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Blood Pressure Distribution Correlated with Body Composition, Physical Activity and Dietary Habits Among University Females

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Abstract

Hypertension is a one of the major cause for ill-health, premature mortality and disability. Knowing hypertension is important as it puts on excessive amount of economic burden on the populations as well as the health care systems. High blood pressure, like other non communicable diseases, is associated with identifiable behavioral and biological risk factors.

Objectives: The present study was designed to find out the prevalence of Hypertension and its association with BMI, body composition, diet and physical activity.

Methods: The present cross sectional study was carried out in University of Hail, Hail, Saudi Arabia, on a random sample consisting of 237 female participants. Data collection was based on the assessment of anthropometric body composition measurements done with the help of Bioelectric impendence technique, and other information collected through a questionnaire. Statistical analysis was done using SPSS-17.0 software.

Results: Results of the study concluded that 22% and 20% of the subjects were overweight and obese respectively. 57.4% of the participants were physically inactive. Mean systolic, and diastolic BP was higher among subjects with Higher BMI and showed an increasing trend with increasing age ($P < 0.005$). Minimum BP was found among underweight and maximum among obese. BMI was also found to be associated with age independently. Although the magnitude of correlation differed, there was significant positive correlation among BMI, age, systolic and diastolic BP ($P = 0.000$).

Conclusion: Although the average systolic and diastolic blood pressures are not very high in this study, prevalence of obesity was found to be alarming with high percentage of subjects being inactive. More emphasis needs to be given on health care programs like blood pressure screening studies, diet modifications and physical activity.

Keywords: *Blood pressure; Hypertension; Obesity; Body mass index; Physical activity*

Background

Recently with the help of various researches it has been estimated that nearly one billion people or 26% of the adult population have hypertension worldwide, which is found to be common in both developed (333 million) and developing (639 million) countries [1].

Presently all over the world, high blood pressure is estimated to cause 7.1 million deaths, which is calculated to be about 13% of the total. About 62% of cerebrovascular disease and 49% of ischemic heart disease are attributable to suboptimal BP (systolic > 115 mm Hg). It is now well documented by researches that overweight and obesity increase the risks of high BP, coronary heart disease, ischemic stroke, type II diabetes mellitus, and certain cancers. Globally, about 58% of diabetes mellitus and 21% of ischemic heart disease are attributable to BMI above 21 kg/m^2 [2]. Developing countries are increasingly faced with the double burden of hypertension and other

cardiovascular diseases, along with infection and malnutrition [3]. The relationship between BMI and BP has long been the subject of epidemiological research. Positive association BMI and BP have also been reported among Asian populations [4,5].

Researchers have also shown that hypertension is also increasing in the young adult population [6]. Since past many years, increasing interest is being devoted to find out the prevalence of hypertension in children and young adults. It is often assumed that the risk of hypertension and afterwards its complications might start very early in life and thus to discover and correct it, would help in future prevention. Studies have shown that essential hypertension can be found among children and adolescents. The pattern of Blood Pressure show a strong correlation to adulthood hypertension which in turn leads to various cardiovascular complications [7].

The correlation have already been identified through various studies done in different countries. In a study done in an Irani young population, it was found that between prevalence of hypertension in people aged between 20-29 years was 6.6% in males and 3.3% in females [8]. In another study in Canada, the results of survey showed that the prevalence of hypertension was 3.4% among young participants aged between 20-39 years [9].

Another recent study done in Basrah-Southern Iraq, concluded that the causes of specific mortality rate resulting due to cardiovascular disease has increased much during the last few years. Such increase is thought to be associated with different risk factors including hypertension [10]. Another researcher studied different risk factors for cardiovascular diseases among college students [11], and observed that the prevalence of blood pressure was 5.6% for SBP and 8.6% for DBP. The need to get Information on the prevalence and pattern of blood pressure (BP) distribution in young adults is thought to be a major step towards wide scale screening of high risk populations [10,12].

Hypertension and other related complications are recognized as emerging clinical and public health problems in Saudi Arabia [13]. Different studies done across the country revealed that several co morbidities and risk factors were also prevalent among young adults . Stress, suboptimal activity and exercise, and obesity ranks highest among these risk factors.

During the course of literature review it was observed that only few studies are done on young people in Saudi Arabia. For example one study shows the prevalence rate of 23.9% among Saudi Females [14], while another study demonstrated prevalence of 3-13% among females [15].

Methods

A cross-sectional study was carried out among 237 University of Hail females, age ranging from 18 to 30+ years, with an objective to know the distribution of Blood Pressure and its correlates. The subjects were divided into five different age groups with to study the age trend of height, weight, BMI, and BP. The participants were randomly selected from all the colleges. A self administered questionnaire was used for the purpose of Data collection. All the subjects who were either pregnant, lactating or in their menstrual periods were excluded from the study. Final analysis was done on a total of 237 subjects.

Short version of Last 7 Days International Physical Activity Questionnaire (IPAQ) was utilized for the purpose of getting the level of physical activity among the participants. According to Craig., *et al*. [16], the IPAQ instrument has acceptable measurement properties for monitoring levels of physical activity among 18 to 65 year old adults.

Information on the total dietary intake of fat, fiber, fruits and vegetables was obtained by using the online free assessment tool for individuals (Nutrition Quest, 2009). For this purpose , all the participants filled the online screeners for fat, fruits, vegetables and fiber. These screeners included food frequency questionnaire. Height was measured using standard stadiometer. Weight, and other body composition analysis like total body proteins, minerals and fat were done using Bioelectric impendence technique (In-Body 720 machine, Bio space, Korea). The BMIs of the participants were calculated from their respective heights and weights using the quetelet index which is

calculated as weight/height^2. After getting the BMI values, underweight, normal, overweight, and obese subjects were classified according to the values given by the World Health Organization (WHO) criteria for body weight determination (WHO, 2006) [17].

Measurement of Blood Pressure

For this purpose an electronic wrist blood pressure machine (Beurer medical - Germany) was used. The individuals' BP was measured after 5 minutes' rest while seated in a chair, with their elbow resting on the arm of chair and their left arm raised to heart level. Two measurements were taken with an interval of 2 minutes between readings, with an average calculation taken from the 2 recordings for systolic and diastolic BPs. High BP was defined as being 140/90 mmHg and over (130/80 mmHg and over in diabetics) and the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High BP (JNC 7) classification of hypertension was used. According to JNC 7, "Normal BP" is defined as SBP < 120 and diastolic blood pressure (DBP) < 80 mm Hg, "Prehypertension" as SBP 120 to 139 or DBP 80 to 89 mm Hg, "Stage I hypertension, (SI)" as SBP 140-159 or DBP 90-99 mm Hg, "Stage II hypertension, (SII)" as SBP ≥ 160 or DBP ≥ 100 mm Hg, "Isole systolic hypertension, (ISH)" as SBP ≥ 140 and DBP < 90 mm Hg and "Isole diastolic hypertension, (IDH)" as SBP < 140 and DBP ≥ 90 mm Hg [18].

Statistical Analysis

The statistical package for social sciences (SPSS) version 17 (Chicago, IL, USA) was used to enter and analyze the data on a personal computer. Obtained data were evaluated by frequency and percentages, variance analysis (ANOVA), Chi-square (χ^2) and regression analysis. The measure for statistical significance was established as $P < 0.05$. In the choice of variables pertaining to high hypertension, the Stepwise multiple regression analysis was performed from different variables which were significant with systolic and diastolic blood pressures.

Ethics

All enrolled participants were introduced about the purpose of the study and were asked to provide a written informed consent before participating in the study. The present study was approved by University of Hail Deanship of Scientific Research.

Results

The mean age of the respondents in the present study was found to be 21.8 ± 4.3 years ranging from 18 to 30+ years, with the maximum number of subjects (66.7%) from 18-21 years. General characteristics and basic data of the study population are displayed in the Table 1. Out of the total subjects, around 76% were unmarried and the rest 24% were married.

The overall mean BMI was found to be at the border line for overweight (24.9 ± 5.8 kg/m^2). A large number of participants were found overweight and obese (21.5% and 20% respectively). 46.6% of the subjects were having normal BMI.

Among the category of chronic illnesses, Gastro Intestinal disturbances was found most prevalent (10.1%) followed by Hypertension (4.6%), diabetes and cardiovascular diseases (1.7% and 0.8% respectively). Almost 44% subjects reported that they have family history of hypertension and cardiovascular diseases. On the other hand 52.7% had a family history of diabetes, 33.7% of renal disease, and 1.3% of cancer.

Table 1 also shows that 50.6% of the subjects had stress at work or home and a very little percentage of the subjects (2.1%) were involved in Health enhancing physical activity (HEPA). 40.5% were found to be moderately active whereas a large number of the participants (57.4%) were completely inactive.

The overall mean Systolic blood pressure was calculated out as 110.65 ± 14.6 mmHg, with approximately 20% of the subjects falling in the category of pre hypertensive stage (SBP 120-139 mmHg), and 4.2% with hypertension stage I (SBP >140 mmHg). Analysis of the DBP on the on the other hand showed that the overall mean DBP was 88.24 ± 10.5 mmHg, with around 14% subjects in pre hypertensive stage and 6.3% in stage I of hypertension.

Variables	Categories	Frequency	Percentage
Age group (yrs)	18–21	158	66.7
	22–23	49	20.7
	24–26	14	5.9
	27–30	7	3.0
	> 30	9	3.8
	Overall mean age	21.8 ± 4.3	
Marital status	Married	57	24.1
	Un married	180	75.9
Body Mass Index	Underweight	29	12.2
	Normal	110	46.4
	Overweight	51	21.5
	Obese	47	19.9
	Mean BMI	24.9 ± 5.8	
History of chronic illness	Cardio vascular diseases	2	0.8
	Hypertension	11	4.6
	Diabetes	4	1.7
	Gastro Intestinal Disorders	24	10.1
Family history of Hypertension or Cardiovascular diseases	Yes	104	43.9
	No	133	56.1
Family history of other chronic diseases	Diabetes	125	52.7
	Cancer	3	1.3
	Chronic renal failure	80	33.7
Stress at work	Yes	120	50.6
	No	117	49.4
Physical Activity	Health Enhancing Physical Activity	5	2.1
	Moderately active	96	40.5
	Inactive	136	57.4
Systolic Blood pressure	< 120 mmHg	180	75.9
	120–139 mmHg	47	19.8
	>140 mmHg	10	4.2
	Overall mean SBP	110.65 ± 14.6	
Diastolic Blood pressure	< 80 mmHg	189	79.7
	80–89 mmHg	33	13.9
	90–99 mmHg	15	6.3
	Overall mean DBP	88.24 ± 10.5	

Table 1: *General and health characteristics of the study population.*

Table 2 shows the analysis of variance ANOVA for BMI and the correlated variables. It is clear from the table that Visceral fat, Percent body fat, Mean pulse, mean SBP as well as DBP were all strongly correlated to BMI. We can observe the same trend for visceral fat and Percent body fat that it gradually increases with increasing BMI, showing a strong positive correlation (P = 0.000). The case was reverse with mean pulse value, as it showed a decreasing trend with increasing BMI. Again in the case of mean SBP and DBP it followed a gradual increase with increasing BMI showing a strong positive correlation between the two. (P = 0.000)

BMI	Mean variables				
	Visceral fat	% Body fat	Pulse	DBP	SBP
Underweight	48 ± 11.6	25.1 ± 6.8	89.2 ± 9.9	69 ± 7.9	104 ± 10.9
Normal	72.2 ± 18.6	34.7 ± 5.1	81.2 ± 10.2	71 ± 8.2	107 ± 10.8
Overweight	101.8 ± 25.0	42.3 ± 4.2	83.5 ± 9.3	73 ± 10.3	112 ± 12.9
Obese I	135.3 ± 22.4	47.2 ± 5.4	79.5 ± 9.7	75 ± 9.4	117 ± 17.6
Obese II	194.5 ± 38.6	49.2 ± 5.7	79.3 ± 11.8	83 ± 13.0	132 ± 23.1
P value	0.000***	0.000***	0.001***	0.000***	0.000***

Table 2: *Analysis of variance for BMI and correlated variables.*

Correlation of age with Blood pressure and pulse is concluded in Table 3. It is very clear from the table that Mean SBP and DBP were strongly correlated with age (P = 0.000). The Mean DBP increased from 71.2 ± 9.1 for lowest age group (18-21 years) to 86.0 ± 12.6 for the highest (> 30 years). The same trend was observed for SBP also. The mean SBP raised from 108.3 ± 12.7 for age group 18-21 years, to 125.7 ± 15.5 for 27-30 years followed by the highest value 135.4 ± 20.7 for the highest age group (> 30 years) showing a strong positive correlation.

Table 3 also shows that the case was just reverse for the mean pulse value. It was found that the mean pulse decreased with increasing age from 84.1 ± 10.4 for age group 18-21 years, to 80.8 ± 9.8 for the age group 24-26 years followed by 77.3 ± 12.1 for the eldest age group (> 30 years), showing a strong inverse correlation between the two (P = 0.000).

Age Group (years)	Mean DBP	Mean SBP	Mean Pulse
18–21	71.2 ± 9.1	108.3 ± 12.7	84.1 ± 10.4
22–23	72.3 ± 7.9	111.3 ± 14.7	78.4 ± 8.8
24–26	73.6 ± 10.7	110.93 ± 11.1	80.8 ± 9.8
27–30	85.7 ± 10.9	125.7 ± 15.5	79.7 ± 10.3
> 30	86.0 ± 12.6	135.4 ± 20.7	77.3 ± 12.1
P value (ANOVA)	0.000***	0.000***	0.000***

Table 3: *Analysis of variance for mean Blood pressure according to different age groups.*

Analysis of the results from table 4 shows the comparison of mean In body measurements with the history of chronic illnesses. Results concluded that the highest amount of visceral fat (135.6 ± 57) was observed for the subjects having previous history of hypertension, followed by the ones having a previous history of cardiovascular diseases (121.6 ± 141). the lowest amount of visceral fat was observed among the subjects suffering from a history of Gastro Intestinal Disorders (65.1 ± 25). Same pattern was repeated for the mean percent body fat. Highest PBF was found among the participants reporting previous history of hypertension (45.3 ± 6.4), followed by Cardiovascular diseases (33.5 ± 25.1) and lastly lowest PBF was seen in the subjects with Gastro Intestinal Disorders [GID] (31.5 ± 8.0).

History of chronic illnesses	Mean variables				
	Visceral fat	% Body fat	Pulse	DBP	SBP
Hypertension	135.6 ± 57	45.3 ± 6.4	77.8 ± 9.9	83.3 ± 12.8	133.4 ± 22.5
Cardiovascular diseases	121.6 ± 141	33.5 ± 25.1	93.5 ± 9.2	84 ± 18.3	136 ± 51.0
Diabetes Mellitus	103.75 ± 41	33.7 ± 1.4	81.3 ± 7.4	74.7 ± 12.8	106.5 ± 18.4
Gastro Intestinal Disorders	65.1 ± 25	31.5 ± 8.0	85.5 ± 11.2	69.7 ± 9.6	103 ± 2.1
No Disease	91.2 ± 38.5	38.2 ± 8.2	82.1 ± 10.2	71.9 ± 8.8	110 ± 12.5
P value	0.000***	0.000***	0.145	0.000***	0.000***

Table 4: *Comparison of chronic illnesses with Mean body composition and Blood pressure.*

With respect to the SBP and DBP, the subjects reporting history of cardiovascular diseases (CVD) were found with the highest mean values (136 ± 51.0 over 84 ± 18.3 mm Hg) followed by Hypertension patients (133.4 ± 22.5 over 83.3 ± 12.8 mm Hg), diabetes (106.5 ± 18.4 over 74.7 ± 12.8 mm Hg) and lastly lowest values were observed for GID (103 ± 2.1 over 69.7 ± 9.6 mm Hg).

Stepwise multiple regression was performed to find out the group of variables best predicting the systolic and diastolic Blood Pressures (table 5 and 6). For SBP (table 5) actual BMI of the participant was the single best predictor entered at the first step (R^2 = 19.9%, P = 0.000) , pulse value was the second best predictor (step 2, R^2 = 23.4%, P = 0.000) followed by age group (step 3, R^2 = 27.8%, P = 0.000). ANOVA table shows that the results were overall highly significant for all the three steps.

Model		R	R Square	ANOVA	
				F	Sig
1	Actual BMI of the subject	0.446	0.199	58.442	0.000***
2	Actual BMI of the subject, pulse value	0.484	0.234	35.733	0.000***
3	Actual BMI of the subject, pulse value, age group	0.527	0.278	29.898	0.000***

Model		Un standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant) Actual BMI of the subject	82.864	3.732	t	22.202	.000
		1.114	.146	.446	7.645	.000
2	(Constant) Actual BMI of the subject pulse value	58.641	8.282		7.081	.000
		1.204	.145	.482	8.276	.000
		.267	.082	.190	3.260	.001
3	(Constant) Actual BMI of the subject pulse value Age group	56.365	8.080		6.976	.000
		.958	.156	.384	6.149	.000
		.304	.080	.216	3.785	.000
		3.433	.911	.235	3.768	.000

Table 5: *Stepwise multiple regression for Systolic blood pressure.*

For DBP (table 6) weight of the participant was the single best predictor entered at the first step (R^2 = 13.7%, P = 0.000), pulse value was the second best predictor (step 2, R^2 = 21.0%, P = 0.000) followed by age group (step 3, R^2 = 23.5%, P = 0.000) and lastly

amount of fiber eaten per day (step 4, R^2 =24.8%, P = 0.000) ANOVA tables shows that the results were overall highly significant for all the four steps.

Model		R	R Square	ANOVA	
				F	sig
1	weight of the participant	.370	.137	37.39	0.000
2	weight of the participant, pulse value	.459	.210	31.12	0.000
3	weight of the participant, pulse value, age group	.484	.235	23.82	0.000
4	weight , pulse value, age group, amount of fiber eaten/d	.498	.248	19.09	0.000

Model		Un standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant) weight of the participant	58.078	2.405		24.154	0.000
		0.230	0.038	0.370	6.115	0.000
2	(Constant) weight of the participant pulse value	35.557	5.362		6.631	0.000
		0.258	0.037	0.416	7.066	0.000
		0.252	0.054	0.274	4.652	0.000
3	(Constant) weight of the participant pulse value age group	34.422	5.306		6.487	0.000
		0.208	0.040	0.336	5.159	0.000
		0.271	0.054	0.295	5.028	0.000
		1.702	0.625	0.178	2.724	0.007
4	(Constant) weight of the participant pulse value age group amount of fiber eaten/d	37.899	5.550		6.828	0.000
		0.206	0.040	0.333	5.140	0.000
		0.277	0.054	0.302	5.170	0.000
		1.557	0.625	0.163	2.492	0.013
		-0.252	0.126	-0.116	-2.004	0.046

Table 6: *Stepwise multiple regression for diastolic blood pressure.*

Discussion

The presents study reports the distribution of blood pressure and the risk factors associated with it among the university students and staff in Hail region of Saudi Arabia. Results of the study indicated that for both SBP and DBP the values increased with increasing age as well as increasing BMI indicating these two as the most important risk factors for hypertension.

The findings of the present study reflect those of some other related studies done in other parts of the world. In a cross sectional study done in Germany, the prevalence of hypertension was increased with age [19]. Other studies done in Tanzania in 2002 and Israel (2000) concluded similar results that blood pressure increases with age [20,21]. Recent experimental and epidemiological studies supports that estrogen deficiency may result in endothelial and vascular dysfunction and can lead to age-related increase in systolic blood pressure, possibly as a consequence of the reduced compliance of the large arteries [22]. A study conducted in a region of north-western Turkey showed that hypertension prevalence increased with age [23]. The reasons for this could be that as age increases, cardiovascular and kidney diseases, Diabetes, and the blockage of coronary arteries due to the accumulation of cholesterol also increase [24].

The present study showed no significant correlation between prevalence of hypertension and physical activity ($P < 0.05$). However, contradictory to the present results, few other studies have shown a positive correlation between physical activity and primary as well as secondary hypertension [25,26]. Now a days it has been proved through various researches that participation in regular sports activities will surely help to reduce the blood pressure. These findings need further in depth studies to actually find out the effect of moderate physical activity on the incidences of hypertension especially in this region as the results regarding this factor in the present study were insignificant.

Results of the regression analysis shows that BMI, or obesity was an important risk factor for the prevalence of hypertension and an elevated SBP and DBP ($P < 0.001$). Numerous other studies have shown similar results of increasing blood pressure with increasing BMI [11,18-20,25,27,28]. Various researchers have concluded that the reason for this positive correlation between hypertension and obesity, and more importantly central obesity, is insulin resistance leading to hyperinsulinemia which in turn triggers the mechanism causing high blood pressure [29,30]. In the present study also mean SBP as well as DBP was found to be increasing with increasing age and increasing BMI. Since the blood pressure readings in the earlier stages of life predict the blood pressure of early and late adulthood, therefore measurement of blood pressure should be considered as an important part of clinical examination in every year of life.

The present study shows a significant correlation between fiber intake and diastolic blood pressure as judged by the regression analysis results. These results could be attributed to the fact that dietary fiber promotes satiety [31], by slowing down the gastric emptying rate, increased colonic transit, and decreased insulin response [32]. Also , it this has also proved to protect against excessive weight gain via effects that could be mediated by, and/or independent of glycemic index [33]. Results from other research studies have also demonstrated that fruits and non-starchy vegetables protect against excessive weight gain [34,35], because they have low energy density, high fiber content, and low glycemic index. This low glycemic load will lead to a decreased insulin response and, therefore, decreases hunger and eventual energy intake [33]. And this will automatically lead to lower BMI which in turn have proven to decrease the blood pressure.

Conclusion

In conclusion, results of the present study suggest that there is a need for further educational programs offering information on BP and the risk factors of hypertension to the young adult population. Screening studies should be undertaken for early detection and timely treatment of hypertension. Results of the study also revealed that the blood pressure increases with increasing age and BMI, so measurement of blood pressure in the course of routine physical examination should be offered especially for those who are above 30 years of age. Public health awareness should be brought among the population through primary health care providers like regular physical exercise, prevention and treatment of obesity, consumption of low salt and high fiber diet including lots of fresh fruits and vegetables, so that the arterial blood pressure is maintained at a normal level. It was found from the present study that only 4.6% participants were aware of their high blood pressure and a fairly high percentage (approx 20%) had undiagnosed hypertension, which is a matter of great concern. These subject considered themselves as normal and didn't checked their blood pressures regularly.

The Seventh Report of the Joint National Committee on Prevention Detection Evaluation and Treatment of High Blood Pressure JNC 7 [36], emphasizes that no matter how effective is the therapy prescribed and no matter how careful and experienced clinician has prescribed it, the goal of BP control is possible only when the patient is aware and motivated for compliance with the treatment and follow-up and to establish and maintain a health promoting life style. The patient's attitude must be understood in order to increase the communication and control of BP [36]. Results of various other studies revealed that awareness of blood pressure among health professionals is suboptimal with a large number of subjects not knowing the recently recommended guidelines and cut off values for systolic and diastolic blood pressure under various clinical subsets of conditions like in healthy people, in patients with diabetes, patients with Cardiovascular diseases, Kidney disease patients, etc [37].

The present study highlights that there is a need for compulsory diet counseling due to the high prevalence of obesity in general and among the hypertensive patients in particular, to match the calorie intake and guidelines to add nutritional support to the treatment of high blood pressure. The results of the present study could serve as a step towards controlling the blood pressure among the female population, which need to be healthy in order to take care of their entire family and specially their children. As the symptoms of hypertension are often undiagnosed, frequent screenings and surveys should be done for early detection and timely management. In order to increase awareness and motivation among the populations, reminders through conferences, guidelines distribution and frequent health assessment should be made by health care professionals.

Competing Interest

'The authors declare that they have no competing interests'.

Author's Contributions

RB and ES carried out the Conception and design of the study. Data Collection, analysis and interpretation was collectively done by RB, ES and MT. RB, ES and EA carried out the Drafting or Revision of the manuscript.

Approval of the final version of the manuscript was done by all the authors.

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