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Risk factors of hypertension in Basra governorate-Iraq

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Abstract
Background: Hypertension is a complicated condition which impacts millions of humans globally. Dyslipidemia is the most common risk factors for hypertension, where elevated concentration of total cholesterol and other lipids in the blood help to the advancement of hypertension. Moreover, there are main roles of minerals and trace elements in the development of hypertension. These minerals and trace elements play important functions in different physiological processes, involving maintaining of blood pressure.
Aim of this study: To examine the relationship among blood pressure, dyslipidemia, minerals and trace elements, as well as to discover the primary risk factors of hypertension in population of Basra city.
Results: This study revealed that hypertensive patients with age group (70-89 years) more than another age groups, and in obese more than over and normal weight, and in smokers higher than non-smokers with significant differences ($p < 0.05$).
Levels Total cholesterol, triglycerides, LDL, and VLDL in hypertension group higher than normotension group, in contrast to levels of HDL in hypertension group less than normotension group, with statistical differences ($p < 0.05$).
Sodium, chloride, calcium, phosphorous, and copper concentrations in hypertensive patients higher than normotensive individuals, while potassium, magnesium and zinc in hypertensive patients lower than normotensive people, with significant differences ($p < 0.05$). Iron level show non-significant difference ($p > 0.05$) between hypertension group and health control group.
Conclusion: The evidence found in the current study indicates that dyslipidemia and disturbances of minerals and trace elements act as the main risk factors for hypertension.

Keywords: Hypertension, dyslipidemia, blood pressure

Introduction

Hypertension is a common chronic disorder which impact millions of people globally and is the primary cause of premature death. The early identification and prediction of hypertension are essential for properly controlling and avoiding of hypertension-related problems [1].

Aging causes circulatory modification, which contribute to an ever-developing pandemic of hypertension. Changes in main artery architecture are manifested initially by a decrease in aortic distensibility and a rise diastolic blood pressure, subsequently accompanied by a significant rise in systolic blood pressure, after a sixth decade. Furthermore, the incidence of salt-sensitive hypertension rise with the age [2].

Smoking is a factor causes functional and initial temporary damage primarily of the endothelium, as well as decreased tolerance for physical testing because of the actions of nicotine and carbon monoxide and consequently lead to hypertension [3].

Recent study has indicated that an increase of BMI is a risk factor for dyslipidemia and hypertension. Moreover, dyslipidemia is common in hypertensive patients, and increased blood concentration of total cholesterol, triglycerides, LDL, and VLDL are all linked with a high risk of hypertension [4].

Sodium-induced hypertension caused by disturbance of sodium in the renin angiotensin aldosterone system (RAAS), an increase in sympathetic activation and an abnormal vascular resistance action. Consumption excessive amount of salt causes sodium buildup, which rise the volume of blood, blood circulation, and heartbeat. The vascular bed increases systemic blood circulation resistance via regulation by itself, forcing the kidneys to remove greater salt

and water, hence preserving water and sodium balance and minimizing sodium shift [5]. Conversely, Excessive potassium intake can reduce the resistance of the kidney vascular system by lowering oxidative damage in endothelial cells of the vascular system and proliferation of smooth muscle. Furthermore, an excessive potassium intake may lead to sodium-chloride cotransporter in the distal convoluted tubule to diminish reabsorption of sodium [6]. These include the identified pathological ways of sodium and potassium on hypertension.
Levels of chloride are one of the factors which contribute to hypertension, recent findings indicate that chloride may have a substantial impact on the regulation of blood pressure in conjunction with sodium [7, 8]. Elevated serum levels of calcium have been correlated with a heightened incidence of hypertension [9].
High levels of blood phosphorus have been scientifically associated with hypertension and an elevated risk of mortality, particularly in individuals with hypertension. studies have demonstrated that the combined impact of hypertension and elevated serum phosphorus significantly influences cardiovascular mortality, underscoring the necessity of regulating phosphorus levels in hypertensive patients. Likewise, dietary phosphorus intake, particularly through supplementary sources, has been related with hypertension, revealing a possible modification in the association between consumption of phosphorous and blood pressure according to the kind of phosphorus [10, 11].
Various studies have demonstrated that magnesium is crucial in the treatment of hypertension. Magnesium deficiency has been attributed to the development of a number of disorders, involving cardiovascular problems and hypertension. It controls blood pressure through raising vasodilation and reducing vasoconstrictors, which has an impact on hypertension. Serum magnesium levels and systolic blood pressure have been reported to be closely related in individuals having hypertensive crises, indicating that magnesium may play a role the regulating blood pressure. The senior people, which are more sensitive to magnesium shortages, is at a greater risk of hypertension and its related issues, emphasizing the importance of adequate intake of magnesium, whether it come from supplements or food sources, in preventing hypertension. Consuming magnesium-rich meals along with avoiding processed foods can help maintain typical magnesium levels, possibly reducing the risk of hypertension [2, 12-14].
Hypertension seems to be associated with increased levels of copper and iron, while some researches have revealed an inverse relationship between zinc concentrations and hypertension [15, 16]. Pregnant women's serum copper, zinc, and iron levels have been linked to hypertensive diseases like preeclampsia [17]. Those with preeclampsia, in particular, have greater copper and iron levels and lower zinc levels compared to individuals without the condition. Furthermore, a study of people with high blood pressure indicated greater levels of copper and iron, exhibiting that these trace metals may have a role in worsening hypertension. Nevertheless, an examination conducted on adults in the United States did not identify a significant autonomous connection between copper, zinc, and hypertension [18]. These results collectively underscore the intricate interaction between copper, zinc, iron, and hypertension, underscoring the necessity for further research to clarify their specific roles in hypertensive conditions.

Materials and Methods

Design of the study

In this study's cross-sectional design, a total of three hundred blood specimens were collected, divided into hypertension and normotension, with an equivalent number (150) for each category. The hypertension group comprised males (75) and females (75), and the normotension group included 75 subjects for each sex.
All participants in the study were in the age range of 30-89 years, and the patients who attended the outpatient clinic of Basra Technical Hospital in Basra Governorate were newly diagnosed with hypertension, from September 4, 2023 to January 9, 2024.
Following the ethical committee approval, all study participants granted their consent. The blood pressure was determined with a mercury sphygmomanometer (Diamond Deluxe BP device, Pune, India), in a seated position in the right arm, utilizing both palpatory and auscultatory procedures. The mean of the three different recordings was calculated. A questionnaire was employed to evaluate each patient alone, covering fundamental data, smoking habits, and exclusion criteria. Body mass index (BMI) was calculated for measured weight and height for every participant.

Exclusion criteria: patients with stroke, diabetes mellitus, cardiovascular diseases, and renal diseases were excluded.

Specimen collection

Venipuncture was the method used to obtain five cubic centimeters of venous blood from every fasting (for 12-14 hours) person, and then transferred into gel tube, which was subsequently coagulated for thirty minutes at room temperature. The serum was obtained by whirling the gel tube at three thousand rotation per minute in rotary centrifuge for a period of fifteen minutes. Lipid profile, minerals, and trace elements were measured directly in the laboratory.

Analysis of biochemical tests

Concentrations of the lipids (total cholesterol, triglycerides, and HDL), minerals (sodium, potassium, chloride, calcium, phosphorus, and magnesium), and trace elements (zinc, copper, and iron) were measured spectrophotometrically by full automation biochemistry analyzer (spin120, spinreact company) used correspond reagents for each test (spinreact reagent kit).

LDL was determined cross used the following formula

LDL = total cholesterol - (HDL + VLDL), while VLDL was calculated by triglycerides/5. BMI was calculated as weight (Kg)/height (m^2).

Analysis of Data

Analysis of data were carried out using SPSS version 26. Data were presented as percentage, mean and standard deviation. P values less than 0.05 were regarded as statistically significant, whereas, P values < 0.001 were considered as a highly significant different.

Results

Table 1 shows the equivalent number of both sexes with no significant differences (P = 1.0000) between healthy control and the patient group in two sexes. As well, the majority of people with hypertension had 69 (74.2%) in the 70-89 year, more than in the 50-69 year, 60 (56%), and in the 30-49 year, 21 (21%), with significant differences (P = 0.002) between the normotensive group and the hypertensive group in three age groups. As stated by BMI, this table showed that among patients who had hypertension, 73 (59.3%) were obese, 69 (58%) were overweight, and 8 (13.8%) were normal weight. Compared to the healthy control groups, obese, overweight, and normal weight were 50 (40.7%), 50 (42%), and 50 (86.2%), respectively. According to smoking, among patients who had hypertension, 118 (100%) were smokers compared to 32 (17.6%) of non-smokers, while the healthy control group were all non-smokers.

Table 1: Distribution of Study Groups According to Basic Demographic Data

Demographic Data			Normotension	Hypertension	Total	Sig. test
Sex	Male	No	75	75	150	X^2=0.0 P = 1.000
		%	50%	50%	100%	
	Female	No	75	75	150	
		%	50%	50%	100%	
Age (years)	49-30	No	79	21	100	X^2=12.14 P=0.002
		%	79%	21%	100%	
	69-50	No	47	60	107	
		%	44%	56%	100%	
	89-70	No	24	69	93	
		%	25.8%	74.2%	100%	
BMI (Kg/m$^{2)}$	Normal weight	No	50	8	58	X^2=12.11 P=0.02
		%	%86.2	13.8%	100%	
	Overweight	No	50	69	119	
		%	%42	58%	100%	
	Obese	No	50	73	123	
		%	40.7%	59.3%	100%	
Smoking	Yes	No	0	118	118	X^2=14.2 P=0.000
		%	0%	100%	100%	
	No	No	150	32	182	
		%	82.4%	17.6%	100%	

Table 2 represents the mean± std. values of systolic blood pressure (SBP) and diastolic blood pressure (DBP) for hypertension patients, which were 151.92±3.03 mmHg and 96.41±4.11 mmHg, respectively, compared to the mean± std. values of SBP and DBP of the healthy control group, which were 115.86±2.91 and 77.78±2.34 respectively. These results clearly indicate that the mean ± std values in patients were significantly higher than in healthy control subjects (P = 0.000, *p*<0.001).

Table 2: Comparison between Study Groups with Blood Pressure

Blood pressure	Study groups	Mean ± std	P. value
Systolic blood pressure (mmHg)	Normotension (150)	115.86 1±2.91	P=0.000
	Hypertension (150)	151.92± 3.03	
Diastolic blood pressure (mmHg)	Normotension (150)	77.78±2.34	P=0.000
	Hypertension (150)	96.41±4.11	

Table 3 showed that the total cholesterol (mg/dl) for the patient with hypertension (212.52±33.68) was higher than that for those with normotension (159.74±43.93) and that there was a significant difference between them (p = 0.001). As well, the mean± std. of triglycerides (mg/dl) for the hypertension group was 192.7±28.85, more than that for normotension group, it was 149.13±10.01, with a significant difference between them (P = 0.001). Conversely, the result of HDL (mg/dl) levels for hypertension patients, it was 31.2±4.51 less than that normotension subjects 45.5±3.23 with significantly difference (P=0.003). However, the result of LDL (mg/dl) levels hypertension patients, it was 147.12±6.32 above than that normotension subjects, it was 109.56±4.05 with a significant different (P=0.002). In addition, VLDL results for hypertension and normotension groups were 38.54±5.77 and 29.95±2.0 respectively with significantly difference (P=0.003). These findings highlight the importance of addressing hypertension in healthcare.

Table 3: Lipid Profile Comparison between the Two Study Groups

Parameters	Study groups	Mean ± std	P. value
Total cholesterol (mg/dl)	Normotension (150)	159.74±43.93	P=0.001
	Hypertension (150)	212.52±33.68	
Triglycerides (mg/dl)	Normotension (150)	149.13±10.01	P=0.001
	Hypertension (150)	192.7±28.85	
HDL (mg/dl)	Normotension (150)	45.5±3.23	P=0.003
	Hypertension (150)	31.2±4.51	
LDL (mg/dl)	Normotension (150)	109.56±4.05	P=0.002
	Hypertension (150)	147.12±6.32	
VLDL (mg/dl)	Normotension (150)	29.95±2.0	P=0.003
	Hypertension (150)	38.54±5.77	

Table 4 revealed that the results of Na^+, K^+, and Cl^- levels showed significant statistical differences ($p<0.05$) in comparison between hypertension and normotension groups. Na^+ (mEq/L) and Cl^- (mEq/L) blood levels in hypertensive patients were 147.52±3.68 and 106.23±1.15, respectively, more than those in healthy participants, 139.16±2.21 and 98.41±2.03, respectively, whereas the K^+ (mEq/L) level in patients with hypertension was 3.54±0.11 lower than that of control subjects, 3.88±0.42. In addition, results of Ca^+, PO4, and Mg^{++} levels showed highly significant differences ($p<0.001$) in comparison between hypertension and normotension groups. Ca^+ (mg/dl) and $PO4^-$ (mg/dl) values in the blood of hypertensive patients were 10.12±0.50 and 4.91±0.89, respectively, more than those of control participants (8.86±0.32 and 3.68±0.22, respectively). In contrast to the mean ± std of Mg^{++} (mg/dl) value in the hypertension group, it was 1.02±0.07, higher than the healthy control group, 2.08±0.91.

Table 4: Mineral-Based Study Group Comparison

Parameters	Study groups	Mean ± std	P. value
Sodium (mEq/L)	Normotension (150)	139.16±2.21	P=0.001
	Hypertension (150)	147.52±3.68	
Potassium (mEq/L)	Normotension (150)	3.88±0.42	P=0.03
	Hypertension (150)	3.54±0.11	
Chloride (mEq/L)	Normotension (150)	98.41±2.03	P=0.01
	Hypertension (150)	106.23±1.15	
Calcium (mg/dl)	Normotension (150)	8.86±0.32	P=0.000
	Hypertension (150)	10.12±0.50	
Phosphorus (mg/dl)	Normotension (150)	3.68±0.22	P=0.000
	Hypertension (150)	4.91±0.89	
Magnesium (mg/dl)	Normotension (150)	2.08±0.91	P=0.000
	Hypertension (150)	1.02±0.07	

Table 5 demonstrated that results were obtained of Zn in the hypertensive patients (56.80±5.37) lower than those in the normal participants (93.80±9.63) with highly significant difference ($p<0.001$), in contrast to Cu level in those with hypertension more than individuals in good health (114.80±11.40) with statistical difference ($p<0.05$). Otherwise, there was a non-significant difference (P = 0.7) in serum Fe levels in hypertension (94.03±11.95) in comparison to normotension (93.65±12.63).

Table 5: Study Group Comparison Based on Trace Elements

Parameters	Study groups	Mean ± std	P. value
Zinc (µg/dl)	Normotension (150)	93.80±9.63	P=0.000
	Hypertension (150)	56.80±5.37	
Copper (µg/dl)	Normotension (150)	114.80±11.40	P=0.02
	Hypertension (150)	124.92±10.51	
Iron (µg/dl)	Normotension (150)	93.65±12.63	P=0.7
	Hypertension (150)	94.03±11.95	

Discussion

Table 1 summarizes that an equal number of both sexes were selected in study groups to avoid the effect of physiological hormonal changes between sexes. According to the study, more people in the 50-69 year age range than in any other age group had hypertension. This result is agreement with the previous study, it present that more than half hypertensive patients at the age over sixty years [19]. It's probable that a decline in artery flexibility led to the development of hypertension in elderly adults. Furthermore, this study evaluated BMI and smoking as other important risk factors for hypertension, in which hypertension developed more in obese people than in overweight and normal people. As a result of other studies, it was found that obesity and smoking have the highest prevalence of hypertension [20-22].

The results in table 2 express the diagnosis of hypertension, which is based on major guidelines that recommend that hypertension be diagnosed. A patient is diagnosed with hypertension if their repeated assessment results in a diastolic blood pressure (DBP) of at least 90 mm Hg or a systolic blood pressure (SBP) of at least 140 mm Hg when they are at rest [23].

The results in the table 3 showed that increased the levels of total cholesterol, triglycerides, LDL and VLDL in the patients had hypertension than the individuals had normotension. This difference was statistically significant. However, HDL level in the hypertensive patients less than normotension peoples, and also the difference was statistically significant. These findings are compatible with the previous study in Nineveh province of Iraqi persons [24].

The entry of circulating low-density lipoprotein cholesterol (LDL) into the subendothelial space and the activation of endothelium that causes the recruitment of monocytes, which develop into macrophages and ingest the LDL to form foam cells, is the main mechanism in hypercholesterolemia that causes atherosclerosis [25]. It is unclear how high triglyceridemia and hypertension are related, although it is thought that high triglyceridemia may interfere with vasodilation processes, which could raise vascular resistance and cause hypertension. Small, dense LDL is formed when triglyceride levels are high. This kind of LDL is especially prone to oxidation, which can result in oxidized small dense LDL (ox-LDL). It has been shown that these ox-LDL particles cause endothelial dysfunction by reducing the generation and/or activity of endothelial nitric oxide [26]. It follows that hypertriglyceridemia may affect vasodilation pathways apart from low-density lipoproteins. Furthermore, it has been demonstrated that the breakdown of triglycerides in adipose tissues results in the generation of non-esterified fatty acids, which have been proven to impair endothelial function by inhibiting endothelium-dependent hyperpolarization, a potent vasodilator in small resistance [26].

The study finding in the table 4 increased blood levels of Na^+, Cl^-, Ca^+ and $PO4^-$, in hypertensive patients than normal control subjects whereas K^+ and Mg^{++} decreased in hypertensive patients than health subject. This results partially disagreement with Nigerian study by (Giasuddin, 1991) who found that normal serum levels of Na^+ and Cl^- and elevated of K^+ and Mg^{++} in hypertensive patients than control participants [27]. It's probable that a lack of knowledge is the root cause of the unfavorable attitudes among the participants in this study about the significance of reducing salt (NaCl) intake. The result of K^+ coincide with previous study, demonstrated that K^+ supplementation is assistant to lower level of systolic blood pressure [28]. A high serum $PO4^-$ level may have the effect of stimulating the renin-angiotensin-aldosterone system more than usual, which could lead to the development of hypertension [29].

The result of Ca^+ in the current study is different from the Indian study by Salonee, *et al*. (2022), who found a decrease in serum concentration of Ca^+ in women with gestational hypertension compared to the women with normal blood pressure. Although the finding of Mg^{++} level in this study is in agreement with the same study, they present a low serum level of Mg^{++} in hypertensive gestational females in comparison to normotensive females [30]. This difference in calcium result may be due to the increased demand for calcium by the fetus, which led to a low level of it. Mg^{++} regulates blood pressure by modulating vascular smooth muscle tone and contractility through the management of Ca^{+} ion concentrations and availability. It is not directly engaged in the control of vascular smooth muscle cell contraction processes. As a result, the calcium level of smooth muscle increases if Mg^{++} levels decrease [2].

Results of trace elements in table 5 showed increased serum Zn but decreased Cu levels in hypertensive patients compared with normotensive individuals and non-statistical different of serum Fe level in comparison between two study groups. Zhengduo Z., *et al*. 2022, who found that serum concentrations of Zn, Cu, and Fe in hypertensive patients higher than normal participants [31]. However, this study disagreement with previous study in Valladolid, Spain that present non-significant difference between normal and hypertensive patients [32]. It is possible that other causes of hypertension in Spain community as a result of intake daily dose of supplements which is different in Iraqi community which is not usually intake supplements. Over seventy enzymes require zinc, such as superoxide dismutase and glutathione peroxidase, which are cofactors of Cu-Zn superoxide dismutase. Ischemic heart disease may be affected by zinc. Because of the antagonistic link between increased zinc consumption and copper absorption, taking zinc supplements reduces Cu-Zn superoxide dismutase activity [33].

Conclusion

A recent study shows that smoking, obesity, and aging are the key risk factors for hypertension in humans. A further risk factor for hypertension is dyslipidemia, which is defined as high levels of LDL, VLDL, triglycerides, and total cholesterol along with low levels of HDL. In addition, abnormalities in trace elements (insufficient Zn and elevated Cu) and minerals (high Na^{+}, Cl^{-}, Ca^{+}, and $PO4^{-}$ and low K^{+} and Mg^{++} values) are the primary risk factors for hypertension in the Basra city population of Iraq.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Competing Interests

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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