Prevalence of hypertension and associated risk factors in Isfahan, Islamic Republic of Iran

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خلاصة: أجري مسح بمحسي مقطعي لتعيين المستويات الوسطى لضغط الدم ومعدلات انتشار ضغط الدم المرتفع، ولمعرفة الاختلافات القائمة في معدلات انتشار عوامل الاختطار الأخرى في المصابين وغير المصابين بارتفاع ضغط الدم. فتم اختيار عينة عشوائية مكوَّنة من عدد مجموعه 8624 رجلاً وامرأة تبلغ أعمارهم 19 سنة أو أكثر. وتبيَّن عموماً أن 18.0% (16.8% من الذكور و19.4% من الإناث) كان بهم ارتفاع ضغط دم مجموعي. وارتفعت مع تقدم السن المستويات الوسطى لضغط الدم الانقباضي والانبساطي، وكذلك معدل انتشار ضغط الدم المرتفع. ولكن لم توجد فروق يعتد بها إحصائياً بين الجنسين بعد تصحيح النتائج بحسب مناسب كتلة الجسم. وكانت حالات السمنة وفرط شحميات الدم والداء السكري أكثر انتشاراً بين المصابين بضغط الدم المرتفع بالمقارنة بغيرهم. وتوحي هذه الدراسة بأن معدل انتشار ضغط الدم المرتفع في إصفهان أكبر مما نتصور.

ABSTRACT A population-based cross-sectional survey was conducted to determine the mean levels of blood pressure and prevalence rates of hypertension and to identify differences in the prevalence of other risk factors in hypertensive and nonhypertensive people. A total of 8624 men and women ≥ 19 years were randomly selected. Overall, 18.0% (16.8% males and 19.4% females) had systemic hypertension. The mean levels of systolic and diastolic blood pressure and the prevalence of hypertension increased with age, but no significant differences were found between the sexes when adjusted for body mass index. There was a high prevalence of obesity, hyperlipidaemia and diabetes mellitus among hypertensive people compared with nonhypertensive . Our study suggests that the prevalence of hypertension in Isfahan is greater than supposed.

Prévalence de l'hypertension et des facteurs de risque associés à Ispahan (République islamique d'Iran)

RESUME Une enquête transversale dans la population a été réalisée pour déterminer les niveaux moyens de pression artérielle et les taux de prévalence de l'hypertension ainsi que pour identifier les différences dans la prévalence d'autres facteurs de risque chez les hypertendus et les sujets non hypertendus. Au total, 8624 hommes et femmes âgés de 19 ans ou plus ont été choisis au hasard. Globalement, 18,0% (hommes 16,8%; femmes 19,4%) avaient une hypertension systémique. Les niveaux moyens de pression artérielle systolique et diastolique ainsi que la prévalence de l'hypertension augmentaient avec l'âge, mais aucune différence significative n'a été observée entre les sexes lorsque les valeurs ont été ajustées en fonction de l'Indice de masse corporelle. Il y avait une forte prévalence de l'obésité, de l'hyperlipidémie et du diabète sucré chez les hypertendus par rapport aux sujets non hypertendus . Notre étude laisse penser que la prévalence de l'hypertension à Ispahan est plus importante qu'on ne le suppose.

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Introduction

Hypertension is a highly prevalent major contributor to atherosclerotic cardiovascular disease [*1*]. The prevalence is higher in men than in women below the age of 35 years but by the age of 65 years the prevalence is higher in women [*2*]. In elderly women, it is the single most important risk factor for cardiovascular disease [*3*].

Data available 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. Epidemiological surveys on hypertension report prevalence rates up to 20%–26% of the adult population [*4*]. In some urban areas high blood pressure may affect up to 30% of the adult population [*5*]. The prevalence of hypertension appears to be lower in rural than urban areas [*5–8*].

Furthermore, it has been found that the prevalence of other risk factors, such as obesity, hypercholesterolaemia, hypertriglyceridaemia, diabetes and smoking, are higher among hypertensive than nonhypertensive people [*9*].

We aimed to determine the prevalence of hypertension, the mean levels of systolic and diastolic blood pressure (SBP and DBP) and how often various risk factors were found in the inhabitants of a homogeneous community in Isfahan, which is one of the largest cities in the Islamic Republic of Iran.

Subjects and methods

This was a cross-sectional study, which included 8624 participants (3424 men and 5200 women) aged ≥ 19 years from 40 randomly selected clusters in the whole city. Isfahan is a large city with a homogeneous population as it has less immigration than the capital and other big cities; it has an intermediate economic level. The population is 1.5 million (45% men and 55% women). On average the participation rate was 90% and participants had been living in the city for at least 5 years. The total number of men and women in the study is in accordance with their ratio in the whole population.

The participants completed a questionnaire in which information was obtained about smoking habits, previous history of hypertension, diabetes and complaints of cardiovascular disease and current use of medication for hypertension and diabetes. To report the prevalence, awareness, treatment and control of hypertension, people being treated for hypertension were also included.

Height and weight were measured using standardized methods; all the participants wore light clothes without shoes. Blood pressure measurement was carried out by trained medical students according to World Health Organization (WHO) standardized criteria [*10*]. They were trained for 1 week on the use of the sphygmomanometer and how to measure blood pressure in the sitting position. Blood pressure was measured at home three times from the right upper arm, with a random zero sphygmomanometer with a 14-cm cuff, after the participants had rested for 10 minutes. Blood pressure was recorded to the nearest 2 mmHg. SBP was recorded at the appearance of sounds (first Korotkoff sounds) and DBP was recorded at the disappearance of sounds (fifth Korotkoff sounds). The mean value obtained from three readings was used in the analysis. Hypertension was defined according to WHO criteria as SBP ≥ 160 mmHg and/or DBP ≥ 95 mmHg and/or the use of antihypertensive medication

[*10*]. Blood samples were drawn after the participants had fasted for 14 hours. Serum was separated and analysed using an Elan 2000 autoanalyser for glucose and lipids [total cholesterol, high-density lipoprotein cholesterol (HDL) and triglyceride]. Low-density lipoprotein (LDL) cholesterol was calculated according to the Friedewald formula [*11*] when the triglyceride level was ≤ 400 mg/dL. A single fasting plasma glucose level of > 7.8 mmol/L was considered as diabetic, but an oral glucose tolerance test was not performed.

The following analyses were carried out using *SPSS*. Unpaired *t*-test was used to find the difference between means of systolic and diastolic blood pressure among men and women. The chi-squared test was used for comparison of frequencies of hypertensive and nonhypertensive men and women and the frequency of other associated risk factors. Multiple regression analysis was performed to examine the relationship between age, sex and body mass index with systolic and diastolic blood pressure separately. A *P*-value of < 0.05 was considered to be significant.

Results

Table 1 shows the prevalence, awareness, treatment and control rates of definite hypertension defined as participants with SBP ≥ 160 mmHg or DBP ≥ 95 mmHg, or with lower levels but under specific antihypertensive treatment by age and sex. The crude prevalence for definite hypertension was 28.6%, 38.9% and 34.8% for men, women and the entire population respectively (age-adjusted prevalence of hypertension was

Table 1 **Prevalence, awareness, treatment and control rates of definite hypertension by age and sex, Isfahan 1995**

Variable	Age group (years)						
	19–29 No. (%)	30–39 No. (%)	40–49 No. (%)	50–59 No. (%)	60–69 No. (%)	≥ 70 No. (%)	Total No. (%)
Prevalence							
Males	37 (9.0)	32 (7.4)	115 (21.8)	186 (27.9)	298 (40.3)	311 (47.5)	979 (28.6)[a]
Females	19 (3.3)	68 (9.7)	254 (26.4)	586 (46.4)	669 (61.3)	426 (67.0)	2022 (38.9)[a]
Aware[b]							
Males	4 (10.8)	4 (12.5)	34 (29.6)	72 (38.7)	145 (48.6)	170 (54.7)	429 (43.8)
Females	1 (5.3)	20 (29.4)	118 (46.4)	352 (60.1)	451 (67.4)	286 (67.1)	1228 (60.7)
Treated[c]							
Males	5 (13.5)	7 (21.9)	25 (21.7)	65 (34.9)	129 (43.3)	157 (50.5)	388 (39.6)
Females	4 (21.0)	23 (33.8)	110 (43.3)	292 (49.8)	425 (63.5)	288 (67.6)	1142 (56.5)
Controlled[d]							
Males	3 (8.1)	3 (9.4)	12 (10.4)	21 (11.3)	32 (10.7)	47 (15.1)	118 (12.1)
Females	4 (21.0)	12 (17.6)	38 (15.0)	42 (7.2)	94 (14.0)	62 (14.5)	252 (12.5)

[a] *Crude prevalence*
[b] *Percentage of hypertensive patients with a previous history of hypertension*
[c] *Percentage of hypertensive patients taking medication*
[d] *Percentage of hypertensive patients with blood pressure < 160/95 mmHg and reported currently taking antihypertensive medications*

16.8%, 19.4% and 18.0% for men, women and whole population respectively). The prevalence of hypertension increased with age in both sexes and women had a lower prevalence only in the third decade.

The number of hypertensive participants who were aware of their disease and were taking medication increased with age in both sexes. Generally, women had a higher rate of awareness and were more commonly treated than hypertensive men. However, among those treated, men had a better control rate than women in the sixth and eighth decades. The overall awareness, treatment and control rates of definite hypertension were 55.2%, 50.9%, and 12.3% respectively.

Among the men and women, SBP showed a steady increase with age, rising from a mean of 126.2 mmHg in men and 117.2 mmHg in women at 19–29 years to 150.4 mmHg in men and 160 mmHg in women at ≥ 70 years, respectively, with a slight drop in the fourth decade in men (P = 0.00) (Figure 1). DBP showed a similar trend, rising steadily from a mean of 77.7 mmHg at 19–29 years to 86.4 mmHg at ≥ 70 years in men, and from 71.4 mmHg at 20–29 years to 91.6 mmHg at ≥ 70 years in women (P = 0.00). Figure 1 also shows that mean pressures for women were higher than those for men after the third decade for SBP and fourth decade for DBP. After adjustment for body mass index (BMI), these differences were not significant ($P > 0.05$). Overall, a modest age gradient existed for both SBP and DBP in both sexes, i.e. the older the age, the greater the mean blood pressure.

The prevalence of isolated systolic hypertension (ISH) is shown in Table 2. ISH, as in the Framingham study, was defined as SBP ≥ 160 mmHg and DBP < 95 mmHg. The prevalence of ISH increased with age and was higher in older women than men,

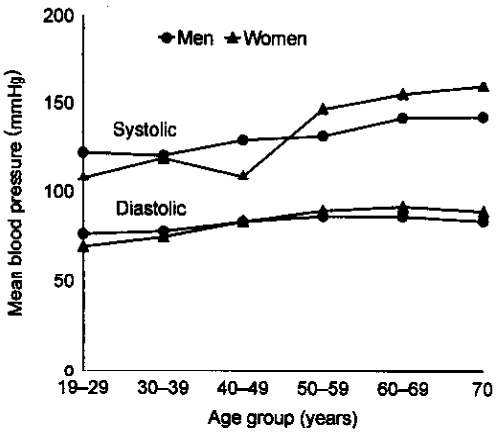

Figure 1 **Mean blood pressure by age and sex, Isfahan 1995**

Table 2 **Prevalence of isolated systolic hypertension by age group and sex, Isfahan 1995**

Age group (years)	Males No.	Males %	Females No.	Females %	*P*-value*
19–29	3	0.7	1	0.2	NS
30–39	1	0.2	5	0.7	NS
40–49	4	0.8	28	2.9	< 0.05
50–59	20	3.0	83	6.5	< 0.05
60–69	60	8.1	126	11.6	< 0.05
≥ 70	113	17.3	91	14.4	NS

**P-value of chi-squared test*
Isolated systolic hypertension defined as systolic blood pressure ≥ 160 mmHg and diastolic blood pressure < 95 mmHg
NS = not significant

except in women over 70 years. The total prevalence of ISH in women was 6.4%, and 5.9% in men.

The prevalence and mean values of oth er cardiovascular risk factors, such as diabetes, smoking, obesity (presenting as increased BMI), increased total and LDL

Table 3 **Comparison of the prevalence of some cardiovascular risk factors between hypertensive and nonhypertensive people in both sexes**

Risk factor	Hypertensive		Nonhypertensive		*P*-value[a]
	No.	%	No.	%	
Males					
Body mass index ≥ 25 kg/m²	602	61.5	1078	44.1	0.000
Total cholesterol ≥ 6.2 mmol/L	413	42.2	577	23.6	0.000
Triglycerides ≥ 2.3 mmol/L	567	57.9	1063	43.5	0.000
HDL cholesterol < 0.9 mmol/L	527	53.8	1350	55.2	0.462
LDL cholesterol ≥ 4.1 mmol/L[b]	298	30.8	503	20.7	0.000
Diabetes mellitus[c]	151	15.4	112	4.6	0.000
Current smoking	164	16.8	577	23.6	0.000
Females					
Body mass index ≥ 25 kg/m²	1793	88.7	1977	62.2	0.000
Total cholesterol ≥ 6.2 mmol/L	1110	54.9	1119	35.2	0.000
Triglycerides ≥ 2.3 mmol/L	1225	60.6	1204	37.9	0.000
HDL cholesterol < 0.9 mmol/L	940	46.5	1379	43.4	0.028
LDL cholesterol ≥ 4.1 mmol/L[b]	935	46.5	1136	35.9	0.000
Diabetes mellitus[c]	342	16.9	175	5.5	0.000
Current smoking	28	1.4	38	1.2	0.641

[a] *P-value of chi-squared test*
[b] *For calculating values, only 3397 men (967 hypertensive, 2430 nonhypertensive) and 5176 women (2012 hypertensive, 3164 nonhypertensive) could be included.*
[c] *Diabetes mellitus defined as: i) known diabetic participant at the time of study; ii) fasting venous whole blood ≥ 7.8 mmol/L*
HDL = high-density lipoprotein
LDL = low-density lipoprotein

cholesterol and decreased HDL cholesterol among hypertensive men and women are shown in Tables 3 and 4.

Significant differences were seen between hypertensive men and women regarding the prevalence of obesity, smoking, increased total and LDL cholesterol and decreased HDL cholesterol. Similar significant differences were seen between men and women regarding mean values of serum total, LDL and HDL cholesterol and triglyceride levels. Among hypertensive women, obesity, increased total cholestrol and LDL cholesterol were significantly higher than hypertensive men ($P < 0.05$), while decreased levels of HDL cholesterol and smoking were more prevalent among hypertensive men than hypertensive women ($P < 0.05$). No significant differences were observed in the mean value of fasting blood glucose or BMI in men and women. However, increased mean levels of serum total, LDL and HDL cholesterol were seen more frequently among hypertensive women and the mean level of serum triglyceride was higher among hypertensive men.

Discussion

Hypertension is the most prevalent cardiovascular disease, and it is one of the most powerful contributors to cardiovascular morbidity and mortality [*12–14*]. Data on

Table 4 **Mean values of some cardiovascular risk factors in hypertensive people of both sexes**

Risk factor	Males Mean ± *s*	Females Mean ± *s*	*P*-value[a]
Body mass index (kg/m²)	26.1 ± 4.1	29.4 ± 28.5	NS
Total cholesterol (mmol/L)	5.8 ± 1.4	6.1 ± 1.5	< 0.05
Triglycerides (mmol/L)	2.7 ± 1.9	2.5 ± 1.4	<0.05
HDL cholesterol (mmol/L)	1.0 ± 2.7	1.1 ± 0.3	< 0.05
LDL cholesterol (mmol/L)	3.7 ± 10.5	3.9 ± 1.3	< 0.05
Fasting blood glucose (mmol/L)	6.5 ± 2.3	6.4 ± 30.0	NS

[a]*P-value of unpaired Student* t-test
s = standard deviation
NS = not significant
HDL = high-density lipoprotein
LDL = low-density lipoprotein

the prevalence of hypertension and the mean levels of SBP and DBP and accompanying risk factors are helpful in planning primary preventive strategies. This is the first comprehensive community-based survey for hypertension and related risk factors conducted on the Isfahan population. More importantly, this survey was performed before the start of the national preventive actions; hence, our findings can serve as baseline data for future comparisons.

Relatively high rates of hypertension in the Isfahan population were found as compared with the United States of America (USA) and Poland [*15*]. The prevalence of hypertension is highly dependent on the definition used and the age distribution of the population studied. An advantage of our study was that blood pressure was measured three times in a standardized way using WHO criteria. A disadvantage was that only one cuff size was used, which can bias the blood pressure measurement [*16*]. The observed differences in the prevalence of hypertension among men and women were not significant when BMI was adjusted.

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, and 22% based on the definition of blood pressure ≥ 160/95 mmHg [*17,18*]. When these data are compared with ours, it seems that in spite of different cultural, behavioural and dietary lifestyles, similar prevalence rates exist. The prevalence rate of hypertension in our society seems to be similar to other areas in the Eastern Mediterranean region [*4*] but lower than the prevalence rate in other urban areas [*5*] or in Cairo (Egypt), where as many as 50% of the adult population is reported to suffer from hypertension [*19*].

According to a survey conducted in the USA between 1976 and 1980, 73% of hypertensive people were aware of their condition, 56% were being treated and 34% were under control [*18*]. Our data concur with the above-mentioned results regarding patients' awareness of their disease. More patients under treatment in our study may

be due to the fact that ours was conducted 15 years later than the US study and there may now be a greater awareness of the disease amongst the population and health personnel. However, among treated patients, lower hypertension control was seen in our study, suggesting that the patient's economic status, health care, public education and cooperation with medical treatment may be factors in this control. These findings should be helpful in planning effective community programmes for hypertension control.

The interaction between age and sex in the prevalence of hypertension has been reported in previous cross-sectional studies; younger men have higher blood pressure than younger women and older men have lower pressures than older women. However, after controlling for obesity (BMI), the differences in prevalence of hypertension according to sex were not significant. Overall, the proportion of women who were aware of their hypertension and were being treated was higher than for men. It seems that in Isfahan more women are treated for hypertension than men.

In most populations, the mean blood pressure level in men and women rises progressively with increasing age [*20,21*]. We found similar results concerning mean SBP and DBP changes with age in both sexes (Figure 1). Nevertheless, there are communities in whom blood pressure does not rise with age and in whom the problem of its complications appears to be virtually non-existent [*22,23*].

It has been suggested that the presence of a genetic tendency to develop hypertension, combined with a Western dietary style concerning sodium intake may cause an increase in blood pressure with age [*24,25*]. Although higher mean SBP and DBP were seen among women, mainly in older age groups, after adjustment for BMI no significant differences between the sexes were observed. Higher mean blood pressure and prevalence of hypertension in some communities may be due in part to higher BMI. In China, hypertension prevalence increased from 7.7% in 1980 to over 11% in 1991 [*26*]. This increase may be due to higher BMI levels and dietary composition. On the other hand, other studies in Isfahan have found a higher obesity rate among women than men, the main reason being lack of exercise [*27*].

The prevalence of ISH, which is defined as SBP $\geq$ 160 mmHg and DBP < 95 mmHg, increases with age in people over 50 years and is higher in women than in men [*28*]. A similar pattern was observed in our study (Table 2). The sex-based differences observed were significant in the age groups after the fourth decade (except in the age $\geq$ 70 years). The prevalence of ISH was not only related to age, sex, and blood pressure, but also to relative weight in women. A higher prevalence of ISH in women has been reported by other investigators [*29, 30*]. The prevalence of ISH in elderly people of different countries varies widely, with values ranging from 1% in Israel to 24% in Norway in men aged 60–69 years [*31*], and 30% in the Japanese population at age 90 years [*32*]. These differences may be related to age, sex, race, social class or different conditions of blood pressure recordings.

It has been reported that the association between hypertension and hypercholesterolaemia is frequently seen in a number of populations and is present more often than would be expected as a result of chance alone [*33*]. One of the objectives in our study was to determine how often various risk factors were observed in hypertensive and non-hypertensive people. Tables 3 and 4 summarize the prevalence and mean levels of some cardiovascular risk factors found in hypertensive participants according to sex.

Except for HDL cholesterol in men, and smoking in women, the prevalence of all types of hyperlipidaemia, diabetes mellitus and obesity were higher among hypertensive men and women than nonhypertensive men and women (Table 3). Many surveys confirm that hypertension is often found in association with multiple metabolic derangements, such as hypercholesterolaemia and obesity. Although the absolute prevalence of these associations varies as a consequence of variable cut-off levels used to define such risk factors, the nature of the study and the ethnic composition of the population under study may affect the prevalence rates [*9,34–36*].

As the results presented in Tables 3 and 4 depict, higher mean levels and prevalence rates of hypercholesterolaemia, obesity (defined as BMI $\geq$ 25 kg/m^2) and increased LDL cholesterol were seen among hypertensive women than men. These sex-based differences were significant except for the mean level of BMI. In contrast, hypertensive men had higher mean levels and prevalence rates of hypertriglyceridaemia, decreased HDL cholesterol and smoking. No significant differences regarding the mean level of fasting blood glucose or prevalence of diabetes between hypertensive men and women were observed. Dietary habits, lack of physical activity, some cultural beliefs and the effect of gender itself may explain some of these sex-based differences.

The recent guidelines for the management of mild hypertension prepared by WHO and the International Society of Hypertension stress that "among individuals with mild hypertension, the risk of serious cardiovascular disease is also determined by a variety of factors other than the level of blood pressure" [*37*]. These guidelines advise that when hypertension is associated with metabolic abnormalities, these risk factors should also be controlled by nutritional counselling and, where appropriate, drug treatment.

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