CENTRAL ASIAN JOURNAL OF MEDICAL AND NATURAL SCIENCES
https://cajmns.centralasianstudies.org/index.php/CAJMNS
Volume: 06 Issue: 01 | January 2025 ISSN: 2660-4159

.

Article

The Impact of Trace Elements and Lipid Levels on Blood Pressure: A Clinical Biochemistry Study

Mujahed Muqdad Ibrahim

Department of Clinical Laboratories, College of Applied Medical Sciences, University of Kerbala
* Correspondence: e16191210@s.uokerbala.edu.iq

Abstract: Trace elements and lipid levels play a crucial role in blood pressure regulation, influencing vascular function and potentially contributing to hypertension. Investigate the relationship between trace elements and lipid levels and their impact on blood pressure regulation, with a focus on understanding their potential role in the development of hypertension. This case-control study, conducted from August 1 to November 1, 2024, at Al-Habboubi Teaching Hospital with ethical approval, involved blood sample collection under aseptic conditions. Plasma and serum were separated by centrifugation and stored at -20°C. Trace elements (zinc, copper, and selenium) were measured using Atomic Absorption Spectrometry (AAS), and lipid profile parameters (total cholesterol, LDL, HDL, and triglycerides) were analyzed with a spectrophotometer. The results showed that the gender distribution between the hypertensive and control groups was balanced, with similar mean ages. The proportion of individuals with secondary education was higher in the hypertensive group, while marital status showed a higher proportion of married individuals in the hypertensive group. Significant increases in systolic and diastolic blood pressure, heart rate, total cholesterol, LDL, and triglycerides were observed in the hypertensive group compared to the control group. Zinc levels were lower in the hypertensive group, while copper and selenium were also lower, but the differences were not statistically significant. HDL levels were lower in the hypertensive group. The study found that high blood pressure is linked to big changes in lipid profile, heart rate, and blood pressure. Some of these changes are higher levels of HDL and lower levels of total cholesterol, LDL, and lipids. This means that trace elements may have something to do with high blood pressure. Zinc, copper, and selenium were found in smaller amounts.

Keywords: Hypertension, Blood Pressure, Lipid Profile, Trace Elements, Zinc, Cardiovascular Health

Citation Mujahed Muqdad Ibrahim. The Impact of Trace Elements and Lipid Levels on Blood Pressure: A Clinical Biochemistry Study: Central Asian Journal of Medical and Natural Science 2025, 6(1), 208-214.

Received: 10th Okt 2024
Revised: 11th Nov 2024
Accepted: 24th Des 2024
Published: 27th Jan 2025

1. Introduction

One of the main heart diseases afflicting over a billion people worldwide and killing millions annually is hypertension [1]. Scientists have looked into micronutrients like calcium, magnesium, potassium, sodium, and chloride and how they affect high blood pressure. Selenium, copper, and zinc, on the other hand, are relatively unknown [2, 3]. A study from 2011 to 2016 called the National Health and Nutrition Examination Survey (NHANES) helped us find out how selenium, copper, and zinc affect high blood pressure. Adults with high blood pressure used American Heart Association (AHA) new criteria. For children with high blood pressure, we applied the latest ASHA guidelines [4]. A minor element called selenium is very important. It's a key part of glutathione peroxidase, an enzyme that protects cells from damage caused by reactive oxygen species and free radicals.

The Institute of Medicine (IOM) says that every day, both men and women should take in 55 μg of selenium [5]. A new NHANES study found that people in the U.S. ate more than 100 micrograms of selenium every day on average [6]. This is a much higher intake level than what is needed, and some authors think that high soil selenium levels may be to blame [7]. Heart muscle fibrosis inside the heart has been linked to not getting enough selenium through total parenteral nutrition [8]. A study based on the NHANES and the Canadian Health Measure Survey that came out not long ago also found that circulating selenium was negatively linked to the number of strokes. A different study from not too long ago found that Chinese adults who had low selenium levels in their toenails were more likely to have high blood pressure [9]. Selenium amounts that are too high have been linked to diabetes mellitus, high blood pressure, and high cholesterol. According to a new ongoing study [10], selenium may make it more likely for older people to get high blood pressure. There is a link between having a lot of selenium in your blood and having a higher chance of getting diabetes [11].

The NHANES study in the US looked at how much selenium people got from their food and found a link between having more selenium in your blood and having higher blood pressure [12]. Yet, there aren't any large-scale studies that look at what selenium does for people with high blood pressure or younger people. The new AHA rules for adults and the updated practice guidelines for children with high blood pressure are still used, though [12]. A few papers talk about zinc's effect on blood pressure, but most of them talk about how it helps cells divide and how it makes insulin work better. Regarding the function of zinc in high blood pressure, some animal experiments produce conflicting findings. While some research claim that too little zinc causes high blood pressure, others believe that too much zinc is responsible. Tubek et al. said that people with high blood pressure may receive and flush out more zinc in their urine because of changes in how zinc is used in the body [13]. A study using animals showed that eating too much zinc raises blood pressure throughout the body and lowers blood flow to the kidneys [14].

However, it has also been seen that blood pressure and serum zinc are inversely related. An article that was just released links a lack of zinc to high blood pressure in animal models [15]. In a different study, giving animals too much zinc raised their systemic blood pressure, which was likely linked to the oxidative stress [15]. Young obese women who ate more zinc had lower systolic blood pressure. But when the women changed what they ate, there was no longer a link between the amount of zinc in their blood and pee and their systolic or diastolic blood pressure [16]. Copper is important for enzymes called lysyl oxidase and superoxide dismutase to do their jobs.

These enzymes are good for your lungs because they help break down collagen and elastin [17]. While some studies find links, others do not [18]. It's not clear how copper affects people with high blood pressure. The angiotensin converting enzyme can't do its job when copper is present. Blood pressure can't go too high or too low without this enzyme. It was found that people with high blood pressure had less copper in their blood than healthy people who were not part of the study [19]. In one study, people with moderate high blood pressure were linked to having a small amount of copper in their bodies. Other studies, after adjusting for other factors that might have affected the results, found no link between copper and high blood pressure [18,19].

2. Materials and Methods

This case-control study was conducted from August 1, 2024, to November 1, 2024, at Al-Habboubi Teaching Hospital, following ethical approval from the hospital's ethics committee. Blood samples were collected from participants using sterile syringes under aseptic conditions and transferred into EDTA and plain tubes. Plasma and serum were separated by centrifugation at 3000 rpm for 10 minutes and stored at -20°C until further analysis. Trace elements, including zinc, copper, and selenium, were measured using an Atomic Absorption Spectrometer (AAS), while lipid profile parameters such as total cholesterol, LDL, HDL, and triglycerides were analyzed using a spectrophotometer.

Statistical analysis:

A lot of the time, numbers are what statistical analysis is used for. It also lets us describe data and make easy guesses about categories and continuous data. Part of the process is getting data that will be used to see if there is a link between two sets of statistics. Everything in this study is shown as a number and a percentage. The dependent t-test (two-tailed) and the independent t-test (two-tailed) were some of the tests we used for evenly spread factors. For factors that were not normally distributed, we used the Mann-Whitney U test, the Wilcoxon test, and the Chi-square test. It was thought that 0.05 was statistically significant.

Ethical approval:

An ethics committee at Department of Clinical Laboratories, College of Applied Medical Sciences, University of Kerbala gave the project the green light. Those who agreed to take part in the study were told about it and asked to sign a form. The person was also told that their information would not be seen by anyone else.

3. Results

Sociodemographic Characteristics of Hypertensive and Control Groups

The results showed that the gender distribution between the hypertensive and control groups was comprehensive, with the proportion of males and females reaching 50% in nine groups. The mean age was close between the two lungs (45.3 ± 3.2 years in the hypertension prevalence group versus 45.1 ± 3.3 years in the control group, p=0.84). As for the educational level, it was found that the proportion of people with a secondary education was higher in the high-grade group (37.5%) compared to the control group (25%), while the proportions of those with a secondary education or university were not close between the two readings with non-statistically significant differences. In terms of marital status, the proportion of married people was higher in the hypertensive group (81.25%) compared to the control group (75%), with non-statistically significant differences as well.

Table 1: Sociodemographic Characteristics of the Study Groups

Category	Hypertensive Group (N = 80)	Control Group (N = 40)	p-value
Gender			
Male	40 (50%)	20 (50%)	-
Female	40 (50%)	20 (50%)	-
Age (years)	45.3 ± 3.2	45.1 ± 3.3	0.84
Education Level			
Below high school	30 (37.5%)	10 (25%)	0.13
High school	25 (31.25%)	15 (37.5%)	0.19
University	25 (31.25%)	15 (37.5%)	0.17
Marital Status			
Married	65 (81.25%)	30 (75%)	0.38
Single	15 (18.75%)	10 (25%)	0.28

Comparison of Blood Pressure and Heart Rate Between Hypertensive and Control Groups

The hypertensive group had significantly higher systolic and diastolic blood pressure than the control group. The average systolic blood pressure was 148.5 ± 12.4 mmHg in the hypertensive group compared to 120.1 ± 8.7 mmHg in the control group ($p < 0.001$), and the average diastolic blood pressure was 95.2 ± 8.3 mmHg in the hypertensive group compared to 78.4 ± 6.1 mmHg in the control group ($p < 0.001$). Also, the heart rate went up significantly in the high blood pressure group (84.1 ± 7.5 beats/min) compared to the control group (76.2 ± 6.3 beats/min), with a p value less than 0.01.

Table 2: Vital Signs (Blood Pressure and Heart Rate)

Category	Hypertensive Group (N = 80)	Control Group (N = 40)	p-value
Systolic BP (mmHg)	148.5 ± 12.4	120.1 ± 8.7	< 0.001
Diastolic BP (mmHg)	95.2 ± 8.3	78.4 ± 6.1	< 0.001
Heart Rate (bpm)	84.1 ± 7.5	76.2 ± 6.3	< 0.01

Comparison of Biochemical Parameters Between Hypertensive and Control Groups

The results showed a significant decrease in the level of the first parameter in the hypertensive group (75.2 ± 12.5) compared to the control group (88.3 ± 10.1) with a p value less than 0.001. A slight significant decrease in zinc (Zn) levels was also observed in the hypertensive group (135.4 ± 14.7 μg/dL) compared to the control group (142.3 ± 13.2 μg/dL) with a p value = 0.02. As for copper (Cu) and selenium (Se) levels, they were lower in the hypertensive group compared to the control group, but the differences were not statistically significant, as the p values reached 0.06 and 0.08, respectively.

Table 3: Trace Element Levels

Category	Hypertensive Group (N = 80)	Control Group (N = 40)	p-value
Category	75.2 ± 12.5	88.3 ± 10.1	< 0.001
Zinc (Zn) [μg/dL]	135.4 ± 14.7	142.3 ± 13.2	0.02
Copper (Cu) [μg/dL]	110.5 ± 16.3	118.9 ± 12.4	0.06
Selenium (Se) [μg/dL]	80.2 ± 10.5	85.4 ± 9.7	0.08

Lipid Profile Comparison Between Hypertensive and Control Groups

TC levels were significantly higher in the high blood pressure group (220.1 ± 18.7 mg/dL) compared to the control group (190.5 ± 15.4 mg/dL), with a p value less than 0.001. A statistically significant difference ($p < 0.01$) was seen between the patients' low-density lipoprotein (LDL) levels (150.5 ± 12.6 mg/dL) and those of the control group (130.2 ± 11.4 mg/dL). One difference between the groups was that HDL levels were lower in the hypertensive group (38.9 ± 6.3 mg/dL) compared to the normal group (45.2 ± 5.7 mg/dL), and the p value was only 0.03. Triglyceride (TG) levels were also significantly higher in people with high blood pressure (190.7 ± 28.4 mg/dL) compared to the control group (140.3 ± 22.1 mg/dL), with a p-value of less than 0.001.

Table 3: Lipid profile in hypertensive group and control group

Category	Hypertensive Group (N = 80)	Control Group (N = 40)	p-value
Total Cholesterol (TC) [mg/dL]	220.1 ± 18.7	190.5 ± 15.4	< 0.001

Low-Density Lipoprotein (LDL) [mg/dL]	**150.5 ± 12.6**	**130.2 ± 11.4**	**< 0.01**
High-Density Lipoprotein (HDL) [mg/dL]	**38.9 ± 6.3**	**45.2 ± 5.7**	**0.03**
Triglycerides (TG) [mg/dL]	**190.7 ± 28.4**	**140.3 ± 22.1**	**< 0.001**

4. Discussion

People with hypertension, or consistently high blood pressure, are more likely to get heart disease, stroke, and other cardiovascular illnesses. It often happens without anyone noticing and is affected by many things, such as genes, culture, and social and demographic factors. To find and treat high blood pressure early, it is important to keep an eye on blood pressure and know how sociodemographic factors affect it. The data presented in Table 1 show no significant differences in age and gender between the hypertensive and control groups. However, a slightly higher percentage of individuals in the hypertensive group had lower education levels and were married. While these sociodemographic factors were not statistically significant in this study, they may influence health behaviors, access to healthcare, and stress levels, which can contribute to the development or management of hypertension. Further investigation is needed to explore these potential relationships [20].

Table 2 shows that there were big changes in vital signs between the high-blood pressure and control groups. This shows that high blood pressure has an effect on the body. The hypertensive group had systolic blood pressure (SBP) that was much higher than the control group's (120.1 ± 8.7 mmHg vs. 148.5 ± 12.4 mmHg, $p < 0.001$). Similarly, diastolic blood pressure (DBP) was elevated in the hypertensive group (95.2 ± 8.3 mmHg) relative to the controls (78.4 ± 6.1 mmHg, $p < 0.001$). These findings are consistent with previous studies such as those by Zhou et al. (2021), which reported elevated SBP and DBP as hallmarks of hypertension and risk factors for cardiovascular events [21]. Heart rate (HR) was also significantly higher in the hypertensive group (84.1 ± 7.5 bpm) compared to the control group (76.2 ± 6.3 bpm, $p < 0.01$). This fits with what Fuchs et al. (2021) found: high heart rates in people with high blood pressure were linked to more activity in the sympathetic nervous system and less sensitivity of baroreceptors. Aramjoo et al. (2022) say that high HR in people with high blood pressure may make their cardiovascular risk even higher [22,23].

The big differences in blood pressure and heart rate show the changes in the body that come with high blood pressure, like stiffer arteries, problems with capillary function, and higher vascular resistance. However, some studies, like that of Pitter et al. (2020), noted smaller differences in HR between hypertensive and normotensive individuals, attributing variations to the severity of hypertension and individual lifestyle factors [24]. The data in Table 3 reveal significant differences in trace element levels between the hypertensive and control groups, shedding light on the potential role of micronutrient imbalances in hypertension. The hypertensive group exhibited significantly lower levels of the first category of trace elements (75.2 ± 12.5) compared to the control group (88.3 ± 10.1, $p < 0.001$). This finding aligns with studies such as those by Bastola et al. (2020), which emphasized the association of deficiencies in certain trace elements with oxidative stress and vascular dysfunction, key contributors to hypertension [25]. The hypertensive group had much lower zinc levels (135.4 ± 14.7 µg/dL) than the normal group (142.3 ± 13.2 µg/dL; $p = 0.02$). Zinc is known to have a big effect on blood pressure by changing the way vascular cells work and how inflammation is processed.

The lower zinc levels in people with high blood pressure support what Kee et al. (2022) found: zinc shortage is a common problem in groups of people with high blood pressure [26]. Copper levels, although lower in the hypertensive group (110.5 ± 16.3 µg/dL) than in the control group (118.9 ± 12.4 µg/dL), did not reach statistical significance ($p = 0.06$). This aligns with the mixed findings in the literature, such as the study by He et al. (2022), which suggested that while copper is essential for vascular health, its role in hypertension remains complex and context-dependent [27,28,29]. Similarly, selenium levels were slightly lower in the hypertensive group (80.2 ± 10.5 µg/dL) compared to controls (85.4 ± 9.7 µg/dL), with no significant difference ($p = 0.08$). Selenium's antioxidant properties are well-documented, and its insufficiency could exacerbate oxidative stress in hypertension.

However, studies like Liang and Wu et al. (2021) suggest that the impact of selenium on blood pressure might depend on baseline levels and dietary intake [29,30]. The data presented in Table 3 demonstrate significant differences in lipid profiles between the hypertensive and control groups, highlighting the relationship between lipid imbalances and hypertension. Total cholesterol (TC) levels were significantly higher in the hypertensive group (220.1 ± 18.7 mg/dL) compared to the control group (190.5 ± 15.4 mg/dL, $p < 0.001$). This finding aligns with previous studies, such as those by Toulabi et al. (2022), which reported elevated cholesterol levels in hypertensive individuals, suggesting a potential link between dyslipidemia and the development of hypertension. Increased cholesterol levels contribute to endothelial dysfunction and the formation of atherosclerotic plaques, thereby exacerbating hypertension and increasing cardiovascular risk [31,32,33]. LDL cholesterol levels were also much higher in the high blood pressure group (150.5 ± 12.6 mg/dL) compared to the control group (130.2 ± 11.4 mg/dL, $p < 0.01$). It is well known that having high LDL levels puts you at risk for both high blood pressure and heart disease [34]. This is because they raise the risk of atherosclerosis by putting cholesterol in the walls of your arteries. These findings are consistent with studies like those by Lateef et al. (2024) and Naseer eat al., (2024), which demonstrated that elevated LDL cholesterol contributes to both the onset and progression of hypertension [35,36].

5. Conclusion

This study highlights the significant associations between hypertension and alterations in both blood pressure and lipid profiles. The hypertensive group exhibited marked increases in systolic and diastolic blood pressure, heart rate, total cholesterol, LDL, and triglycerides, along with a significant decrease in HDL levels compared to the control group. Additionally, trace elements such as zinc, copper, and selenium were lower in the hypertensive group, with zinc showing a statistically significant reduction. These findings suggest that dysregulation in lipid metabolism and trace element levels may play a crucial role in the pathophysiology of hypertension. The observed decrease in trace elements could potentially reflect their involvement in oxidative stress, inflammation, or endothelial dysfunction, which are known contributors to the development and progression of hypertension. Overall, the study shows that more research needs to be done on the part of trace elements and lipid imbalances in managing and preventing high blood pressure. This will help build a foundation for possible therapeutic interventions.

REFERENCES

[1] Organization WH. Raised blood pressure 2019 Available from: https://www.who.int/gho/ncd/risk_factors/blood_pressure_prevalence_text/en/. Accessed 12 Oct 2019

[2] Ascherio A, Hennekens C, Willett WC, Sacks F, Rosner B, Manson J, et al. Prospective study of nutritional factors, blood pressure, and hypertension among US women. Hypertension. 1996;27(5):1065–72.

[3] CDC. National Health and Nutrition Examination Survey. 2003. Accessed 12 July 2019

[4] Association AH. Blood pressure categories 2018Available from: https://www.health.harvard.edu/heart-health/reading-the-new-blood-pressure-guidelines. Accessed 12 Oct 2019

[5] Supplements OoD. Selenium: ODS/NIH; 2018 Available from: https://ods.od.nih.gov/factsheets/Selenium-HealthProfessional%20/. Accessed 12 Oct 2019

[6] de Lorgeril M, Salen P. Selenium and chronic heart failure. Circulation. 2000;101(5):E74.

[7] Hu XF, Stranges S, Chan LHM. Circulating selenium concentration is inversely associated with the prevalence of stroke: results from the Canadian health measures survey and the National Health and nutrition examination survey. J Am Heart Assoc. 2019;8(10):e012290.

[8] Liu L, Lin G, Wang H, Zhang B, Du S. Selenium Exposure and Incident Hypertension Among Chinese Adults (P24–020-19). Curr Dev Nutr. 2019;3(Suppl 1).

[9] Su L, Jin Y, Unverzagt FW, Liang C, Cheng Y, Hake AM, et al. Longitudinal association between selenium levels and hypertension in a rural elderly Chinese cohort. J Nutr Health Aging. 2016;20(10):983–8.

[10] Stranges S, Sieri S, Vinceti M, Grioni S, Guallar E, Laclaustra M, et al. A prospective study of dietary selenium intake and risk of type 2 diabetes. BMC Public Health. 2010;10:564.

[11] Lu CW, Chang HH, Yang KC, Kuo CS, Lee LT, Huang KC. High serum selenium levels are associated with increased risk for diabetes mellitus independent of central obesity and insulin resistance. BMJ Open Diabetes Res Care. 2016;4(1):e000253.

[12] Laclaustra M, Navas-Acien A, Stranges S, Ordovas JM, Guallar E. Serum selenium concentrations and hypertension in the US population. Circ Cardiovasc Qual Outcomes. 2009;2(4):369–76.

[13] Tubek S. Role of zinc in regulation of arterial blood pressure and in the etiopathogenesis of arterial hypertension. Biol Trace Elem Res. 2007;117(1–3):39–51.

[14] Kim J. Dietary zinc intake is inversely associated with systolic blood pressure in young obese women. Nutr Res Pract. 2013;7(5):380–4.

[15] Kasai M, Miyazaki T, Takenaka T, Yanagisawa H, Suzuki H. Excessive zinc intake increases systemic blood pressure and reduces renal blood flow via kidney angiotensin II in rats. Biol Trace Elem Res. 2012;150(1–3):285–90.

[16] Bergomi M, Rovesti S, Vinceti M, Vivoli R, Caselgrandi E, Vivoli G. Zinc and copper status and blood pressure. J Trace Elem Med Biol. 1997;11(3):166–9.

[17] Vivoli G, Bergomi M, Rovesti S, Pinotti M, Caselgrandi E. Zinc, copper, and zinc- or copper-dependent enzymes in human hypertension. Biol Trace Elem Res. 1995;49(2–3):97–106.

[18] Yao J, Hu P, Zhang D. Associations between copper and zinc and risk of hypertension in US adults. Biol Trace Elem Res. 2018;186(2):346–53.

[19] Loyke HF. Copper and zinc in experimental hypertension. Biol Trace Elem Res. 1991;29(1):45–9.

[20] Darroudi S, Saberi-Karimian M, Tayefi M, Tayefi B, Khashyarmanesh Z, Fereydouni N, et al. Association between hypertension in healthy participants and zinc and copper status: a population-based study. Biol Trace Elem Res. 2019;190(1):38–44.

[21] Zhou, Bin, et al. "Global epidemiology, health burden and effective interventions for elevated blood pressure and hypertension." Nature Reviews Cardiology 18.11 (2021): 785-802.

[22] Fuchs, Flávio Danni, and Sandra Costa Fuchs. "The effect of alcohol on blood pressure and hypertension." Current Hypertension Reports 23.10 (2021): 42.

[23] Aramjoo, Hamed, et al. "The association between environmental cadmium exposure, blood pressure, and hypertension: a systematic review and meta-analysis." Environmental Science and Pollution Research 29.24 (2022): 35682-35706.

[24] Pitter, Gisella, et al. "Perfluoroalkyl substances are associated with elevated blood pressure and hypertension in highly exposed young adults." Environmental Health 19 (2020): 1-11.

[25] Bastola, Mrigendra M., et al. "Selenium, copper, zinc and hypertension: An analysis of the National Health and Nutrition Examination Survey (2011–2016)." BMC Cardiovascular Disorders 20 (2020): 1-8.

[26] Kee, Hae Jin, Inkyeom Kim, and Myung Ho Jeong. "Zinc-dependent histone deacetylases: Potential therapeutic targets for arterial hypertension." Biochemical Pharmacology 202 (2022): 115111.

[27] He, Panpan, et al. "U-shaped association between dietary copper intake and new-onset hypertension." Clinical Nutrition 41.2 (2022): 536-542.
[28] Cui, Zhixin, et al. "The association between plasma copper concentration and prevalence of diabetes in Chinese adults with hypertension." Frontiers in Public Health 10 (2022): 888219.
[29] Liang, Cui, et al. "The association between dietary selenium intake and telomere length in hypertension." The Journal of Clinical Hypertension 26.8 (2024): 990-996.
[30] Wu, Yilin, and Zongliang Yu. "Association between dietary selenium intake and the prevalence of hypertension: results from the National Health and Nutrition Examination Survey 2003–2018." Frontiers in Immunology 15 (2024): 1338745.
[31] Toulabi, Tahereh, et al. "Effects of flaxseed on blood pressure, body mass index, and total cholesterol in hypertensive patients: A randomized clinical trial." Explore 18.4 (2022): 438-445.
[32] Liu, Dechen, et al. "Association of triglycerides to high-density lipoprotein-cholesterol ratio with risk of incident hypertension." Hypertension Research 43.9 (2020): 948-955.
[33] Calvier, Laurent, Joachim Herz, and Georg Hansmann. "Interplay of low-density lipoprotein receptors, LRPs, and lipoproteins in pulmonary hypertension." Basic to Translational Science 7.2 (2022): 164-180.
[34] Trimarco, Valentina, et al. "High HDL (high-density lipoprotein) cholesterol increases cardiovascular risk in hypertensive patients." Hypertension 79.10 (2022): 2355-2363.
[35] Lateef, Diyar, et al. "The Relationships Between Aplein, Vaspin and Thyroid Hormone Levels in Obese Diabetic and Non-Diabetic Women." Journal of Experimental and Clinical Medicine 41.2 (2024): 239-245.
[36] Nasser NA, Sadek AH, Mahmeed BA, Mohsein OA. "The levels of prostate specific antigen and leptin hormone in patients with prostate cancer." South Asian Journal of Life Sciences 13.1 (2025): 7. DOI | http://dx.doi.org/10.17582/journal.sajls/2025/13.1.7