Journal of Hypertension: March 2008 - Volume 26 - Issue 3 - p 419–426
doi: 10.1097/HJH.0b013e3282f2d34d
Original papers: Epidemiology

Nationwide survey of prevalence and risk factors of prehypertension and hypertension in Iranian adults

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Objective **The aim of this study was to estimate the prevalence and risk factors of prehypertension (Pre-HTN) and hypertension (HTN) among the adult population of Iran.**

Methods **A nationwide cross-sectional survey was conducted from December 2004 to February 2005. The selection was conducted by stratified probability cluster sampling through household family members in Iran. Blood pressure (BP) and associated risk factors of 35 048 men and 34 674 women aged 25–65 years (mean 44.1 years) were measured.**

Results **The prevalence of Pre-HTN was 59.6% in men and 44.5% in women; and 19.8% of men and 26.9% of women were hypertensive, according to Joint National Committee 7 criteria. Pre-HTN was more common among men whereas HTN was more common among women. Multivariate analysis revealed that age, overweight, obesity, abdominal obesity and high cholesterol were strongly associated with Pre-HTN in both genders. In women, low educational attainment, residence in an urban area and high blood glucose were also associated with Pre-HTN. Age, low educational attainment, overweight, obesity, abdominal obesity and high cholesterol and blood glucose were strongly associated with HTN in both genders.**

Conclusion **Pre-HTN and HTN appear to be quiet common in Iran and were associated with obesity. More men than women present with Pre-HTN, whereas more women than men present with HTN. Prevention and treatment strategies are urgently needed to address the health burden of Pre-HTN and HTN and to prevent prehypertensive people from developing HTN and cardiovascular disease. *J Hypertens* 26:419–426 © 2008 Wolters Kluwer Health | Lippincott Williams & Wilkins.**

Journal of Hypertension 2008, **26**:419–426

Keywords: adults, hypertension, Iran, prehypertension, prevalence, risk factors

Abbreviations: BMI, body mass index; INHANES, Iranian National Health and Nutrition Examination Survey; NHLBI, National Heart, Lung, and Blood Institute; NCD, noncommunicable disease; STEPS, STEPwise approach to Surveillance; JNC7, The Seventh Report of Joint National Committee; WC, waist circumference

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Received 7 June 2007 **Revised** 7 August 2007
Accepted 1 October 2007

Introduction

The Seventh Report of Joint National Committee (JNC 7) on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure introduced a new blood pressure category, prehypertension (Pre-HTN), defined as a systolic blood pressure (SBP) of 120–139 mmHg and/or a diastolic blood pressure (DBP) of 80–89 mmHg, and stages 2 and 3 of hypertension (HTN) were combined [1]. Since the publication of the JNC 7 report, several studies have assessed the prevalence and significance of Pre-HTN and have reported that individuals who are prehypertensive are at higher risk for HTN [2] and cardiovascular disease [3–9]. Pre-HTN is not currently categorized as a disease, but is considered as an independent predictor of cardiovascular risk factors, morbidity and mortality [3–9]. Since screening and treatment efforts are to be directed based on these new criteria, knowledge about the prevalence of these new categories of HTN in different populations are important.

The rapid social and economic transition of Iran has been accompanied by cultural changes, reduction of communicable diseases, increased life expectancy, changes in nutritional habits and physical activity, and increases in non-communicable diseases such as HTN, diabetes, cardiovascular disease and their risk factors.

Although a number of studies on the local prevalence of HTN are available for Iran [10,11], the prevalence of Pre-HTN has not been reported. Accurate information regarding the prevalence of Pre-HTN and HTN according to the new guidelines, using more recent and nationally representative survey data, is important for appropriate public health responses.

The objectives of this nationwide population-based survey were to estimate the prevalence of Pre-HTN and HTN among adults aged 25 to 65 years in Iran, in accordance with JNC 7 guidelines, and to conduct a

0263-6352

preliminary investigation of the determinants of Pre-HTN and HTN. These data will also serve as the baseline for future examination of secular trends.

Methods

Data source

The recruitment methods and examination procedures of the Iranian National Health and Nutrition Examination Survey (INHANES) have been described before [12]. In summary, from December 2004 to February 2005, we conducted a population-based cross-sectional survey among 89 404 Iranian men and women studied for non-communicable disease (NCD) risk factors. The survey was designed to provide information about a wide range of behaviours that affect Iranians' health at a provincial level, so that provincial health authorities can adjust national policies and programmes and respond to their local needs. By accumulating the provincial data, an estimate of the national figures can be obtained. The study protocol is based on the World Health Organization (WHO) STEPwise approach to Surveillance (STEPS) of risk factors for NCD [13]. STEPS uses different levels of risk factor assessment, including collecting information using questionnaires (Step 1), taking physical measurements (Step 2), and taking blood samples for biochemical assessment (Step 3).

Participants

A stratified, multistage probability cluster sample, with a probability in proportion to size procedure, was used to obtain a nationally representative sample of the population. The frame for the selection of the sampling units was based on the Iranian national zip code databank. The postal addresses of the starting points for the survey in each cluster were determined centrally, using the Iranian national zip code databank. A counterclockwise movement from this point was used to ensure a representative sample of households. We excluded 19 682 (22.0%) individuals who were 15–25 years old because they were not invited to a referral laboratory for blood testing. As expected, those who participated were older and had slightly higher SBP (124.7 versus 112.5 mmHg; $P < 0.001$) and DBP (78.9 versus 71.8 mmHg; $P < 0.001$); body mass index (BMI: 26.3 versus 22.5 kg/m^2; $P < 0.001$) and waist circumference (WC: 90.7 versus 77.9 cm; $P < 0.001$), had a higher proportion of current smokers (21.2 versus 5.3%; $P < 0.001$) and were married (92.1 versus 24.0%; $P < 0.001$), but included a lower proportion of individuals with higher education (8.8 versus 12.3%; $P < 0.001$). The sample had similar distributions in gender as those not selected. Therefore this study uses data for 69 722 individuals only (35 048 men and 34 674 women) aged 25–64 years. Of the total of 69 722 participants in the study, 866 (1.2%) participants had missing data on education, 740 (1.1%) on marital status, 1276 (1.8%) on physical activity, 1286 (1.8%) on BP and 16 637 (23.9%) on laboratory tests. These individuals were excluded from subgroup analyses. The participants had a mean age of 44.1 years. Women who reported they were pregnant at the time of the survey, homeless people and individuals living in institutions or in the armed forces were excluded from the analysis.

Data collection

Participants were contacted to schedule an interview in their home at their convenience. Trained staff members of local medical universities/schools served as interviewers (in pairs), and a trained supervisor monitored the process in each district. Before the data collection began, the interviewers thoroughly explained the purpose and procedure of the study to participants and sought their consent. Interviews and anthropometric measurements were performed at each participant's home with standard techniques and equipment [14], and participants aged 25–64 years were then invited to a referral laboratory for blood testing; 25 511 (72.8%) men and 27 574 (79.5%) women provided a blood sample.

Blood pressure (BP) was measured with a standard mercury sphygmomanometer and a cuff of suitable size to the individual's arm circumference after an adequate rest period of at least 15 min. Korotkoff phases I and V were used for SBP and DBP, respectively. Three measurements were taken for each participant with a 30-s interval between measurements in the sitting position, and mean values were calculated.

Height and weight were measured with participants in light clothes and without shoes, using standard apparatus. Weight was measured to the nearest 0.1 kg on a calibrated beam scale. Height and WC were measured to the nearest 0.5 cm with a measuring tape. To measure height, a measuring tape was fixed to the wall and the participant stood with heels, buttocks, shoulders and occiput touching the vertical tape. The head was held erect with the external auditory meatus and the lower border of the orbit in one horizontal plane. The waist was measured midway between the lower rib margin and the iliac crest at the end of a gentle expiration.

Overnight fasting blood samples were taken, and plasma was separated and analysed on the same day. Total cholesterol and fasting blood glucose were assessed by standardized procedures. In addition to measurements, all participants completed a set of interviewer-administered questionnaires on sociodemography, smoking habits, diet, physical activity, diabetes mellitus, and HTN. The Medical Ethics Committee of the Ministry of Health and Medical Education approved the study protocol, and all participants gave their written consent. The study complied with the current version of the Declaration of Helsinki.

Definitions

The criteria for normal BP, Pre-HTN and HTN used in the present study were consistent with the definitions set by the JNC 7 report [1]. Normal BP was defined as not being on antihypertensive medication and having a SBP <120 mmHg and DBP <80 mmHg. Pre-HTN was defined as not being on antihypertensive medication and having a SBP of 120–139 mmHg and/or DBP 80–89 mmHg. HTN was defined as SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg and/or the current use of antihypertensive medications. BMI is recognized as the measure of overall obesity. The criteria for underweight, desirable weight, overweight and obesity used in the present study were based on BMI [weight/height^2 (kg/m^2)] and were consistent with the definitions set forth by the World Health Organization (WHO) and the National Heart, Lung, and Blood Institute (NHLBI) as follows: underweight, <18.5; desirable weight, 18.5–24.9; overweight, 25–29.9; and obesity, ≥ 30 [15,16]. WC was used as a measure of abdominal obesity, defined as WC ≥ 102 cm in men and ≥ 88 cm in women, to distinguish individuals at increased cardiovascular risk [17,18]. Smoking was estimated from self-report and categorized as current, former and never smokers. The leisure-time physical activity variable was based on a detailed interview about activity at work and leisure time. Interviewers had a codebook that listed an activity level beside common occupations and also probed participants about the nature of their activity outside of working hours. When a participant repeatedly spent at least 30 min/week of their leisure time performing physical activity, this was considered as 'regular physical exercise'. Diabetes was based on a history of physician-diagnosed report.

Analysis

Data were entered on a computer in each medical university/school, with EPI info software (US Department of Health and Human Services, Centers for Disease Control and Prevention). Datasets were transferred into an SPSS-compatible format to calculate means and standard errors (SE), *t*-test, and chi-squared tests (SPSS for Windows computer package; SPSS Inc., Chicago, Illinois, USA). All analyses were stratified by gender. The mean (SE) and 95% confidence interval (CI) were calculated for SBP and DBP. Robust SEs were calculated to minimize the effect of cluster sampling on the test statistics. Multivariate logistic regression was performed with the SPSS for Windows computer package to assess significant determinants of prehypertensive and hypertensive status, with Pre-HTN or HTN serving as the dichotomous outcome variable (Pre-HTN or HTN versus normotension) and age, weight categories, abdominal obesity, marital status, educational level, leisure-time physical activity, smoking habits, area of residence, fasting blood glucose and total cholesterol as the independent predictor variables. All tests for statistical significance were two tailed and performed at $\alpha < 0.05$.

Results

Characteristics

Distributions of selected characteristics among 35 048 men and 34 674 women are shown in Table 1. Women had lower educational level, physical activity, age-adjusted weight, height, and SBP and DBP and were more likely never to have smoked than men. Men had lower age-adjusted BMI, WC, cholesterol, and fasting blood glucose than women. Women had higher prevalence of clinical diabetes than men. The age-adjusted mean (SE) SBP was 125.1 (0.09) mmHg in men, and 124.3 (0.09) mmHg in women. The age-adjusted mean (SE) DBP was 79.5 (0.06) mmHg in men and 78.2 (0.06) mmHg in women.

Prevalence of prehypertension and hypertension

Tables 2 and 3 present the gender-specific prevalence of Pre-HTN and HTN according to selected characteristics. Normal BP was measured in 20.6% of the men and 28.7% of women. More than half of Iranian adults aged 25–65 years were prehypertensive (52.1%; 95% CI 51.7, 52.5). Overall, 59.6% men (95% CI 59.1, 60.1) and 44.5% women (95% CI 43.9, 45.0) were prehypertensive, and 19.8% men (95% CI 19.4, 20.3) and 26.9% women (95% CI 26.4, 27.4) were hypertensive. The prevalence rates of Pre-HTN among men and women in rural areas were 58.4% (95% CI 57.5, 59.3) and 43.8% (95% CI 42.9, 44.7),

Table 1 Age-adjusted means and proportions of selected characteristics among 35 048 men and 34 674 women

	Age-adjusted mean (SE)	
Characteristics	Men	Women
Age (years)	44.3 (0.06)	44.0 (0.06)
Weight (kg)	72.2 (0.07)	66.5 (0.07)
Height (cm)	169.3 (0.04)	155.9 (0.04)
Waist circumference (cm)	88.8 (0.07)	92.6 (0.07)
BMI (kg/m^2)	25.2 (0.03)	27.4 (0.03)
Systolic BP (mmHg)	125.1 (0.09)	124.3 (0.09)
Diastolic BP (mmHg)	79.5 (0.06)	78.2 (0.06)
Cholesterol (mg/dl)	196.9 (0.27)	206.7 (0.26)
Fasting blood glucose (mg/dl)	96.2 (0.21)	98.5 (0.20)
Education (%)		
Primary or below	52.4	70.2
Secondary	36.1	23.8
Matriculation or above	11.6	5.9
Marital status (%)		
Married	91.3	83.9
Single	7.9	7.9
Divorced/widowed	0.8	8.2
Smoking (%)		
Never smoked	58.8	90.0
Current smoker	32.8	7.0
Ex-smokers	8.4	3.0
Leisure-time physical activity (%)		
Yes	29.6	17.4
No	70.4	82.6
Residential area (%)		
Urban	64.8	64.6
Rural	35.2	35.4
Diabetes (%)	4.1	6.7

Age-adjusted means were calculated using general linear models. BMI, body mass index; BP, blood pressure; SE, standard error.

Table 2 Prevalence rate (%) and odds ratio (95% CI) of prehypertension in 35 048 men and 34 674 women according to selected characteristics, Iran

	Men		Women	
Variables	Prevalence of prehypertension	Multivariate-adjusted odds ratio (95% CI)[a]	Prevalence of prehypertension	Multivariate-adjusted odds ratio (95% CI)[a]
All ages (years)	59.6	(59.4, 60.1)	44.5	(43.9, 45.0)
Age (years)				
25–34	62.6	1.00	43.1	1.00
35–44	63.7	1.24 (1.14, 1.35)***	49.5	1.37 (1.26, 1.48)***
45–54	60.0	1.75 (1.59, 1.92)***	47.1	2.16 (1.98, 2.37)***
55–64	52.2	2.43 (2.19, 2.69)***	38.1	3.27 (2.93, 3.66)***
Education				
Primary or below	57.2	1.00	43.9	1.00
Secondary	62.0	–	46.4	0.84 (0.77, 0.91)***
Matriculation or above	63.2	–	43.7	0.75 (0.65, 0.86)***
Marital status				
Married	59.3	1.00	45.1	1.00
Single	63.5	–	43.7	–
Others	55.6	–	39.2	–
Smoking				
Non-smokers	60.8	1.00	44.7	1.00
Current smokers	58.2	0.93 (0.82, 1.06)	43.2	–
Ex-smokers	57.2	0.75 (0.70, 0.81)***	40.3	–
Physical activity				
No	58.9	1.00	44.1	1.00
Yes	61.4	–	46.0	–
Residential area				
Urban	60.3	1.00	44.8	1.00
Rural	58.4	–	43.8	0.93 (0.87, 0.996)*
Weight categories[b]				
Desirable weight	59.4	1.00	42.7	1.00
Underweight	50.8	0.65 (0.56, 0.75)***	35.8	0.75 (0.63, 0.89)**
Overweight	61.8	1.59 (1.48, 1.72)***	46.0	1.30 (1.20, 1.41)***
Obesity	56.7	2.02 (1.72, 2.36)***	45.4	1.79 (1.62, 1.98)***
Abdominal obesity[c]				
Absent	60.2	1.00	43.3	1.00
Present	56.4	1.52 (1.31, 1.76)***	45.3	1.33 (1.23, 1.44)***
Glucose (mg/dl)				
≤126	58.6	1.00	44.6	1.00
>126	51.9	–	38.2	1.38 (1.18, 1.61)***
Cholesterol (mg/dl)				
≤200	58.0	1.00	43.8	1.00
>200	58.3	1.40 (1.06, 1.22)***	44.4	1.23 (1.15, 1.31)***

BMI, body mass index; CI, confidence interval. [a]Category definitions are based on World Health Organization and National Heart, Lung and Blood Institute cut-offs [4,12]. Underweight, BMI <18.5 kg/m^2; desirable weight, BMI 18.5–24.9 kg/m^2; overweight, BMI 25–29.9 kg/m^2; obesity, BMI ≥30 kg/m^2. [b]Abdominal obesity was defined as waist circumference ≥102 cm in men and ≥88 cm in women [4,26]. *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

while these rates in urban areas were 60.3% (95% CI 59.6, 60.9) and 44.8% (95% CI 44.2, 45.5), respectively. The prevalence rates of HTN among men and women living in rural areas were 18.8% (95% CI 18.1, 19.5) and 26.4% (95% CI 25.6, 27.2), which were slightly lower than the rates in urban areas, 20.4% (95% CI 19.9, 20.9) and 27.2% (95% CI 26.6, 27.7), respectively. In all age groups Pre-HTN was more common among men whereas HTN was more common among women.

In both genders systolic and diastolic BPs were correlated with BMI ($r = 0.24$ for men and 0.23 for women for SBP; $r = 0.22$ for men and 0.22 for women for DBP) and WC ($r = 0.28$ for men and 0.29 for women for SBP; $r = 0.24$ for men and 0.25 for women for DBP).

Risk factors of prehypertension and hypertension

Table 4 shows the mean (SE) of age, systolic and diastolic BP, cholesterol, fasting blood glucose, and height, weight, BMI and WC by BP class. As expected, all of the variables increased with increasing BP class in both men and women.

Multivariate adjusted odds ratio (OR) and 95% CI of Pre-HTN and HTN, as the dependent variables, in relation to age, physical activity, smoking, education, marital status, overweight, obesity, underweight, abdominal obesity, blood glucose and cholesterol level, and residence are shown in Tables 2 and 3. The prevalence of Pre-HTN was higher in men than in women; among obese men and women compared with men and women of desirable weight; among men and women with abdominal obesity; among older compared with younger people; among men and women with high cholesterol compared with men and women with low cholesterol; among women, but not men, with high fasting blood glucose compared with men and women with low blood glucose; and among women, but not men, residents of urban compared with rural areas. Low educational attainment was positively associated with Pre-HTN in women

Table 3 Prevalence (%) rate and odds ratio (95% CI) of hypertension in 35 048 men and 34 674 women according to selected characteristics, Iran

	Men		Women	
Variables	Prevalence of hypertension	Multivariate-adjusted odds ratio (95% CI)[a]	Prevalence of hypertension	Multivariate-adjusted odds ratio (95% CI)[a]
All ages (years)	19.8	(19.4, 20.3)	26.9	(26.4, 27.4)
Age (years)				
25–34	6.3	1.00	6.6	1.00
35–44	12.1	2.06 (1.77, 2.41)***	15.8	2.45 (2.14, 2.80)***
45–54	23.9	5.81 (4.99, 6.78)***	33.6	7.64 (6.68, 8.75)***
55–64	37.0	13.78 (11.73, 16.19)***	51.5	21.55 (18.58, 25.00)***
Education				
Primary or below	24.8	1.00	32.4	1.00
Secondary	14.1	0.81 (0.72, 0.91)***	14.7	0.65 (0.58, 0.72)***
Matriculation or above	15.2	0.83 (0.70, 0.98)*	10.5	0.53 (0.42, 0.67)***
Marital status				
Married	20.7	1.00	26.3	1.00
Single	8.6	–	14.8	1.01 (0.84, 1.22)
Others	29.4	–	44.4	1.26 (1.08, 1.47)**
Smoking				
Non-smokers	20.6	1.00	26.2	1.00
Current smokers	16.9	1.08 (0.91, 1.28)	30.7	–
Ex-smokers	25.7	0.70 (0.63, 0.77)***	38.9	–
Physical activity				
No	20.7	1.00	27.7	1.00
Yes	17.7	–	23.1	–
Residential area				
Urban	20.4	1.00	27.2	1.00
Rural	18.8	–	26.4	–
Weight categories[b]				
Desirable weight	14.2	1.00	18.0	1.00
Underweight	10.1	0.49 (0.38, 0.64)***	15.3	0.83 (0.64, 1.07)
Overweight	23.4	2.33 (2.09, 2.59)***	27.3	1.69 (1.51, 1.89)***
Obesity	33.8	4.16 (3.43, 5.05)***	37.2	2.97 (2.61, 3.38)***
Abdominal obesity[c]				
Absent	17.0	1.00	15.5	1.00
Present	35.3	1.86 (1.57, 2.20)***	33.8	1.72 (1.54, 1.92)***
Glucose (mg/dl)				
≤126	20.3	1.00	25.8	1.00
>126	36.6	1.74 (1.44, 2.11)***	50.1	2.14 (1.81, 2.53)***
Cholesterol (mg/dl)				
≤200	18.5	1.00	20.4	1.00
>200	25.0	1.21 (1.10, 1.34)***	34.5	1.39 (1.28, 1.52)***

BMI, body mass index; CI, confidence interval. [a]Category definitions are based on World Health Organization and National Heart, Lung and Blood Institute cut-offs [4,12]. Underweight, BMI <18.5 kg/m^2; desirable weight, BMI 18.5–24.9 kg/m^2; overweight, BMI 25–29.9 kg/m^2; obesity, BMI ≥30 kg/m^2. [b]Abdominal obesity was defined as waist circumference ≥102 cm in men and ≥88 cm in women [4,26]. * $P<0.05$; ** $P<0.01$; *** $P<0.001$.

Table 4 Comparison of selected age-adjusted[a] cardiovascular risk factors between normotensive, prehypertensive and hypertensive[b] participants by gender, Iran

	Age-adjusted mean (SE)					
	Normotensive		Prehypertensive		Hypertensive	
Variables	Men	Women	Men	Women	Men	Women
Age (years)	40.0 (0.13)	38.0 (0.10)	43.6 (0.08)*	43.7 (0.08)*	51.4 (0.13)*	51.5 (0.11)*
SBP (mmHg)	107.9 (0.14)	106.6 (0.14)	124.5 (0.08)*	123.7 (0.11)*	145.5 (0.14)*	144.6 (0.15)*
DBP (mmHg)	67.1 (0.10)	65.4 (0.10)	80.0 (0.06)*	79.4 (0.07)*	91.2 (0.10)*	89.8 (0.10)*
Cholesterol (mg/dl)	190.4 (0.59)	200.5 (0.51)	198.1 (0.35)*	207.0 (0.39)*	201.6 (0.60)*	211.6 (0.52)*
Fasting blood glucose (mg/dl)	93.5 (0.45)	94.1 (0.42)	96.2 (0.26)*	97.6 (0.32)*	100.3 (0.45)*	103.9 (0.43)*
Height (cm)	168.6 (0.09)	155.6 (0.08)	169.5 (0.05)	156.2 (0.06)	169.3 (0.10)	155.9 (0.08)
Weight (kg)	66.9 (0.16)	62.2 (0.14)	72.7 (0.09)*	67.2 (0.11)*	76.5 (0.16)*	70.3 (0.15)*
BMI (kg/m^2)	23.6 (0.05)	25.7 (0.06)	25.3 (0.03)*	27.6 (0.04)*	26.7 (0.06)*	29.0 (0.06)*
Waist circumference (cm)	84.4 (0.15)	88.4 (0.15)	88.9 (0.09)*	92.8 (0.11)*	93.2 (0.16)*	96.7 (0.15)*

BMI, body mass index; BP, blood pressure; DBP, diastolic blood pressure; SBP, systolic blood pressure; SE, standard error. [a] Age-adjusted means were calculated using general linear models. [b] Category definitions are based on the Joint National Committee (JNC 7) on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure [1]. Normotensive: SBP <120 mmHg and DBP <80 mmHg; prehypertensive: SBP 120–139 mmHg or DBP 80–90 mmHg; hypertensive: SBP ≥140 mmHg and/or DBP ≥90 mmHg and/or the current use of antihypertensive medication. * $P<0.001$ for comparison between normotensive, prehypertensive and hypertensive subjects.

but not men. No group difference was observed for marital status and physical activity (Table 2). Hypertensive adults were more likely to be older, to be less educated, to be overweight and obese, and to have abdominal obesity, to have high blood glucose and cholesterol. No group difference was observed for physical activity and residential areas (Table 3). Underweight men and women have lower BP or a lower rate of Pre-HTN than those of desirable weight.

Discussion

In this nationwide cross-sectional study of 69 722 adults aged 25–65 years; we found that Pre-HTN and HTN are very common in Iran, as 59.6% of men and 44.5% of women were prehypertensive. The HTN prevalence was 19.8% in men and 26.9% in women. These data are consistent with local reports of the high prevalence of HTN in Iran [10,11] and other Asian countries [19]. As in other studies, Pre-HTN and HTN tend to increase with age and are more common in overweight and obese men and women. To our knowledge, this is the first Iranian nationwide study to employ the new category of Pre-HTN and HTN, in accordance with the definitions established by the JNC 7 report.

The estimated prevalence of HTN was found to be generally comparable with the prevalence of HTN in other Asian countries. The prevalence of HTN has been reported to be highest in Germany (55%), followed by Finland (49%), Spain (47%), England (42%), Sweden (38%), Italy (38%), USA (28%) and Canada (27%) [20]. In Asian countries the prevalence of HTN was 24% in China, 27% in Singapore, 22% in Thailand [19] and 31.6% in Korea [21]. Prevalence rates of Pre-HTN in various studies from around the world show considerable variation. One study from Korea among Korean adults aged ≥ 20 years, found 22.9% to be prehypertensive [21]. Another study from Taiwan of individuals aged 18–96 years found that 32% of women and 36% of men were prehypertensive [22]. A study from rural adults of China, which has a low prevalence of coronary heart disease in the general population, found that the prevalence of Pre-HTN in men and women aged ≥ 35 years was 51.2 and 42.6%, respectively, and, for HTN, 35.8 and 36.7%, respectively [23]. The prevalence of Pre-HTN among young Israeli men and women was reported to be 50.6 and 35.9%, respectively [24]. The current prevalence of Pre-HTN in the USA is about 37.4% [25]. Another study from the USA of individuals aged 18 years and older found that about 60% of American adults have Pre-HTN or HTN, and that some population groups, such as African–Americans, older people, groups of low socioeconomic status and overweight groups, are disproportionately affected [26]. Another study from the USA of participants aged 20 years and older found that about 31% of American adults were prehypertensive and 29% were hypertensive [4]. The prevalence of Pre-HTN in Iran is higher than the values reported in Korea [21], Taiwan [22] and the USA [25], but comparable to those of Israel [24] and China [23], in the same age group. The minor differences observed between studies might be attributable to variation in methodology and population characteristics, because ethnic differences have been shown to play a role in the prevalence of Pre-HTN [27]. Economic development, changes in lifestyle, diet and lack of physical activity and an increase in life expectancy may help to explain the rapid increase in the prevalence of Pre-HTN and HTN in Iran. Another salient factor is that obesity has increased substantially in Iran [11]. Many previous studies have indicated that obesity is an important risk factor for HTN [18,28]. Taken together, these findings show that the potential health benefits conferred by obesity prevention are of considerable importance with regard to public health.

Consistent with earlier studies [4,22–24,26], the prevalence of Pre-HTN was found to be higher among men than women across all age groups. The reason for this difference remained unclear.

We also found that the prevalence of Pre-HTN increased with increasing age, which was similar to findings with the Taiwanese [22] and one study group of American people [4], but different from Chinese rural adults [23] and another study group of American adults [26]. BP levels are known to be a function of age.

Consistent with many earlier studies [4,18,22,24], Pre-HTN and HTN were more common among overweight and obese individuals, and among men and women with abdominal obesity, whereas they were lower among underweight individuals, after adjustment for other confounders. The association between BP and weight is strong and linear, even in the normal range of BP and BMI [27,29,30]. Therefore, it follows that weight should be a major determinant of Pre-HTN and HTN.

Another finding that requires further elaboration is the high prevalence of Pre-HTN and HTN in high cholesterol and blood glucose groups. This is most likely because of the fact that Pre-HTN is associated with the higher prevalence of the additional cardiovascular risk factors, which collectively result in a high-risk profile. Aggregation of multiple risk factors, including obesity, high BP and hyperlipidaemia, has been shown to increase the development of coronary heart disease [31–33]. Furthermore, consistent with our findings, a study of 506 Japanese individuals found that the prevalence of the metabolic syndrome among prehypertensive individuals was higher than that among normotensive individuals, but lower than that of hypertensive individuals [34]. It seems that Pre-HTN and HTN tend to coexist with other cardiovascular risk factors.

The lack of the effect of physical activity and smoking on risk of Pre-HTN in the Iranian general population is of interest. A similar result was found in a survey in Taiwan [22]. Educational level was a protective factor in HTN but not in Pre-HTN. Compared with people with education to primary level or below, people with secondary education or higher were more likely to know about HTN and subsequently to have a healthier lifestyle.

Our study has several strengths and limitations. The strengths include the large sample, consisting of both urban and rural populations; sound representation of the national population; and information on potential determinants of Pre-HTN and HTN. BP was measured three times during only one visit. Nevertheless, other reports of the same nature used a similar methodology, making it suitable for purposes of comparison. As a cross-sectional study, the present analysis is limited in its ability to elucidate causal relationships between risk factors and Pre-HTN and HTN. Another limitation was that study participants were aged 25–64 years, and results may not apply to the broader age groups. Despite the above limitations, the findings here add to our understanding of the epidemiology of Pre-HTN and HTN in Iran. Furthermore, this study provides new nationwide data from Iran, a developing country that has been underrepresented in past studies.

In summary, Pre-HTN and HTN appear to be quite common in Iran. More men than women present with Pre-HTN, whereas more women than men present with HTN. Overweight and abdominal obesity were major determinants of Pre-HTN and HTN. A lack of physical activity is common in these patients and, as JNC 7 recommendations indicate, lifestyle modification for prehypertensive individuals would probably be the most effective strategy. Preventive and treatment strategies are urgently needed to prevent HTN and cardiovascular disease in prehypertensive individuals, to promote weight maintenance and weight loss and address the health burden of Pre-HTN.

Acknowledgements

This work was sponsored by the Iranian Ministry of Health and Medical Education and Isfahan University of Medical Sciences and Health Services, Iran. We are grateful to Mr Majid Abyar for computer technical assistance and to the agencies that organized and support the Iranian non-communicable disease risk factor surveillance system, including the Ministry of Health, Treatment and Medical Education, participating households and participants who have given their full cooperation and support to the study.

There are no conflicts of interest.

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