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REVIEW ARTICLE

Prevalence of Prehypertension among Saudi Adults: A Narrative Review

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Abstract:

Background:

Prehypertension is a pre-disease state wherein an individual has a blood pressure (BP) measurement above normal (≥120/80 mmHg) but below the hypertensive range (<140/90 mmHg). Large population-based studies have shown that individuals with a BP in the prehypertensive range have an increased risk of developing hypertension and cardiovascular events. Despite these risks and high mortality rates associated with pre-hypertension, there are currently no reviews that define the prevalence of pre-hypertension in the Saudi population.

Objective:

To determine the magnitude of the pre-hypertension problem among Saudi adults and identify areas for future research based on the current gaps in the literature.

Methods:

This narrative review considers studies addressing the prevalence of pre-hypertension among Saudi adults; 8 studies were identified for this review.

Results:

In total, 14,782 men and women participated in these studies. The overall prevalence of pre-hypertension in both sexes ranged from 18.5-54.9%. Men had higher rates of pre-hypertension (24.7-66.1%) than women (7-48.1%).A modifiable risk factor reported in the majority of the studies was increased adiposity.

Conclusion:

Lifestyle changes to reduce weight may be effective in preventing or at least delaying the progression to hypertension and its associated cardiovascular events. Large, prospective, epidemiological studies are needed to estimate the risk of incident hypertension and cardiovascular events in pre-hypertension patients. Randomized clinical trials are also needed to evaluate the effectiveness of lifestyle modification and/or pharmacotherapy in reducing the risk of incident hypertension.

Keywords: Prehypertension, Saudi population, Hypertension, Cardiovascular events, Prevalence, Cardiovascular risk.

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1. INTRODUCTION

Hypertension, “the silent disease” or the “silent killer”, is a global health problem [1, 2] and a major cause of morbidity and mortality among the Saudi population [3]. In large national studies, the estimated prevalence of hypertension among Saudi adults was 15.2-25.5% [4, 5]. Many people with hypertension are not aware of the problem, and those diagnosed are either not being actively treated or their hypertension is not well controlled [4, 5]. The consequences of undiagnosed, untreated, or uncontrolled hypertension are serious and morbid, including heart failure, coronary heart disease, and renal failure. All these morbidities pose a great burden on the healthcare system and contribute to increased mortality rates associated with hypertension-induced cardiovascular disease.

The importance of screening populations for high blood pressure cannot be over-emphasized. Despite all efforts to raise awareness among the general population and screening for hypertension, the problem persists. More efforts are needed to minimize the detrimental consequences of this disease.

Prehypertension, in contrast, is a transitional stage preceding the development of actual hypertension and is

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defined as systolic blood pressure (BP) of 120-139 mmHg and/or a diastolic BP of 80-89 mmHg among adults [6]. Globally, the prevalence of pre-hypertension in adult populations is 25-50% [7]. There is accumulating evidence from large epidemiological studies that patients with pre-hypertension are more likely to progress to hypertension [8] and cardiovascular (CV) events [9 - 11]. Therefore, it is of the utmost importance to identify patients with pre-hypertension, as lifestyle modification plays an important role in delaying its progression to hypertension, as well as in preventing or delaying the consequential CV events [6].Currently, no reviews clearly define the prevalence of pre-hypertension in the Saudi population. Therefore, the aim of this review was to determine the magnitude of the pre-hypertension problem among Saudi adults and identify areas for future research based on the current gaps in the literature.

2. MATERIALS AND METHODS

For this narrative review, PubMed and Google Scholar searches were performed using the following keywords: "pre-hypertension", "high normal blood pressure" OR "hypertension" AND "prevalence" AND "Saudi". Additional references were sought by a manual search of the retrieved articles. Studies assessing adults aged >18 years were included. The seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC-7) was used in all the studies to define pre-hypertension (systolic BP between 120 and 139 mmHg and/or diastolic BP between 80 and 89 mmHg in patients not taking antihypertensive medications) [6].

3. RESULTS AND DISCUSSION

3.1. Prevalence of Pre-hypertension

Studies on prevalence that were conducted among adults were included in this review. A total of 8 studies were included in Table **1**.

The first study to address the prevalence of pre-hypertension among Saudi adults was conducted in Jeddah, in 2008 and included 1,476 school teachers from 55 different schools selected by a multistage stratified random sampling technique [12].The sample studied included both male (52.8%)and female teachers with ages ranging from 22-60 years. BP was measured following a standard protocol with a mercury sphygmomanometer, and the JNC-7 criteria were used to define pre-hypertension [6]. The overall prevalence of pre-hypertension was 43% and was higher among male teachers (50.7*vs* 34.4%; $p<0.001$). Although the study participants included teachers with diabetes mellitus (18.2%) and impaired fasting blood glucose level (9.9%), the only significant predictors for pre-hypertension in this study were male gender (OR=3.22, CI: 2.49-4.16), age ≥40 years (OR= 1.48, CI: 1.09-1.95) and BMI ≥25 kg/m^2 (OR=1.35, CI: 1.02-1.77).

Table 1. Summary of Saudi studies addressing prevalence of pre-hypertension.

Authors/Year	City/Region	Sample size/sex	Age mean (SD) and/or range	Obesity rate/mean BMI	Prevalence of prehypertension	Risk factors OR (95% CI)
Ibrahim *et al*. [12]/2008	Jeddah/Western region	1,476/ male (52.8%) and female	36.5(7.6)/ 22-60 years	35%	Overall 43% Male 50.7% Female 34.4%	Male sex, OR 3.22 (2.49-4.16) BMI ≥25, OR 1.35(1.02-1.77) Age group≥40 years, OR 1.48(1.09-1.95)
Koura *et al*., [13]/2012	Dammam/Eastern region	370/ females only	19.9(1.4) years	29.1% (overweight & obesity)	13.5%	Overweight/obesity, OR 3.34 (1.77-6.30)
El Bcheraoui *et al*., [5]/2014	National study from 13 regions	10,735/ male (48.9%) and female	15-65+ years	-	Overall 40.6%	Female sex, OR 0.36 (0.31-0.43) Age, OR 1.03(1.02–1.04) Obesity, OR 1.55 (1.30-1.83)
Sonbol *et al*., [15]/2017	Jeddah/Western region	100/ females only	22.1(1.6)years	9% 22.8 (4.9)kg/m^2	7%	-
Al-Mohaissen *et al*., [16]/2017	Riyadh/Central region	530/ females only	20.5 (1.8)/ 17-29 years	32.3% (overweight & obesity)	24.3%	-
Gutierrez *et al*. [17]/2018	Tabuk/North Western region	432/male (54.4%) and female	18-50+years	69.9%/ male 27.9(5.8) kg/m^2 female 28.7(6.7) kg/m^2	Overall 18.5% Male (72.5%) Female (27.5%)	-

(Table 1) contd.....

Authors/Year	City/Region	Sample size/sex	Age mean (SD) and/or range	Obesity rate/mean BMI	Prevalence of prehypertension	Risk factors OR (95% CI)
Aldiab *et al*., [18]/2018	Alkharj/Central region	1,019/male (37.4%) and female	18-67 years	34.4%	Overall 54.9% Male 66.1% Female 48.1%	Female sex, OR 0.476 (0.319-0.712) Overweight, OR 3.374(2.045-5.568) Obesity class I, OR 2.560 (1.537-4.264) Obesity class II/III, OR 1.810 (1.048-3.126)
AlWabel *et al*. [19]/2018	Qassim/Central region	130/male (71%) and female	22.5(1.67)/ 19-27 years	22.3%	Overall 29.2%	Male sex, OR3.721 (1.384-10.002)

Abbreviations: BMI, Body Mass Index; CI, Confidence Interval; OR, Odds Ratio; SD, Standard Deviation

In 2012, another study was conducted in the Eastern province of Dammam [13]. A total of 370 female students (mean age ±SD: 19.9±1.4 years) were enrolled in the study through multistage stratified random sampling. Details regarding BP measurement techniques were not described, apart from the number of measurements and the position of the subject while their BP was measured. The prevalence of pre-hypertension among the study group was found to be 13.5%, using the JNC-7 criteria [6]. The only significant predictor of pre-hypertension was overweight/obesity (OR=3.34, 95% CI:1.77-6.30). Only 4 subjects had diabetes (1%), but overweight/obesity was prevalent among 29.1% of the study group.

The Saudi Health Information Survey is the largest national study to be conducted thus far, consisting of 10,735 participants aged ≥15 years across 13 different regions in Saudi Arabia [5]. The study participants included patients with chronic diseases, including diabetes and hypercholesterolemia. BP was measured following the National Health and Nutrition Examination Survey standardized protocol for BP measurement [14]. The overall prevalence of pre-hypertension among the study population (referred to as "borderline hypertension" by the authors) was 40.6%. Age (OR=1.03, 95% CI:1.02-1.04) and obesity (OR=1.55, 95% CI:1.30-1.83) were associated with increased risk of prehypertension, while being a female was protective (OR=0.36, 95% CI: 0.31-0.43).

A pilot study investigating pre-hypertension among 100 apparently healthy female university students in the Western region of Jeddah [15], reported a prevalence of 7%. BP was measured using an automated BP monitor that was validated by the British Hypertension Society. This low pre-hypertension prevalence could be explained by the low prevalence of obesity among the study group (9%). However, this was a pilot study with a small sample size which is not representative of the whole population; limitations that were explicitly acknowledged by the authors.

In 2017, a study was conducted in Riyadh involving 530 female students, with a mean age of 20.5±1.8 years [16]. An automated BP monitor was used, and BP was measured using a standardized method. The reported prevalence of pre-hypertension was 24.3%. Almost one-third of the study participants were obese or overweight (32.3%), and 46.5% reported a family history of hypertension. Risk estimates were not reported in this study, however, BMI was significantly higher in the prehypertensive group (mean[SD]=25.5[6.5] kg/m^2) compared with those with normal BP (< 120/80 mmHg) (mean[SD]= 23.4[4.8] kg/m^2).

A cross-sectional study assessing cardiovascular disease risk factors among 432 citizens (54.4% males), 18-50+ years old (48% were between 18-30 years old), was conducted in Tabuk (North-Western region of Saudi Arabia) [17]. The study was conducted in the major city malls involving participants who voluntarily agreed to take part in the study. BP was measured using a manual mercury sphygmomanometer by trained nursing and medical interns. Despite the high prevalence of overweight and obesity among the study participants (69.9%), pre-hypertension was only found in 80 subjects with a prevalence rate of 18.5%, mainly affecting males (72.5 *vs* 27.5%; p<0.001).

Another relatively large population-based study in Al Kharj (Central Saudi Arabia) was conducted by Aldiab *et al*. [18]. The sample included 1,019 subjects of both sexes aged 18-67 years (90% of the participants were <40 years old). BP was measured in a standardized manner using a mercury sphygmomanometer. The overall prevalence of pre-hypertension was 54.9% (66% in males *vs*. 48% in females). The risk of pre-hypertension was lower in females (OR =0.48; 95% CI: 0.32-0.71). More than 60% of the prehypertensive subjects were either overweight (26.7%) or obese (34.4%), and this was a significant predictor for pre-hypertension (OR and 95% CI for overweight, class I obese and class II obese were: 3.374 [2.045-5.568]; 2.560 [1.537-4.264]; and 1.810 [1.048-3.126], respectively). Moreover, 30% of the prehypertensive subjects had high levels of glycosylated haemoglobin (HbA1c) and 14% had high levels of serum cholesterol (≥5.6 mmol/L).

A recent study on the assessment of hypertension among 130 medical students at Qassim University, reported the prevalence of pre-hypertension to be 29.2% in both sexes (70.8% males) [19]. BP was measured by trained medical students following the American Heart Association guidelines [20]. Despite the young age of the participants (mean age 22.5 years, range 19-27 years), hypertension was prevalent in14.6% of the study group, and almost 50% of them were either overweight (26%) or obese (22%). Nevertheless, the only significant predictor of pre-hypertension in this study was the male sex (OR=3.721, 95% CI: 1.384-10.002).

Table 2. Methodology used to measure BP.

Authors/Year	Instrument used for BP measurement	Position of subject	Use of an appropriately sized cuff	Resting period	Arm supported at the level of the heart	Number of readings
Ibrahim *et al*. [12] /2008	Mercury sphygmomanometer	Sitting	-	5 min	Yes	-
Koura *et al*. [13] /2012	-	Sitting				2
El Bcheraoui *et al*. [5] /2014	Following the National Health and Nutrition Examination Survey instructions					3
Sonbol *et al*. [15] /2017	Automated BP monitor (Omron)	Sitting	Adult	3-5 min	Yes	3
Al-Mohaissen *et al*. [16] /2017	Automated BP monitor (Omron M6 comfort)	Following the National Health and Nutrition Examination Survey instructions				3
Gutierrez *et al*. [17] / 2018	Mercury sphygmomanometer	Sitting	-	10 min	-	2
Aldiab *et al*. [18] / 2018	Mercury sphygmomanometer	Sitting	Adult	-	-	-
AlWabel *et al*. [19] /2018	Following the American Heart Association guidelines					

Abbreviations: BP, Blood Pressure

The BP measurement technique is extremely important for valid results. Table **2** summarizes the methodologies used to obtain BP measurements in the different studies. None of the studies on prevalence included the out-of-office recording of BP. However, a recent systemic review and meta-analysis showed that automated office BP measurements, taken when the patient is sitting alone in a quiet place, are better correlated with awake ambulatory BP readings, which is the gold standard for predicting cardiovascular risk. This method eliminates the white coat effect and if implemented appropriately, may result in lower prevalence rates of pre-hypertension [21].

3.2. Risk Factors Associated with Pre-hypertension

Modifiable risk factors that were reported in a majority of the studies included being overweight or obese [5, 12, 13, 16, 18]; hence, maintaining a normal weight is important, especially in patients who are at a higher risk of pre-hypertension due to the co-existence of non-modifiable risk factors such as male sex, family history of hypertension, older age, genetic factors and racial background (given the multiracial makeup of the Saudi society in several provinces). The link between obesity and higher BP has been well documented [22] and is beyond the scope of this review. However, the recommended lifestyle changes [23] to maintain an optimum body mass index, especially a healthy diet and physical activity, should be applied to improve this modifiable risk factor. This is extremely important in view of the growing prevalence of obesity and diabetes, which are major health problems among the Saudi population [24, 25].

Apart from obesity which is a well-documented modifiable risk factor for pre-hypertension/ hypertension reported in the majority of the studies, chronic cigarette smoking increases blood pressure by inhibiting reflex vasodilation, increasing oxidative stress [26] and stimulating the sympathetic nervous system [27]. Nevertheless, none of the studies included in this review reported smoking as a risk factor for pre-hypertension. This could be due to the low rates of smokers in some studies, especially those recruiting females only (1.4% [13], 6.8% [16]). However, smoking was not prevalent even in studies recruiting both sexes (15.6% [12] and 1.5% [19]). Nevertheless, the validity of establishing smoking status by questionnaires may be curbed by underreporting, especially among the youth. Also, the interaction between some highly prevalent factors (*e.g*., older age and higher BMI, smoking habits and male sex, etc...) and the risk of pre-hypertension should be acknowledged and carefully considered.

3.3. Interpretations, Limitations and Implications

The discrepancy in the reported prevalence of pre-hypertension among the different studies is expected and most likely stems from the differences in the characteristics such as age, sex, and presence of co-morbidities among the study population, and different methods of BP measurement (mercury *vs*. automated).A similar variation in the prevalence of pre-hypertension was reported in an earlier published meta-analysis that included 22 studies with a total of 242,322 subjects of both sexes from all over the world [28]. The prevalence of pre-hypertension reported in this review [28] ranged from as low as 14.5% in a Turkish population to as high as 58.7% in a Nigerian population, with an overall pooled prevalence of 38%. No similar review studies conducted in the gulf region were found in the literature to compare with the results of the present review. However, two recent systematic reviews and meta-analyses on the prevalence of pre-hypertension in the Middle East and North Africa [29] and the Middle East region [30] revealed a pooled prevalence rates of 30.6% (95% CI 25.2-36.0%) and 28.6% (95% CI: 24.2-33.8%), respectively.

It can be noted from Table **1** that the prevalence of pre-hypertension in studies that recruited both sexes, was higher in males. This is consistent with other recent studies [31, 32] conducted on different populations. The higher BP in males is well documented and physiologically explained by the effects of sex hormones on the renin-angiotensin system, and differences in renal and the sympathetic nervous system functions [33, 34]. Women before menopause are at a lower risk of hypertension due to the vasodilator effects of estrogens [35]. These sex differences in BP regulation may have an impact on the management of hypertension according to the sex of the patient, where certain antihypertensive medications may be more effective in one sex than the other.

Despite the standardized methods of BP measurement implemented in most studies included in this review, accurate BP readings are challenged by many factors like environmental ambient temperature, time of day, phase of the menstrual cycle, stress level, caffeine intake, physical activity, smoking, bladder

fullness, etc. Such factors, which are not usually controlled or accounted for, result in methodological variations that may contribute to the observed differences in the reported prevalence of pre-hypertension among different studies.

Moreover, the studies in this review were heterogeneous in terms of the characteristics of the studied populations (*e.g*., age, sex, BMI, geographical region, occupation, smoking status, and presence of chronic diseases and other co-morbidities). Four of the studies included young university students only [13, 15, 16, 19], some only recruited female students [13, 15, 16] and in some, the sampling was from certain occupations (school teachers) [12] or specified regions of Saudi Arabia [12, 13, 16 - 19]. Only one national study that included subjects from different regions of Saudi Arabia was found [5].

To avoid misleading results, a meta-analysis was not attempted because of this heterogeneity in addition to the small number of studies included in this review.Another key reason is that one study [5] represents 10,735 of the 14,782 participants in the 8 studies (*i.e*. 72.6%).

3.4. Recommendations and Future Research

Given the high prevalence of pre-hypertension reported in several local studies, raising awareness among the public about the associated risks should be seriously considered by primary health care authorities. Efforts should be dedicated to using the results of "Knowledge, attitude and practice (KAP)" studies to highlight the progress of national prevention campaigns.

More research is needed to accurately estimate the magnitude of the problem among the general population, preferably using BP measurements within an office setting or 24h ambulatory BP monitoring, which may result in lower rates of pre-hypertension. Prospective cohort studies are also needed to identify risk factors for progression to hypertension and to estimate the risk of cardiovascular events in these patients. Other clinical, environmental and metabolic risk factors (*e.g*. prediabetes, inflammatory markers, psychological stress, smoking and drinking, physical activity, diet, dyslipidaemia and hyperglycaemia) should be thoroughly investigated in future studies. Appropriate management strategies with lifestyle interventions and/or pharmacotherapy should be addressed with well-designed, randomised controlled clinical trials. Clear guidelines on the management of pre-hypertension, based upon the best available evidence, should be available for healthcare providers.

CONCLUSION

A limited number of studies have addressed the prevalence of pre-hypertension among Saudi adults. The prevalence of pre-hypertension ranged from as low as 7% to as high as 66%. This review revealed that pre-hypertension research is still in its infancy, and more work is needed to address the magnitude of the problem and its consequences. Screening for pre-hypertension and efforts focused on the prevention of hypertension through lifestyle modification measures should be strengthened.

LIST OF ABBREVIATIONS

BMI = Body Mass Index

BP = Blood Pressure

CV = Cardiovascular

JNC-7 = Seventh Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure

KAP = Knowledge, Attitude and Practice

CONSENT FOR PUBLICATION

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CONFLICT OF INTEREST

The author declares no conflict of interest, financial or otherwise.

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