Original article

Gender differences in the prevalence of hypertension in a representative sample of Iranian population: the Isfahan Healthy Heart Program

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Abstract. *Background:* Management and control of hypertension is an important potential health challenge that may result in considerable cardiovascular adverse events especially for women. In this population-based survey, we sought to determine the epidemiology of hypertension among women compared with men in a community sample of Iranians in the 2008s. *Methods:* Data were originated from the Isfahan healthy heart program (IHHP) that was designed and launched in 2000 in order to assess the efficacy of lifestyle interventions such as determining the cumulative prevalence of hypertension in a representative sample of Iranian women and to compare it to men. Blood pressure was measured in 12514 individuals (6123 men and 6391 women aged ≥ 19 years) selected through multistage random cluster sampling in each sex and age groups. Baseline data were also collected using a special questionnaire and interviews by expert and trained nurses for this survey. *Results:* It was revealed a significant increasing trend in the prevalence of hypertension in both urban and rural population in the two genders (p for trend <0.001). The prevalence of hypertension in women was estimated from 4.4 % in subjects aged < 30 years to 39.1% in the elderly aged ≥ 60 years in urban population. Moreover, hypertension was also estimated from 8.6% in individuals aged < 30 years to 32.0% in the elderly aged ≥ 60 years in rural population. Both systolic and diastolic blood pressures were frequently higher in women than in men aged 50-60 years. Women more than men are aware of their blood pressure changes and hypertension is more controlled and under pharmacological treatment in women. *Conclusion:* Our study supports the pivotal role of women-specific control and management of hypertension and emphasizes the global education programs about the importance of hypertension control and monitoring and also lifestyle modification for reducing the risk of hypertension in Iranian women. (www.actabiomedica.it)

Key words: hypertension, Isfahan Healthy Heart Program, blood pressure

Introduction

Although hypertension continues to be one of the strongest determinants of cardiovascular disease in both genders, substantial excess risk associated with hypertension in women is more highlighted and is extremely prevalent in older women (1). Epidemiological surveys in the United States showed an increasing trend of hypertension rates among women, so that the prevalence of uncontrolled hypertension in adult women increased from 17% to more than 22% between the early 1990s and early 2000s, whereas this rate in men decreased from 19% to 17% in the same period of time (2). Moreover, it was estimated that 30% of the American women aged more than 65 years present isolated systolic hypertension (3). Another survey in the US indicated that women had higher overall rates of hypertension: it was more

prevalent in women (260.9 per 1,000) than in men (243.0 per 1,000 men) (4). It suggests that the hormonal changes have an essential role in the mechanism of hypertension and its higher occurrence in women than in men. Physiological studies on hemodynamic characteristics of hypertension in women could have demonstrated that the shorter stature and the obligatory shorter arterial tree in women may induce faster heart rates and earlier reflected arterial pulse waves and therefore lead to the difference in systolic blood pressure, pulse pressure amplification, diastolic time, and diastolic blood pressure between the two genders (5). Moreover, this gender difference might be due to different rates of awareness among hypertensive women compared with men. In the National Health and Nutrition Examination Survey NHANES to determine trends in the prevalence, awareness, and control of hypertension in the US, women had higher rates of awareness and control of hypertension compared with men from1988 to1994, however, in the 1999-2000 survey, no significant difference was found in terms of gender, and was suggested to be as a result of significant increases in awareness in men (6). Furthermore, some studies showed that the female gender might be a strong predictor of poor blood pressure control (7-8). Our previous study showed that the prevalence of hypertension in our community was 17.3 and awareness, treatment and control of hypertension were 40.3%, 35.3%, and 9.1% respectively (9). Although it has been suggested that Asian women have the lowest prevalence of hypertension (about 150.4 per 1,000) worldwide, few population-based studies are available about the gender differences in the prevalence of hypertension among Iranian population. In the present study, we sought to determine the epidemiology of hypertension among women compared with men in a community-based sample of Iranians in the 2000s.

Methods

Study population

Data of the present study was originated from the Isfahan Healthy Heart Program (IHHP) that was designed and launched in 2000 in order to assess the efficacy of lifestyle interventions in a developing country setting. We have previously published its details (10-11). These community-based interventions included education through mass media, inter-sectoral collaboration, marketing and organizational development, legislation and coordination, policy development, as well as research and evaluation. The main strategies of IHHP are focused on the improvement of the nutritional condition, the increase in physical activity, tobacco avoidance, and stress control.

The study was approved by the Ethics Committee of Isfahan Cardiovascular Research Center (ICRC, a WHO collaborating center), Isfahan University of Medical Sciences.

The main goal of the current paper is to determine the cumulative prevalence of hypertension in a representative sample of Iranian women in comparison with men. Systolic and diastolic blood pressures (BP) were measured in 12514 individuals (6123 men and 6391 women aged ≥ 19 years) selected through multistage random cluster. Baseline data were collected using a special questionnaire and interviews by expert and trained nurses for this survey (12).

Blood pressure measurement

Blood pressure readings were obtained at home. The average of the second and third systolic and diastolic blood pressure readings were used in the analyses, while palpating the radial pulse. After one minute, the cuff was re-inflated to 30 mmHg higher than the pressure at which the radial pulse was no longer palpable. A stethoscope was lightly placed over the brachial artery. The cuff was at the level of the heart and the cuff was deflated at a rate of 2 to 3 mmHg/s. Systolic blood pressure (SBP) was the pressure reading at the onset of the Korotkoff sounds. Diastolic blood pressure (DBP) was then recorded as the pressure at which the sounds disappear or the sound was abruptly muffled. Hypertension was defined as a systolic blood pressure of ≥ 140 mmHg or a diastolic blood pressure of ≥ 90 mmHg, or those who were receiving anti-hypertensive therapy at the time of the examination (13).

Statistical analysis

Results were reported as mean ± standard deviation (SD) for quantitative variables and percentages for categorical variables. The groups were compared using the Student's *t*-test for continuous variables and the chi-square test or the Chi-square test for trend for categorical variables. We used multivariate linear regression analysis in order to investigate the potential confounding effects of the patients' characteristics and the clinical data on the association between age and blood pressure in the two sex groups. Beta and Standard Error for Beta were calculated. P values of 0.05 or less were considered as statistically significant. All the statistical analyses were performed using SPSS version 13.0 (SPSS Inc., Chicago, IL, USA).

Results

A significant increasing trend in the prevalence of hypertension was found in urban and rural population in both genders (p for trend <0.001) (Figure 1).

Regarding the prevalence of hypertension in different age groups (Table 1), it was observed that only in the age group of 19-39 years, the prevalence of hypertension was significantly higher in rural than urban areas in women (p<0.05), whereas in men, similar hypertension prevalence was found in the two studied areas in all age groups.

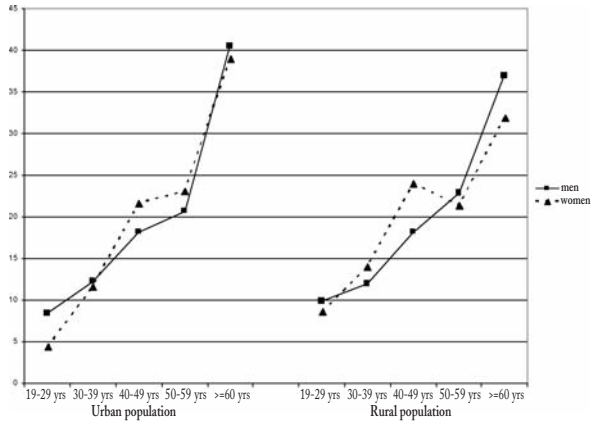

Figure 1. Age trend of hypertension in urban and rural populations in men and women

Mean of SBP in men aged <40 years old was higher than in women of similar age range; while on the contrary, the mean of SBP was higher in women than in men aged 40-59 years and was similar in the two genders in older ages. Moreover, mean of DBP was found to be higher in men aged 19-39 years then in women of the same age range. Mean of DBP in men and women aged 40-49 years was similar and trend of this variable was increased more in women than in men of older ages (Table 2).

SBP was positively associated with advanced age in both genders (men: β=0.478, SE=0.013, p<0.001; women: β=0.695, SE=0.015, p<0.001). This positive association was also observed between DBP and in-

Table 1. Prevalence of hypertension in different age groups in urban and rural populations

Age groups	Urban population	Rural population	p-value
Men:			
19-29 yrs	63/1483 (4.2)	29/567 (5.1)	0.397
30-39 yrs	93/1141 (8.2)	35/411 (8.5)	0.818
40-49 yrs	137/755 (18.1)	53/285 (18.6)	0.867
50-59 yrs	156/481 (32.4)	67/177 (37.9)	0.193
=>60 yrs	305/592 (51.5)	108/231 (46.8)	0.219
Women:			
19-29 yrs	41/1418 (2.9)	33/554 (6.0)	0.001
30-39 yrs	109/1359 (8.0)	54/462 (11.7)	0.017
40-49 yrs	202/320 (24.6)	92/337 (27.3)	0.344
50-59 yrs	215/472 (45.6)	82/184 (44.6)	0.820
=>60 yrs	362/572 (63.3)	123/213 (57.7)	0.155

Data are presented as number total number (percentage)
P<0.05 as statistically significant

Table 2. Mean of systolic and diastolic blood pressures in different age groups in men and women

Age groups	Men	Women	p-value
Systolic BP:			
19-29 yrs	111.13±12.77	105.46±13.26	<0.001
30-39 yrs	111.48±13.20	109.50±15.23	<0.001
40-49 yrs	115.90±16.09	118.31±19.58	0.002
50-59 yrs	123.38±19.42	128.28±21.78	<0.001
=>60 yrs	132.90±22.15	134.87±21.80	0.074
Diastolic BP:			
19-29 yrs	72.89±8.75	70.46±9.35	<0.001
30-39 yrs	74.12±9.39	72.85±9.74	<0.001
40-49 yrs	76.74±10.07	77.46±11.91	0.124
50-59 yrs	79.58±11.13	82.08±12.18	<0.001
=>60 yrs	81.86±11.69	83.03±11.50	0.044

Data are presented as mean ± SD
P<0.05 as statistically significant

crease in age (men: β=0.209, SE=0.008, p<0.001; women: β=0.314, SE=0.009, p<0.001).

In comparison with pre-menopausal women, post-menopausal women had higher means of SBP and DBP (p<0.001). Regarding the knowledge towards hypertension, 50.1% of women and 29.8% of men were aware of their hypertension which was significant higher in women (p<0.001). Overall, in 43.7% of women and 24.5% of men hypertension was controlled to less than 140 mm Hg for systolic and 90 mm Hg for diastolic pressure (p<0.001). Additionally, women were more than men under pharmacological treatment (10.9% versus 5.2%, p<0.001).

Discussion

The prevalence of controlled and uncontrolled hypertension in women has been determined in national cross-sectional surveys, epidemiological investigations, community studies, health maintenance organizations, and reports of physician office practices from various populations. However, no documented data has been available in the prevalence of hypertension and its sex ratio and age-related trends in Iranian population. The present study was designed in order to assess these trends among a fairly large sample of Iranian women. Our study showed that the prevalence of hypertension in women was estimated from 4.4 % in subjects aged < 30 years to 39.1% in the elderly aged ≥ 60 years in urban population. Moreover, hypertension was also estimated from 8.6% in individuals aged < 30 years to 32.0% in the elderly aged ≥ 60 years in rural population. However, other similar studies obtained a wide range of hypertensive women estimations. In a population based survey in the United States in 2000, the estimated overall prevalence of hypertension in women was 28.7% (7). In another study in the Chicago area public announcements in 1992, 47.6% of women older than 35 years old were hypertensive (14). Another study performed before 1995 in the United States showed a higher prevalence of hypertension in women from 51% in white and 79% in black women > 45 years of age and 71% in women > 65 years of age (15). It is hypothesized that the difference in the prevalence of hypertension may be attributed to several factors such as race, obesity, socioeconomic status, level of education, and lifestyle modifications in women. The association between hypertension and socioeconomic status was complex and different between men and women. Additionally, with regard to the relationship between race and prevalence of hypertension, it was suggested that in women older than 45 years of age, 60% of Caucasian women and 79% of African-American women have hypertension. Our study also showed that the prevalence of hypertension substantially increased with age in both genders in the interventions and reference areas. In addi-

tion, systolic hypertension was showed to be higher in women than men aged < 40 years, whereas it was vice versa in the 40-59 years age group, and in older ages, this difference was not witnessed. In the DBP the trend was different so that men in the <40 age group and women in the ≥ 50 age group had higher mean diastolic blood pressures, whereas means of DBP were similar in the age group 40-49 years in both genders. In a study by Ghannem et al. in the urban population of Tunisia, nearly similar results were found so that before the age of 40 years, the mean SBP was significantly higher for men than for women and in the age group more than 40 years of age, women had a slightly higher mean SBP than men. For DBP before 40 years, no statistically significant difference between men and women was observed; however, at or after 40 years, women had significantly higher DBP than men (16). In another study by Wenger et al. it was indicated that SBP peaked in middle age for men but continued to increase in women until beyond 80 yrs. of age. In their study, hypertension was more prevalent in women than men after 65 yrs. of age (15). Other longitudinal studies found different results. In the Dormont High School Follow-Up Study between 1957 and 1990, men tended to have higher mean systolic and diastolic blood pressures than women in all ethnic groups and through middle age, the prevalence of hypertension is higher among men than women. However, after the age of 59 years, hypertension was more prevalent among women than men (17). The Community Hypertension Evaluation Clinic Program as a large population survey from 1973 to 1975 found that mean DBP was higher in men than in women at all ages, whereas mean SBP was higher in men than in women until the age of 50 for blacks and 65 for whites and was higher in women thereafter (18).

The findings of the Framingham study also showed that mean SBP in older women approached that in older men, but did not exceed it; mean DBP was lower in women at all ages and declined in both sexes after the age of 65 (19). The change of the trend of blood pressure in women can be related to several mechanisms such as baseline physiological hormonal changes and meanwhile estrogen reduction has a pivotal role in the mechanisms of hypertension in women. Relationships between estrogens and improved endothelial function confirmed this finding. Postmenopausal normotensive and untreated hypertensive women exhibit a greater increase in pulse pressure due to both a greater increase in SBP and a greater decline in DBP. This relationship can explain the greater prevalence of isolated systolic hypertension in elderly women than in the younger (20-7-21). Furthermore, a study of hemodynamic changes associated with the menstrual cycle reported lower blood pressure during the luteal phase than during the follicular phase (22). Of course, the probable role of other determinants of high BP such as lower education level, overweight, and lower level of physical activity in older women should not be ignored (23).

In our study, half of the women were aware of their hypertension where only 29.8% were so. In Hajjar et al. study, among 1565 participants with hypertension, 68.9% were aware of the problem (9). In NHANES III, rates of awareness among hypertensive were significantly higher in women compared with men (24). In another study by Minh et al. only 17.4% were aware of their hypertensive status (25). It seems that some major factors such as governmental education programs about the importance of hypertension control and monitoring and also lifestyle modification for reducing the risk of hypertension can effectively influence the individuals' knowledge towards hypertension. Therefore, main efforts of governments should be focused on enhancing the awareness of individuals especially women about hypertension and its determinants though global healthy education programs.

In the present study, women were receiving more pharmacological treatment than men. Data on the association of gender with hypertension control have been conflicting. In the predominantly white Framingham Heart Study cohort between 1990 and 1995, 29% of hypertensive participants were controlled (26). In NHANES III, rates of control among hypertensive individuals were significantly higher in women compared with men (24). However, it has been also indicated a difference in the response to antihypertensive therapy, with a lesser benefit for women in heart disease prevention (4). Also, cohorts of the Framingham Heart Study between 1990 and 1999 showed a notable decreasing in hypertension control rates with advancing age, especially in women (27). This sex-relat-

ed difference can be due to the different response to anti-hypertensive treatment. Although our study suggested higher quality management of hypertension in women than in men, some studies found less benefit receiving antihypertensive therapy in women than in men and in some others, no sex-related difference in the response to antihypertensive treatment was observed (28-30).

In summary, this population based study showed an increasing trend in the prevalence of hypertension with age in both urban and rural population in both genders. Similar to previous findings, trend of changes in SBP and DBP is different in men and in women and is potentially influenced by sex-related hormones causing both blood pressures to increase in post-menopausal women. Additionally, women are more aware than men about their blood pressure, and hypertension is more controlled and under pharmacological treatment in women than in men.

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