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Prevalence Rate and Correlation Between Triglyceride Level and Human Body Mass Index in Sulaimani Province, Iraq

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Abstract

The condition of elevated concentrations of triglyceride in the blood is called hypertriglyceridemia, which triggers the onset of some physiological disorder. This study was carried out to find the correlation between body weight and hypertriglyceridemia. Out of 518 cases, 342 individuals were underweight, with body mass index (BMI) values of ≤18, while their mean serum triglyceride level was 172.4 ± 25.2mg/dl. In addition, 99 cases had normal BMI of >18, whereas 60 were overweight (BMI = 25-29), with mean serum triglyceride level of 182.3 ± 15.9. Also, 17 cases were obese (BMI >30), where the mean triglyceride level was 202 ± 25.6. The results showed no significant differences in terms of weight categories and triglyceride levels, whereas significant effects of marital status, daily exercise, and diet on elevated triglyceride levels were observed. These findings conclude that underweight and normal BMI individuals were as much at risk of elevated level of triglyceride as overweight and obese ones, which are mostly at higher risk. Moreover, daily exercise and supplementary nutrient have significant effects on triglyceride level.

Keywords: Triglyceride, BMI, Hypertriglyceridemia, Nutritional status, Underweight.

معدل الانتشار و العلاقة بين مستوى الدهون الثلاثية و مؤشر كتلة جسم الانسان في محافظة السليمانية– العراق

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الخلاصة

يسمى التركيز المرتفع للدهون الثلاثية في الدم بفرط الدهون الثلاثية في الدم والذي يسبب بعض الاضطرابات الفسيولوجية في الجسم. اجريت هذا الدراسة لايجاد العلاقة بين وزن الجسم و فرط الدهون الثلاثية في الدم. اشتملت هذا الدراسة 518 حالة, منها 342 فرداً كانوا يعانون من نقص الوزن وكان مؤشر كتلة الجسم (BMI) فيهم يساوي او اقل من 18 (BMI ≤18) و معدل مستوى الدهون الثلاثية في الدم لهذه الفئة كانت 25.2 ± 172.4 و 99 حالة كانوا من ذوي الاوزان الطبيعية وكان مؤشر كتلة الجسم لهم اكثر من

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18 و اقل من 25 و 60 حالة من المشاركين كانوا يعانون من زيادة الوزن (مؤشر كتلة الجسم كان ما بين 25–29) و كان متوسط مستوى الدهون الثلاثية في الدم (15.9 ± 182.3) في حين كان 17 من المشاركين يعانون من السمنى و كان مؤشر كتلة الجسم لهم اكثر من 30 و معدل تركيز الدهون الثلاثية كان (202±25.6). اظهرت النتائج عدم وجود فرق معنوي بين مؤشر كتلة الجسم ومستويات الدهون الثلاثية في الدم, في حين لوحظ حصول زيادة معنوية في مستوى تركيز الدهون الثلاثية نتيجة الحالة الزوجية, السلوك الغذائي و الرياضة اليومية. ان نتائيج هذا الدراسة اشارت بان اصحاب الاوزان القليلة او الاشخاص النحيفين كانوا معرضين لزيادة مستوى الدهون الثلاثية في دمهم وان الرياضة, والغذاء الصحي من اهم العوامل التي لها علاقة مباشرة بزيادة و انخفاض الدهون الثلاثية في الدم.

Introduction

Triglycerides (TGs) are composed of one glycerol molecule attached to three fatty acids. Dietary triglycerides are considered as an exogenous source. TGs are hydrolyzed in the stomach and small intestine to form 2-monoacylglycerol and fatty acids which are absorbed by enterocytes [1]. After a meal, chylomicrons that are triglyceride-rich lipoproteins (TRLs) are produced and exported from enterocytes into the lymph before they are transported to the circulation [2]. Subsequently, chylomicrons are hydrolyzed by lipoprotein lipase (LPL) into fatty acids, that provide energy to the heart and skeletal muscles, or stored in the adipose tissue [3-4]. Remnants of chylomicrons are removed from the circulation after binding to the LDL receptors in the liver [5].

Very low-density lipoprotein (VLDL) is biosynthesized as an endogenous source of triglycerides that occurs in the hepatocytes. VLDL is delivered to peripheral tissues such as the heart and muscle or stored in the adipose tissue as a long-term TG reservoir when more calories are consumed than the body requires [4]. However, the excess TG, after a meal rich in fat, is temporarily stored in cytoplasmic lipid droplets (CLDs) to prevent lipotoxicity [6].

Hypertriglyceridemia may contribute to atherosclerosis, cardiovascular disease (CVD), diabetes mellitus, pancreatitis, inflammation, and metabolic syndrome. For the management of TG level in borderline screening, observation of fasting and postprandial (non-fasting) levels is recommended. However, in the assessment of serum TG, fasting is a more reliable parameter than postprandial. The main causes of hypertriglyceridemia are fat and carbohydrate-rich diets. Nonetheless, obesity, high waist circumference, alcohol, stress, and lifestyle may elevate TG plasma levels [7].

Elevated triglyceride levels may not be associated with obesity, as many gene polymorphisms are associated with a transcriptional and post-transcriptional gene defect in the triglyceride biosynthetic pathway, which may cause elevation of triglyceride plasma levels [8-9]. Also, many genes in the adipose tissue may contribute to elevated TG levels. In an earlier study [10], the authors demonstrated that gene expression in the adipose tissue is associated with serum TG levels. Gene expression in the adipose tissue was observed in two different populations, namely the Finnish and the Mexican. In each study sample, novel genes involved in TG regulation and significantly associated with serum TG levels were explored.

Hsieh *et al*. [11] showed that the waist circumference might be related to the metabolic syndrome (MS), abnormal liver function, and increased triglyceride as well as sugar levels.

Consumption of carbohydrates as sugar-sweetened and soft drinks is associated with increased levels of serum TG and low concentrations of high-density lipoprotein (HDL) [12-13]. In another study [14], it was demonstrated that soft drinks, in addition to sucrose and carbonic acid, contain caffeine and phosphoric acid. Caffeine promotes the release of fatty acids from the adipose tissue, thus enhancing the synthesis of VLDL in the liver. In addition, poor diet, environment, obesity, and low physical activity are considered as risk factors for high triglyceride levels. Huang *et al*. [15] showed that the consumption of carbohydrates is related to hypertriglyceridemia, where increased fructose level leads to the accumulation of hepatic triglyceride, while drinking alcohol is associated with the development of extremely high TG levels.

Hass *et al*. [10] examined the relationship between triglyceride and excessive alcohol drinking and indicated that drinking alcohol increases the synthesis of TGs and TG-rich lipoproteins in the liver. In addition, alcohol stimulates lipolysis in fatty tissue, which increases the supply of fatty acids to the liver.

Smoking is one of the factors that influence the level of triglycerides in the human body. Nicotine affects the accumulation of free fatty acids in the human body, resulting in the rapid release of free fatty acids into the circulation, tissues, and fat depots. Nicotine stimulates the sympathetic nervous system ganglia and postganglionic fibers to release norepinephrine, which causes the rapid release of fatty acids from the body"s fat stores [16].

There are associations between serum insulin and plasma triglycerides (TG) levels [17]. Accumulation of triglycerides in hepatocytes causes oxidation of fatty acids, resulting in mitochondrial abnormalities and production of free radicals. Increased free radicals cause cell damage, impaired liver function, inflammation, and fibrosis. Insulin resistance induces mitochondrial damage and intracellular beta-oxidation that causes fat deposition in hepatocytes, as well as an increase in serum triglyceride levels, which is considered as a risk factor for cardiovascular disease [18].

Talayero and Sacks [19] showed that triglyceride level is an important biomarker of cardiovascular disease because triglyceride with Apoc-III and foam cells enhance fatty streak formation, which triggers atherosclerotic plaque. In another study [20], both high levels of triglyceride and hyperglycemia were shown to cause endothelial dysfunction and endothelial-dependent arterial relaxation, which are biomarkers of atherosclerosis and CVD.

The rise in serum cholesterol and triglycerides seems to be due to the stress caused, respectively, by changes in hormonal levels and peripheral lipolysis. Mental stress is one of the factors that cause hypertension and atherosclerosis. Another study [21] demonstrated that hormones such as cortisol trigger triglyceride level elevation.

The increase in age-related plasma TG concentration indicates that plasma TG levels are elevated with age due to less physical activity and dietary changes [22].

Sarac *et al*. [23] demonstrated that women have high triglyceride levels relative to men and that the production of very-low-density lipoprotein in hepatocytes is higher in women than in men; this finding may be related to differences in lipid metabolism in men and women [23]. However, triglyceride and nutritional status among the Kurdish population are not adequately studied. Malnutrition and nutritional status among Kurdish children were estimated previously [24 -25], indicating that about 16% of Kurdish children were underweight, and recent study estimated the effect of Eruca sativ on the lipid profile among Kurdish peoples inSulaimani Province-Iraq [26]. Triglyceride and cholesterol estimates are medically important in relation to the nutritional status. The goal of this study was to determine the prevalence of hypertriglyceridemia among the Kurdish population and to find a correlation between triglyceride levels with nutritional status, exercise, lifestyle, community habits, and body mass index.

Materials and Methods

This study was carried out from January 2018 to June 2019 with 518 cases (202 males and 316 females; age range 15-83 years) of the selected population in the province of Sulaimaniya, northern Iraq. For the determination of triglyceride (mg/dL) in serum, 5 ml of venous blood was obtained from each participant after fasting for approximately 12 hrs, the blood was kept in the gel content tube to be clotted, then the clotted blood centrifuged to obtain the serum. The triglyceride level was estimated by spectrophotometer using the commercial Kits (BIOLABS, France), followed the instruction of manufacturing company, brifly 10 μL of serum was taken and mixed with 1000μL of the reagent incubated for 5 minutes at 37°C, then the absorbance was read at 500nm using apel – 303 Uv-Vis photometer.

Anthropometric Measurements

Body height and body weight of the subjects were measured, then BMI was calculated as weight divided by height (kg/m^2). BMI $\leq$ 18 was classified as underweight according to the World Health Organization.

Questionnaire

General and lifestyle information was obtained directly by filling out a questionnaire form via a direct interview with the participants. This information included age, gender, marital status, fast food, drinking juice or cola, exercise hours per week, number of meals per day, smoking, drinking alcohol, standard of living, stress, type of job, hard worker or unemployed, family history of participants, and taking therapy for any disease.

Statistical analyses were conducted with a commercially available software program (Graph Pad Prism 6.0, WI, USA). Chi-square was used to identify the significant differences among factors. A p-value below or equal to 0.05 was adopted to reflect significant differences.

Results

Triglyceride level

Our study enrolled 518 participants, including 202 males and 316 females aged 15-83 years, who were randomized to attend the Shar Hospital in Sulaimaniya Province. The studied sample included students, teachers, employees, and patients. Based on the level of triglyceride in serum, it was assessed in our study that out of 518 cases, only 281 (54.3%) were normal, with a mean level of 141.8 ± 12.0ml/dl, while 98 (18.9%) were borderline (i.e. levels >150), with a mean of 180.6 ± 12.23, and 139 (26.8%) showed a severely high TG level (i.e., at risk), with a mean value of 201.7 ± 30.5 (Figure 1).

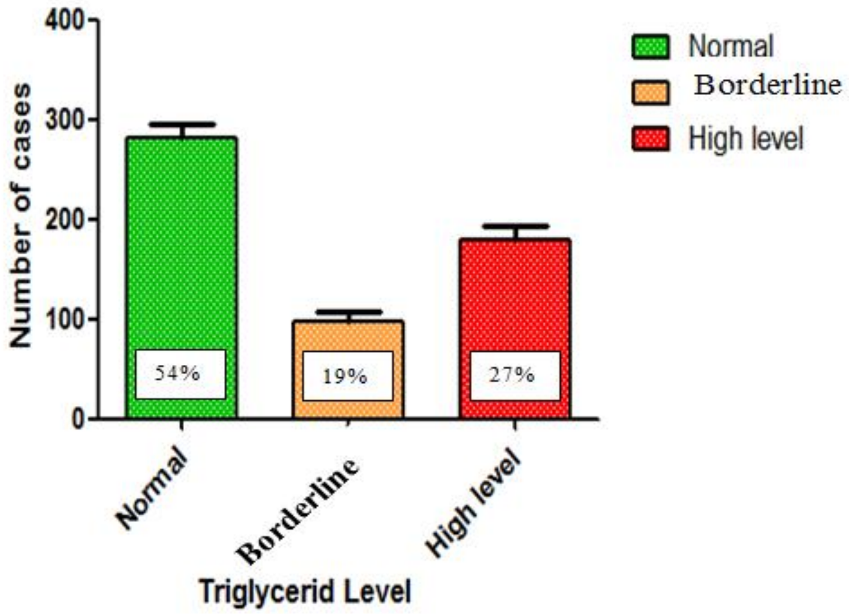

Figure 1- Triglyceride level categories (normal, borderline, risk) in the sera of healthy participants from Sulaimaniya Province.

Body mass index (BMI)

Table (1) shows the association of BMI, nutritional status (underweight, normal, and overweight or obese), and triglyceride level. There is no significant association between BMI and triglyceride levels (P<0.05). The BMI values for 342 participants were equal to or lower than 18 and those for 99 participants were normal (above 18). The values were in the overweight range (25-29) for 60 donors and in the obese range for 17 donors (higher than 30). Most participants were underweight (66%).

Table 1- Correlation between BMI, nutritional status, and Triglyceride triglyceride level of the healthy participants from Sulaimani Province

Nutritional status	BMI	Number (%)	Triglyceride Mean±SD	p-value
Underweight	≤18	342 (66)	172.4 ± 25.2	0.3
Normal	>18	99 (19.1)	177.5 ± 18.2	
Overweight	From 25-29	60 (11.6)	182.3± 15.9	
Obese	≥30	17 (3.3)	202.0 ± 25.6	

Physical and social parameters

The association between triglyceride level and age was assessed in our study. The subject population was divided into three age groups; group 1 (15-25 years of age), group 2 (26-45 years of age), and group 3 (46-83 years of age). The triglyceride level was slightly elevated in the age group of 26-45 years of age, but there was no significant effect of age on triglyceride level (Figure 3).

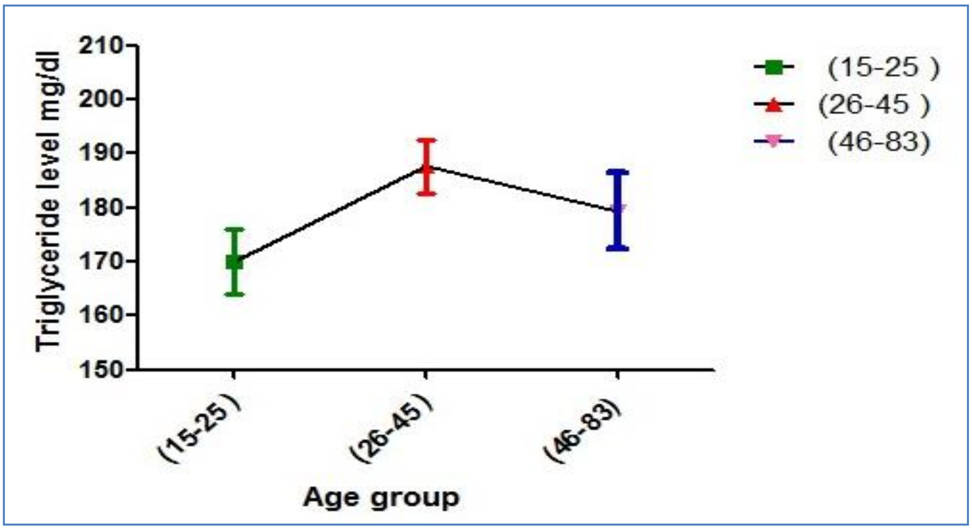

Figure 3- The association between triglyceride level and age among healthy participants in Sulaimani Province .

The results of the effects of gender, marital status, waist circumference, and exercise on triglyceride levels are listed in the table (2). Gender does not have a statistically significant effect on triglyceride (p=0.31). Also, our results show that a married state can contribute to elevated triglyceride levels. The mean triglyceride level among single persons was at borderline (171.4 ± 2.5 ml/dl), but in married cases, the level was higher (187.1 ± 15.2), with a statistically significant difference (p=0.01).

The waist circumference of participants has no significant effects on triglyceride levels (p=0.3).

Regular daily exercise for 1 hour has a direct impact on decreasing triglyceride levels, with a statistically significant effect (p=0.01) being observed (Table 2).

Table 2-The effects of sex, marital status, waist circumference, and exercise on serum triglyceride level.

Factors		**No. (%)**	**Triglyceride level gm/dl** Mean ± SD	**Statistical analysis**
Sex	Male	202 (40)	172.4 ± 26.3	P=0.31
	Female	316 (61)	176.6 ± 29.1	
Marital status	Married	153 (29.5)	187.1 ± 15.2	P=0.01
	Single	365 (70.5)	171.4 ± 2.5	
Waist circumference	26-31	240 (46.3)	184.4 ± 13.2	P=0.3
	32-41	278 (53.7)	188.7 ± 17.5	
Exercise	O hr/day	102(19.7)	194.7 ± 12.2	P= 0.017
	1 hr/day	187 (36.1)	156.0± 19.5	
	2 hr/day	229 (44.2)	145.5± 27.8	

Discussion

About 518 subjects were enrolled in this study to evaluate the association of triglyceride levels with lifestyle factors. Only 54% of the studied sample had normal triglyceride levels, while 19% were at borderline and 27% had severe hypertriglyceridemic levels. The results indicated that nearly half of the participants had hypertriglyceridemia .

The triglyceride level of underweight (BMI ≤18) participants was at the borderline level, indicating that underweight persons also have a similar risk of hypertriglyceridemia. However, high levels of triglyceride were found among obese and overweight persons. This indicates that there is a slight difference in triglyceride level in our population between underweight and overweight individuals. Elevated levels of triglyceride among underweight persons may be caused by lifestyles, such as fast food consumption, inactivity, stress, drinking cola, and juice. The studies of Zewinger *et al*. [27] and Parvez *et al*. [28] support our results, showing that triglyceride levels increased among obese (BMI>30) subjects as compared to those with normal and underweight conditions. However, our findings demonstrate that even underweight people are at risk of diseases that can be caused by elevated levels of triglyceride.

Underweight and normal-weight people should take caution measures in relation to their consumption of fast food and check for triglyceride levels more frequently than overweight and obese people do. This is because when overweight people consume food, they store high amounts of sugar in the adipose tissue and, after 24 hours, the triglyceride level decreases. However, when underweight people consume high-calorie food, the triglyceride level raises for a long time, which could cause serious inflammation in the blood vessels [29].

In our cases, 54% of the participants were at the normal range, which indicates that 46% percent of our population was at the borderline range or at risk of high triglyceride levels. This is a high proportion of risk and needs immediate awareness and guidelines of healthy food as well as lifestyle to avoid the elevation of TG level.

Among our cases, we could indicate the effect of marital status on an elevated level of triglyceride. The triglyceride level among married people was higher than that among single ones. This can be due to lifestyle changes as well as stress. Our result is similar to that of an earlier study [29], in which hypertriglyceridemia was shown to be more prevalent among married people.

The association between age and triglyceride levels was also demonstrated in our study. Young people (ages 15-25) showed similar results to adults and elderly people. However, adults with a higher triglyceride level may be subjected to lifestyle changes and stress, since these individuals can be less active at this stage. Elderly people have lower triglycerides levels relative to adults. This finding may be attributed to consuming healthy and regular food rather than junk and fast food, cookies, cake, and carbonated beverages.

In order to demonstrate the difference in triglyceride levels between genders, we assessed hypertriglyceridemia among 202 males and 316 females. In the current research, there was a slight difference between males and females. However, females had a higher triglyceride level than males. These results are consistent with those of a previous work [30], which found that women have a significantly higher triglyceride level than men. Waist circumference was not associated with triglyceride levels according to the current data. This finding is supported by an earlier study [31], which showed that changes in waist circumference did not lead to elevated triglyceride and LDL levels.

Exercise was correlated with triglyceride level. The mean triglyceride level of inactive persons was 194.7 ± 12.2, whereas that of people who exercised about 1-4 h/week was 156± 19.5. Likewise, a previous study [32] demonstrated the association of regular exercise and lower TG levels. Exercise has a remarkable impact on triglyceride levels, as was found in the current study. People who exercise more than 5 hours/week a decreased triglyceride level, within the normal range. However, cases with exercise of less than 5 hours/week are still at borderline.

Conclusions

The findings of the current study conclude that underweight persons at the borderline range are the same as normal BMI persons, both being at a risk of hypertriglyceridemia. About 46% of the sampled Kurdish population has a high triglyceride level. Marital status and exercise have significant effects on triglyceride level. The underweight individuals should be more regularly checked for triglyceride levels in comparison with overweight and obese ones.

References

1. Demignot, S.F., Beilstein, and Morel, E. 2014. Triglyceride-rich lipoproteins and cytosolic lipid droplets in enterocytes: key players in intestinal physiology and metabolic disorders, Biochimie, (96), pp: 48-55. https://doi.org/10.1016/j.biochi.2013.07.009

2. Siddiqi, S. A., and Mansbach,C.M. 2008. *Protein Kinase C* (PKC) mediated phosphorylation controls budding of the pre-chylomicron transport vesicle, Journal of cell science, 121(14), pp: 2327-2338. doi: 10.1242/jcs.022780

3. Bouchoux, J., Beilstein, F., Pauquai, T., Guerrera, I. C., Chateau, D., Ly, N., Alqub, M., Klein, C., Chambaz, J., Rousset, M. 2011. The proteome of cytosolic lipid droplets isolated from differentiated Caco-2/TC7 enterocytes reveals cell-specific characteristics, Biology of the Cell, 103(11), pp: 499-517. https://doi.org/10.1042/bc20110024

4. Zhu, J. B., Lee, K. K., Buhman, and Cheng, J.X. 2009. A dynamic, cytoplasmic triacylglycerol pool in enterocytes revealed by ex vivo and in vivo coherent anti-Stokes Raman scattering imaging," Journal of lipid research, 50 (6), pp:1080-1089. https://doi.org/10.1194/jlr.m800555-jlr200

5. Rosenson,R.S., Davidson,M.H., Hirsh,B., Kathiresan,J. S. and Gaudet,D. 2014. Genetics and causality of triglyceride-rich lipoproteins in atherosclerotic cardiovascular disease, Journal of the American College of Cardiology, 64(23) pp: 2525-2540. https://doi.org/10.1016/j.jacc.2014.09.042

6. Listenberger, L. L., Han, X. , Lewis, S. E., Cases, S., Farese, R. V., Ory, D. S., Schaffer, J. E. 2003. Triglyceride accumulation protects against fatty acid-induced lipotoxicity. *Proceedings of the National Academy of Sciences, U S A*. 100(6): pp3077–3082. doi:10.1073/pnas.0630588100

7. Zheng,C. C., Khoo, J. Furtado, and Sacks,F.M. 2010. Apolipoprotein C-III and the metabolic basis for hypertriglyceridemia and the dense low-density lipoprotein phenotype," Circulation, 121 (15), pp: 1722. https://doi.org/10.1161/CIRCULATIONAHA.109.875807

8. Haidari, M., Leung, N., Mahbub, F., Uffelman, K. D., Kohen-Avramoglu, R., Lewis, G. F., & Adeli, K. 2002. Fasting and postprandial overproduction of intestinally derived lipoproteins in an animal model of insulin resistance. Evidence that chronic fructose feeding in the hamster is accompanied by enhanced intestinal de novo lipogenesis and ApoB48-containing lipoprotein overproductionThe Journal of biological chemistry, 277(35),pp:31646–31655. https://doi.org/10.1074/jbc.M2005442009.

9. Rashid, S., Tavori, H., Brown, P. E., Linton, M. F., He, J., Giunzioni, I., & Fazio, S. 2014. Proprotein convertase subtilisin kexin type 9 promotes intestinal overproduction of triglyceride-rich apolipoprotein B lipoproteins through both low-density lipoprotein receptor-dependent and -independentmechanisms. Circulation, 130(5),pp:431-441. https://doi.org/10.1161/CIRCULATIONAHA.113.00672010.

10. Haas, B. E., Horvath, S., Pietiläinen, K. H., Cantor, R. M., Nikkola, E., Weissglas-Volkov, D., Rissanen, A., Civelek, M., Cruz-Bautista, I., Riba, L. 2012. Adipose Co-expression networks across Finns and Mexicans identify novel triglyceride-associated genes.Biomed Central, Medical Genomics,5(61),pp:6-10 https://doi.org/10.1186/1755-8794-5-61

11. Hsieh, M.-H., Lin, W.-Y., Chien, H.-H., Chien, L.-H., Huang, C.-K., Yang, J.-F., Chang, N.-C., Huang, C.-F., Wang, C.-L., Chuang, W.-L. 2012. Waist circumference, body mass index, serum uric acid, blood sugar, and triglyceride levels are important risk factors for abnormal liver function tests in the Taiwanese population, The Kaohsiung journal of medical sciences, 28(9), pp. 470-476, 2012. https://www.sciencedirect.com/science/article/pii/S1607551X12000976

12. Pierre, J. St., Isabelle, L., Marie-C., Patrice, P., G.éraldT. 2002. Contribution of abdominal obesity and hypertriglyceridemia to impaired fasting glucose and coronary artery disease. The American journal of cardiology, 90(1), pp. 15-18, 2002. https://doi.org/10.1016/S0002-9149(02)02378-0

13. Zhao, S.P. and Ye,H.J. 2009. Hypertriglyceridemia, Encyclopedia of Molecular Mechanisms of Disease, pp. 951-952.

14. Kelishadi, R., Cook, S. R., Motlagh, M. E., Gouya, M. M., Ardalan, G., Motaghian, M., Majdzadeh, R., & Ramezani, M. A. 2008. Metabolically obese normal weight and phenotypically obese metabolically normal youths: the CASPIAN Study. Journal of the American Dietetic Association, 108(1), pp:82–90. https://doi.org/10.1016/j.jada.2007.10.01319.

15. Huang, D., Dhawan,T., Young,S., Yong,W.H., Boros, L.G. and Heaney,A. P. 2011. Fructose impairs glucose-induced hepatic triglyceride synthesis, Lipids in health and disease, 10(1), p: 20. http://www.lipidworld.com/content/10/1/20

16. Wu, K.-T., Kuo, P.-L., Su, S.-B., Chen, Y.-Y., Yeh, M.-L., Huang, C.-I., Yang, J.-F., Lin, C.-I., Hsieh, M.-H., Hsieh, M.-Y. 2016. Nonalcoholic fatty liver disease severity is associated with the ratios of total cholesterol and triglycerides to high-density lipoprotein cholesterol, Journal of clinical lipidology, 10 (2), pp. 420-425.

17. Steiner,G. 1991. Altering triglyceride concentrations changes insulin-glucose relationships in hypertriglyceridemic patients: a double-blind study with gemfibrozil with implications for atherosclerosis, Diabetes Care, 14(11), pp: 1077-1081.
18. Chang, T. I., Streja, E., Soohoo, M., Kim, T. W., Rhee, C. M., Kovesdy, C. P., Kashyap, M. L., Vaziri, N. D., Kalantar-Zadeh, K., Moradi, H. 2017. Association of Serum Triglyceride to HDL Cholesterol Ratio with All-Cause and Cardiovascular Mortality in Incident Hemodialysis Patients, Clinical Journal of the American Society of Nephrology, 12(4), pp: 591-602.
19. Talayero, B.G. and Sacks,F.M. 2011. The role of triglycerides in atherosclerosis," Current Cardiology reports, 13(6), p. 544.
20. Chang, T. I., Streja, E., Soohoo, M., Kim, T. W., Rhee, C. M., Kovesdy, C. P., Kashyap, M. L., Vaziri, N. D., Kalantar-Zadeh, K., Moradi, H. 2002. Evidence for an independent and cumulative effect of postprandial hypertriglyceridemia and hyperglycemia on endothelial dysfunction and oxidative stress generation: effects of short-and long-term simvastatin treatment, Circulation, 106(10), pp: 1211-1218.
21. Agarwal,V., Gupta,B., Singhal,U. and Bajpai,S.K. 1997. Examination Stress: Changes in Serum Cholesterol Triglycerides and Total Lipids, Indian journal of physiology and pharmacology, 41 pp. 404-408.
22. Greenfield,M. S., Kraemer,F., Tobey,T. and Reaven,G. 1980. Effect of age on plasma triglyceride concentrations in man," Metabolism, 29(11), pp: 1095-1099.
23. Sarac, I., Backhouse, K., Shojaee-Moradie, F., Stolinski, M., Robertson, M. D., Bell, J. D., Thomas, E. L., Hovorka, R., Wright, J., Umpleby, A. M. 2012. Gender differences in VLDL1 and VLDL2 triglyceride kinetics and fatty acid kinetics in obese postmenopausal women and obese men, The Journal of Clinical Endocrinology & Metabolism, 97(7), pp: 2475-2481.
24. Hama, A. A., and Rahimo Z.I. 2007. Intestinal parasites in relation to malnutrition among primary schoolchildren in Erbil province, with the evaluation of some anti-parasitic drugs', M.Sc. Thesis, Science College, Salahaddin University.
25. Hama, A. A., and Rahimo, Z.I. 2016. Nutritional Status in Relation to Intestinal Infection Among Primary Schoolchildren in Erbil Province Kurdistan-Iraq, First international conference of natural science (ICNS) proceeding book, Charmo University, pp:67-7.
26. Weli, M. Kareem, S. I., Shareef, O. H., Rauf, H. G., Raouf, C. G. and Hama, A. A. 2021. The Effects of the Aqueous Extract of the Leaves of the Local Plant Eruca sativa on Lipid Profile and Some Minerals in the Blood of Male White Mice, eijs, 62 (4), pp. 1088-1093. https:// DOI: 10.24996/ijs.2021.62.4.5
27. Zewinger, S., Reiser, J., Jankowski, V., Alansary, D., Hahm, E., Triem, S., Klug, M., Schunk, S. J., Schmit, D., Kramann, R. 2019. Apolipoprotein C3 induces inflammation and organ damage by alternative inflammasome activation. Nature Immunology.DOI: 10.1038/s41590-019-0548-1
28. Parvez,A., Rafiq,A., Ahmad,N. and . Khan, E.H. 2010. Relationship of glycaemia and triglycerides with BMI in diabetic patients," Journal of Ayub Medical College Abbottabad, 22(2), pp:164-166.
29. Woo,J., Leung,S. S. F., Sham,S.C. Ho., Lam,A. T. H. and Janus,E. D. 1999. Influence of educational level and marital status on dietary intake, obesity and other cardiovascular risk factors in a Hong Kong Chinese population," European Journal of Clinical Nutrition, 53(6), p: 461.
30. Furusyo, N. Shimizu, M., Ikezaki, H., Hiramine, S., Ura, K., Mitsumoto, F., Ai, M., Okazaki, M., Schaefer, E., Hayashi, J. 2015. Effects of gender and menopause on the cholesterol and triglyceride content of lipoprotein subclasses as separated by high performance liquid chromatography, Atherosclerosis, 241 (1), p: e118.
31. Hobkirk, J. P., King, R. F., Davies, I., Harman, N., Gately, P., Pemberton, P., Smith, A., Barth, J. H., & Carroll, S. 2014. The metabolic inter-relationships between changes in waist circumference, triglycerides, insulin sensitivity and small, dense low-density lipoprotein particles with acute weight loss in clinically obese children and adolescents. Pediatric obesity, 9(3), pp:209–217. https://doi.org/10.1111/j.2047-6310.2013.00165.x
32. Alpert, P. T. 2010. Exercise and lipids: How much exercise is adequate to increase HDL and lower triglycerides, Home Health Care Management & Practice, 22(7), pp: 539-542.