

# Prehypertension among young adult females in Dammam, Saudi Arabia

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مقدمات فرط ضغط الدم بين الشابات في الدمام، المملكة العربية السعودية  
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**الخلاصة:** هدفت الدراسة إلى التعرف على معدل انتشار مقدمات فرط ضغط الدم وعوامل الاختطار المترابطة معه بين الشابات في الدمام، في المملكة العربية السعودية، وهي دراسة مستعرضة شملت عينة تتألف من ثلث الطالبات المنتسبات إلى أربع كليات في جامعة الدمام. وقد تمّ تحوّر الشابات من حيث ارتفاع ضغط الدم وعوامل الاختطار القلبية الوعائية المترابطة معه لديهنّ من خلال استبيان يستكمل أثناء المقابلة. وقد قامت الباحثات بقياس الوزن والطول ومحيط الخصر والورك وضغط الدم، واختبارات عشوائية لسكر الدم، وقد أظهرت النتائج أن 13.5% من بين 370 طالبة مصابات بمقدمات فرط ضغط الدم. وأن عامل الاختطار الأكثر شيوعاً للأمراض القلبية الوعائية هو نقص النشاط البدني (53.2%)، يتلوه البدانة وفرط الوزن (29.1%)، وأن 16.3% من الطالبات المصابات بمقدمات فرط ضغط الدم لديهن ثلاثة أو أكثر من عوامل الاختطار، كما أظهر تحليل التحوف اللوجستي أن البدانة وفرط الوزن كان المنبئ الأقوى بمقدمات فرط ضغط الدم. وتدلل هذه الدراسة على الحاجة إلى قياسات روتينية لضغط الدم وتقييم الاختطار لدى الشابات في المملكة العربية السعودية.

**ABSTRACT** The aim of present study was to determine the prevalence of prehypertension and associated risk factors among young adult females in Dammam, Saudi Arabia. A cross-sectional study was conducted on a sample of about one-third of female students enrolled in 4 colleges of the University of Dammam. They were screened for high blood pressure and associated cardiovascular risk factors by an interview questionnaire. Weight and height, waist and hip and blood pressure measurements and random blood glucose testing were done. The results revealed that 13.5% of the 370 students were prehypertensive. The most prevalent risk factor for cardiovascular diseases was physical inactivity (53.2%), followed by overweight/obesity (29.1%); 16.3% of prehypertensive students had 3 or more risk factors. Logistic regression analysis revealed that overweight/obesity was the strongest predictor of prehypertension. Our study indicates a need for routine blood pressure measurements and risk assessment in young adult females in Saudi Arabia.

## Préhypertension chez des jeunes femmes à Dammam (Arabie saoudite)

**RÉSUMÉ** L'objectif de la présente étude était de déterminer la prévalence de la préhypertension et les facteurs de risque associés chez des jeunes femmes à Dammam (Arabie saoudite). Une étude transversale a été menée sur un échantillon d'environ un tiers des étudiantes inscrites dans quatre facultés de l'Université de Dammam. Les étudiantes ont bénéficié d'un dépistage de l'hypertension artérielle. Les facteurs de risque cardio-vasculaire associés ont été recueillis par questionnaire lors d'un entretien. La taille et le poids, le tour de taille et des hanches ont été mesurés, ainsi que la tension artérielle. En outre, une analyse de la glycémie a été effectuée de manière aléatoire. Les résultats ont révélé que 13,5 % des 370 étudiantes souffraient de préhypertension. Les facteurs de risque les plus prévalents pour les maladies cardio-vasculaires étaient la sédentarité (53,2 %), suivie par la surcharge pondérale/l'obésité (29,1 %) ; 16,3 % des étudiantes préhypertendues présentaient trois facteurs de risque ou plus. L'analyse de régression logistique a mis en évidence le fait que la surcharge pondérale/l'obésité était le facteur prédictif le plus important de la préhypertension. Notre étude souligne la nécessité d'une surveillance systématique de la tension artérielle et d'une évaluation des risques chez les jeunes femmes en Arabie saoudite.

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Received: 11/11/10; accepted: 05/04/11

## Introduction

Chronic diseases such as cardiovascular diseases (CVD) are rising dramatically in the Eastern Mediterranean Region. About 45% of the region's disease burden is due to noncommunicable diseases and it is expected that this burden will rise to 60% by the year 2020. Primary prevention, with a focus on reducing avoidable risk factors, is the most cost-effective approach to containing this emerging epidemic [1]. One of these risk factors is hypertension, which is associated with an increased risk of morbidity and mortality from CVD and is one of the main preventable causes of death. Prospective observational studies have suggested that the risk of CVD death begins at systolic/diastolic blood pressure (BP) 115/75 mm Hg and doubles for each increment of 20/10 mm Hg in a nearly linear fashion. Also, arterial stiffness and other abnormal effects begin long before the 140/90 mm Hg threshold at which clinicians began treating hypertension [2]. Accordingly, the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC7) introduced a new category, "prehypertension", defined as systolic BP of 120–139 mm Hg and/or a diastolic BP of 80–89 mm Hg, replacing former categories of "above optimal" and "high normal". The rationale for redefining this category was to emphasize the excess risk associated with BP in this range and to focus increased clinical and public health attention on prevention [3].

In Saudi Arabia a national study was conducted in 1998 to determine the prevalence of hypertension among the adult population. It revealed that its prevalence was higher among males (18.7%) than females (14.0%) and was highest in the Eastern province [4]. A more recent national study in 2007 reported a higher prevalence rate of hypertension among Saudi adults (28.6% for males and 23.9% for females),

indicating a rising trend in hypertension in Saudi Arabia [5]. Screening of young men for prehypertension in the Western region of Saudi Arabia in 2008 revealed that its prevalence was 17.3% [6], while among male university students in the Eastern region the prevalence was 32.7% [7]. Data on prehypertension in young adult females in the Eastern province, however, is lacking. Thus, the aim of the present study was to determine the prevalence of prehypertension and associated risk factors among young adult females in Dammam city, Eastern province, Saudi Arabia.

## Methods

A cross-sectional study was conducted in the University of Dammam, after taking all the necessary academic and administrative approvals from the related authorities.

### Sample

The target population consisted of 1300 female university students registered for the academic year 2005–06 in 4 colleges. The sample size was calculated using *Epi Info*, version 2.3.1. It was found that at expected frequency of prehypertension of 14% [4], at worst acceptable frequency of  $\pm 3\%$  and at a confidence level of 95%, the minimum required sample size was 368. Accordingly, 370 students were selected by multistage stratified random sampling with proportional allocation from the different colleges and academic levels. Within each level students were selected from the registration list by systematic random sampling, choosing every 3rd student until the proportionate sample was obtained. Pregnant students were excluded from the sample. The sample size represented about 28% of the target population.

### Data collection

A modified Arabic version of the World Health Organization STEPwise

approach to Surveillance (WHO-STEPs) instrument for collecting data on noncommunicable diseases risk factors was used, which was reviewed and approved by all members of the faculty of family and community medicine.

### Interviews

Trained interviewers approached the selected students in their classrooms, informed them about the nature of the study, assured them about the confidentiality of collected data and requested their participation. Interviewers were specially trained to ask questions in a non-judgemental manner to avoid bias in responses.

The interview questionnaire collected data on sociodemographic details and risk factors for CVD (e.g. current daily tobacco smoking, moderate intensity physical activity for 30 minutes 3 times per week, hypercholesterolaemia, diabetes, hypertension and family history of hypertension), as well as dietary habits (e.g. frequency of consuming vegetables, fruits and fast food per week and type of fat used for cooking). The later was an open-ended question categorized into saturated or unsaturated fat by the researchers during data entry for statistical analysis.

### Physical measurements

Physical measurements and blood samples were taken by a trained nurse during lunch time at the university clinic under the supervision of the research team and after taking informed consent from the participants. Weight and height were measured and body mass index (BMI) was calculated. It was classified into: normal weight (BMI 18.5–24.9 kg/m<sup>2</sup>), overweight (BMI 25–29.9 kg/m<sup>2</sup>) and obesity (BMI  $\geq 30$  kg/m<sup>2</sup>). Waist to hip ratio was estimated and a value  $\geq 0.8$  was considered as central obesity. Two BP measurements were taken while the student was seated and the average was recorded. BP was classified according to the JNC7 criteria as follows: normal < 120 mm Hg systolic and < 80 mm Hg diastolic; prehypertension: 120–139

mm Hg systolic or 80–89 mm Hg diastolic; hypertension:  $\geq 140$  mm Hg systolic or  $\geq 90$  mm Hg diastolic [3]. Students on anti-hypertensive medications were considered as hypertensive. Diabetes was considered if random capillary blood glucose was  $> 200$  mg/dL. Students on hypoglycaemic medications were considered as diabetic.

### Data analysis

The collected data was analysed by SPSS, version 17. After verification of data, they were analysed and presented in descriptive tables. The chi-squared test was used for qualitative binomial analysis and Fisher exact test was used if the expected frequency was less than 5 in more than 20% of the cells. Logistic regression analysis of different sociodemographic characteristics and risk factors affecting prehypertension was conducted and a *P*-value of  $< 0.05$  was considered statistically significant.

## Results

While all the 370 selected students agreed to respond to the questionnaire, 9 students declined to have their physical measurements and blood samples taken, giving a response rate of 97.6% for some of the data.

The mean age of the students was 19.9 (SD 1.4) years. The great majority were single (91.9%) and the rest were married. More than half of the students' fathers were university graduates (53.5%) and only 4.9% were illiterate, in comparison with 33.2% and 8.1% of the mothers respectively. Of the students 69.7% came from high-income families and only 4.9% from low-income families.

It was found that 13.5% of these female university students had prehypertension (3.8% had high normal BP 130–139 mm Hg systolic BP or 85–89

mm Hg diastolic BP) and 2.7% had hypertension. Only 40% of hypertensive students were aware of being hypertensive.

No significant associations between sociodemographic characteristics and high BP was detected. However, hypertension was more common among students from low-income families compared with high-income families (11.8% versus 1.6%) ( $P=0.059$ ) (Table 1).

The most prevalent risk factor for high BP among these female university students was physical inactivity (53.2%), followed by overweight and obesity (20.6% and 8.5% respectively; 29.1% overall), family history of hypertension (17.6%) and central obesity (6.6%) (Table 2).

Table 2 also shows a strong association between high BP and overweight/obesity, diabetes and

**Table 1 Sociodemographic characteristics of female university students by blood pressure group**

Sociodemographic characteristic	Total No.	Blood pressure group			<i>P</i> -value
		Normal %	Prehypertension %	Hypertension %	
<b>Age (years)</b>					
< 20	165	81.0	15.8	3.2	0.487
$\geq 20$	205	85.7	11.8	2.5	
<b>Marital status</b>					
Single	340	83.5	14.1	2.4	0.183
Married	30	85.7	7.1	7.1	
<b>Father's education</b>					
Illiterate/read & write	18	83.3	11.1	5.6	0.936
Primary/preparatory	51	82.4	15.7	2.0	
Secondary/diploma	103	85.0	12.0	3.0	
University/postgraduate	198	83.2	14.1	2.6	
<b>Mother's education</b>					
Illiterate/read & write	30	86.7	13.3	0.0	0.791
Primary/preparatory	110	81.1	14.2	4.7	
Secondary/diploma	107	86.3	12.7	1.0	
University/postgraduate	123	82.9	13.8	3.3	
<b>Income</b>					
Low	18	82.4	5.9	11.8	0.059
Middle	94	86.2	9.6	4.3	
High	258	82.8	15.6	1.6	
<b>Total</b>	370	83.6	13.5	2.7	

**Table 2 Risk factors for cardiovascular disease among female university students by blood pressure group**

Risk factor	Total No.	Blood pressure group			P-value
		Normal %	Prehypertension %	Hypertension %	
<b>Physical inactivity</b>					0.54
Yes	197	83.3	13.0	3.6	
No	173	84.0	14.2	1.8	
<b>Overweight/obesity<sup>a</sup></b>					0.001
Yes	105	71.7	24.5	3.8	
No	256	88.6	9.0	2.4	
<b>Family history of hypertension</b>					0.42
Yes	65	82.0	14.8	3.3	
No	305	87.2	11.1	1.7	
<b>Central obesity<sup>a</sup></b>					0.50
Yes	24	78.3	17.4	4.3	
No	337	83.6	13.7	2.7	
<b>Hypercholesterolaemia</b>					0.001
Yes	12	58.3	8.3	33.3	
No	358	84.1	14.0	1.8	
<b>Smoking</b>					1.00
Yes	5	100.0	0.0	0.0	
No	365	83.4	13.8	2.8	
<b>Diabetes<sup>a</sup></b>					0.001
Yes	4	25.0	0.0	75.0	
No	357	84.3	13.7	2.0	

<sup>a</sup>9 students declined to participate.

hypercholesterolaemia. One-quarter of overweight/obese female university students (24.5%) had prehypertension and 3.8% had hypertension, compared with only 9.0% and 2.4% of normal weight students respectively. Three quarters (75.0%) of diabetic students had hypertension, compared with only 2.0% of non-diabetic students. Also, about one-third of hypercholesterolaemic students (33.3%) had hypertension, compared with only 1.8% of students with cholesterol in the normal range. These differences were highly statistically significant ( $P < 0.001$ ). No significant associations between high BP and physical inactivity, family history of hypertension and central obesity were recognized. All the students who smoked ( $n = 5$ ) were normotensive.

Table 3 shows that 71.4% of female prehypertensive students had 1 or more CVD risk factors; 32.7% had

1 risk factor, 22.4% had 2 risk factors and 16.3% had 3 or more risk factors. A positive correlation between number of risk factors and BP was also recognized, as 30.0% of hypertensive students and 16.3% of prehypertensive students had 3 or more risk factors compared with only 4.6% of normotensive students ( $\chi^2 = 11.79$ , Fisher exact  $P = 0.047$ ).

Table 4 reveals that 31.9% of the families of female university students used saturated fat for cooking, as 16.5% used saturated fat only and 15.4% used a combination of saturated and unsaturated fat. It also showed that some of the female students did not eat vegetables or fruits at all (3.0% and 9.5% respectively) and only 45.1% and 28.6% respectively ate them daily. Regarding "fast food" consumption, it was found that 20.9% ate this at least 4 times per week. No significant differences were found between normotensive and prehypertensive or

hypertensive students regarding food habits.

Sociodemographic characteristics (age, marital status, mother's education and family income) as well as risk factors (overweight/obesity, physical inactivity, hypercholesterolaemia and family history of hypertension) were included in the logistic regression analysis model. It revealed that overweight/obesity was a significant predictor of prehypertension among female university students, with an odds ratio of 3.34 (95% CI: 1.77–6.30) (Table 5).

## Discussion

Several recent studies have reported an increased risk of CVD among prehypertensive people, especially among those with high normal BP. The Framingham Heart Study indicated that men and

**Table 3 Number of cardiovascular disease risk factors among female university students by blood pressure group**

No. of risk factors	Blood pressure group			Total (n=370)
	Normal (n=310)	Prehypertension (n=50)	Hypertension (n=10)	
	%	%	%	
0	27.5	28.6	0.0	26.9
1	45.4	32.7	30.0	43.2
2	22.5	22.4	40.0	23.0
3+	4.6	16.3	30.0	6.9

$\chi^2 = 11.79$ , Fisher exact  $P = 0.047$

women with high normal BP had a more than 2-fold increase in relative risk for CVD compared with those who had optimal BP [8–11]. Prehypertension is associated with subclinical atherosclerosis, including increased coronary atherosclerosis and increased arterial intima-media thickness. In addition, prehypertension is associated with elevated C-reactive protein, tumour necrosis factor  $\alpha$ , homocysteine, oxidized low-density lipoprotein cholesterol and other inflammatory markers [9,12,13].

The present study revealed that 13.5% of female university students in Dammam in the Eastern province of Saudi Arabia had prehypertension. A similar study conducted in the same region on male university students recorded a higher prevalence of prehypertension (32.7%) [7]. In comparison 35.8% of Israeli females and 56.8% of males aged 16.5–19 years were considered prehypertensive [14]. Many recent studies conducted in different countries reported similar sex differences.

Prehypertension was recognized to be more common among males than females, regardless of age [15–18]. Also, national studies conducted in Saudi Arabia revealed that hypertension was more common among males than females [4,5].

The numerous risk factors for CVD other than hypertension are usually categorized as modifiable (e.g. dyslipidaemia, smoking, diabetes, abdominal obesity, excess alcohol intake and sedentary lifestyle) and non-modifiable (e.g. increasing age, male sex and family history of premature CVD). The rate of these risk factors have been found to be higher in prehypertensive than normotensive subjects, at rates between those with normotension and hypertension [16,19,20]. The present study revealed that the most prevalent risk factor among female university students was physical inactivity, followed by overweight/obesity, family history of hypertension and central obesity. By comparing the prevalence

**Table 4 Dietary habits among female university students by blood pressure group**

Dietary habit	Blood pressure group				P-value
	Total No.	Normal %	Prehypertension %	Hypertension %	
<b>Cooking fat</b>					
Saturated	61	88.7	11.3	0.0	0.162
Unsaturated	252	81.6	15.8	2.6	
Combined	57	83.0	9.4	7.5	
<b>Frequency of vegetable consumption (times/week)</b>					
0	11	81.8	18.2	0.0	0.764
1–6	192	83.2	13.0	3.8	
7+	167	84.6	13.6	1.9	
<b>Frequency of fruit consumption (times/week)</b>					
0	35	82.9	11.4	5.7	0.729
1–6	229	83.2	14.5	2.3	
7+	106	84.6	12.5	2.9	
<b>Frequency of fast food consumption (times/week)</b>					
0	21	90.0	10.0	0.0	0.994
1–3	272	82.8	14.2	3.1	
4+	77	83.8	13.5	2.7	

**Table 5 Logistic regression analysis of sociodemographic characteristics and risk factors for prehypertension among female university students**

Variable	Risk of prehypertension	
	OR (95% CI)	P-value
Age	0.77 (0.41-1.45)	0.419
Marital status	0.70 (0.15-3.28)	0.645
Mother's education	0.86 (0.61-1.22)	0.395
Family income	1.69 (0.82-3.47)	0.153
Physical inactivity	0.77 (0.41-1.45)	0.419
Overweight/obesity	3.34 (1.77- 6.30)	0.001
Family history of hypertension	0.80 (0.40-1.62)	0.541
Hypercholesterolaemia	1.83 (0.21-16.2)	0.589

OR = odds ratio; CI = confidence interval.

of overweight/obesity (29.1%) with similar studies, it was found to be relatively high, as 14% of Israeli and 15% of American adolescent girls were classed as overweight/obese [14,21].

Regression analysis revealed that overweight/obesity was a significant predictor of prehypertension in our study. Similar findings were reported by several other studies [6,14,17,18,22,23]. The association between BP and weight is strong and linear, even in the normal range of BP and BMI [24]. Al-Hazza, who reviewed 3 national cross-sectional studies conducted in Saudi Arabia, reported an increasing prevalence of BMI over time in the adolescent population [25]. Consequently, a rising trend in prevalence of prehypertension is expected among young adults in the coming decades.

In contrast with the results on BMI, central obesity was not associated with high BP in our study. Similar findings were reported by a study conducted on a Japanese population, where the risks for CVD incidence were similar among participants who had the same number of risk factors, with and without abdominal obesity [26].

Certain factors have been shown to be protective against the development of CVD, namely daily consumption of fruits and vegetables and regular physical activity [27]. According to the present study fruits and vegetables were consumed daily by only 28.6%

and 45.1% of female university students respectively. However, no relationship was found between high blood pressure and food habits.

Like hypertension, prehypertension tends to cluster with other CVD risk factors. The proportion of prehypertensive individuals with 1 or more risk factor is about 85% [28]. The increased risk of CVD resulting from multiple risk factors is frequently greater than simply additive, indicating a synergistic effect [29]. According to the present study, 71.4% of female prehypertensive university students had at least 1 other risk factor for CVD and 16.3% had 3 or more risk factors.

As with hypertension, prehypertension tends to increase in severity over time. Progression of prehypertension to clinical hypertension depends on the level of BP and age. Yearly measurement of BP in patients with prehypertension is recommended by the JNC-7 to detect and treat hypertension as early as possible [3]. The 2003 European Societies of Hypertension and Cardiology guidelines emphasize the importance of a complete risk assessment for prehypertensive people. The search for other CVD risk factors, e.g. diabetes, obesity or dyslipidaemia, and the presence of target organ damage, e.g. left ventricular hypertrophy, microalbuminuria or increased carotid intima-media thickness, should be

encouraged [30]. Japanese guidelines for the management of hypertension published in 2009 consider patients to be in a high-risk group (and requiring antihypertensive therapy) if they have diabetes, chronic kidney disease, 3 or more risk factors, target organ damage or CVD, even if they have only high normal BP [31]. According to JNC-7 the following major lifestyle modifications are recommended for management of prehypertension: weight reduction; the Dietary Approaches to Stop Hypertension (DASH) eating plan, which is rich in potassium and calcium and reduced in total and saturated fat; reduced sodium intake; regular aerobic physical exercise; and moderation of alcohol intake. However, the JNC-7 report recommends drug treatment "if a trial of lifestyle modification fails to reduce BP to 130/80 mm Hg or less" in patients with either diabetes mellitus or chronic kidney disease [3]. Our findings, mainly that overweight/obesity was a major determinant of prehypertension, that physical inactivity was common and that daily consumption of fruits and vegetables was uncommon, indicate that lifestyle modification would probably be the most effective strategy for management of prehypertension among this group of young adult females.

Our study had some limitations, such as random blood glucose testing and assessment of hypercholesterolaemia by history-taking, which may have resulted in underestimation of these risk factors. Therefore it was not always possible to compare our findings with similar studies.

In conclusion, our study demonstrates that prehypertension was prevalent in female university students in Dammam and was associated with multiple CVD risk factors. These results underline the need for routine BP measurements in young adults to identify subjects with prehypertension, who should be the target for annual measurement of BP, assessment for other CVD risk factors and lifestyle modifications.

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