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Evaluation of Lipid Profile, Body Mass Index and Glucose Level in Patients with Essential Hypertension in Hadhramout – Yemen

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Abstract: Hypertension is a major global health problem and a primary risk factor for cardiovascular diseases, often associated with lipid disorders. Therefore, a cross-sectional study was conducted in Mukalla, to evaluate the lipid profile body mass index (BMI), and glucose levels in patients with hypertension and compare them with healthy individuals. A total of 60 participants (28 males and 32 females) were enrolled in the study. Among them, 40 participants (18 males and 22 females) were diagnosed with hypertension (patient group), while 20 were healthy (control group). Blood samples were analyzed using the enzymatic methods to measure the lipid profile and glucose level in the serum, and BMI was also measured. The results of the study showed a significant increase in the levels of total cholesterol (T.C), triglycerides (TG), low-density lipoproteins (LDL), BMI, and glucose levels in the patient group compared with the healthy group. However, no statistically significant increase in high-density lipoprotein (HDL) levels was observed between the two groups. Correlation analysis showed significant positive correlations between systolic pressure and BMI, glucose, TC, and LDL. Conversely, diastolic pressure correlated significantly only with TG. No significant correlations were found between blood pressure and HDL. The study concluded that hypertension is significantly associated with lipid disorders, and patients with hypertension need regular lipid analysis to prevent heart and cardiovascular diseases. The study recommends further research on other hematological and biochemical markers, as well as on the relationship between the disease, nutrition, and environmental factors.

Keywords: Body mass index; Hadhramout; Hypertension; Lipid disorders; Lipid profile

1. Introduction

Hypertension (high blood pressure) is a chronic medical condition characterized by elevated blood pressure in the arteries, occurring when the pressure in the blood vessels is too high (140/90 mmHg or higher) [1]. This increase requires the heart to work harder than usual to pump blood through the blood vessels [2]. Hypertension is a significant contributor to premature death globally. Approximately 46% of adults with hypertension are unaware that they have this condition [3].

In 1975, the number of people worldwide affected by hypertension reached 590 million. By 2015, this number

had increased to 1.13 billion [4]. In 2024, approximately 1.4 billion individuals aged 30-79 worldwide were affected by hypertension [3]. The prevalence of hypertension significantly increases with advancing age, affecting around 6% of individuals aged 18 to 34, and this percentage rises to 75% among adults aged 75 and older [5]. In the coastal region of Hadhramout, hypertension is among the top ten most prevalent diseases according to health facility records in 2019, with a total of 8,849 affected patients, including 4,208 males and 4,641 females [6].

Dyslipidemia, which refers to elevated blood lipids, has been identified as an independent risk factor for

cardiovascular diseases, particularly in association with high blood pressure. Hypertension and dyslipidemia are closely interconnected and are among the most common risk factors for the development of heart and cardiovascular diseases [7, 8].

Although some studies have analyzed the lipid profile in patients with hypertension, there is significant variability in the results of blood lipid levels among different population groups [9]. Furthermore, to the best of our knowledge, no studies of this nature have been conducted in Hadhrumout Governorate. Therefore, this study was designed to determine the blood lipid levels in patients with hypertension in the city of Mukalla, Hadhrumout Governorate. The study hypothesized that hypertensive patients have significantly higher levels of total cholesterol, triglycerides, LDL, BMI, and glucose compared to healthy individuals.

2. Materials and Methods

2.1 Study Methodology

The study methodology was based on a cross-sectional, analytical, and laboratory study. Patients were interviewed after obtaining official permission and approval. A form was completed for each patient, and the blood samples were taken from them and analyzed in the laboratory, to determine some biochemical parameters related to kidney functions and blood minerals and to compare these parameters with those of the control group (healthy people).

2.2 Sample and Study Area

The current study was conducted during the period from December 2021 to March 2022. The study sample included 60 volunteers of both genders, and the cases were divided into two groups:

Patient group: It included 40 hypertensive patients attending the internal medicine clinic at Ibn Sina Hospital in Mukalla, Hadhrumout Governorate. Eighteen cases were male patients and 22, cases were female patients and their age ranged between 30 and 70 years.

The healthy group (Control group): It included 20 of healthy people who did not suffer from any symptoms of hypertension or any chronic disease. Ten males and ten females were included from the same age group as the patients.

2.3 Ethical considerations

Ethical approval was obtained through official correspondence from the Faculty of Science at Hadhrumout University to the administration of Ibn Sina General Hospital and its laboratory department. Furthermore, informed consent was obtained from all participants prior to their inclusion in the study, ensuring full awareness of the research objectives and procedures.

2.4 Work Methods

2.4.1 Data Collection Tool

The information related to the study was collected according to a questionnaire prepared for this purpose. The questionnaire the following information: patient name, age, gender, place of residence, educational level, weight, height, body mass index, systolic and diastolic pressure, number of years since infection, anxiety, smoking, and family history of the disease.

(A) Blood Pressure Measurement

The blood pressure of both groups the patients as well as the control (healthy) group was measured in the internal medicine clinic using the mercury sphygmomanometer (German KD-METER Company). The blood pressure level was classified according to [10] as follows: normal blood pressure: 120/80 mm Hg, pre-hypertension: 120-139/80-89 mmHg; stage 1 hypertension: 140-159/90-99 mmHg; and stage 2 $\geq$ 160/100 mmHg.

(B) Body Mass Index (BMI)

Weight and height were measured using the instrument (Zt - 120) from Health Scale Company (Germany). The Body mass index measurement has been approved according to (Saudi Ministry of Health, 2021 (Body mass index = weight in kilograms/height in meters squared. The cases were divided according to the World Health Organization (WHO, 1997) into: people with underweight BMI < 18.5 kg/m², normal weight BMI = 18.5-24.9 kg/m², overweight people = 25.0-29.9 kg/m² BMI and obesity (BMI $\geq$ 30.0 kg/m²).

2.4.2 Blood Samples Collection

Three ml of venous blood was collected from the hypertensive patients group as well as from the control group, using disposable medical syringes (5cc) (Italy), which were placed in dry, clean tubes free of any anticoagulant (Plain tubes) (China). To perform biochemical tests, the samples were left for 10 minutes at room temperature before being placed in a centrifuge (HuMax 4k) from Human Company (Germany) to separate the serum from the blood, at a speed of 3000-4000 rpm deleted and for a period not exceeding five minutes, The separated serum was withdrawn using an automatic micropipette (China), and then placed in Eppendorf plastic tubes (China) to conduct the subsequent tests.

2.4.3 Biochemical tests

The levels of glucose, total cholesterol, triglycerides, and high-density lipoprotein (HDL) cholesterol were measured using an enzymatic method, with an AU480 instrument manufactured by the American company Bechman Coulter, connected to a computer (DTX company, Japan) and for this purpose, special diagnostic kits manufactured by Beckman Coulter were used according to the instructions provided with each test kit. Low-density lipoprotein (LDL) cholesterol levels were calculated using the Friedewald formula. The tests were conducted at the National Center for Public Health Laboratories in Mukalla, Yemen.

2.5 Statistical Analysis

The data from the study samples were collected after the completion of the study and statistical analysis was conducted using SPSS Version 24, Analysis of variance (ANOVA) was used to compare the groups, followed by an independent t-test. The results were expressed as mean $\pm$ standard deviation, and statistical significance was set at $P < 0.05$. Some variables were examined for linear correlations. The strength of the correlation was measured using the Pearson correlation coefficient.

3. Results

3.1 Blood glucose

Table 1, presents the mean $\pm$ standard deviation of glucose levels. It indicates a significant increase in blood glucose

levels in hypertensive patients compared to the control group.

3.2 lipid profile

As presented in Table 1, the results demonstrate a significant elevation in the mean values of total cholesterol, triglycerides, and low-density lipoprotein cholesterol in the hypertensive patient group compared to the healthy group. However, there was no significant difference in the level of high-density lipoprotein cholesterol between the two groups.

3.3 Body mass index (BMI) in both study groups

As illustrated in Table 1, there was a statistically significant increase in the mean BMI of hypertensive patients ($30.1 \pm 3.72 \text{ kg/m}^2$) compared to the control group ($25.6 \pm 1.97 \text{ kg/m}^2$; $P = 0.048$).

3.4 Mean arterial pressure (MAP) in both study groups

Table (1) shows a significant increase in the value of mean arterial pressure in the hypertensive patient group ($123. \pm 11.2 \text{ mmHg}$) compared with the control group ($98.7 \pm 7.4 \text{ mmHg}$; $P = 0.001$).

Table 1. Clinical Parameters Summary.

Parameters	Study Groups (Mean $\pm$ SD)		P- value
	Control Group (n=20)	Hypertensive Group (n=40)	
Glucose (mg/dL)	88.35 $\pm$ 8.79	109.18 $\pm$ 28.54	0.001
TG (mg/dL)	127.3 $\pm$ 30.0	151.6 $\pm$ 53.8	0.043
T.C (mg/dL)	128.1 $\pm$ 26.9	193.7 $\pm$ 60.4	0.040
LDL (mg/dL)	108.9 $\pm$ 28.9	115.0 $\pm$ 32.1	0.048
HDL (mg/dL)	50.1 $\pm$ 11.7	54.0 $\pm$ 15.9	0.065
BMI	25.6 $\pm$ 1.97	30.1 $\pm$ 3.72	0.048
Mean Arterial Pressure	98.7 $\pm$ 7.4	123.0 $\pm$ 11.2	0.001

HDL. High Density Lipoprotein LDL. Low Density Lipoprotein
T.C Total cholesterol TG. Triglycerides BMI Body mass index

3.5 MAP, weight and BMI by gender in the patient group

Table (2) indicates a non-significant increase in mean arterial pressure values in males compared to females in the study group.

Table 2. MAP, weight and BMI according to gender in the patient group

Parameter	Male Group 18 (Mean $\pm$ SD)	Female Group 22 (Mean $\pm$ SD)	P-value
Weight (kg)	74.9 $\pm$ 10.19	76.9 $\pm$ 15.02	0.118
BMI	27.4 $\pm$ 3.8	30.3 $\pm$ 5.7	0.018
Mean arterial pressure	130.0 $\pm$ 18.8	116.2 $\pm$ 13.2	0.302

3.6 Correlations

3.6.1 Correlation between hypertension and glucose Levels

Table (3) indicates a positive and statistically significant correlation between systolic blood pressure and glucose levels, with a correlation coefficient (r) of 0.314 and a p-value of 0.015. Conversely, there is no statistically significant correlation between diastolic blood pressure and glucose levels, as evidenced by a correlation coefficient (r) of 0.081 and a p-value of 0.538.

3.6.2 Correlation between hypertension and Lipid profile

The current study results (Table 3) revealed a positive and statistically significant correlation between systolic blood pressure and both cholesterol and low-density lipoprotein (LDL), with correlation coefficients of (0.355 and 0.300) and p-values of (0.005 and 0.020), respectively. Conversely, no statistically significant correlation was found between high-density lipoprotein (HDL) or triglycerides, with correlation coefficients of (0.083 and 0.098) and p-values of (0.529 and 0.458), respectively.

Regarding diastolic blood pressure, the results indicated a positive and statistically significant correlation with triglycerides, with a correlation coefficient of 0.364 and a p-value of 0.004. However, no statistically significant correlation was observed between diastolic blood pressure and total cholesterol, HDL, or LDL, with correlation coefficients of 0.073, 0.017, and 0.188, respectively, and p-values of 0.579, 0.896, and 0.150 respectively.

Table 3. Correlations between blood pressure and study variables.

Variable 1	Variable 2	Correlation Coefficient (r)	P-value
Systolic BP	Glucose	0.314	0.015
	Triglycerides	0.098	0.458
	Cholesterol	0.355	0.005
	HDL	0.083	0.529
	LDL	0.300	0.020
Diastolic BP	BMI	0.389	0.002
	Glucose	0.081	0.538
	Triglycerides	0.364	0.004
	Cholesterol	0.073	0.579
	HDL	0.017	0.896
	LDL	0.188	0.150
	BMI	0.238	0.067

3.6.3 Correlation between hypertension and BMI

Table (3) showed a positive significant correlation between systolic pressure and body mass index, where the correlation coefficient reached 0.389 and the p- was 0.002, while there was no significant correlation between diastolic pressure and body mass index. The correlation coefficient (r) was 0.238 and the p-value was 0.067.

4. Discussion

Hypertension is defined as a condition in which the blood pressure in the blood vessels is equal to or above 140/90 mmHg [1]. It contributes to the development of cardiovascular diseases and can lead to myocardial infarction [11]. Additionally, it affects the functions of other organs such as the brain and kidneys, and it remains with the affected individual throughout life [10]. The disease poses a threat to the lives of patients and can result in death if severe complications occur and are not carefully managed, or if the recommendations of specialized physicians are not followed. The current study aimed to assess the lipid profile, BMI, and glucose levels among hypertensive patients and compare them with healthy individuals.

The results of this study indicated a significant increase in fasting blood glucose levels among patients with hypertension compared to healthy individuals. This finding is consistent with the study by [12] conducted in

Iraq, which reported a significant increase in fasting glucose levels in the hypertensive group compared to healthy controls. This may be due to the fact that diabetic patients are more prone to developing hypertension [13] confirmed a significant increase in fasting blood glucose concentrations in hypertensive patients compared to healthy individuals, suggesting that this may be linked to the consumption of sugar-rich foods or the presence of insulin resistance [14], also reached similar conclusions, while [15] attributed the significant increase to higher levels of fats and cholesterol in the blood. They explained that these changes may be due to the role of the hormone aldosterone, secreted by the adrenal gland, which raises blood pressure and increases insulin resistance, potentially leading to type 2 diabetes [16]. [17] Supported this by noting that age might influence pancreatic and glandular activity, and the coexistence of diabetes and hypertension puts individuals at a higher risk for more severe and dangerous cardiovascular diseases. [18] Explained the interrelationship between hypertension and diabetes as being rooted in common risk factors, such as aging, obesity, physical inactivity, thyroid diseases, and chronic stress. [19] Indicated that the significant correlation between glucose levels and hypertension could be due to metabolic disorders, including elevated cholesterol or general lipid metabolism issues. Furthermore, [20] in India confirmed the link between hypertension and diabetes, suggesting that social, biological, cultural factors, and lifestyle patterns may play a role in this relationship.

The results of the study showed a significant elevation in the mean values of total cholesterol, triglycerides, and low-density lipoprotein cholesterol in the hypertensive patient group compared to the healthy group. However, there was no significant difference in the level of high-density lipoprotein cholesterol between the two groups. This finding is consistent with the results of a recent systematic review study conducted by [8].

The current study found that hypertensive patients have significantly higher cholesterol levels compared to healthy individuals, which aligns with the significant increase in total cholesterol reported in studies conducted in Iraq by [21] and [22] as well as with a study conducted in China by [23]. However, this finding contradicts the results of a study by [24] conducted in Pakistan, which found no significant difference between hypertension and an increase in total cholesterol levels. This difference may be attributed to weight gain and obesity, as emphasized by [25] in a study conducted in Italy. The elevation of cholesterol levels in hypertensive patients may be attributed to increased fat intake [26]. This is because cholesterol contributes to narrowing the blood vessels, increasing arterial resistance, leading to hypertension, arterial stiffness, and the risk of cardiovascular diseases [19]. High cholesterol levels may be due to dietary factors characterized by high-fat content, resulting in elevated cholesterol. Alternatively, the cause may be psychological and emotional, as chronic stress and emotional strain can lead to increased secretion of adrenaline and cortisol hormones, which constrict blood vessels, increase heart rate, and promote the deposition of fats on the inner walls

of arteries, ultimately leading to increased blood resistance and hypertension [27]. Additionally, high concentrations of cholesterol associated with hypertension can be attributed to various factors such as genetic factors, lack of physical exercise, and stress [28].

The results of the study showed a significant increase in triglyceride levels in hypertensive patients, and the findings of the current study were consistent with the results of a study conducted by [14] in Iraq, [29] in India, and [23] in China, which all found a significant increase in triglyceride levels in hypertensive patients compared to healthy individuals. However, these findings differ from a study conducted by [25] in Italy, which indicated a non-significant increase in triglyceride levels in hypertensive patients. The increase in triglyceride levels may be attributed to aging, as fats deposit on arterial walls, making them stiffer and less elastic, leading to hypertension [30]. Alternatively, it may be due to the consumption of foods high in triglycerides, as they increase the production of chylomicrons in the intestines, which, when broken down, release fatty acids and result in the uptake of large amounts of fatty acids by liver cells, leading to an increase in triglyceride release [21].

The current study indicated a significant increase in the LDL level, and this increase is consistent with the findings of studies conducted by [29] in India and [23] in China. However, these findings differ from the results of a study by [25] conducted in Italy, which showed a non-significant increase in LDL levels in hypertensive patients. This increase may be associated with an imbalanced diet that leads to atherosclerosis, which is considered a fundamental factor in cardiovascular diseases [21]. Obesity may also play a role in this increase [24].

HDL is a type of cholesterol that functions to remove cholesterol from and transport it to the liver [31]. This study demonstrated a non-significant increase in HDL cholesterol levels in hypertensive patients compared to healthy individuals, which is consistent with the findings of a study by [24] and [22] conducted in Algeria, although the latter study also reported non-significance. However, these findings differ from the results of the study by [28] and [23] conducted in China, which showed a significant decrease in HDL levels in hypertensive patients. Additionally, [21] confirmed the significant decrease in HDL cholesterol in hypertensive patients and suggested that this decrease may be attributed to liver diseases or elevated levels of cholesterol, triglycerides, and LDL in the plasma.

BMI serves as a guide and indicator for measuring the proportion of fat in the human body, thus classifying overweight or obesity by calculating the weight-to-height ratio in kilograms per square meter [32]. It has been observed that there is a close correlation between BMI and hypertension [33], as an increase in BMI is associated with an increase in blood pressure [34].

The results of the current study showed a significant increase in BMI among the group of patients with hypertension compared to the healthy group. This increase is consistent with the findings of the study by [25] conducted in Italy and the results of the study by [35],

which indicated a relationship between BMI and hypertension. It was further confirmed that visceral fat is more important in this relationship, and there may be localized effects from perirenal fat that affect the development of hypertension, despite its relatively small proportion [9]. A study conducted in China also reported an association between increased BMI and hypertension, as well as the occurrence of complications, notably stroke. They found that increased BMI is closely associated with older age and the presence of chronic diseases.

The significant increase in BMI can be attributed to the consumption of saturated fats in the diet, as well as an increase in LDL. It may also be a result of consuming trans fats [34].

5. Conclusion

The results of the current study concluded that hypertension is closely associated with dyslipidemia. Patients with hypertension need to monitor their blood pressure and lipid levels regularly to prevent cardiovascular diseases.

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تقييم صورة الدهون، مؤشر كتلة الجسم ومستوى الجلوكوز عند مرضى ارتفاع ضغط الدم الأساسي في م/حضر موت - اليمن

المخلص: يُعدّ ارتفاع ضغط الدم مشكلة صحية عالمية رئيسية، وعامل خطر أساسي لأمراض القلب والأوعية الدموية، وغالبًا ما يرتبط باضطرابات الدهون. لذلك، أُجريت دراسة مقطعية في المكلا لتقييم صورة دهون الدم، ومؤشر كتلة الجسم، ومستوى الجلوكوز لدى مرضى ارتفاع ضغط الدم، ومقارنتها بالأفراد الأصحاء. تم اختيار 60 شخصًا، منهم 28 ذكرًا و32 أنثى، للمشاركة في الدراسة. من بينهم، شُخِّصَ 40 شخصًا (18 ذكرًا و22 أنثى) مريضًا بارتفاع ضغط الدم (مجموعة المرضى)، بينما كان 20 شخصًا أصحاء (مجموعة الضبط). تم تحليل عينات الدم باستخدام الطرائق الإنزيمية لقياس مستوى الدهون والجلوكوز في المصل، بالإضافة إلى قياس مؤشر كتلة الجسم. أظهرت نتائج الدراسة ارتفاعًا معنويًا في مستويات الكوليسترول الكلي، والدهون الثلاثية، والبروتينات الدهنية منخفضة الكثافة (LDL)، ومؤشر كتلة الجسم (BMI)، ومستوى الجلوكوز لدى مجموعة المرضى مقارنةً بمجموعة الأصحاء. بينما لم يُلاحظ ارتفاع ذو دلالة إحصائية في مستويات البروتينات الدهنية عالية الكثافة (HDL) بين المجموعتين. وأظهر تحليل الارتباط وجود ارتباطات إيجابية ذات دلالة معنوية بين ضغط الدم الانقباضي ومؤشر كتلة الجسم، والجلوكوز، والكوليسترول الكلي، والبروتين الدهني منخفض الكثافة (LDL). في المقابل، ارتبط ضغط الدم الانبساطي ارتباطًا معنويًا فقط مع الدهون الثلاثية. ولم تُلاحظ أي ارتباطات معنوية بين ضغط الدم والبروتين الدهني عالي الكثافة (HDL).

خُصِّصَت الدراسة إلى وجود ارتباط وثيق بين ارتفاع ضغط الدم واضطرابات الدهون، وأن مرضى ارتفاع ضغط الدم بحاجة إلى تحاليل دورية للدهون للوقاية من أمراض القلب والأوعية الدموية. وتوصي الدراسة بإجراء المزيد من البحوث حول المؤشرات الدموية والكيموحيوية الأخرى، بالإضافة إلى دراسة العلاقة بين المرض والتغذية والعوامل البيئية.

الكلمات المفتاحية: ارتفاع ضغط الدم، صورة الدهون، مؤشر كتلة الجسم، اضطرابات الدهون، حُضر موت