ORIGINAL ARTICLE

High Blood Pressure and Associated Cardiovascular Risk Factors in Iran: Isfahan Healthy Heart Programme

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Summary

This study was done to estimate the prevalence of high blood pressure (BP) in treated and non-treated subjects with respect to age and gender and its association with other cardiovascular risk factors in Iran. This cross sectional study was performed in three cities of Iran on participants over 19 years at 2002. First a questionnaire consisting of demographic details, drug intake and smoking status was filled. Then physical examination including systolic and diastolic blood pressure (SBP, DBP), body mass index (BMI) and waist to hip circumference (WHC) was performed. Fasting blood sample was drawn for sugar (FBS), total cholesterol (TC) and triglyceride (TG) and a 2-hour postprandial glucose was also measured. In this study performed on 12494 subjects, 48% were males and 52% females. The mean age of men and women was 38.99±15.30 and 38.80±14.54 years respectively. The prevalence of high BP in men and women was 15.6% and 18.8% respectively. The prevalence of high BP was higher in women than in men, except in the younger age classes. Overall 26.7% of hypertensive men and 47.7% of hypertensive women were on anti-hypertensive pharmacological treatment. Among the treated patients, BP was under control in 6.4% of the men and 13.8% of the women. In 86.5% of men with high BP and 89.3% of women with high BP, at least one other cardiovascular risk factor was present and its prevalence increased with age in both genders. BMI >25 (especially abdominal obesity) was the most frequent associated risk factor (41.9% in male, 59% in female). Except for smoking, the prevalence of each cardiovascular risk factor increased with the severity of hypertension, except in young women. The prevalence of high BP- even in treated subjects- is high in Iran. Many subjects with high BP have at least one other associated cardiovascular risk factor. These data emphasize the necessity of implementing community-based interventions.

Key Words: Blood pressure, Cardiovascular risk factors, Epidemiological study

Introduction

Cardiovascular disease (CVD) is the most prominent cause of premature death in different countries, and high blood pressure (BP) is one of its most important modifiable risk factors[1]. It has been shown that the reduction of highly or moderately elevated BP levels results in a decrease in the risk of CVD complications including stroke, coronary heart disease and renal insufficiency[2-3]. Consequently, primary prevention of CVD should focus on screening and control of high BP levels, for which international guidelines have been issued[2-3]. Nevertheless, results from several epidemiological studies have shown that screening for hypertension is less than desirable and its management is sometimes insufficient in the general population, resulting in a low rate of normalization[4].

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Available data from several Eastern Mediterranean countries indicate that hypertension is emerging as a considerable challenge to public health and an important cause of morbidity and mortality[5]. Other risk factors, such as obesity, hyperlipidaemia, diabetes and smoking have been reported to be higher among hypertensive than normotensive subjects[6]. It is now well established that decisions about management of hypertensive patients should not be based on the level of BP alone, but also on the presence of other CVD risk factors[7].

Iran is well known to have considerable rates of CVD[8]. However, little information is available on the prevalence and treatment of hypertension in the Iranian population. In order to collect more information in this regard, the prevalence of high BP and associated cardiovascular risk factors and the rate of controlled patients were assessed among subjects examined in three cities of Iran in this cross-sectional study performed as the present situation analysis of a community-based interventional program called Isfahan Healthy Heart Program[9].

Materials and Methods

This cross-sectional study was performed on participants (men and women) aged ≥19 years from three cities of Iran (Isfahan, Najafabad and Arak) with homogenous populations, less immigration than the capital and other cities with intermediate economic levels. The participation rate was 90% and participants had been living in the above cities for at least 10 years. The total number of subjects in this study was calculated according to the ratio in the whole population. These geographical subdivisions include middle sized and large towns in rural and urban areas.

Quota sampling was conducted to stratify the study population by their living area (urban vs. rural) according to the regional population distribution as per national population census in 1999. Isfahan was divided into 93 clusters, Najafabad into 47 and Arak into 60. Approximately 5-10 percent of households within these clusters were randomly selected for inclusion. One individual aged >19 years per household was randomly selected. The sample size was calculated as 1207 in each sex then distributed into different age groups according to distribution in the community. The total number was doubled using the cluster method, then after considering the missing rate for cohort study the total number was 13763 [9].

Written informed consent was obtained from subjects after full explanation of the procedure involved. The subjects completed a questionnaire in which information was obtained about previous history of high BP, diabetes, hyperlipidemia, current drug intake and smoking habits (current smoker, non-smoker and ex-smoker).

Physical examination including height, weight, waist and hip measurements were performed at clinics by trained nurses. All participants were lightly clothed and barefoot. Blood sample was drawn after 14 hours of fasting. All blood samples were analyzed in the central laboratory of Isfahan Cardiovascular Research Center, which is under the external quality control of St Rafael University, Leuven, Belgium. Serum was separated and fasting blood glucose (FBS), total cholesterol (TC) and triglyceride (TG) were assessed on the Elan 2000 auto analyzer. Oral glucose tolerance test (OGTT) after 2 hours was also done.

BP measurement: Trained physicians recorded BP according to the World Health Organization (WHO) standard criteria[3]. BP was measured in the sitting position after 10-minute rest and the mean of three readings from right arm was used in the analysis. High BP was defined according to the JNC VII and WHO Guideline criteria: a systolic BP (SBP)≥140 mmHg or a diastolic BP (DBP) ≥90mmHg or being on treatment 2-3. Stage I (mild hypertension) was defined as a SBP between 140-159mmHg or a DBP between 90-99mmHg. Stage II and III (moderate and severe hypertension) were defined as a SBP≥160mmHg or a DBP ≥100mmHg. Subjects receiving at least one antihypertensive drug and presenting with a normal BP level (<140/90mmHg) were identified. Those subjects having high BP in spite of pharmacological treatment were classified as uncontrolled hypertensives.

Definition of cardiovascular risk factors:
Criteria for diabetes was a FBS>1.26 g/l and 2 hour postprandial glucose >200 or being on treatment[10]. Hypercholesterolemia was defined as TC >2g/l or intake of TC-lowering drug[11], and hypertriglyceridaemia as fasting TG concentration >2g/l or being on a TG-lowering treatment[12]. A body mass index (BMI) 25-29.9kg/m^2 was defined as overweight and ≥30kg/m^2 was obesity[13], the abdominal fat distribution was determined by waist to hip ratio (WHR) which was considered as abdominal obesity when shown to be >0.9 in men and >0.8 in women[14].

Statistical analysis:
Data was analyzed using SPSS V11 /win. Age was subdivided into five categories: 19-25, 26-35, 36-45, 46-

55 and ≥ 56 years. The chi-square test was used for comparison of frequencies of hypertensive and non-hypertensive men and women and the frequency of other associated risk factors.

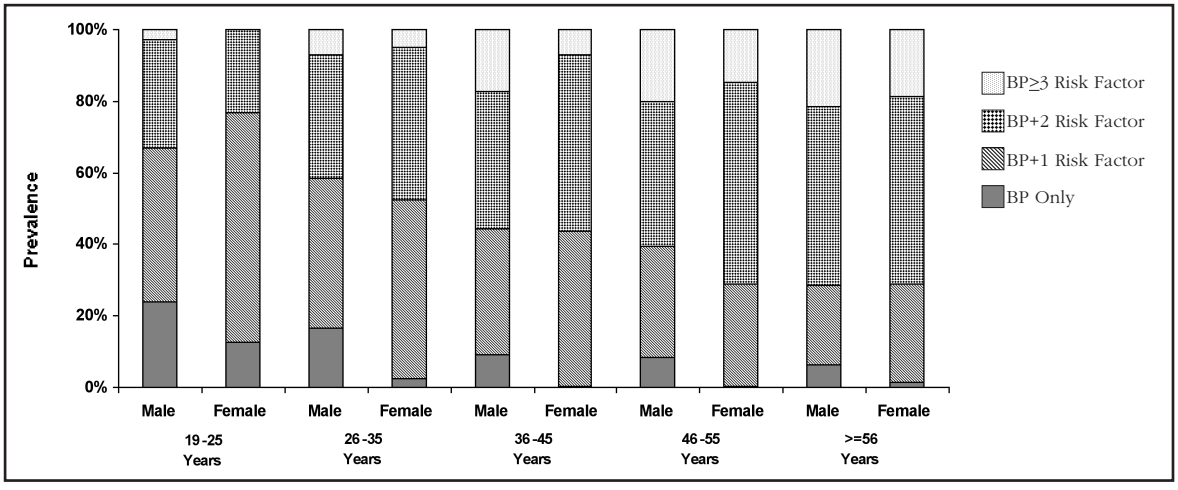
Results

Characteristics of the studied population:
During this study, 12494 subjects were evaluated, of them 35% were in Isfahan, 50.1% in Arak and 14.9% in Najafabad according to the populations of these cities. The mean age of men and women were 38.99±15.30 and 38.80±14.54 years respectively. Subjects were selected in near equal proportion in both sexes (48% male and 52% female).

The mean value of cardiovascular risk factors increased with age. Women, especially the younger ones, had a mean BP level lower than men, but the difference between genders was shown to decrease with age, especially in the older age groups. Mean fasting TC and WHR values were quite similar in both genders, while mean FBS, fasting TG and weight were slightly higher in men. Mean BMI was higher in women than in men. According to the questionnaire, 1.6% of women and 29% of men were smokers (Table I, II).

Prevalence and control of high BP:
The prevalences of high BP in men and women were 15.6% and 18.8% respectively (Table III). The prevalence of high BP was higher in women than in men, except in the younger age classes, this difference decreased with age. About 43.4% of the subjects with high BP had stage I hypertension (8.3% in all men, 6.7% in all women). The severity of hypertension increased with age. Stages II-III of hypertension was more frequent in men than in women but this difference was not significant (3.2 vs. 3.1%) and 8.8% of the older patients had moderate to severe hypertension. In addition, 26.7% of hypertensive men and 47.7% of hypertensive women were on anti-hypertensive pharmacological treatment. Among the treated patients, BP was normalized in 6.4% of the men and 13.8% of the women. In other treated subjects 60% had stage-I and 30% had stage II-III of hypertension (Table III).

Clustering of cardiovascular risk factors in subject with high BP:
In 86.5% of men with high BP and 89.3% of women with high BP, at least one other cardiovascular risk factor was present and its prevalence increased with age in both genders (Fig 1). The prevalence of cardiovascular risk factors according to the stage of hypertension is presented in Table IV. Obesity was shown to be the most frequent associated risk factor especially in women. Except for smoking, the prevalence of each cardiovascular risk factor increased with the severity of hypertension, except in young women. The prevalence of hypercholesterolemia increased with age and with the severity of hypertension in both genders. The percentage of current smokers decreased with the severity of high BP.



Prevalence of associated cardiovascular risk factors in high blood preassure (BP) subjects, according to age.

Table I: Distribution of cardiovascular risk factors in women according to age groups

	19-25 years (n=1969) mean±SD	26-35 years (n=1817) mean±SD	36-45 years (n=1157) mean±SD	46-55 years (n=654) mean±SD	56-65 years (n=784) mean±SD	All (n=6381) mean±SD
SBP[1] (mmHg)	105.50±13.55	109.45±15.25	118.32±19.80	128.35±21.99	135.11±2.30	111.75±16.93
DBP[2] (mmHg)	70.45±9.44	72.83±9.98	77.44±11.94	82.16±12.43	83.10±11.76	73.72±10.48
MAP[3] (mmHg)	82.14±9.93	85.04±10.74	91.07±13.82	97.55±14.57	100.44±14.34	86.41±11.76
TC [4] (mg/dl)	179.20±52.17	195.84±4.35	210.85±48.48	233.69±52.90	238.31±51.96	202.49±54.80
TG[5] (mg/dl)	122.42±70.07	152.98±90.49	181.86±104.41	212.86±122.78	210.33±110.24	161.92±99.93
FBS[6] (mg/dl)	76.62±18.13	79.90±29.31	85.02±25.78	87.98±43.59	88.91±39.78	81.58±29.33
Smoker (%)	0. 5	2.1	1.4	1.7	3.3	1.6
Non-Smoker (%)	99.3	97.4	97.3	96.9	93.5	97.4
Ex-Smoker (%)	0. 2	0. 5	1.3	1.4	3.2	1.0
Weight (kg)	61.26±11.98	67.01±12.26	68.99±12.58	69.84±13.00	63.62±12.42	65.26±12.70
BMI[7] (kg/m^2)	24.34±5.41	27.18±5.47	28.52±5.96	28.61±5.83	27.63±6.19	26.74±5.92
WHR[8]	0.87±0.09	0.90±0.10	0.92±0.09	0.94±0.09	0.96±0.10	0.90±0.10

[1] Systolic blood pressure, [2] Diastolic blood pressure, [3] Mean arterial blood pressure, [4] Total cholesterol, [5] Triglyceride, [6] Fasting blood sugar, [7] Body mass index, [8] Waist to hip ratio

Table II: Distribution of cardiovascular risk factors in men according to age groups

	19-25 years (n=1969) mean±SD	26-35 years (n=1817) mean±SD	36-45 years (n=1157) mean±SD	46-55 years (n=654) mean±SD	56-65 years (n=784) mean±SD	All (n=6381) mean±SD
SBP[1] (mmHg)	111.05±12.80	111.38±13.25	115.86±16.07	123.47±19.83	133.63±23.38	114.88±16.07
DBP[2] (mmHg)	72.85±8.76	74.03±9.52	76.74±10.15	79.56±11.14	82.01±11.95	75.13±9.87
MAP[3] (mmHg)	85.58±9.24	86.49±9.85	89.78±11.23	94.17±13.04	99.21±14.63	88.38±11.02
TC[4] (mg/dl)	177.03±62.80	197.36±44.99	207.15±63.96	211.08±53.28	204.49±49.11	194.65±57.73
TG[5] (mg/dl)	146.26±95.65	189.60±123.73	209.35±36.00	202.34±130.25	180/44±111.80	178.58±120.04
FBS[6] (mg/dl)	77.17±17.05	80.52±28.01	82.57±21.17	86.52±24.47	88.21±29.43	81.33±23.75
Smoker (%)	24.2	36.5	35.8	26.6	20.3	29.0
Non-Smoker (%)	71.8	58.2	52.9	61.7	63.5	63.0
Ex-Smoker (%)	4	5.3	11.3	11.7	16.2	8.0
Weight (kg)	69.42±12.11	73.17±12.38	74.16±12.36	74.37±12.26	68.19±11.75	71.54±12.41
BMI[7] (kg/m^2)	22.95±4.52	24.87±4.15	25.93±5.79	26.28±4.33	25.05±4.46	24.58±4.81
WHR[8]	0.86±0.07	00.90±00.08	0.93±0.08	0.94±0.8	0.95±0.09	0.90±0.09

[1] Systolic blood pressure, [2] Diastolic blood pressure, [3] Mean arterial blood pressure, [4] Total cholesterol, [5] Triglyceride, [6] Fasting blood sugar, [7] Body mass index, [8] Waist to hip ratio

Table III: Prevalence of high BP and stage of hypertension in men and women, according to age groups

		19-25 years	26-35 years	36-45 years	46-55 years	56-65 years	All
n	M	2048	1549	1038	657	821	6113
	F	1969	1817	1157	654	784	6381
Normal BP [1]	%M	95.7	92.8	83.5	70.8	52.3	84.4
	%F	96.2	92.2	77.4	58.9	42.6	81.2
High BP							
Under control	%M	0.2	0.1	1.1	2.3	3.8	1.0
	%F	0.3	0.8	1.8	5.5	11.2	2.6
Stage I	%M	3.5	5.4	10.1	15.3	17.5	8.3
	%F	2.5	4.3	10.6	11.5	13.2	6.7
Stage II, III	%M	0.6	1.2	3.3	5.5	11.4	3.1
	%F	0.9	1.8	4.5	6.9	6.1	3.1
Uncontrolled	%M	0.0	0.5	2.0	6.1	15.0	3.2
	%F	0.1	0.9	5.7	17.2	26.9	6.4
Prevalence	%M	4.3	7.2	16.5	29.2	47.7	15.6
	%F	3.8	7.8	22.6	41.1	57.4	18.8

[1] Blood pressure

Table IV: Prevalence of associated cardiovascular risk factors according to the stage of hypertension in both genders

		Normal BP	Normalized	Stage I	Stage II, III	Uncontrolled	All
n	M	5159	61	507	190	196	6113
	F	5181	166	428	198	408	6381
Cardiovascular risk factor							
TC[1] >200mg/dl	%M	15.0	29.0	21.5	27.3	29.9	16.5
	%F	17.0	43.6	32.0	34.0	45.7	21.2
TG[2] >200mg/dl	%M	26.9	37.1	39.6	44.9	44.7	29.2
	%F	20.3	41.2	42.7	43.8	52.5	25.1
TC>200mg/dl or TG>200mg/dl	%M	32.6	50.8	44.6	57.1	52.6	35.1
	%F	28.6	56.4	53.6	55.1	65.7	24.0
Smoking	%M	30.8	15.9	21.0	21.9	14.6	29.0
	%F	1.4	4.2	9.0	1.0	3.7	1.6
BMI[3] >25kg/m_	%M	38.36	57.1	59.0	62.8	6.9	41.9
	%F	54.9	73.9	74.6	77.9	79.9	59.0
WHR[4] >0.9	%M	41.7	74.2	65.3	80.9	83.9	46.5
WHR>0.8	%F	84.5	95.8	95.1	94.4	97.3	86.6
BS[5] >126mg/dl or 2hpp[6] >200mg/dl	%M	2.4	12.9	8.0	9.7	12.3	3.5
	%F	3.0	11.0	8.0	7.8	14.6	4.4

[1] Total cholesterol, [2] Triglyceride, [3] Body mass index, [4] Waist to hip ratio, [5] Blood sugar, [6] 2 hour post prandial glucose

Discussion

Hypertension is the most prevalent cardiovascular disease, and is one of the most powerful contributors to cardiovascular morbidity and mortality[15-16]. Data about the prevalence of hypertension, mean levels of SBP and DBP and concomitant risk factors can be helpful in planning preventive strategies. This paper presents the first phase of a comprehensive community based survey for prevention and control of CVD and its risk factors in Iran.

The prevalence of hypertension is highly dependent on the definition used and the age distribution of the population studied. Data from the National Health and Nutrition Examination survey from 1976 to 1980 indicate a hypertension prevalence of 29.7% for people 18-74 years of age in the USA, based on the definition of blood pressure ≥ 140/90 mmHg[17]. The prevalence is also high in other urban areas in the Eastern Mediterranean region[5]. In Cairo (Egypt) as many as 60% of the adult population is reported to be hypertensive[18]. Data from the survey performed in 1996 in France showed the hypertension prevalence to be 37.9% in men and 22.2% in women[4]. In Malaysia the prevalence of hypertension was 30.3% in the rural areas[19].

Comparison of these data with the present study suggests that different cultural, behavioral and dietary lifestyles have caused different prevalences of hypertension. Data from epidemiological studies in industrialized countries showed conflicting results in the trend of controlled BP among treated hypertensive subjects[20-21]. Population studies from several countries have shown that the proportion of controlled hypertension was less than 30%, when controlled hypertension was defined as a BP level below 140/90mmhg[22-23]. A recent survey in the UK revealed that only 6% of hypertensive subjects had such BP levels[24]. In USA (NHANES III), 14, 25 and 24% of Hispanic, Afro-American, and White non-Hispanic patients, respectively, achieved an adequate control of hypertension[25]. In France, the rate of treated patients achieving the target BP level < 140/90 mmHg was estimated to be 24% in a study conducted in general practice[26]. The study performed between 1992 and 1997 in Paris reported 24% of hypertensive men and 30% of hypertensive women had controlled BP[27]. The current results confirm that the prevalence of hypertension and uncontrolled BP level was high in treated subjects, even in apparently healthy people who were not aware of their BP levels.

This study also shows that adequate BP control is achieved more frequently in treated hypertensive women than in men. These findings are in line with the results of previous studies performed in other countries [28-30, 23-25] and indicate that this is a general trend. The reasons for the discrepancy between sexes are unknown[31].

The estimation of high BP prevalence, following the current guidelines for the management of hypertension[2-3], was essentially based on SBP and DBP measurements, two specific inflection points of the BP wave, which are usually considered in isolation. However, BP propagates through the arterial tree as a repetitive continuous wave and is more accurately described as consisting of a steady component (mean blood pressure). The interaction between age and sex in the prevalence of hypertension has been reported in previous cross sectional studies, younger men have higher BP than younger women, and older men have lower BP than older women. In most populations, the mean BP level in men and women rises progressively with increasing age[32]. We found similar results concerning mean BP changes with age in both sexes. Nevertheless, there are communities in which BP does not rise with age and in which the complications from high BP appear to be virtually non-existent[33].

However, among treated patients, lower hypertension control was seen in our study, suggesting that the economic status, healthcare, public education and cooperation with medical treatment may be factors in control. These findings should be helpful in planning effective community based programs for hypertension control.

It has been suggested that the presence of a genetic tendency to develop hypertension, combined with a dietary style concerning sodium intake, may cause an increase in the prevalence of hypertension and in some communities may be due in part to higher BMI [34-35]. Studies in Iran have shown a higher rate of obesity among women then men, one of the main reasons being lack of enough physical activity [36]. It has been reported that the association between high BP and other CVD risk factors is present more often than chance alone. One of the objectives in our study was to determine how often various risk factors were observed in Iranian hypertensive subjects. The present study confirms that high BP is often associated with other cardiovascular risk factors. This high prevalence may be explained in part by environmental factors, such as nutrition [37]. These data emphasize the need to

treat high BP together with modifying environmental factors by changes in lifestyle and the pharmacological treatment when needed.

Conclusion

This study indicates that, even in a relatively highly motivated population, the percentage of patients with elevated BP levels is high, as is the percentage of uncontrolled hypertension in those under treatment. It also shows the high prevalence of other CVD risk factors in subjects with high BP.

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