlari**

**Annotatsiya:** :Semizlik epidemiyasi butun dunyo bo'ylab, xususan Afrika mamlakatlarida tashvishli sur'atlarda o'sib bormoqda .Ayollarda erkaklarga qaraganda ko'proq semirish va bu yosh, jins va qon bosimi bilan bog'liq(1) .Ortiqcha vazn tana vaznining ortiqcha miqdorini bildiradi. mushaklar, suyaklar, yog'lar va suv, semizlik esa tanadagi ortiqcha yog' miqdorini bildiradi va gipertoniya, dislipidemiya, 2-toifa diabet, koroner yurak kasalligi, insult, o't pufagi kasalliklari, osteoartrit, uyqu apnesi, nafas olish yo'llari tufayli kasallanish va o'linga olib keladi. muammolar va saraton.(2). Ushbu tadqiqotning maqsadi Sudanning Xartum shtatidagi semirib ketgan sub'ektlar o'rtasida xolesterin, triglitseridlar va leptin gormonlari darajasining bog'liqligini baholashdir. 2017-yilning yanvaridan 2018-yilning avgustigacha bo'lgan davrda vaziyatni nazorat qilish bo'yicha tadqiqot o'tkazildi. Ushbu tadqiqot, jumladan, 130 semiz sudanlik shaxs va 50 yoshga to'g'ri keladigan sog'lom ko'ngillilar nazorati sifatida. Umumiy xolesterin va TRG (Mindary BS

380, Xitoy) leptin gormoni darajasini o'lchash uchun Elishay usuli ishlatilgan. Ma'lumotlar s (IBM, SPSS) 21-versiyasi bo'yicha tahlil qilindi. O'rtacha va standart og'ish uchun T.test, o'rganish o'zgaruvchilari o'rtasidagi Pearson korrelyatsiyasi esa. BMI, T. xolesterin, TRG va leptin gormonining o'rtacha darajasi semiz sub'ektlar

# МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 11.79/2023

SJIF 2024 = 5.444

Том 2, Выпуск 5, 31 Май

orasida boshqa nazorat guruhiga qaraganda sezilarli darajada oshdi, mos ravishda P qiymati (0,000, 0,000, 0,000) .O'rtacha tadqiqotda sezilarli farq yo'q edi.

Semizlik guruhining jins tasnifiga ko'ra leptin gormonidan tashqari parametrlari ayollar guruhida sezilarli darajada o'sdi, P.value (0,005). Korrelyatsiya tadqiqotlari BMI (T.CH,TRG,leptin) R.qiymati (0,352,0,373) o'rtasida ijobiy bo'ldi. ,0,452) mos ravishda P.qiymati (0,034,0032,0,004). Ushbu tadqiqot shuni ko'rsatdiki, semirib ketgan odamlarda qon zardobida lipidlar, umumiy xolesterin, triglitseridlar va leptin miqdori nazorat guruhiga nisbatan sezilarli darajada oshgan, BMI va umumiy xolesterin, triglitserid va leptin gormoni o'rtasida ijobiy korrelyatsiya kuzatilgan.

**Kalit so'zlar** :- semirish; xolesterin; triglitserid; BMI; leptin

## 1. INTRODUCTION

Obesity is defined as excessive fat accumulation in the body caused by an imbalance of energy between caloric consumption and expenditure also its an eating disorder accompanied by an imbalance between energy consumed and energy expended<sup>(3)</sup>. Excess weight in obesity may come from muscles, bone, fat, and/or body water, but obesity specifically refers to having an abnormally high proportion of total body fat <sup>(4)</sup>

Lack of physical activity and sedentary behavior is a known risk factor for obesity. Factors proposed to contribute to the development of obesity include viral and bacterial infections, exposure to endocrine disruptors, staying in the thermo neutral zone, prescribed pharmaceuticals, suboptimal intake of micronutrients, psychosocial stress, increasing gravid age, fetal over nutrition and lack of sleep <sup>(5)</sup>. Co- morbidities associated with obesity include psychological distress, osteoarthritis, type 2 diabetes mellitus, hypertension, hyperlipidemia, liver steatosis, cardiovascular disease and certain types of cancer <sup>(6)</sup>.

Leptin is derived from the Greek word —Leptos meaning —Thin. Its discovery has created great enthusiasm due to possible treatment of obesity its product of the obesity (ob) gene and its poly peptidic hormone produced by the white adipocyte under the control of the adiposity gene <sup>(7)</sup> *Leptin* is produced by adipose tissue and is secreted into the circulation and its plays a critical role in the

# МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 11.79/2023

SJIF 2024 = 5.444

Том 2, Выпуск 5, 31 Май

regulation of body weight by inhibiting food intake and stimulating energy expenditure<sup>(8)</sup> The major role of leptin in the body weight regulation by maintaining a balance between food intake and expenditure of energy<sup>(9)</sup>

Leptin was the first identified adipokine (adipose-derived cytokine) and has a significant role in BP regulation in obesity. In both males and females, mutations in the human leptin gene or global deficiency in leptin (Ob/Ob) or leptin receptors (Db/Db) in rodents results in obesity, hyperphagia, and hyperinsulinemia, but notably not hypertension, suggesting that obesity per se does not increase BP but rather

that leptin is required for obesity-associated increases in BP.

(10)

Cholesterol is a waxy substance that naturally occurs in some food and is produced in the liver. The normal functioning of the body requires cholesterol. Cell membrane contains cholesterol and cholesterol produce some hormones as well. (11) Cell cholesterol is mainly acquired from two sources: Dietary cholesterol or intracellular synthesized cholesterol .Almost all tissues have the ability to de novo synthesize cholesterol; however, the liver produces the majority of total body cholesterol. Dietary cholesterol absorption is the second source of cholesterol in the body after de novo synthesized cholesterol and it is needs to be emulsified by bile acids. (12)

A triglyceride consists of glycerol and three fatty acids .In the liver, triglyceride hydrolysis provides fatty acids for  $\beta$ - oxidation, signaling, and substrates for the assembly of very low-density lipoprotein (VLDL) triglycerides. Triglycerides are one of the major components of apolipoproteins, such as chylomicron, VLDL, intermediate-density lipoprotein (IDL), LDL, and high-density lipoprotein (HDL). (13)

The present study was designed to assess the serum Leptin hormone and lipids among Sudanese obese with healthy control group.

## 2. MATERIALS AND METHODS

The study was conducted during the period from January 2017 to August 2018, which comprised 180 Samples Was collected from patients presented in National Ribat University Hospital and Major General Omar Sway Medical Complex..

# МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 11.79/2023

SJIF 2024 = 5.444

Том 2, Выпуск 5, 31 Май

The study involved two groups: a control group of healthy 50 persons matched for age with a test group of 130 obese subjects. The participants of this study was (Obese diabetic, obese diabetic hypertensive and Obese Non diabetic non hypertensive) adult Sudanese males and females having  $BMI \geq 30$  kg/m. This study was ethically approved by Research Board ethical committee at National Ribat University.

The samples were collected under aseptic environment; 5ml of blood from fasting patients (10-12hrs.) blood drawn from each individual (case and control). collected in plain container to isolate the serum by centrifuging it at 3000 RPM for 10 minutes , and then stored at  $-20^{\circ}C$ , till the time of biochemical analysis (T.CH and TRG) using automated chemical analyzer ((Maindary BS 380) Leptin hormone was measured by using Sandwich Enzyme-Linked Immunosorbent Assay (ELISA). The precision and accuracy of all methods used in this study were checked each time; a batch was analyzed by including commercially prepared control se

Statistical Package for Social Science (SPSS version 21) was used for comparison means  $\pm$  standard deviation and Pearson's correlation for association between the study variables. P-value  $<0.05$  was considered significant.

### 3. RESULTS

The study revealed that: the distribution of study population and control group by gender, 48 (36.9%) of samples were collected from obese male and 82 (63.1%) were obese females as compared to control group male were 16 (32 %) and female 34 (68%) Fig [1] .The results also showed that; the mean and STD of obese subjects and control group with age, BMI and other variables (cholesterol, triglyceride and leptin hormone). The age of the studied groups was ranging from 25-65 years old, with a mean of  $(45 \pm 12.4$  years) versus  $(41. \pm 13.5$  years) in the control group. ; Cholesterol and Triglyceride mean was  $(174.6 \pm 49.34$  mg/dl,  $105.3 \pm 56.96$  mg/dl) versus  $(149.8 \pm 32.76$  mg/dl,  $58.30 \pm 23.88$  mg/dl) in the control group. The study revealed that the mean of the leptin hormone in the obese population was  $(23 \pm 16$  ng/ml) versus  $(5.7 \pm 4.6$  ng/ml) in the control group. Mean level of BMI, T. cholesterol, TRG and leptin hormone were significantly increase among obese subjects rather than other control group, P value (0.000, 0.000, 0.000) (Table1). The mean and STD of variables (BMI, cholesterol, triglyceride and leptin hormone) compare with gender .There was no significant

# МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 11.79/2023

SJIF 2024 = 5.444

Том 2, Выпуск 5, 31 Май

difference in mean of study parameters of the obese group according to gender classification except leptin hormone was found significant increase among female group, P.value (0.005) (Table 2). In this study the association between BMI with study variables (cholesterol, triglyceride and leptin hormone was positive correlation. (Fig.2, 3, 4).

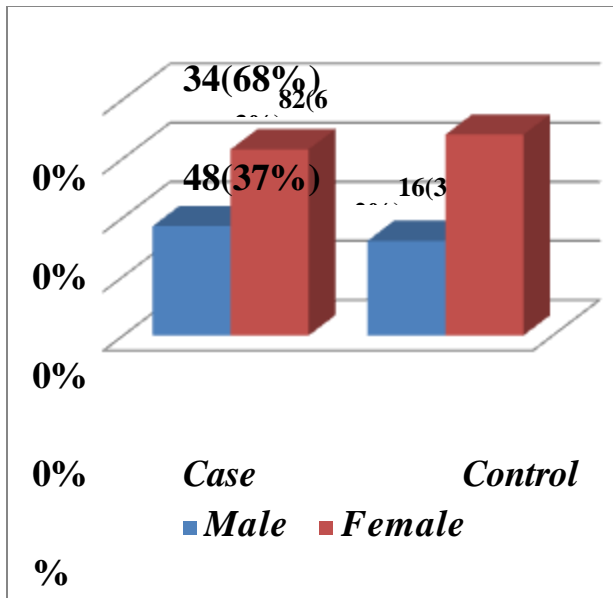


Fig [1]: Distribution of study population and control group by gender

Table [1]: Shows the mean and STD of obese subjects and control group with age, BMI and other variables (cholesterol, triglyceride and leptin hormone).

Parameters	Case (Mean±STD)	Control (Mean±STD)	P-value
Age	44.98±12.41	41.68±13.51	0.121
BMI	34.22±4.13	22.31±2.44	0.000
Cholesterol (mg/dl)	174.6±49.34	149.8±32.76	0.001
Triglyceride (mg/dl)	105.3±56.96	58.30±23.88	0.000
Leptin	23.31±19.68	5.64±4.65	0.000

Table [2]: Shows the mean and STD of variables (BMI,cholesterol,triglyceride and leptin) compare with gender

МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ:  
ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 11.79/2023

SJIF 2024 = 5.444

Том 2, Выпуск 5, 31 Май

Parameters	Male (Mean±STD)	Female (Mean±STD)	P-value
BMI	33.49±3.98	34.65±4.18	0.124
Cholesterol (mg/dl)	174.0±64.95	174.9±37.79	0.925
Triglyceride (mg/dl)	109.5±57.82	102.8±56.66	0.524
Leptin	13.78±11.76	28.89±21.25	0.000

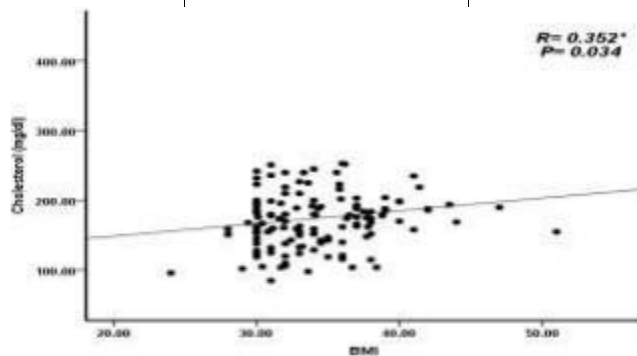


Fig [2]: Shows the correlation between BMI and cholesterol in obese subjects.

R =positive or negative correlation. P= Strength of correlation.\* = significant \*\*= highly significant

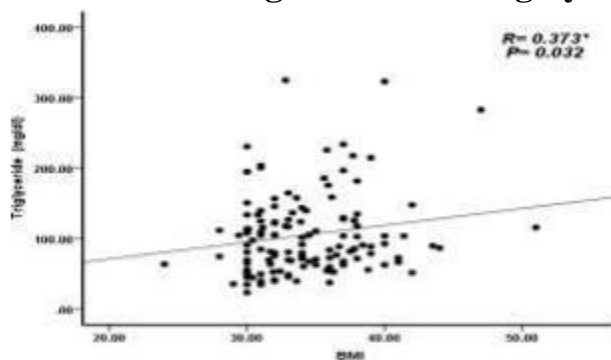


Fig [3]: Shows the correlation between BMI and triglyceride in obese subjects.

R =positive or negative correlation. P= Strength of correlation.\* = significant \*\*= highly significant



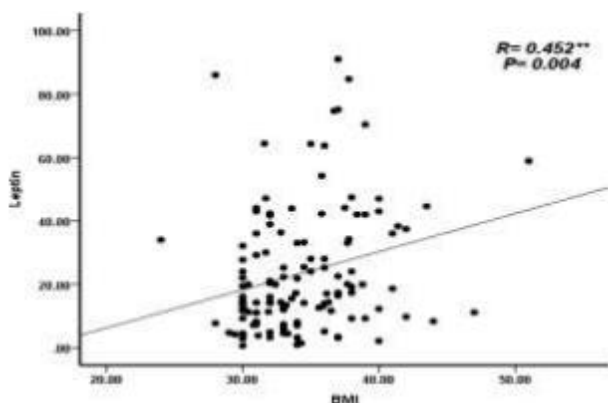


Fig [4]: correlation between BMI and Leptin in obese subjects.

R =positive or negative correlation. P= Strength of correlation.\* = significant \*\*= highly significant

#### 4. DISCUSSION

In this study 36.9% of subjects were males and 63.1% were females. This result agrees with the study conducted in Iran 2012<sup>(14)</sup> who found the 32.2% of studied subjects were males and 67.8% were females another study were collected from 273 Sudanese participants (36.3% males and 63.7% females)<sup>(15)</sup>.

The mean of BMI when calculated was found significantly higher in obese subjects when compared with healthy control group, ( $34.22 \pm 4.13$  %,  $22.31 \pm 2.44$ %), respectively, (P.value 0.000). These findings in accordance to previous study was conducted in Pakistan 2013 <sup>(16)</sup>, P. Value (0.001), parallel to anther research reported in Iraq <sup>(17)</sup>

The mean levels of T.Ch and TRG were significantly higher among obese subjects rather than in control group with P. value (0.001, 0.000), respectively, this result was agreed with the study conducted in Canada and India. (18, 19) Furthermore the results of this study revealed significantly high leptin hormone in obese population compared with their controls. Mean serum leptin levels was (23 ng/ml) and of the control subjects was (5.6 ng/ml) similarly Pakistanian <sup>(16)</sup> were in agreement with our study findings.

In this study there was no significant difference in mean of study parameters (BMI, T.Ch and TRG) of the obese group according to gender classification as well as reported by Omotoye, Gracein Nigeria 2016<sup>(20)</sup>, who said the gender differences in Lipid profile were not significant.

# МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 11.79/2023

SJIF 2024 = 5.444

Том 2, Выпуск 5, 31 Май

Serum leptin concentrations were significantly higher in female gender rather than males, consistently to our results (16) had mentioned the same findings. This study also concurs with our findings (21)

In this study, Positive correlation was observed between BMI and Cholesterol in obese subjects ( $r = 0.352$ ,  $p = 0.034$ ) similar to study in India 2017. (19)

Positive correlation was observed between BMI and triglyceride in obese subjects ( $r = 0.373$ ,  $p = 0.032$ ) (22, 23) .

A strong relationship between BMI and serum leptin in the obese group was revealed in our study hence it was documented in Pakistan and Iran. (24, 25)

In conclusion, the serum cholesterol, triglyceride and leptin hormone levels are important risk factors for obesity, there was association between BMI and study parameters (T.CH, TRG and leptin).

## 5. ACKNOWLEDGMENT

We would like to thanks everybody who was important to the successful realization of this research, all the people who have supported us to complete the research work directly or indirectly.

## REFERENCES

[1] Ali Yasmeeen A. , Ahmed O. Almobarak , HeithamAwadalla , Wadie M. Elmadhoun , Mohamed H. Ahmed.(2017) . Obesity among Sudanese adults with diabetes: a populationbased survey. Annals of Translational Medicine, Ann Transl Med 2017;5(12):252

[2] . Elfaki BA, Mustafa HE and Elnimeiri MK.(2017) . Overweight and Obesity among Sudanese Rural Population, Sinaar State, Sudan. Austin J Nurs Health Care. 4(1): 1040

[3] . World Health Organization: Obesity and overweight: Factsheet 311. Geneva:WHO;2012.<http://www.who.int/mediacentre/factsheets/fs311/en>

[4] . A. K.Afridi and A. Khan .(2004) . Prevalence and etiology of obesity— an overview,|| *Pakistan Journal of Nutrition*, vol. 3, no. 1, pp. 14–25, 2004

[5] Mustelin Linda.(2012) .obesity, physical activity and cardiorespiratory fitness in young adulthood.helsinki, 2012.

# МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 11.79/2023

SJIF 2024 = 5.444

Том 2, Выпуск 5, 31 Май

[6] Yazdi Fereshteh T., Susanne M. Clee and David Meyre.(2015). Obesity genetics in mouse and human: back and forth, and back again. , PeerJ, DOI 10.7717/peerj.856 .

[7] Ahima RS, Flier JS. (2000) . Leptin. Annu. Rev. Physiol 2000; 62: 413–437

[8] Harris Ruth B.S.(2014).Direct and Indirect Effects of Leptin on Adipocyte Metabolism, Biochim Biophys Acta. 2014 March ; 1842(3): 414–423.

[9] . Wasim Muhammad.(2015). Role of Leptin in Obesity, Journal of Obesity & Weight Loss Therapy, 2015, 5:2 DOI: 10.4172/2165 - 7904.1000258

[10] Faulkner Jessica L and Eric J Belin de Chantemèle. (2018). sex differences in mechanisms of hypertension associated with obesity. Hypertension. 2018 January ; 71(1): 15–21. doi:10.1161/HYPERTENSIONAHA.117.09980 .

[11] Panawala Lakna.(2017).Difference Between Good and Bad Cholesterol.pediaa 2017LeptinGenes in Women Post-Menopause Int. J. Environ. Res. Public Health 2016, 13, 543;).

[12] Vicente Asier Benito, Kepa B. Uribe, Shifa Jebari, Unai Galicia-Garcia, Helena Ostolaza and Cesar Martin.(2018). Familial Hypercholesterolemia: The Most Frequent Cholesterol Metabolism Disorder Caused Disease. nt. J. Mol. Sci. 2018, 19, 3426; doi:10.3390/ijms19113426

[13] Tada Hayato.(2018).Atsushi Nohara and Masa-aki Kawashiri, Cardiovascular Disease: Insights from Clinical and Genetic Studies. Nutrients 2018, 10, 1789; doi:10.3390/nu10111789

[14] Tabatabaei-Malazy Ozra , Hossein Fakhrzadeh , Mostafa Qorbani, Parvin Amiri , Bagher Larijani , Javad Tavakkoly-Bazzaz and Mahsa M Amoli.(2012) .Apolipoprotein E gene polymorphism and its effect on anthropometric measures in normoglycemic subjects and type 2 diabetes. Journal of Diabetes & Metabolic Disorders 2012, 11:18 <http://www.jdmdonline.com/content/11/18>

[15] Abdalla Eltagi Abdalla M., Nafeisa Abdulwahab A.(2016). Socio-Demographic Determinants of Overweight and Obesity among Adults in Jabra

# МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 11.79/2023

SJIF 2024 = 5.444

Том 2, Выпуск 5, 31 Май

Area in Khartoum State - Sudan: a Community Based Study, International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064.

[16] Kazmi A., Abdus S., Rizwan H., Shahida Parveen K., Mohammad Y., Farooq Ahmed K. (2013). Serum Leptin values in the healthy obese and non-obese subjects of Rawalpindi. Journal of the Pakistan Medical Association · Vol. 63, No.2 February 2013

[17] Ahmed Shaimaa E., Firas Taher Maher and Nazar Ahmed N. (2016). Effect of Leptin and Oxidative Stress in the Blood of Obese Individuals, Biochem Anal Biochem, 5:3 DOI: 10.4172/2161-1009.1000288

[18] Khoury M., Cedric M., Stafford D., Don G., Nita C., Helen W., Jolie D., Karen S., Amanda F., Brian W. McCrindle, (2012). Role of Waist Measures in Characterizing the Lipid and Blood Pressure Assessment of Adolescents Classified by Body Mass Index, Arch Pediatr Adolesc Med. 2012;166(8):719-724.

[19] Gayathri B., Vinodhini V. M. (2017) Correlation of lipids and lipoprotein concentration with body mass index in obese, overweight and normal weight south Indian adults, International Journal of Research in Medical Sciences Gayathri B et al. Int J Res Med Sci. 2017 Nov;5(11):4803-4807

[20] Omotoye Funmilayo E., Grace Tanimoowo F. (2016). Effect of Body Mass Index on Lipid Profile of Type 2 Diabetic Patients at An Urban Tertiary Hospital In Nigeria, Journal of Dental and Medical Sciences (IOSR-JDMS) e-ISSN: 2279-0853, p-ISSN: 2279-0861. Volume 15, Issue 9 Ver. VIII (September). 2016), PP 65 -70

[21] Awede B., Diane A., Grace A., Niall G., MacFarlane, Simon A., Emmanuel D., Marcellin Amoussou-G. & Francois D. (2018). Adiponectin, in contrast to leptin, is not associated with body mass index, waist circumference and HOMA-IR in subjects of a west- African population . Physiological Reports ISSN 2051-817X. 2018 | Vol. 6 | Issue 11 | e13718.

[22] Miralles Clara Silvana W., Luana Maria W.1, Débora M., Julia Pasqualini G., Veronica C., Simone Morelo Dal B. (2015). Waist-to-height ratio (WHtR) and triglyceride to HDL-c ratio (TG/HDL-c) as predictors of cardiometabolic risk. Nutr Hosp. 2015;31(5):2115-2121 ISSN 0212-1611.

**МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ:  
ТЕОРИЯ И ПРАКТИКА**

**Researchbib Impact factor: 11.79/2023**

**SJIF 2024 = 5.444**

**Том 2, Выпуск 5, 31 Май**

[23] Stępień A., Mariusz S., Rafał N., Wlazeł Marek P., Maciej B., Jacek R. (2014). Assessment of the Relationship between Lipid Parameters and Obesity Indices in Non-Diabetic Obese Patients: A Preliminary Report. *Med Sci Monit*, 2014; 20: 2683-2688.

[24] Najam Syeda S., Fazli Rabbi A., Mehboob I., Mohsin K., Abdul Rehman K., Tehmina S., Maryam Z. and Ahmed B. (2016). Leptin Correlation with Obesity, Diabetes and Gender in a Population from Faisalabad, Pakistan, *ARCHIVES OF MEDICINE* (2016) ISSN 1989 - 5216 Vol.8 No.5:11 .

[25] Montazerifar F., Ahmad B., Raheleh Sharifian P., Mahbubeh Khodadadpour M., Mansour K. (2016) Obesity, Serum Resistin and Leptin Levels Linked to Coronary Artery Disease, Adipokines and coronary artery disease. 2016; 107(4):348-353.