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Взаимосвязь между уровнем артериального давления и факторами риска артериальной гипертензии

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Резюме

Цель исследования — анализ характеристик артериальной гипертензии (АГ) у лиц, проходящих профосмотры в Медицинском центре Эль-Садер в Наджафе; определение потенциальных предикторов, которые способствуют развитию и прогрессированию АГ. **Материалы и методы**. В исследование отбирались лица, проходившие медицинский осмотр в Медицинском центре Эль-Садер в Наджафе на юге Ирака в период с апреля по октябрь 2023 г. Регистрировали следующие данные: возраст, пол, индекс массы тела, уровень липидов, уровень глюкозы крови и уровень артериального давления в соответствии с классификацией АГ. Статистический анализ включал описательную статистику, проверку на нормальность, t-критерий, дисперсионный анализ, *post hoc* анализ, критерий χ^2. **Результаты**. Всего 334 человека было включено в исследование, из них 192 мужчины и 142 женщины. Средний возраст составил 46,04 ± 14,958 года (от 20 до 94 лет). Из них у 118 человек (35,3 %) был семейный анамнез АГ и 59 человек (17,7 %) были курильщиками (в прошлом или на момент исследования). У женщин зарегистрированы более высокая частота аномальных показателей уровня общего холестерина, триглицеридов (ТГ), липопротеинов высокой плотности (ЛВП) и низкой плотности (ЛНП), по сравнению с мужчинами, особенно в возрасте 50–59 лет. Средние уровни общего холестерина, ЛНП и глюкозы натощак были выше у женщин, по сравнению с мужчинами ($p < 0,05$). Кроме того, уровни общего холестерина, глюкозы, ТГ, ЛНП и других показателей оказались значительно выше при более высоких градациях АГ ($p < 0,05$)**. Выводы**. Наше исследование показало, что такие факторы, как возраст, пол, индекс массы тела, уровень глюкозы и липидов (включая ТГ и ЛНП) в крови и наличие сахарного диабета, ассоциированы с АГ. Эти факторы вносят свой вклад в широкую распространенность АГ и играют роль в разработке подходов к лечению АГ в исследуемой популяции.

Ключевые слова: артериальное давление, артериальная гипертензия, факторы риска, половые различия

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Association between blood pressure and predictive risk factors of hypertension

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Abstract

Objective. This study aims to analyze the characteristics of hypertension among individuals undergoing health examinations at Al-Sader Medical City in Najaf. We seek to determine potential predictors that contribute to the development and progression of hypertension. **Design and methods**. The study population was selected based on individuals undergoing routine health examinations from Al-Sader Medical City in Kufa city, Najaf, south of Iraq, within the period between April to October 2023. The collected data included information on age, gender, body mass index, blood lipids, blood glucose levels, and hypertension classification indices. Statistical analysis included descriptive statistics, normality testing, t-test, one-way analysis of variance (ANOVA), post hoc analysis, chi-square test. **Results**. A total of 334 individuals participated in the study (192 males and 142 females). The average age of the participants was 46,04 ± 14,958 years, ranging from 20 to 94 years. Among them, 118 people (35,3 %) had a family history of hypertension, and 59 people (17,7 %) had a history of smoking. Notably, female participants exhibited a higher rate of abnormal cholesterol, triglycerides (TG), high-density lipoprotein (HDL), and low-density lipoprotein (LDL) levels compared to males, particularly in the age group of 50 to 59 years. The mean levels of cholesterol, LDL, and fasting blood glucose were higher in females compared to males ($p < 0,05$). Furthermore, the levels of cholesterol, fasting glucose, TG, LDL, and other indicators demonstrated a significant increase with the progression of hypertension grades ($p < 0,05$)**. Conclusion**. The study showed that factors such as age, gender, body mass index, blood glucose levels, blood cholesterol levels (including TG and LDL), and the presence of diabetes are closely associated with hypertension. These factors play a significant role in understanding and addressing the prevalence and management of hypertension within the examined population.

Key words: blood pressure, hypertension, cardiovascular risk factors, gender differences

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Introduction

Hypertension, or high blood pressure, is a chronic disease characterized by consistently increased blood pressure levels [1–3]. It is a significant risk factor for cardiovascular diseases such as heart attacks, strokes, and kidney problems [4–10]. Understanding the predictive risk factors associated with hypertension is important for its early detection, prevention, and effective management [5, 11, 12]. Several predictive risk factors have been reported through intensive research and statistical analysis [13]. These risk factors can be broadly divided into modifiable and non-modifiable factors [14, 15]. Modifiable risk factors are those that can be influenced or changed through lifestyle modifications or medical interventions, while non-modifiable risk factors are inherent characteristics that cannot be changed [14–16].

Modifiable risk factors include unhealthy lifestyle choices such as smoking, excessive alcohol consumption, poor diet (high in sodium and low in fruits and vegetables), sedentary behavior, and

obesity. These factors contribute to the development of hypertension by affecting blood vessel health, increasing inflammation, and damaging normal physiological processes [17, 18]. On the other hand, non-modifiable risk factors include age, family history of hypertension, and certain medical conditions like diabetes and chronic kidney disease. Advancing age is associated with an increased risk of hypertension, and individuals with a family history of hypertension are more likely to develop the condition [19–21].

By analysis of these risk factors and their relationship with blood pressure measurements, healthcare professionals can enhance predictive models to assess an individual's likelihood of developing hypertension [22, 23]. This information can be used to implement preventive measures, provide targeted interventions, and improve overall patient care. Our study is based on a survey and is focused on analyzing the characteristics of hypertension among individuals undergoing health examinations in Najaf city. The findings from this analysis serve as a foundation for developing effective strategies for the prevention and control of hypertension.

Design and methods

Sample Selection

A cross-sectional study was conducted among individuals undergoing routine health examinations in the city of Kufa and surrounding cities, which fall under the field practice area of Al-Sader Medical City in Kufa city, Najaf, south of Iraq. The study took place from April to October 2023 and included a total population of approximately 230,000 residents. Among them, blood pressure measurements were performed in 334 individuals (192 males and 142 females). The average age was 46,04 ± 14,958 years, ranging from 20 to 94 years.

Methods

Healthcare specialists and nurses collected and recorded anthropometric, demographic, and lifestyle data using health-related questionnaires that covered information such as demographics, physical activity, cardiovascular risk factors e. g. hypertension, smoking habits, obesity and diabetes. Biochemical parameters, including fasting blood glucose, total cholesterol, triglycerides (TG), high-density lipoprotein cholesterol (HDL), and low-density lipoprotein cholesterol (LDL), were assessed. Participants were instructed to fast overnight for 8–12 hours before blood sampling. A 3 ml venous blood sample was drawn from the forearm and analyzed in the clinical laboratory using the oxidase method with a biochemical analyzer (Mindray BS-230, China).

Grouping Categories

The people were categorized into different groups based on their age, gender, and hypertension levels. For age grouping, patients between the ages of 20–29 years were included in group 1, those aged 30–39 years old in group 2, those aged 40–49 years in group 3, those aged 50–59 years in group 4, and those aged over 60 years in group 5. Regarding gender grouping, patients were divided into two groups: male and female. Furthermore, hypertension was categorized into different grades based on the Common Terminology Criteria for Adverse Events (CTCAE) [24]. Grade I: systolic blood pressure (SBP) ranging from 120–139 mmHg and/or diastolic blood pressure (DBP) ranging from 80–89 mmHg; Grade II: SBP ranging from 140–159 mmHg and/or DBP ranging from 90–99 mmHg; Grade III: SBP equal to or greater than 160 mmHg and/or DBP equal to or greater than 100 mmHg. Blood pressure measurements were taken using a desktop sphygmomanometer, following the criteria set by the World Health Organization (WHO) [25]. Two measurements were recorded during the examination, and the mean value of these measurements was used for analysis. BMI was categorized into different groups based on the World Health Organization (WHO) criteria: underweight — body mass index (BMI) under 18,5 kg/m^2; normal weight — BMI within 18,5–24,9 kg/m^2; overweight — BMI within 25–29,9 kg/m^2; obesity — BMI greater than or equal to 30 kg/m^2 [26]. The criteria for normal and abnormal levels of the biochemical parameters in our study were based on WHO guidelines [27]. The specific cut-off levels considered in our study for key biochemical parameters are as follows: fasting blood glucose: normal < 100 mg/dL; abnormal: ≥ 100 mg/dL (impaired fasting glucose) or ≥ 125 mg/dL (diabetes mellitus). Total cholesterol: normal < 200 mg/dL; high ≥ 200 mg/dL. LDL: normal < 100 mg/dL; high ≥ 100 mg/dL. HDL: normal ≥ 40 mg/dL for men, ≥ 50 mg/dL for women; low: < 40 mg/dL for men, < 50 mg/dL for women. TG: normal < 150 mg/dL; high ≥ 150 mg/dL.

Statistical Analysis

The data was entered into the SPSS database and analyzed using the SPSS 22,0 software package. A normality test was performed for all key statistical indicators. Variables following a normal distribution were presented as mean ± standard deviation (SD), assessed by Kolmogorov–Smirnov test. The t-test was used to compare two groups, while one-way analysis of variance (ANOVA) was used for multiple group comparisons. The chi-square test was implied to evaluate associations between categorical variables,

such as hypertension grades and different age groups. The differences were considered significant at p-level < 0,05. We have applied Fisher's least significant difference (LSD) method to account multiple comparisons.

Results

1) Hypertension grades in the studied groups

The mean systolic blood pressure (SBP) of individuals with hypertension was found to be 145,61 ± 10,881 mmHg, while the mean diastolic blood pressure (DBP) was 90,30 ± 8,483 mmHg. With increasing age, there was an observed upward trend in mean SBP for males and mean DBP for both males and females (Table 1). The differences in mean DBP between males and females were statistically significant when comparing group 1 to groups 2, 3, 4, and 5, as well as between group 2 and groups 4 and 5 (p < 0,01). However, SBP in males in group 4 and SBP in females in group 5 showed a decline trend, and there was no statistically significant difference (Table 1).

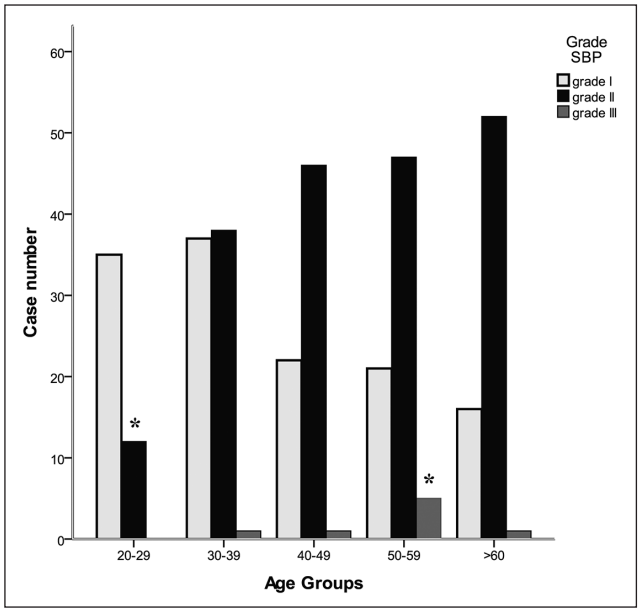

Figure 1. Prevalence of grades of hypertension and ages (*p < 0,001)

The comparison of mean blood pressure of individuals with hypertension across different age groups showed a significant variation with increasing age (Table 2). Older age groups had significantly higher mean SBP than groups 1 and 2 (p < 0,05), indicating a progressive increase in hypertension severity with age. However, the mean SBP in groups 3, 4, and 5 was the highest, with no statistically significant difference observed among them.

The majority of people (58,4 %) had grade II hypertension, while the smallest proportion (2,4 %) had grade III hypertension (Fig. 1 and Table S1). Notably, there was a significant increase in the number of males aged ≥ 60 years and females aged 50–59 years with grade II hypertension. Additionally, there was a statistically significant difference in hypertension grades between genders (Fig. 2 and Table S2).

2) Association between hypertension and clinical parameters

The SBP and DBP in hypertensive people tend to increase as BMI increases (Table 3). Furthermore, the comparison between obese and overweight, normal weight and underweight participants showed a statistically significant difference in SBP and DBP (p < 0,01). However, the differences in mean SBP and DBP were not statistically significant when comparing underweight to normal weight, as well as between normal weight and overweight (Table S3).

Among all the participants 118 people (35,3 %) had a family history of hypertension, while 59 people (17,7 %) had a history of smoking (Table 4). The highest proportion of individuals with both a family history of hypertension and smoking belonged to the

Table 1

THE MEAN BLOOD PRESSURE OF HYPERTENSIVE PATIENTS OF VARIOUS GENDER AND AGE

Age groups	Age, years	Male			Female		
		SBP, mmHg	DBP, mmHg		SBP, mmHg	DBP, mmHg	
		Mean	Mean	N	Mean	Mean	N
Group 1	20–29	124 ± 8,54	77 ± 6,16	31	121 ± 6,55	73 ± 4,37	16
Group 2	30–39	129 ± 8,95	79 ± 6,67	52	127 ± 7,47	81 ± 5,65	24
Group 3	40–49	132 ± 9,19	82 ± 7,04	39	133 ± 9,26	84 ± 8,45	30
Group 4	50–59	131 ± 12,07	82 ± 6,98	35	134 ± 12,87	85 ± 7,80	38
Group 5	> 60	134 ± 9,42	83 ± 8,05	35	131 ± 8,82	85 ± 7,73	34
	Total	130 ± 10,04	81 ± 7,25	192	130 ± 10,56	83 ± 8,07	142

Table 2

PAIRWISE COMPARISON OF MEAN BLOOD PRESSURE ACROSS DIFFERENT AGE GROUPS IN HYPERTENSIVE PATIENTS

(I) Age groups	(J) Age groups	Mean difference (I-J)	Std error	p-level	95% Confidence interval	
					Lower bound	Upper bound
Group 1	Group 2	–5,589-*	1,805	0,002	–9,14	–2,04
	Group 3	–9,335-*	1,839	< 0,001	–12,95	–5,72
	Group 4	–9,768-*	1,819	< 0,001	–13,35	–6,19
	Group 5	–9,770-*	1,839	< 0,001	–13,39	–6,15
Group 2	Group 1	5,589*	1,805	0,002	2,04	9,14
	Group 3	–3,746-*	1,617	0,021	–6,93	–0,56
	Group 4	–4,179-*	1,594	0,009	–7,31	–1,04
	group 5	–4,181-*	1,617	0,010	–7,36	–1,00
Group 3	Group 1	9,335*	1,839	< 0,001	5,72	12,95
	Group 2	3,746*	1,617	0,021	0,56	6,93
	Group 4	–0,433	1,633	0,791	–3,65	2,78
	Group 5	–0,435	1,656	0,793	–3,69	2,82
Group 4	Group 1	9,768*	1,819	< 0,001	6,19	13,35
	Group 2	4,179*	1,594	0,009	1,04	7,31
	Group 3	0,433	1,633	0,791	–2,78	3,65
	Group 5	–0,002	1,633	0,999	–3,21	3,21
Ggroup 5	Group 1	9,770*	1,839	< 0,001	6,15	13,39
	Group 2	4,181*	1,617	0,010	1,00	7,36
	Group 3	0,435	1,656	0,793	–2,82	3,69
	Group 4	0,002	1,633	0,999	–3,21	3,21

Note: * The mean difference is significant at the 0,05 p-level.

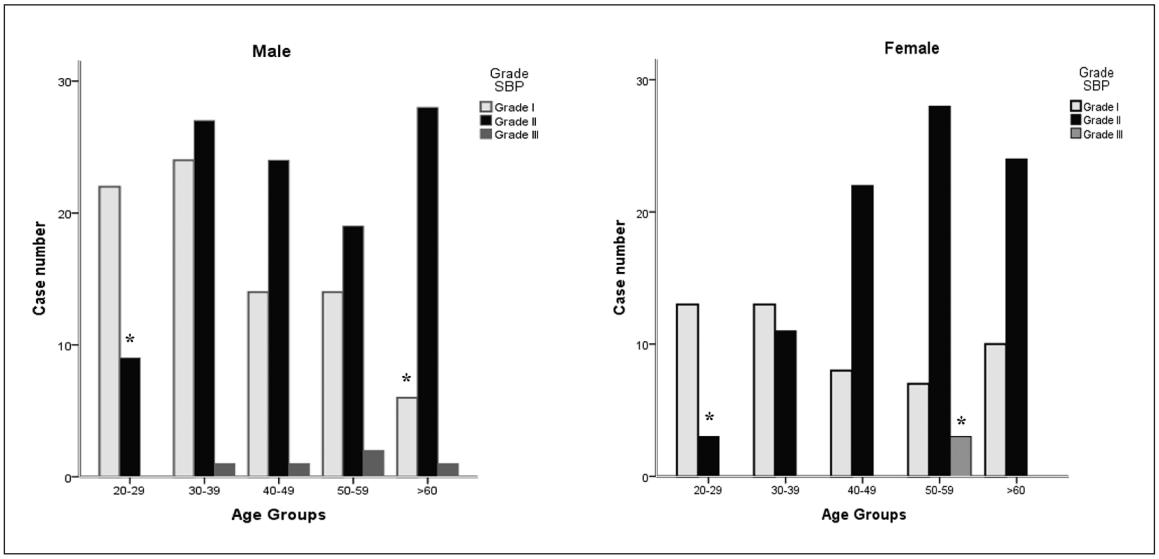

Figure 2. Prevalence of grades of hypertension and ages and genders (*p < 0,001)

Table 3

THE MEAN BLOOD PRESSURE OF HYPERTENSIVE PEOPLE ACROSS DIFFERENT CATEGORIES OF BODY MASS INDEX

BMI	N	SBP, mmHg	DBP, mmHg
		Mean	Mean
Underweight	23	122,61 ± 6,549	75,00 ± 4,264
Normal weight	71	125,70 ± 7,851	77,54 ± 6,807
Overweight	105	128,43 ± 7,731	80,14 ± 6,258
Obese	135	135,04 ± 11,354	85,74 ± 7,318
Total	334	130,12 ± 10,251	81,50 ± 7,672

Note: BMI — body mass index; SBP — systolic blood pressure: p = 0,001; DBP — diastolic blood pressure: p = 0,023.

Table 4

COMPARISON OF HYPERTENSION GRADES BASED ON PARENTAL HISTORY OF HYPERTENSION AND SMOKING STATUS

The grade of hypertension		Parental history of hypertension		Total	Smoking status		Total
		No history of hypertension	History of hypertension		Non-smoking	Smoking	
Grade I	Sample size	86	45	131	107	24	131
	Proportion	25,7%	13,5%	39,2%	32,0%	7,2%	39,2%
Grade II	Sample size	123	72	195	162	33	195
	Proportion	36,8%	21,6%	58,4%	48,5%	9,9%	58,4%
Grade III	Sample size	7	1	8	6	2	8
	Proportion	2,1%	0,3%	2,4%	1,8%	0,6%	2,4%
Total	Sample size	216	118	334	275	59	334
	Proportion	64,7%	35,3%	100,0%	82,3%	17,7%	100,0%

Note: Parental history of hypertension: $\chi^2 = 2,097$, $p = 0,351$; 1 cell (16,7%) has expected count less than 5. The minimum expected count is 2,83.

Smoking: $\chi^2 = 0,408$, $p = 0,815$, 1 cell (16,7%) has expected count less than 5. The minimum expected count is 1,41.

grade II hypertension category, with 21,6% having a family history of hypertension and 9,9% having a history of smoking.

In the age group of 50 to 59 years, females showed a notably higher abnormal rate of cholesterol, TG, HDL, and LDL compared to males. On the other hand, in the age group of 30 to 39 years, males had a significantly higher abnormal TG rate compared to females. Additionally, among females aged 50 to 59 years, the abnormal LDL rate was significantly higher than that in males (Table 5). The study results indicate that hypertensive individuals across all age groups had a median fasting blood glucose level of approximately 200 mg/dL (Fig. 3). Additionally, the median cholesterol level was around 240 mg/dL in age groups 1, 2, 4, and 5. The group 3 has the lowest median cholesterol level compared to other groups, while groups 4 and 5 show slightly higher median cholesterol levels. Age groups 1 and 2 had a median level of TG close to 300 mg/dL, whereas the other age groups had median TG levels below 300 mg/dL. Furthermore, among hypertensive individuals, age groups 2 and 3 exhibited a median high-density lipoprotein (HDL) level of approximately 40 mg/dL.

The mean levels of cholesterol, LDL and fasting blood glucose in females was higher than those in males (Table S4).

Table 7

METABOLIC RISK FACTORS IN MALES AND FEMALES WITH HYPERTENSION

Items	Number of male patients (%)	Number of female patients (%)	Total	χ^2	p-level
Overweight	6	7,5	32	1,095	0,295
Obese	41,8	37,3	40,4	0,542	0,461
FBG abnormality	41,8	43,3	65,6	3,263	0,071
TG abnormality	47,8	46,3	75,4	3,663	0,056
Cholesterol abnormality	32,8	43,3	48,2	9,641	0,002
HDL abnormality	25,4	14,9	28,1	1,55	0,213
LDL abnormality	11,9	26,9	21,3	9,011	0,003

Note: TG — triglycerides; HDL — high-density lipoproteins; LDL — low-density lipoproteins.

The levels of cholesterol, glucose, TG, LDL, and other indicators showed a significant increase with the progression of hypertension grades (Table 6).

In terms of gender differences, males exhibited higher rates of obesity, abnormal TG, and abnormal HDL compared to females. Conversely, females had higher rates of overweight and abnormal fasting glucose compared to males. Notably, females also showed higher rates of abnormal cholesterol and abnormal LDL compared to males (Table 7).

Discussion

Hypertension is a prevalent cardiovascular disease that poses a significant public health challenge globally. The current approach for managing hypertension emphasizes early detection and intervention. This study observed that the average SBP in both men and women, as well as the average DBP in women, exhibited an upward trend with increasing age. Furthermore, as age increased, there was a significant rise in the number of males and females diagnosed with grade II hypertension. Notably, there was a substantial increase in the number of males aged 60 years and above, as well as females aged 50–59 years, who were diagnosed with grade II hypertension (Fig. 2).

The results indicated that there was a positive correlation between BMI and mean SBP and DBP in hypertensive people. As BMI increased, the average SBP and DBP also showed an upward trend. The mean blood pressure was the highest among obese patients and the lowest among underweight patients. These findings were consistent with those reported in the previous hypertension survey [28, 29] referring that age, gender, and BMI were significant factors influencing the average levels of blood pressure [29]. Additionally, previous studies have demonstrated that changes in body weight can lead to increases or decreases in blood pressure, and vice versa. Furthermore, elevated blood pressure can also contribute to an increase in body weight [29, 30]. According to this study, the highest proportion of patients with hypertension in the health examination population was found to have grade II hypertension, while the lowest number had grade III hypertension. Among hypertensives, 97,6% had grade I and II hypertension which corresponds to mild-to-moderate hypertension. Our results indicate that there was a statistically significant difference in parental history of hypertension and smoking among individuals with different grades of hypertension.

Our findings highlight significant variations in fasting blood glucose, total cholesterol, TG, and HDL levels across different age groups in hypertensives. Notably, in age group 4 the lowest glucose level comprised 188 mg/dl and was observed in hypertensive individuals, whereas age group 1 had the minimal glucose level of 73 mg/dl. This suggests potential differences in metabolic control across age groups, which may be influenced by factors such as disease duration, lifestyle, and medication use. The highest glucose level in age group 1 was 209 mg/dl, while in age group 5 the maximal glucose level was 250 mg/dl, indicating a possible association between older age and poorer glycemic control [31, 32].

Similarly, cholesterol levels were variable across the age groups. The lowest value was 150 mg/dl in age groups 2 and 3. Age groups 1 and 5 had a minimal cholesterol level of approximately 127 mg/dl. On the other hand, the maximal cholesterol level was 313 mg/dl in age groups 1 and 2, while age group 4 had the maximal cholesterol level at 334 mg/dl. These variations may reflect age-related metabolic changes or differences in dietary habits and lipid-lowering therapy

adherence among the groups. The lowest TG level was 68 mg/dl in age groups 5 and 96 mg/dl in age group 2. Conversely, the maximal TG level in age group 2 was 505 mg/dl, suggesting possible unique dyslipidemia patterns in this group. The lowest HDL level was approximately 20 mg/dl in age groups 1 and 4, while the highest HDL level was 73 mg/dl in age group 1 (Fig. 3). This variability may indicate differences in cardiovascular risk profiles across age groups, emphasizing the need for targeted lipid management strategies in hypertensive patients.

The study showed that females in the age group of 50 to 59 years had a higher abnormal rate of cholesterol, TG, HDL, and LDL compared to males. Conversely, in the age group of 30 to 39 years, males had a significantly higher abnormal TG rate compared to females. Additionally, indicators such as cholesterol, fasting glucose, TG, LDL increased with higher grades of hypertension, aligning with findings from recent clinical and epidemiological studies [33–35]. The study showed that hypertensive males had higher rates of obesity, abnormal TG levels, and abnormal HDL levels compared to hypertensive females. On the other hand, females had higher rates of overweight and abnormal fasting blood glucose levels compared to males. It is worth noting that females also showed higher rates of abnormal cholesterol and abnormal LDL levels compared to males. These results were consistent with those reported in the previous hypertension study [33].

Our study found a strong association between hypertension and obesity, elevated fasting glucose, and dyslipidemia, similar to findings in European, American, and Asian cohorts. Studies from Western countries consistently report obesity as a key contributor to hypertension [36–38]. Likewise, Asian studies, including those from China and Japan, emphasize the role of metabolic syndrome and diabetes mellitus in hypertension development [39]. However, the prevalence of metabolic disorders in Middle Eastern populations, including Iraq, appears to be increasing due to dietary shifts towards high-calorie processed foods and sedentary lifestyles, a trend also seen in Gulf countries [40, 41].

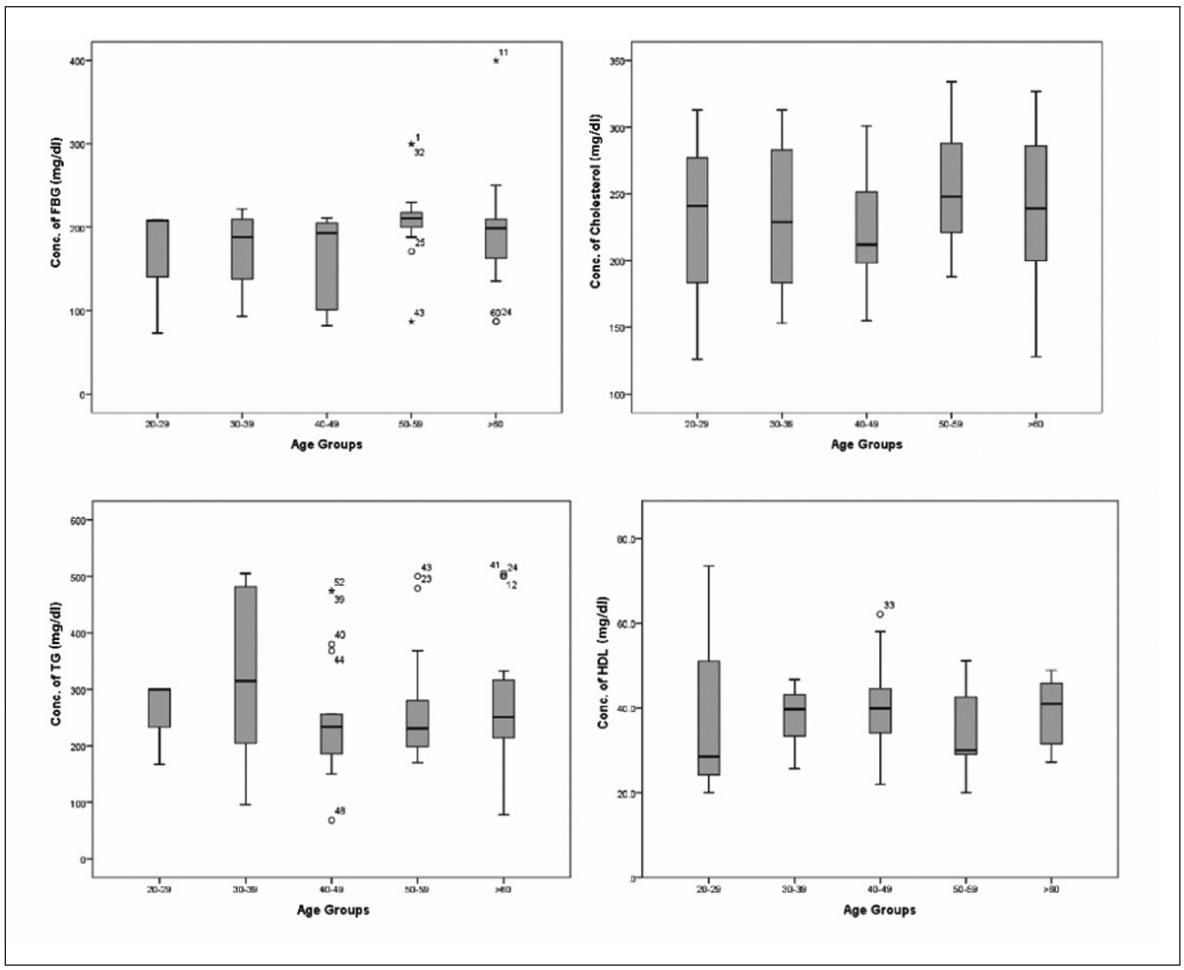

Figure 3. The concentration of fasting blood glucose, cholesterol, triglyceride and high-density lipoprotein levels across different age groups in hypertensive individuals (p < 0,05)

Note: FBG — fasting blood glucose; TG — triglycerides; HDL — high-density lipoproteins.

Conclusion

Our study indicates a strong association between hypertension and factors such as age, gender, body mass index, blood glucose levels, blood cholesterol levels (including TG and LDL). These factors are crucial in understanding and addressing the prevalence and management of hypertension within the examined population. The results highlight the increasing public health challenge of Non-Communicable Diseases (NCDs), specifically hypertension, in Najaf as a significant public health concern. However, further community-based and statistical studies are necessary to determine the extent of this problem and identify risk factors for hypertension in other communities within Najaf. Interventions aimed at reducing the identified risk factors are essential and should target both the high-risk individuals and the general population. By implementing such interventions, we can effectively reduce the risk and prevalence of hypertension in the community.

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Conflict of interest / Конфликт интересов

Author declares no conflict of interest. / Автор заявил об отсутствии конфликта интересов.

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