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Research Article

A community screening plan for the prevalence of some chronic diseases in specified adult populations in Saudi Arabia-II: pre-hypertension and hypertension

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Abstract

Aim: Determine the prevalence of both pre-hypertension and hypertension (HTN) among recruits forty years of age and older in the Kingdom of Saudi Arabia (KSA) and associated risks, including body mass index (BMI), smoking, lipid profile, random blood glucose (RBG) measurements, and physical activity.

Methodology: Part of a "community diagnosis" plan by Prince Mansour Hospital (PMH) in Taif, KSA, recruits ≥40y were screened in 2010-1011.

Results: The participants' median age was 45y (40y-54y, IQR=5y); their mean systolic blood pressure (SBP) was 126 mmHg±12.5. Out of 117 screened, 70(59.8%) were pre-hypertensive (SBP: 120-139mmHg); 60(51.3%) of them were unaware of their diagnosis. Among 24(20.5%) hypertensive found (SBP≥140mmHg), 22(18.8%) were also newly diagnosed. Age significantly influenced SBP [$H(2)=8.25$, $P=.016$]. Adjusted by age, and also by smoking, the SBP was significantly impacted by the participants' BMI (Fisher's exact=18.92, $p=0.005$, Fisher's exact=16.67, $P=.032$, respectively). The SBP level varied by recruits' lipid profile condition (Fisher's exact=44.68, $P=.013$). Both RBG and physical activity were not significantly related to SBP [$rho(115)=0.082$, $P=.4$, $U=466$, $P=.38$].

Conclusions: Pre-HTN and HTN are prevalent among Saudi recruits≥40y old. Intervention for risk reduction and preventing transformation of pre-HTN to frank HTN is needed, e.g., through periodic screening, control of modifiable lifestyle factors, and consider pharmacotherapy for pre-HTN.

Keywords: chronic diseases, risk factors, pre-hypertension, hypertension, military, Saudi Arabia

1. Introduction

Chronic diseases, often referred to as non-communicable diseases (NCDs), usually start to emerge after long exposure to an unhealthful lifestyle, e.g., consumption of high-calorie diet, lack of regular physical activity, and tobacco use. Such lifestyle results in higher levels of risk factors that can act independently and synergistically, such as HTN, obesity, and diabetes.[1] Among all, HTN is an increasingly important medical and public health issue. The worldwide prevalence estimates for HTN may be as much as 1 billion individuals, and approximately 7.1 million deaths per year may be attributable to HTN.[2] According to the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC7),[3] approximately 30 percent of adults are alarmingly unaware of their hypertension, 40 percent of individuals with HTN are not on treatment, and two-thirds of hypertensive patients are not being controlled to BP levels <140/90 mmHg. Further, the decline rates in coronary heart disease (CHD) - and stroke-associated deaths have slowed in the past decade. In addition, the prevalence and hospitalization rates of heart failure (HF) where in the majority of patients, who have HTN prior to developing HF have continued to increase. Moreover, there is an increasing trend in end-stage renal disease (ESRD) by primary diagnosis. Hypertension is second only to diabetes as the most common antecedent for this condition. Undiagnosed, untreated, and uncontrolled HTN clearly places a substantial strain on the healthcare delivery system. The World Health Organization (WHO) reports that suboptimal BP (>115mmHg SBP) is responsible for 62 percent of cerebrovascular disease (CVD) and 49 percent of ischemic heart disease (IHD), with little variation by sex. In addition, suboptimal BP is the number one attributable risk factor for death throughout the world.[2] Generally, the prevalence of HTN increases with advancing age, so that more than half of people 60–69 years of age are affected.[4] The impressive increase of BP to HTN levels with age is also illustrated by data indicating that the 4-year rates of progression to HTN are 50 percent for those 65 years and older with BP in the 130–139/85–89 mmHg range and 26 percent for those with BP between 120–129/80–84 mmHg range.[5] On the other hand, the long-term risk of HTN is best summarized by the lifetime risk statistic, which is the probability of developing HTN during the remaining years of life. Framingham Heart Study investigators recently reported the lifetime risk of HTN to be approximately 90 percent for men and women who were non-hypertensive at 55 or 65 years and survived to age 80–85.[6] Even after adjusting for competing mortality, the remaining lifetime risks of HTN were 86–90 percent in women and 81–83 percent in men. Specifically, age-related rise in SBP,[7] coupled with the time-bound nature of the hypertensive phenomenon urged for adopting an early prevention strategy to mitigate the progression of BP in high risk individuals to hypertensive level.

In its lengthy and in-depth strategic work to set updated guidelines for the management and control of HTN problem, the JNC introduced the term "pre-hypertension" for SBP levels of 120-139 and diastolic BP levels of 80-89mmHg in its seventh report of 2003.[8] Historically, the JNC work was also preceded by diligent work from concerned parties, given the fact that a considerable portion of the world's population was eventually growing hypertensive. Data from the National Health and Nutrition Examination Survey (NHANES) have indicated that 50 million or more Americans have high BP warranting some form of treatment.[4, 9] For instance, the increasing awareness of HTN among Americans has improved from a level of 51 percent in the period 1976–1980 to 70 percent in 1999–2000. The percentage of patients with HTN receiving treatment has increased from 31 percent to 59 percent in the same period, and the percentage of persons with high BP controlled to below 140/90 mmHg has increased from 10 percent to 34 percent. Between 1960 and 1991, median SBP for individuals ages 60–74 declined by approximately 16 mmHg. These changes have been associated with favorable change in the morbidity and mortality attributed to HTN. Since 1972, age-adjusted death rates from stroke and CHD have declined by approximately 60 percent and 50 percent, respectively. These benefits have occurred independent of gender, age, race, or socioeconomic status. Committed to evidence-based practice in providing basis for the prevention and management of hypertension, too, the JNC7 reports that better treatment of HTN has been associated with a considerable reduction in the hospital case-fatality rate for HF within the last three decades[3]. Although the JNC7's report largely serves as a guide, the committee emphasizes that responsible physician's judgment remains paramount; that is positive experience, trust in the clinician, and empathy improve patient motivation and satisfaction. It follows that key messages of the JNC7 report are: in those older than 50, SBP of >140mmHg is a more important cardiovascular disease (CVD) risk factor than diastolic BP (DBP); beginning at 115/75mmHg, CVD risk doubles for each increment of 20/10 mmHg; those who are normotensive at 55 will have a 90 percent lifetime risk of developing HTN; prehypertensive individuals require health promoting lifestyle modification to prevent the progressive rise in BP and CVD; for uncomplicated hypertension, this report delineates specific high-risk conditions, which are compelling indications for the use of other antihypertensive drug classes (angiotensin-converting enzyme inhibitors, angiotensin-receptor blockers, beta blockers, calcium channel blockers); two or more antihypertensive medications will be required to achieve goal BP (<140/90mmHg, or <130/80mmHg among diabetics and renal patients); for patients whose BP is >20mmHg above the SBP goal or 10mmHg above the DBP goal, initiation of therapy using two agents, one of which usually will be a thiazide diuretic, should be considered; regardless of therapy, hypertension will only be controlled if patients are motivated to stay on their treatment plan. Further, meticulous clinical trials to scrutinize the impact of non-pharmacological therapies upon BP and CVD events in patients with HTN, e.g., over periods up to 1 to 2 years showed that interventions, such as weight reduction in overweight patients,[10,11,12] increased physical activity,[13] sodium reduction,[14,15,16] potassium supplementation, [7,18,19,20] decreased alcohol intake,[21] and stress management,[22] all can lead to variable reductions in BP ranging from 2 to 15mm Hg, according to the following rates: 4-15mmHg with 2-10kg weight reduction;[10] 5-7mmHg with moderate to vigorous exercise;[13] 5.8mmHg with 100mmol/L (1 teaspoon) reduction in salt intake;[14]1mmHg with 60mmol (=60meq) of potassium supplementation;[18] 3.3mmHg with 50 percent reduction in alcohol use in persons drinking 20-40 drinks/week; [21] and 9-10mmHg for persons receiving single or multi-component stress management interventions.[23]

Locally, the situation regarding the epidemiology of hypertensive diseases is no departure from that described in many other areas. In an epidemiologic study to investigate the prevalence and associated risk factors of HTN and pre-HTN among school teachers in Jeddah, 2006-2007, 25.2% and 43.0% of the participants were found with HTN and pre-HTN, respectively. Only 30.4% of those with HTN were aware of their condition. Hypertensive individuals also had either abnormally high BMI and or were older than normotensive peers.[24] More recent Saudi studies adopting health promotion interventional approaches for the elevated BP problem were attempted. In 2010, one year after attending a newly-established health promotion clinic stressing on diet and physical activity counseling in Abha southern district, 90% (n=429) of attendees failed to abandon imbalanced diet or to perform the recommended type of physical activity. Further, 25 percent of the study subjects were overweight. Pre-HTN and HTN were therefore detected in 44 percent and 12 percent of the study population, respectively, and 21 percent of individuals had pre-diabetes.[25] The current work was based on the hypothesis that in view of the body of knowledge on the increasing risk of cardiovascular events by age, worrying reports of HTN with its variable degrees among Saudi adults and that disease severity is associated with age, priority groups, i.e., servicemen 40y and above need to be protected from the complications of HTN, e.g., through systematic screening, to help them maintain optimum health standards in pursuit of their patriotic mission.

2. Methodology

In line with its community-oriented mission, PMH had started a multi-phase community diagnosis plan to indentify the health profile of the served community. In the first phase,[26] 2007-2008, mainly military recruits of all ages were targeted. In the current phase, (2010-2011), servicemen 40 years and older were targeted in a health screening project that would help identify some health and disease determinants in this particular population. Participating servicemen belong to military corps based in Taif region, west of Saudi Arabia. All seven major centers in the region were admitted, from which our study population was selected. A validated Arabic-language questionnaire form[27] was employed to accomplish aim of this study. Responding to the questionnaire's items was considered a consent each participant had given. The questionnaire consists of thirty-eight "items," (the term "item" will be used throughout the text to describe every single "question" asked to identify to what extent it "measures the same point"). Should an item be handled, e.g., during statistical analysis, then the term it would be referred to as a "variable". The items fall under five broad scales, including a) demographic criteria, e.g., age, income, marital status, children, education, b) risk factors, e.g., smoking, and calorie, c) lifestyle, engagement in physical activity, d) chronic diseases, e.g., perceived health status, HTN, lipid profile, diabetes mellitus (DM), and e) screening tests, e.g., history of lipid profile measuring and history of having colonoscopy done (if 50y or older). Some items of quantitative nature, e.g., age, duration of smoking, for smokers, height and weight, were addressed as their original interval or a ratio scale forms within the pertinent questions, (in which case, normality distribution for those variables would rather be evaluated in selecting most appropriate statistical techniques). Other quantitative-nature variables, such as income, number of daily smoked cigarettes, duration since a lipid-profile has ever been checked; all were addressed as categorical (or discrete) responses. The questionnaire takes 17-20 minutes to complete. All required official permissions were first obtained, arrangements with the participating organizations done prior to conducting our survey. A clearance from PMH Research Ethics Committee was granted, too. All returned questionnaires reported valid answers on ≥80% of the items, so were admitted to the study and then analyzed. A pilot administration was first conducted to assess the questionnaire's test-retest reliability. Twenty-six active-duty officers≥40 years of age from the PMH area were given the questionnaire to respond to (response-a). The same questionnaire was re-administered by the same pilot group one week later (response-b). A panel of juries (four public health and family medicine specialists) was selected to judge the responses. Test-retest reliability was then calculated to assess temporal stability of the utilized questionnaire items, using Pearson correlation (or Spearman *rho*, based on normality distribution of the item-variables). Obtained correlation coefficients for each pair of items (response -a vs. response-b) were as follows: a) number of daily smoked cigarettes: $r(24) = 0.84$ and $P < .05$, b) duration of cigarette smoking: $rho(24)=0.81$ and $P < .05$, c) height: $r(24)$ 0.73 and $P < .05$, e) weight: $rho(24)=0.72$ and $P < .05$, f) health status: $r(24)=0.68$ and $P < .05$, g) duration since last lipid profile measurement: $rho(24)=0.49$, $P > .05$. Further, acceptable –to- strong reliability evidence for the questionnaire's items existed: reliability alphas 0.78 for health risks, 0.83 for lifestyle, 0.76 for chronic diseases, and 0.91 for screening tests scales. (Likewise, alphas for reported subscales ranged between 0.801 and

0.92). Parallelly, all surveeys were interviewed, some of their clinical measurements assessed, namely: a) weigh (kg), b) height (m), c) BMI (kg/m²), [28] a BMI between 20-24.9 was considered normal, between 25-29.9 overweight, 30-34.9 stage-1 obesity, 35-39.9 stage-2 obesity, and ≥40 morbid obesity d) waist circumference (WC) (cm), as described by Wahrenberg et al[29] using tape measure, starting above the top of the hip bone (mid-way between the lateral lower ribs and the iliac crest), then brought all the way around, horizontally, leveled with the umbilicus; a WC≥ 102 was considered high. e) BP (mmHg), measured at the right arm in sitting position, using mercurial sphygmomanometer (*Sphygmomanometer MDS9410-Premier Aneroid-1999 Medline Industries, Inc., Mundelein, IL 60060, USA. Made in Japan. www.medline.com 1-847-949-3150 RJ99NSS*) and stethoscope [30]. Each subject was asked to take rest for at least 10 minutes in the supine position before recording the SBP and DBP. Another measurement of BP was taken after the interview, using the same sphygmomanometer and by the same health-worker[31] Blood pressure was measured using cuff of a size appropriate to the arm circumference in accordance with the recommendations of the British Hypertension Society Hypertension [32] for this screening was defined as "a SPB of 140 mmHg or higher or a DBP of 90mmHg or higher"[33, 34] while pre-HTN was defined as "a SPB of 120-139 mmHg or a DBP of 80-89 mmHg,"[3] and f) RBG (mg%) through a fingertip pinprick (using Accu-CheckÒ gluucometer system from Roche, manufacturer SKU 04528280001, ADM ID: 3231), where results could be obtained in 5 seconds. The scales and sphygmomanometers were checked regularly.

In practice, each participant eventually was re-classified as high or low risk for each risk factor, based on the JCN staging of HTN, so that stage-1 HTN means BP ranging from 140 to 159 systolic (or 90 to 99 diastolic), stage-2 means BP ranging from 160 to 179 systolic (or 100 to 109 diastolic), and stage-3 means BP equals to or greater than 180 systolic (or 110 diastolic) [35] On our part, too, those with SBP 120-139mmHg (or DBP 80-98mmHg) were called "pre-hypertensives." In practice, too, the SBP, not the DBP, measurement would be utilized in the most part of the analysis, since the former SBP predicts cardiovascular risk better than diastolic pressure,[36] especially in those older than 50 [3] Further, the awareness of these individuals of their high BP status determined whether they would be described as "known prehypertensive" or "newly prehypertensive," as appropriate. Likewise, individuals whose SBP and or DBP attained higher levels could either be "known hypertensive" or unaware they had HTN, so would also be called "newly hypertensive"[1]. Pre-diabetes is a term given to those with newly RBG≥200mg%, and diabetes = self-identified as having type-I or type-II diabetes while reported being seen by a medical professional about diabetes treatment.[37] A "smoker" was a term given to those who were "currently smoking - or quit ≤5 years" prior to the survey. [1] Data were entered to a Microsoft program with adequate back up; open-ended questions coded, and observations were made ready for statistical analysis. First, descriptive statistics, including frequency data, would be displayed. Parametric techniques, e.g., *t*-test, could be used, as appropriate, otherwise, non-parametric alternatives, e.g., Mann-Whitney *U* test, would be used. Testing the differences between groups (three or more) in the means of normally distributed outcome data, analysis of variance (ANOVA) would be used, (breeching normality assumption warrant using, e.g., Kruskal-Wallis alternative). Either a Pearson correlation or Spearman *rho*, depending on normality distribution, to examine the strength of correlation between any two continuous variables could also be used. Other non-parametric tests, e.g., chi-square test of independence, were used analyzing the associations between categorical variables, [in which case, the odds ratio (OR) with its 95% confidence interval (95%CI) may be used to measure the strengths and stability of the association, respectively]. The SPSS software for Microsoft- version-15 was used for statistical analysis. All tests were at level of significance a=0.05; results with *P*-values<.05 were considered "statistically significant."

3. Results

Out of 162 servicemen 40 years and older from the selected corps, 131(81%) voluntarily participated in this screening. Only 117(89%) of the returned questionnaires were valid to enter. From the demographic standpoint, (Table 1), the participants' median age was 45y, IQR=5y. Broken down into their ordinal age ranges (40-44, 45-49, 50-54), 58(49.6%), 48(41.0%), 11(9.4%) individuals fell under these categories, respectively (none was above 54y) (Table 3). The three age groups showed significant difference in their SBP levels [$H(2)= 8.25$, $P=.01$] (Table 3). Risk-wise, the mean BMI of the study population was 28.98 ± 4.11Kg/m² (corresponds to overweight) (Table 1). Split into BMI categories (Table 2), only 17(14.5%) of participants had normal BMI, 51(43.6%) were overweight, 39(33.3%) had first-degree obesity (obese-1), and 10(8.6) were obese-2. As high as 73(62.4%) participants had WC<102cm and 44(37.6%) were otherwise. Further, the overall mean WC (100±9.65cm) was still below the central adiposity level (102cm) considered for this population the time of the survey (Table 1).

Table 1: Demographic and physiological criteria of surveyees (n = 117)

	Minimum	Maximum	Range	Mean ±SD	Median	Percentiles		IQR [b]
						25th	75th	
Age (y)[a]	40.0	54.0	14.0	44.80 ±3.3	45.00	42.00	47.00	5.0
BMI (Kg/m²)[a]	20.1	39.8	19.7	28.98 ±4.13	29.04	26.15	31.17	5.0
WC (cm)a	70.0	125.0	55.0	100.17±9.63	99.00	94.00	106.0	7.0
SBP (mmHg) [a]	100.0	160	60.0	126.1±12.5	125.00	120.00	130.0	10.0
DBP (mmHg)[a]	70.0	110.0	40.0	83.0±9.6	80.00	80.00	90.0	10.0
RBG (mg/dl)[a]	66.0	475	409.0	138.9±70.2	118.00	103.00	139.5	36.5

[a] *K-S(z,p-value): Age(1.38, 0.042); BMI(0.64.0, 0.81); WC(0.99, 02.8), SBP(1.7, 0.04), DBP(2.0, 0.001), RBG(2.7, 0.001)*
[b] *IQR=Interquartile range (75th centile–25th centile) measured on the same scale for corresponding variables.*

Both SBP and BMI showed a rather weak, yet significant correlation [*rho*(115)=0.268, *P*=.38]. (In parallel, the DBP levels varied significantly between the BMI groups) [*H*(3)=7.87, *P*=.049]. However, SBP and BMI reported a modest but a highly significant correlation [Spearman *rho(115)*=0.268, *P*=.004] (Table 3). Likewise, SBP was significantly influenced by WC among the two WC groups [*U*=1127.5, *P*=.006] (Table 3).

The participants' RBG did not correlate with their BP values [correlation attempt for SBP with RBG: Spearman *rho*(115)=0.014, *P*=.88, another correlation attempt for DBP with RBG: Spearman *rho*(115)=0.082, *P*=.38].

Table 2: Distribution of age by BMI, and by WC

#	Categorical	Age			P-value
	BMI (kg/m²)[c]	**n(%)**	**Mean rank**	**Statistic**	
1	Normal (20-24.9)	17(14.5)	39.44	H=(10.16)[a]	.017*
2	Overweight (25-29.9)	51(43.6)	58.36		
3	Obese-1 (30-34.9)	39(33.3)	62.96		
4	Obese-2 (35-39.9)	10(8.6)	80.05		
	Total	117(100)			
	WC (cm)[c]				
1	(<201)	73(62.4)	53.3	U=(1191.0)[b]	.019*
2	(≥102)	44(37.6)	58.4		
	Total	117(100)			

[a] *Kruskal Wallis test*
[b] *Mann-Whitney test*
c Correlation: (BMI with WC): [Spearman rho(115)=0.3, P=<.001]

Smoking also did not correlate with- or influence -the recruits' BP, either as being a smoker or not (*U*=115, *P*=.35), by the daily number of smoked cigarettes category [*H*(6)=7.8, *P*=.253], or by the duration of smoking (in years) [*rho*(115)=0.138, *P*=.459]. The SBP levels did not differ by the recruits' physical activity behavior, too (*U*=466.5, *P*=.4).

The impact of some selected factors, either upon the presence of "pre-HTN" or "HTN" alongside with each subject's awareness of his BP health condition has been examined.

Table 3: Distribution of BP scale by BMI, WC, and age

#	Categorical	SBP (mmHg)			P-value
		n(%)	Statistic		
BMI (kg/m²) ├		117(100.0)	Correlation [a] coefficient = 0.268		.004*
WC (cm)			U=1127 [b]	Mean rank	.006*
1	(<201)	73(62.4)		52.45	
2	(≥102)	44(37.6)		69.88	
	Total	117(100)			
Age (year)					.016*
1	(40-44)	58(49.6)	H(2)=(10.16) [c]	50.84	
2	(45-49)	48(41.0)		64.65	
3	(50-54)	11(9.4)		77.36	
	Total	117(100)			

[a] *Correlation: (SBP and BMI): [Spearman rho(115)=0.268, P=.004]*

[b] *Mann-Whitney test: (SBP by WC)*

[c] *Kruskal-Wallis test*

Table 4 exhibits the incidence of each BMI/BP category. First, the subjects' SBP observations were split into six ordinal groups, based both on the span and the subjects' awareness of their BP condition (as self-identified, whether or not any of them was diagnosed and receiving medical treatment for high BP). For instance, the majority of subjects [60(51.3%)] were those who had a pre-hypertensive BP range (SBP category no.3 = 120-139mmHg, Table 4) and who were unaware of their elevated BP condition.

Table 4: Distribution of BP categories by BMI

#	Risk Category	SBP Category (mmHg)							P-value*
		1(<120)	2(<120)	3(120-139)	4(≥140)	5(≥140)	6(≥140)		
	BMI [a] (kg/m2)	Normtensive No H/O HTN	Normtensive On AHTN	Pre-HTN** Unawrae	Pre-HTN** On AHTN	HTN** Unaware	HTN** On AHTN		
		n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	Total	
1	Normal (20-24.9)	5(4.3)	0(0.0)	8(7.4)	2(1.7)	2(1.7)	0(0.0)	17(14.5)	.004*
2	Overweight (25-29.9)	8(7.4)	4(3.4)	28(23.9)	2(1.7)	8(7.4)	1(0.9)	51(43.6)	
3	Obese-1[b] (30-34.9)	4(3.4)	2(1.7)	16(13.7)	4(3.4)	12(10.3)	1(0.9)	39(33.3)	
4	Obese-2[b] (35-39.9)	0(0.0)	0(0.0)	8(7.4)	2(1.7)	0(0.0)	0(0.0)	10(8.5)	
	Total	17(14.5)	6(5.1)	60(51.3)	10(8.5)	22(18.8)	2(1.7)	117(100)	

[a] *Correlation: (SBP with BMI): [Spearman rho(115)=0.190, P=.004]*

[b] *Crosstabulation: (BP unadjusted): HTN (obese/normal BMI) vs. Pre-HTN (obese/normal BMI): OR:1.58, 95%CI:0.62, 3.99*

NB. For 1 unit increase in BMI, SBP increases by 0.95kg; for each 1kg weight increase, there is 1.2mmHg increase in SBP.

These individuals meet our standard "pre-hypertension" definition and are newly diagnosed. In comparison, only 10 individuals (8.5%) recorded a similar pre-HTN range but they were under medical treatment prior to the study. (These individuals initially could be either pre-hypertensive and then remained so, or may have progressed to frank HTN and failed to achieve remission despite the medical care they were given). The same tendency is observed among the hypertensive group; for 22(18.8%) subjects are newly hypertensive while only 2(1.7%) known hypertensive are uncontrolled (Table 4). After all, only 23(19.6%) subjects (whether physiologically normotensive or having fully-controlled HTN had SBP below 120mmHg, compared to the remaining sub-cohort (94 = 80.4%) who has SBP elevation (Table 4).Generally, belonging to a certain BP stratum significantly correlates with a corresponding BMI [*rho*(115)=0.190, *P*=.04].

Table 5: Distribution of prehypertension & hypertension by BMI

#		Pre-hypertension a			Hypertension b			Total
	BMI (kg/m2)	**n (%)**	**Statistic**	**P-value**	**n (%)**	**Statistic**	**P-value**	
1	Normal (20-24.9)	10 (10.6)	$H(3) = (8.22)^a$	0.04	2 (2.1)	$H(3) = (7.58)^b$	.023*	12 (12.8)
2	Overweight (25-29.9)	30 (31.9)			9 (9.6)			39 (41.5)
3	Obese-1[b] (30-34.9)	20 (21.3)			13 (13.8)			33 (35.1)
4	Obese-2[b] (35-39.9)	10 (10.6)			0 (0.0)			10 (10.6)
	Total	70 (74.5)			24 (25.5)			94 (100.0)

a Kruskal-Wallis test: Pre-HTN (SBP) by BMI: H(3)=8.22, P=.042
b Kruskal-Wallis test: HTN (DBP) by BMI: H(2)=7.58, P=.023

However, assessing the odds of having BMI-based obesity (either 1st degree - or - 2nd degree, as in numbers 3 and 4 rows, Table 4) against having normal BMI (no.1 row, Table 4) among individuals with HTN (either newly-diagnosed or known, columns 5 and 6 in Table 4), compared to having the same risk among pre-hypertensives (either newly-diagnosed or known, columns 3 and 4 in Table 4), no such significant relationship has been found [OR=1.58, 95%CI: 0.62, 3.99] (Table 4, footnote).

Table 6: Distribution of pre-HTN & HTN groups by BMI, controlling for age

	Risk	**Pre-hypertension (by Age)**			**Hypertension (by Age)**				**Statistic**	**P-value**
#	**BMI (kg/m2)**	**40-49y n (%)**	**≥50y n(%)**	**Total n(%)**	**40-49y n(%)**	**≥50y n(%)**	**Total n(%)**	**SUM n(%)**	Fisher's exact =18.92	.005*
1	Normal (20-24.9)	12 (12.8)	0 (0.0)	12 (12.8)	0 (0.0)	0 (0.0)	0 (0.0)	12 (12.8)		
2	Overweight (25-29.9)	31 (33.0)	1 (1.1)	32 (34.1)	6 (6.4)	1 (1.1)	7 (7.4)	39 (41.5)		
3	Obese-1 (30-34.9)	19 (20.2)	1 (1.1)	20 (21.3)	12 (12.8)	1 (1.1)	13 (13.9)	33 (35.2)		
4	Obese-2 (35-39.9)	7 (7.4)	3 (3.2)	10 (10.6)	0 (0.0)	0 (0.0)	0 (0.0)	10 (10.6)		
	Total	69 (73.4)	5 (5.3)	74 (7 8.7)	18 (19.1)	2 (2.1)	20 (21.3)	94 (100.0)		
Pre-hypertension (by smoking)					**Hypertension (by smoking)**					
	BMI (kg/m2)	**Non-smoker**	**Smoker**	**Total**	**Non-smoker**	**Smoker**	**Total**	**SUM**	Fisher's exact =16.67	.032*
1	Normal (20-24.9)	6 (6.5)	4 (4.3)	10 (10.8)	0 (0.0)	2 (2.2)	2 (2.2)	12 (12.9)		
2	Overweight (25-29.9)	13 (14.0)	16 (17.2)	29 (31.2)	7 (7.5)	2 (2.2)	9 (9.7)	38 (40.9)		
3	Obese-1 (30-34.9)	13 (14.0)	7 (7.5)	20 (21.5)	5 (5.4)	8 (8.6)	13 (14.0)	33 (35.5)		
4	Obese-2 (35-39.9)	2 (2.2)	8 (8.6)	10 (10.8)	0 (0.0)	0 (0.0)	0 (0.0)	10 (10.8)		
	Total	34 (36.6)	35 (37.6)	69 (74.2)	12 (12.9)	12 (12.9)	24 (25.8)	93 (100.0)		
Pre-hypertension (by Exercise)					**Hypertension (by Exercise)**					
	BMI (kg/m2)	**No Exercise**	**Exercise**	**Total**	**No Exercise**	**Exercise**	**Total**	**SUM**	Fisher's exact =10.06	0.19
1	Normal (20-24.9)	1 (1.1)	9 (9.7)	10 (10.8)	2 (2.2)	0 (0.0)	2 (0.0)	12 (12.9)		
2	Overweight (25-29.9)	2 (2.2)	28 (30.1)	30 (32.3)	8 (8.6)	1 (1.1)	9 (9.7)	39 (41.9)		
3	Obese-1 (30-34.9)	5 (5.4)	15 (16.1)	20 (21.5)	9 (9.7)	3 (3.2)	12 (12.9)	32 (34.4)		
4	Obese-2 (35-39.9)	1 (1.1)	9 (9.7)	10 (10.8)	0 (0.0)	0 (0.0)	0 (0.0)	10 (10.8)		
	Total	9 (9.7)	61 (78.7)	70 (88.4)	19 (20.4)	4 (4.3)	23(24.7)	93 (100.0)		

As per the study design, hypertensive subjects were stratified into three-BP stages: stage1, 2, and 3. All hypertensive subjects only fell under stages 1, none were stage 3 (Table 5).The incidence of individuals with pre-HTN accounts up to 70(74.5%, n=94), compared to only 24(25.5%) individuals with frank HTN. In the two groups, there was a significant relationship between BP level and BMI (*H*(3)=8.22, *P*=.042, and *H*(2)=7.58, *P*=.023, respectively) (Table 5). To this end, there was not a significant difference in the influence of BMI particularly developing g either pre-HTN or HTN, when both BP states were examined crudely (unstratified). The next step, thereby, was to study the two principal BP groups in this Stratified by age (40-49y, and ≥50y), the incidence of individuals with pre-HTN compared with that for HTN for different BMI ranges significantly varied (Fisher's exact=18.92, *P*=.005). For instance, younger-age pre-HTN subjects from the overweight group accounted up to 31(33%, n=94), vs. only 6 counterparts from the older age group with HTN. The overall frequency of subjects with pre-HTN, vs. those with THTN across the MBI groups was as much as 74(78.7%), vs. only 20(21.3%). Further stratification by smoking revealed that pre-HTN and HTN varied significantly in their frequencies throughout the BMI groups (Fisher's exact=168.67, *P*=.032) (Table 6). Stratification by exercise status did not impact the variability in the frequency of having pre-HTN and HTN. The same pattern of having pre-HTN incidences more than HTN ones is almost recognized the entire comparisons. [For example, there are 8(8.6%, n=93) pre-HTN smokers against none HTN peers; and the total number of Pre-hypertensives (smoker and non-smoker) is almost triple that of hypertensive peers: 69(74.2%) vs. 24(25.8%).

Table 7 shows the relationship between SBP of the study population and their self-identified blood lipid status (as being diagnosed and receiving treatment at a professional medical setting). A significant relationship between dyslipidemia status and SBP has been found (Fisher's exact=44.69, *P*=.013). [Further analysis revealed that pre-hypertensives had 7.6-times odds of reporting medically diagnosed dyslipidemia than normotensive counterparts (95%CI: 1.6, 35.1). Added up together, pre-hypertensives-hypertensives had 6.9 odds of reporting lipid disorders than normotensive (95%CI: 1.5, 29.96); hypertensives also had 5.2 odds of reporting lipid disorders, compared to normotensives, however the relationship was barely insignificant (95%CI: 0.99, 27.1)].

Table 7: Distribution of BP by dyslipidemia status

#	SBP						
	Dyslipidemia Treatment	**Normal**	**Pre-HTN**	**HTN**	**Total**	**Statistic**	**P-value**
1	Not reported	21(18.1)	40(34.5)	16(13.8)	77(66.4)	Fisher's exact = 44.68	.013*
2	Reported	2(1.7)	29(25)	8(6.9)	39(33.6)		
	Total	23(19.8)	69(59.5)	24(20.7)	116(100.0)		

Crosstabulation: Pre-HTN/ Normal BP by dyslipidemia (reported/un-reported): OR=7.6, 95CI: 1.6, 35.1
Crosstabulation: Pre-HTN-HTN/Normal BP dyslipidemia (reported/un-reported): OR=6.9, 95CI: 1.5, 29.96
Crosstabulation: HTN/Normal BP dyslipidemia (reported/un-reported): OR=5.2, 95CI: 0.99, 27.1

4. Discussion

The study endorses a health problem of an utmost importance to the public's health, universally. Hypertensive disease and surrounding risks are widely prevalent, worldwide.[33,10] In this study, 100(85.5%) individuals importantly had an abnormally high BMI (51=43.6% overweight, 39=33.3% first-degree obesity, 10=8.6% were second-degree obesity). In fact, overweight and obesity are a major health threat to the Saudi community. Saudi Arabia is now number 29- fattest country in the world.[38] The Saudi community is growing fatter in association with the pronounced change in the people's lifestyle brought by prosperity and accompanying transition to high-calorie food, abandoning locally grown natural produce, together with declining level of activity and increased reliance on technology. Based on the "National Nutrition Survey" of 2007, the Obesity Research Center, King Soud University, KSA estimates that the prevalence of overweight and obesity among Saudis men (all ages) is 30.7% and 14%, respectively.[39] In their community-based survey, part of a major national "Coronary Artery Disease in Saudis Study- CADISS" project, Al-Nozha and colleagues revealed that the prevalence of overweight among Sudi households was 36.9% (31.8% in females and 42.4% in males). Also age-adjusted obesity was as 35.5% prevalent (26.4% in males and 44% in females).[40]

Our population's BP consistently showed a significant relationship with the BMI at different levels of the analysis. For instance, the two variables were rather correlated when they were analyzed solely [*rho*(115)=0.268, *P*=.004, Table 3]. Adjusted by age and also by smoking, the participants' BMI impacted the development of either pre-HTN or HTN in the two scenarios (Table 6). (Parallelly, both HTN and pre-HTN varied by the level of their BP among the BMI groups, Table 5). In Brazil, a similar study to estimate the prevalence of HTN and associated risks in military personnel had been carried out . Among 83(22%, n=380) hypertensives, overweight and obesity were 75% and 17.8% significantly higher than among the normal-weighted, respectively. In comparison, our hypertensives who were -overweight and those who were obese; each subset was significantly 66.7% higher than hypertensives with normal BMI (Table 5). Among the hypertensive Brazilians, too, more than two-thirds (15%, n=380) were ex-smokers, compared to non-smokers. Comparatively, too, the incidence of Saudi hypertensive smokers vs. non-smokers was equal (12:12) (Table 6). In our study, the smoking rate among hypertensives affects the BP level when the BMI has been covariate (Table 6). While HTN was 52% less frequent among physically-active than among physically-inactive Brazilians, no such associating has been found among our study sample. The difference between the Brazilian risk-outcome pattern and ours, e.g., regarding smoking, is most probably that such risks often has to work synergistically, when their impact upon the individual's vascular bed by time, and hence BP, has been evident.[1] In this screening, it was difficult to determine the duration each lifestyle or risk behavior had been in place prior to the study, relying instead on the participant's own estimation. Not only is duration important from the statistical viewpoint, i.e., shaping the strength of association, (e.g., the *rho* or the OR), and test stability, (e.g., the *P*-value or the CI) in the risks- BP analysis, but it helps track the patho-physiological changes that take place, e.g., in order for a marginally high BP to progress to overt hypertension. In 2006, Grossman and his collaborates [42] aimed to assess the rate of progression to HTN over 18±7ys of follow-up, among a cohort of male recruits, 48% (n-367) of whom had pre-HTN at the onset of the study. First, all pre-hypertensives were to meet an abnormally high BMI standard. Through the study period, 110(30%) subjects (77 with pre-HTN and 33 with normal BP), developed HTN, compared to 20.5% in the Saudi recruits, while the remaining majority (257=70%) were in the pre-HTN zone, compared to 59.8% Saudi peers. The two experiences, Grossman's and the current work generate almost comparable pre-HTN: HTN ratios (2.33:1 and 2.9:1, respectively). Apparently, the incidence of pre-HTN is consistently higher than HTN. The OR for pre-hypertensives turning hypertensive was 3.7 times greater than among the normotensives ($p<0.05$) among Grossman's cohort. Given the prognostic derangement of sustained pre-HTN, subjects with pre-HTN would rather be closely monitored, adequate medical care advised, their unhealthful lifestyle be changed into protective dietary and physical activity to prevent future complications.[3,18,43] In Kuwait, determining the proportion of pre-HTN and HTN with some related risks in college students[43] the measurements of the identified BP groups were as follows: normotensive = 53.5%, pre-hypertensives = 39.5%, and hypertensives=7%, (7.6:5.6:1, respectively, compared to 19.6% normotensive, 59.8% pre-hypertensives, 20.5% hypertensives (0.9:2.9:1, respectively) in the current screening. More than 80% of Saudis (59.8%+20.5%) had high BP, compared to 46.5% (39.5% +7%) Kuwaitis. The latter only aged 17-23 (range=6y), while our population's age(40-54) ranged more than twice the Kuwaiti range (14y: 6y). Not only is age risk for HTN and cardiovascular events, but obesity [10,12], dyslipidemia[44], and DM are. [42,45] These morbidities perse are risk factors for CVD. Interestingly, the studied college students[43] were also at risk of developing morbid BP in association with their lipid disorders, as was the case in our screening, despite the age difference. Kuwaitis and Saudi Arabians are neighbors who share common ethnic lineage and social values. The two communities are experiencing similar health consequences of prosperous life. Apparently, both young- and old-age populations in this area of the world are growing hypertensive.[4,9] Elsewhere, too, there is a growing concern that young adults have a relatively comparable risk of developing cardiovascular events[46,47,48]

In the 2008 study to identify the prevalence of pre-HTN/HTN, their risks among recruits in Taif [26], the recruits' age ranged between 18 and 50y, and more than 70% of them were younger than 40. While 80.3% of this study's cohort had high BP, HTN only involved 19.1% of the 2008-study recruits (17.3% pre-HTN: 1.7% HTN=10.2:1). IN terms of absolute numbers, the burden of pre-HTN in older Taif recruits is 3.5-times that e.g., in Kuwait college student population (59.8% vs. 17.3% = 3.5:1). Nonetheless, the relative burden of pre-HTN to HTN compared to HTN is 3.5 times as in our population (10.2: 1/2.9: 1). In a given population, the occurrence rate of pre-HTN predominantly exceeds the occurrence of frank HTN.[42,43,26,49] In Saudi Arabia, too, investigators from metropolitan Jeddah on west cost, found that 43.0% and 25.2% of the school teachers, all ages analyzed for their BP epidemiology were pre-hypertensive and hypertensive, respectively.[49]

Alarmingly, too, only 30.4% of the hypertensives were aware of their condition. Not only the majority of pre-hypertensives recruits (60/70 =85.7%) were unaware of their BP elevation, but the hypertensives, too (22/24=91.2%) (Table 4), compared to only 30.4% of the Jeddah hypertensives who were aware of their ailment.[49] in the US, 31% of hypertensive Americans were unaware that they had HTN [50] The American record of the rate of populations' unawareness of their hypertensive diagnosis is distinct from the Saudi records, e.g., 69.6% (100.0% - 30.4%) in Jeddah;[49] and 85% to 91.2% in Taif (the current screening). While 29% diagnosed hypertensive Americans (i.e., aware of their high BP) are under treatment but are not controlled, only 10.2% of our hypertensives are not controlled (10=8.5% in pre-HNT zone, 2=1.7% in the HTN zone), another promising finding toward an effective medical care and risk reduction alternative programs. On the other hand, Jeddah population;[49] demonstrates that for every 4Kg increase in teacher's weight, SBP increases by 1mmHg. Comparably, each 1kg/m^2 increase in BMI may result in 0.95kg increase in SBP; and each 1kg of weight increase yields

0.312mmHg increase in SBP, in a regression, or that 4kg in excess of MBI results in 1.2mmHg in excess of SBP (Table 4, footnote). Our finding is also comparable to findings from other researches that 4-15mmHg reduction in BP can be achieved with 2-10kg weight reduction[10].

Studies show that as affluence increases, the prevalence of CVD, including high BP.[51] The hardship and scarce resources that stigmatize rural areas in developing countries tempt many to seek better life opportunities, e.g., urbanize and often volunteer in the army, ensuring better income and sustaining a stable career. urbanization, not uncommonly suggests a shift in diet to a high salt and calorie intake, reduced potassium intake due to consuming less fruit and vegetables[52] and hence the likelihood of a higher mean BP. However, some upsides can still be seen with this study's regard. For instance, the reported HTN proportion ranked third, e.g., among 5 other studies addressed for comparison: first, is Grossman et al study (30%),[42] second is Jeddah study (25.2%),[49] forth is the Abha attempt (12%)[25] fifth is the Kuwaiti screening[43] (7%), and lastly, the earlier Taif study (1.7%). The relative differences in some of these studies' population criteria, e.g., age range and setting, partly justify the differences in proportions of BP elevation patterns. The Grossman et al model enjoys highest representativeness and generalizability likelihood among all these studies, thanks to the prospective approach, and long follow-up period it has sustained. It provides that even in the military setting where a better opportunity to a healthier and more physically active life is presumably ensured, enlisted personnel keep sustaining unsatisfactory cardiovascular health. However, an upside of the epidemiologic BP picture formed by this research can be foreseen: first, only pre-HTN not HTN was predominant in the elevated BP problem, second, all hypertensives are grade 1 and 2 only; none is grade 3; third, the scarcity (only 10.2%) of hypertensives who are not controlled. All these findings perhaps favor more successful control of HTN and allow enhance the likelihood of a better prognosis of cardiovascular health status both at the individual patient's level and at the military community level. An efficient medical treatment approach together with an alternative risk reduction and lifestyle modification intervention[3,18] that highlight relevant needs, such as weight reduction[10,11] increased physical activity[13] sodium reduction,[14,16,17] potassium supplementation[18,19] and that may only want to recall the previous physical activity and health fitness experiences this particular population had to sustain early in their military career, is able to bring tangible improvement in their cardiovascular health in the forecasted timeframe.

Our study has some limitations, important of which is that most participants disagreed to have their blood tested for lipoproteins, especially those who had high BP, probably for fear of being labeled on the worksite with "dyslipidemia and HTN.[47,48] This study provides that our military community was not immune against the consequences of today's way of life that promotes for technology comfort, little fiber and fast food consumption. The prevalence of pre-HTN/HTN and some associated risks, most of which are modifiable, such as obesity, smoking, and dyslipidemia is rather challenging. However, planners should not be discouraged, e.g., by the modest results from Abha health promotion attempt[25] that probably meant to assess the program's outcome, e.g., before it has reached maturity.[10] The merits our population still enjoys, e.g., less likelihood of frank HTN and trivial treatment failure rate, make a well-planned lifestyle modification program success more likely. Also, pharmacotherapy for pre-HTN, when added, bolsters the proposed program's success opportunity, especially for specific high-risk conditions, such as those with renal disease and diabetics.

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