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Prevalence of Hypertension Risk Factors Among Young Female Students of Umm Al-Qura University, Makkah, Saudi Arabia: A Cross-Sectional Study

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Abstract **Background:** Conditions concerning high blood pressure create substantial health risks both worldwide and within the Gulf nations because of accelerated changes in lifestyles and expanding young demographic statistics. **Objective:** The current cross-sectional research evaluated hypertension frequency in Saudi Arabian girls along with its relationship between obesity factors and cholesterol levels. **Methods:** Researchers obtained data from 120 young Saudi females between the ages of 18-25 years who were students at Umm Al-Qura University in Makkah. The study evaluated blood pressure levels and body mass index alongside waist circumference and waist-hip ratio and fasting blood glucose and lipid profile including HDL, LDL and TC among young Saudi female subjects. **Results:** The data showed that 41.7% of participants maintained normal blood pressure levels yet stage 2 hypertension affected 18.3% of the sample size. Additionally 30.8% experienced stage 1 hypertension and 9.2% had elevated BP. Statistical research showed hypertension related significantly to WC ($p = 0.007$) and WHR ($p = 0.020$) measurements though BMI, FBG, HDL, LDL and TC did not demonstrate statistical significance. **Conclusion:** Young Saudi female subjects showed waist-hip ratio (WHR) and WC as important indicators for hypertension development. The research shows that preventive approaches along with lifestyle changes need to be directed specifically toward developing populations. Further multi-centered studies are warranted.

Key Words Hypertension, Young Female Students, Obesity Indicators, Waist-Hip Ratio (WHR), Saudi Arabia, Blood Pressure

INTRODUCTION

Hypertension is an important cause of several critical diseases including cardiovascular, neurological and renal diseases [1]. Over the last few decades, epidemiological investigations have revealed a consistent and independent link between hypertension and coronary heart disease events which is a major cause of death worldwide [2,3].

Hypertension affects about 1.1 billion people globally, with higher prevalence in middle- and low-income countries where about two-thirds of the patients live. It is estimated that about 77% of adults with a first stroke, 74% of adults with Heart failure and 69% of adults with a first myocardial infarction are having hypertension. Moreover, according to the data from the World Health Organization (WHO), hypertension is the leading cause of death for 51% of stroke patients and 45% of cardiovascular disease patients [4,5].

Unfortunately, hypertension not only affects the old adult population but also affects children and young adults and its incidence among them increases rapidly [6,7]. Its increased incidence rate among children and young is estimated to be about 30% and it is attributed to the high rate of obesity and the low rate of physical activity among them globally [4].

Hypertension is a type of medical disease that cannot be cured but only be managed or modified through using antihypertensive drugs, especially in the early stages [8]. The management and treatment of hypertension is considered a

major health and economic challenge due to its treatment cost and its possible future health consequences. The incidence of hypertension is increasing globally due to several risk factors such as the increase in the aging population and the spreading of the bad lifestyle including unhealthy diets and low physical activity [9].

In Saudi Arabia the incidence of hypertension increases rapidly in the last few years. Several risk factors may contribute to that increase in hypertension incidence rate in Saudi Arabia such as sex, age, obesity ,familial history and others [8].

Several studies could confirm the possibility to modify some of these risk factors which give hopes to control or even prevent hypertension [8,10].

Hypertension should be managed and controlled as soon as it is confirmed to prevent or decrease its complications. The treatment of hypertension depends on two main pillars, the first is the non- pharmacological treatment which include lifestyle modification and stopping many bad habits as high fat diet and smoking. The second pillar is the pharmacological treatment which should be suitable for the patient hypertension stage, age and comorbidity [11].

The present study aims to investigate the incidence of hypertension among young Saudi females and evaluate the effect of Body Mass Index (BMI), Waist Circumference (WC), waist-hip ratio, blood lipid profile and Fasting Blood Glucose (FBG) on the capability of controlling the hypertension condition and its complication among female patients.

The evolving food choices, inactive lifestyle and societal changes that mostly impact Saudi Arabian young female populations have led to an uptick in non-communicable diseases and hypertension prevalence. Modern health risks now challenge Saudi youth due to their combination of rising fast food consumption and minimal structured physical education access and increasing digital screen time.

This research decision specifically targeted young female university students since very few studies had previously studied this demographic. Female youth participate in specific health behaviors and encounter gender-specific challenges because of how they interact with their lifestyle and how aware they are about their health. Research conducted early in this population would help public health services create strategies for planning effective interventions. The present study aims to investigate the prevalence of hypertension among young Saudi females and examine the associations between BP status and various risk factors including BMI, WC, WHR, lipid profile and FBG.

METHODS

Subject and Study Design

This is a cross-sectional study aimed to investigate the hypertension incidence among young Saudi females and evaluate the impact of BMI, waist circumference, waist hip ratio, lipid profile and fasting blood glucose on the capability of controlling the hypertension condition and its complication among female patients. 120 healthy Saudi female students at Umm Al Qura University Makkah, Saudi Arabia, who attended in May 2022 was enrolled in this study with age ranged from 18 to 25 years. Women who were pregnant, lactating, or who were using antihypertensive medication were excluded from the study. Each participant in this study was given the opportunity to sign a consent form and to withdraw from the study at any time.

Ethical Approval

This study was approved by the researcher ethic committee at faculty of Medicine at Umm Al Qura University No. (HAPO-02-K-012-2022-05-1077).

Lab and Investigations

All participants underwent a (BMI), Waist Circumference (WC), waist hip ratio, lipid profile and fasting blood glucose measurements.

The research omitted hypertensive patients from participation but did control for pregnancy and lactation factors while it did not measure lifestyle elements including diet and exercise along with sleep quality and stress levels. The research team cannot properly measure behavioral confounders because of this exclusion. The investigation would be strengthened if future studies conducted research on additional lifestyle and environmental risk elements to build a more extensive analytical framework.

Blood Pressure Measurement

All participants' BP will be measured using a (Automatic digital blood Co, China) device. BP was measured at each visit using a standard measurement method. Hypertension was defined as (DBP) $\geq$80 mmHg or (SBP) $\geq$130 mmHg. All BP measurements were taken by trained personnel using standardized procedures recommended by the American Heart Association to minimize inter-observer variability and ensure consistency.

Lipid Profile

All participants gave about 2.5 ml of blood samples in a plain tube after at least eight hours fast and measured the following: FBG, LDL, HDL and the TC. (ACCU-CHEK Instant, India) will be used to assess FBG where Human International Co. provided all reagents and kits (Germany) for assessment of total cholesterol. The analysis has been carried out using the fully automated Humastar-200 (Human Diagnostics International Co, Germany) in accordance with the established procedures and manufacturer's instructions.

Anthropometric Parameters

Anthropometric parameters of each participant. Inbody 570 (Korea) will be used to evaluate several factors including WC, weight (kg), height (cm) and BMI.

Statistical Analysis

Statistical processing took place through SPSS software version 26 developed by IBM in New York USA. The Shapiro-Wilk test checked distribution normality in this study while Levene's test evaluated homogeneity of variances. The researchers displayed continuous data values as Mean±standard deviation (SD) while categorical data appeared through frequencies and percentages. Statistical analysis of hypertension categories and risk factors relationships occurred through Chi-square (χ^2) tests. The study used a p-value less than 0.05 to determine statistical significance. Further research should add effect sizes and confidence intervals to analysis because they help understand the force of relationship connections.

RESULTS

A total of 120 female students participated in this study, with a mean age of 21.03±1.51 years. Blood Pressure (BP) was categorized according to the five classifications defined by the American Heart Association (AHA): normal BP (SBP<120 mmHg and DBP<80 mmHg), elevated BP (SBP 120-129 mmHg and DBP<80 mmHg), stage 1 hypertension (SBP 130-139 mmHg and DBP 80-89 mmHg), stage 2 hypertension (SBP ≥140 mmHg and DBP ≥90 mmHg) and hypertensive crisis (SBP>180 mmHg and DBP>120 mmHg). In this study, no participants were classified as having a hypertensive crisis. Among the 120 students, 50 (41.7%) had normal BP, 11 (9.2%) had elevated BP, 37 (30.8%) were classified as having stage 1 hypertension and 22 (18.3%) had stage 2 hypertension. These findings are summarized in Table 1.

Table 1: Hypertension categories

		Frequency	Percent
Valid	Normal	50	41.7
	Elevated	11	9.2
	Hypertension Stage 1	37	30.8
	Hypertension Stage 2	22	18.3
	Total	120	100.0

Table 2: Fasting Blood Sugar (FBS) levels and hypertension categories

Hypertension	Normal FBS	High FBS	Total	p-value
Normal	48	2	50	0.286
Elevated	11	0	11	
Hypertension stage 1	32	5	37	
Hypertension stage 2	20	2	22	
Total	111	9	120	

Fasting Blood Glucose (FBG)

According to the American diabetes association normal FBG level is considered less than 100 mg/dl. Accordingly FBG of more than 100 mg/dl is labelled as high FBG in our study. Two out of 50 normal hypertensive participants had shown high FBS, while in the elevated hypertension group 11 participants, no one has shown high FBS. Five participants had shown high FBS from the 37 hypertensive stage 1 participants. Only two had shown high FBS from the 22 hypertensive stage 2 participants with a total of nine high FBS among 120 participants as shown in Table 2.

There was no statistical significance on the effect of elevated FBS as a risk factor on hypertension (p = 0.286).

Body Mass Index (BMI)

In this study, BMI was classified according to the World Health Organization (WHO) classification into four categories: underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2) and obese (≥30 kg/m^2).

A total of 27 participants (22.5%) were classified as underweight. Among them, 16 participants (13.3%) were normotensive, nine (7.5%) had stage 1 hypertension and two (1.7%) had stage 2 hypertension. The normal BMI category included 63 participants (52.5%), with 24 (20%) being normotensive, nine (7.5%) having elevated blood pressure, 19 (15.8%) classified as stage 1 hypertensive and 11 (9.2%) classified as stage 2 hypertensive. The percentage of normotensive individuals among underweight and normal BMI students was higher than that of hypertensive individuals within the same BMI categories.

The overweight BMI category included 15 participants (12.5%). Among them, four (3.3%) were normotensive, one (0.8%) had elevated blood pressure, seven (5.8%) were classified as stage 1 hypertensive and three (2.5%) as stage 2 hypertensive. Similarly, the obese BMI category also consisted of 15 participants (12.5%), with six (5%) being normotensive, one (0.8%) having elevated blood pressure, two (1.7%) classified as stage 1 hypertensive and six (5%) classified as stage 2 hypertensive. Overall, the percentage of individuals with elevated blood pressure and hypertension was higher among overweight and obese participants compared to their normotensive counterparts. These findings are summarized in Table 3. Despite the fact that increased BMI is a well-known risk factor of hypertension, it appears that it is not in our study as there is no statistical significance (p-value = 0.069).

High Density Lipoproteins (HDL)

According to WHO normal HDL for Women aged 20 or older. In our study, HDL is considered normal as it is more than 50 mg/dl. 111 participants (92.5%) had normal HDL, 47 participants (39.5%) out of them were normotensive, ten participants (8.3%) had elevated blood pressure, 35 participants (29.2 %) were hypertension stage 1 and 19 participants (15.8%) were hypertension stage 2. Low level HDL were nine participants (7.5%) ,Three participants (2.5%)

Table 3: Relationship between BMI and hypertension

BMI classes	Normal BP	Elevated BP	Hypertension stage 1	Hypertension stage 2	Total	p-value
Underweight	16 (13.3%)	0 (0.0%)	9 (7.5%)	2 (1.7%)	27 (22.5%)	0.069
Normal	24 (20.0%)	9 (7.5%)	19 (15.8%)	11 (9.2%)	63 (52.5%)	
Overweight	4 (3.3%)	1 (0.8%)	7 (5.8%)	3 (2.5%)	15 (12.5%)	
Obese	6 (5.0%)	1 (0.8%)	2 (1.7%)	6 (5.0%)	15 (12.5%)	
Total	50 (41.7%)	11 (9.2%)	37 (30.8%)	22 (18.3%)	120 (100%)	

Table 4: Relationship between HDL classes and hypertension

HDL classes	Normal BP	Elevated BP	Hypertension stage 1	Hypertension stage 2	Total	p-value
Normal	47 (39.2%)	10 (8.3%)	35 (29.2%)	19 (15.8%)	111 (92.5%)	0.653
Low	3 (2.5%)	1 (0.8%)	2 (1.7%)	3 (2.5%)	9 (7.5%)	
Total	50 (41.7%)	11 (9.2%)	37 (30.8%)	22 (18.3%)	120 (100%)	

Table 5: Relationship between LDL and hypertension

LDL classes	Normal BP	Elevated BP	Hypertension stage 1	Hypertension stage 2	Total	p-value
Normal	46 (38.3%)	11 (9.2%)	35 (29.2%)	20 (16.7%)	112 (93.3%)	0.746
Borderline	4 (3.3%)	0 (0.0%)	2 (1.7%)	2 (1.7%)	8 (6.7%)	
Total	50 (41.7%)	11 (9.2%)	37 (30.8%)	22 (18.3%)	120 (100%)	

Table 6: Relationship between cholesterol levels and hypertension

Cholesterol levels	Normal BP	Elevated BP	Hypertension stage 1	Hypertension stage 2	Total	p-value
Normal	50 (41.7%)	11 (9.2%)	37 (30.8%)	21 (17.5%)	119 (99.2%)	0.213
Borderline	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.8%)	1 (0.8%)	
Total	50 (41.7%)	11 (9.2%)	37 (30.8%)	22 (18.3%)	120 (100%)	

Table 7: Relationship between waist circumference and hypertension

Waist circumference	Normal BP	Elevated BP	Hypertension stage 1	Hypertension stage 2	p-value
Normal	47 (39.2%)	9 (7.5%)	33 (27.5%)	14 (11.7%)	0.007
High	3 (2.5%)	2 (1.7%)	4 (3.3%)	8 (6.7%)	
Total	50 (41.7%)	11 (9.2%)	37 (30.8%)	22 (18.3%)	

were normotensive, one participant (0.8%) had elevated blood pressure, two participants (1.7%) had hypertension stage 1 and three participants (2.5%) had hypertension stage 2, as shown in Table 4.

Low Density Lipoproteins (LDL)

According to the Centers for Disease Control and Prevention (CDC), an optimal LDL level is below 100 mg/dL, while levels above this threshold are considered borderline. In the present study, 112 participants (93.3%) had normal LDL levels, whereas eight participants (6.7%) had borderline LDL levels, as shown in Table 5. There was no statistically significant association between LDL levels and hypertension categories (p = 0.746).

Total Cholesterol (TC)

The normal level of TC is 125 to 200 mg/1 d as recommended by WHO. 119 participants (99%) were of normal total cholesterol level. Only one participant (0.8%) was of borderline total cholesterol level as shown in Table 6. There was no statistically significance between cholesterol levels and hypertension categories, (p = 0.213).

Waist Circumference (WC)

Waist Circumference (WC) was classified into normal and high categories. Among the total participants, 103 (85.8%) had a normal WC, while 17 (14.2%) had a high WC.

In the normal WC group, 47 participants (39.2%) were normotensive, nine participants (7.5%) had elevated blood pressure, 33 participants (27.5%) were classified as hypertension stage 1 and 14 participants (11.7%) had hypertension stage 2.

In the high WC group, three participants (2.5%) were normotensive, two participants (1.7%) had elevated blood pressure, four participants (3.3%) had hypertension stage 1 and eight participants (6.7%) had hypertension stage 2, which showed statistically significant association (p = 007) (Table 7).

Waist/Hip Ratio

The Waist-to-Hip Ratio (WHR) was categorized into two groups: high and normal. Among the total participants, 56 (46.7%) had a normal WHR, while 64 (53.3%) had a high WHR. In the high WHR group, 21 participants (17.5%) were normotensive, eight (6.7%) had elevated blood pressure, 18 (15%) were classified as hypertension stage 1 and 17 (14.2%) had hypertension stage 2. In the normal WHR group, 29 participants (24.2%) were normotensive, three (2.5%) had elevated blood pressure, 19 (15.8%) were classified as hypertension stage 1 and five (4.2%) had hypertension stage 2 (Table 8).

There was a statistically significant association between WHR categories and hypertension levels (p = 0.02), indicating that a higher waist-to-hip ratio may be a risk factor for hypertension.

Table 8: Relationship between waist hip ratio and hypertension

Waist/hip ratio classes	Normal BP	Elevated BP	Hypertension stage 1	Hypertension stage 2	p-value
High	21 (17.5%)	8 (6.7%)	18 (15.0%)	17 (14.2%)	0.020
Normal	29 (24.2%)	3 (2.5%)	19 (15.8%)	5 (4.2%)	
Total	50 (41.7%)	11 (9.2%)	37 (30.8%)	22 (18.3%)	

DISCUSSION

The findings of this cross-sectional study revealed that the prevalence of hypertension among young females is approximately 49%, which is relatively high for this age group. According to the updated 2020 guidelines of the American Heart Association (AHA), the study population was classified into four main categories: 41.7% were normotensive, 9.2% had elevated blood pressure, 30.8% were classified as stage 1 hypertensive and 18.3% as stage 2 hypertensive. Our results align with recent studies conducted in Saudi Arabia. A study investigating the prevalence of undiagnosed hypertension in the western region reported that among individuals aged 20-29 years, the prevalence of elevated blood pressure, undiagnosed stage 1 hypertension and undiagnosed stage 2 hypertension was 11.3%, 38.1% and 14.8%, respectively [12]. Similarly, research conducted in Tabuk, Saudi Arabia, found that among individuals aged 18-27 years, the incidence of elevated blood pressure, stage 1 hypertension and stage 2 hypertension was 7.2%, 8% and 4%, respectively [8]. Notably, the same study indicated a significant correlation between advancing age and the progression from elevated blood pressure to hypertensive crisis . Previous reports have also suggested that the peak incidence of hypertensive crises typically occurs between the ages of 40 and 50 in uncontrolled hypertensive patients [13]. In line with this, our study found no cases of hypertensive crisis among young participants. Another study in Al Kharj, Saudi Arabia, by Aldiab et al. examined 1,019 participants, of whom 733 were aged 18-29 years. Their results revealed that 52% were prehypertensive, while only 3.5% were hypertensive, indicating that younger individuals were at considerable risk of developing hypertension [14].

Hypertension is a leading modifiable risk factor for cardiovascular diseases, with obesity-related hypertension being the most prevalent form [15]. However, our study did not find a statistically significant relationship between obesity (as measured by BMI) and hypertension. This contrasts with findings by Aldiab et al., who reported that being overweight posed the highest risk for hypertension and that obesity increased the likelihood of hypertension by 3.5 times [14]. Additionally, Linderman *et al.* [16] demonstrated a positive correlation between BMI and blood pressure, reporting that every 1 kg/m^2 increase in BMI was associated with an increase in blood pressure of approximately 1.3 mmHg in men and 1.4 mmHg in women.

Previous research has established obesity as a cause of high blood pressure but this study failed to detect statistical proof between BMI measurements and hypertension development. The significant relationship between waist measurements and hip size with blood pressure shows that distribution of body fat might be more important than total body weight for hypertension risk assessment in female university students.

The environment of Makkah with its restricted outdoor activity, rising fast food availability and high sedentary behaviors among female youth plays a role in increasing central obesity and hypertension rates. University settings should implement specific health education and lifestyle programs which aim to reduce these emerging health threats. Waist circumference, a well-established predictor of hypertension, showed a significant correlation with high blood pressure in our study. This is consistent with multiple studies that have reported a positive association between WC and hypertension [17,18]. A study from Korea further supported this finding, demonstrating that WC and waist-to-height ratio were strongly associated with hypertension, whereas BMI failed to establish a similar correlation [19]. Additionally, our results identified a significant relationship between waist-to-hip ratio (WHR) and hypertension. This finding aligns with an Iranian study involving 230 females over 30 years of age, which reported that WHR had the strongest correlation with hypertension [20]. Similarly, a Chinese study involving 8940 adults aged 20-74 years found that BMI, WHR and WC were all associated with hypertension, with WC exhibiting the highest correlation [21].

High-Density Lipoproteins (HDL) are widely recognized for their inverse relationship with hypertension [22]. However, the precise role of HDL in blood pressure regulation remains unclear. Our study found no statistically significant association between low HDL levels and hypertension. This finding is in line with previous research by Aldiab et al., which observed that while low HDL levels were more prevalent among prehypertensive and hypertensive individuals, the association was not statistically significant [14]. Another Saudi study found a significant correlation between low HDL and hypertension in men but not in women [23]. Conversely, a two-year study of 200 participants aged 19-32 years reported a significant relationship between HDL levels and hypertension risk [24].

Similarly, our study did not find a significant association between LDL levels and hypertension. It is important to note that 93% of our participants had normal LDL levels and our sample size was relatively small. Previous research has suggested a strong relationship between LDL levels and hypertension severity, disease control and progression to coronary artery disease [25]. Furthermore, obesity-measured by WC and WHR-has been reported to have a positive correlation with both low HDL and high LDL levels, which are themselves associated with hypertension [26].

Hyperlipidemia is a common disorder among women and is a major risk factor for cardiovascular diseases, including stroke, peripheral vascular disease and ischemic heart disease. Several studies have established a significant correlation between hypertension and hyperlipidemia [27]. However, our results align with prior studies that found no significant relationship between cholesterol levels and hypertension [14,28]. Other studies, in contrast, have reported a significant association between total cholesterol, fasting serum triglycerides and hypertension [27].

Hypertension is nearly twice as prevalent in diabetic patients compared to the non-diabetic population [29] and it is widely recognized as the most common comorbidity in individuals with diabetes [30]. While multiple studies have investigated the relationship between diabetes and hypertension, fewer studies have explored the connection between elevated Fasting Blood Glucose (FBG) levels and hypertension in non-diabetic individuals [31]. Our study found no significant association between elevated FBG and hypertension. However, several large-scale studies have identified elevated FBG as an independent risk factor for hypertension development [31,32].

CONCLUSION

This research shows that hypertension affects many university-educated Saudi female students at a young age. Research data demonstrated that blood pressure elevation correlations existed with WC and WHR central obesity indicators requiring early intervention strategies for managing abdominal fat accumulation. Health programs serving university populations should incorporate standardized blood pressure screenings in combination with nutrition education and physical exercise education. Additional research endeavors from multiple centers must evaluate large sample sizes and life choices like diet patterns and stress levels and physical activity participation to establish root causes of high blood pressure among young adults.

Ethical considerations

All participant data were handled with strict confidentiality and anonymized during analysis to protect personal information.

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