Abstract

Background: Hypertension (HTN) is a major risk factor of cardiovascular diseases and has a high prevalence in the Eastern Mediterranean Region.

Aims: The aim of this study was to estimate the prevalence and awareness of hypertension and its associated factors in the central district of the Islamic Republic of Iran.

Methods: This cross-sectional study was conducted among 2320 adults aged 40–80 years in Yazd, Islamic Republic of Iran, in 2010–2011. Multivariable logistic regression analysis was performed to calculate the odds ratios (OR) for exploring the association between hypertension and associated risk factors. Of eligible subjects, 2098 participated in clinical exams (response rate: 90.4%).

Results: The sex- and age-standardized prevalence of HTN was 52.8% (95% CI: 49.6; 56.1%). Of participants with HTN (n=1170), 421 cases were diagnosed for the first time in this survey; therefore, unawareness proportion was 36.0% (95% CI: 33.2%-38.8%). Among known cases
(749 out of 1170 participants with HTN), 68.5% (95% CI: 65.0; 71.8) had uncontrolled blood pressure. Age [OR age group 70–80 vs. age group 40–50 =7.01 (95% CI: 4.01; 12.24)], obesity [OR=2.78 (95% CI: 2.06; 3.75)], diabetes [OR=1.46 (95% CI: 1.12; 1.89)], hyperlipidemia [OR=1.60 (95% CI: 1.26; 2.03)] and living in rural area [OR=1.57 (95% CI: 1.00; 2.45)] were significantly associated factors with HTN.

Conclusions: Although age is the inevitable risk factor of HTN, a high proportion of unawareness and uncontrolled HTN and modifiable associated risk factors such as obesity, hyperlipidemia and diabetes demand effective preventive and curative strategies.

Keywords: Hypertension, high blood pressure, prevalence, risk factor, Iran

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Introduction

Hypertension (HTN) is a major risk factor of cardiovascular diseases including coronary heart disease, heart failure, arrhythmia and cardiomyopathy. There is also an increased risk of chronic kidney disease and stroke among hypertensive patients (1,2). According to The Global Burden of Disease Study, hypertensive heart disease account for 17.5 million disability-adjusted life years in 2015 (3). Research-based evidence demonstrates an increased risk of HTN with older age, male, and hyperlipidemia (4).

World Health Organization (WHO) reported that 30.7% of men and 29.1% of women in the Eastern Mediterranean Region are estimated to have HTN. In 2008, the prevalence of HTN in
the Islamic Republic of Iran among adults older than 25 years was estimated to be 31% in men and 27% in women (5). Previous studies conducted in different provinces of the Islamic Republic of Iran (6–8) showed a large variation of HTN prevalence among different provinces. A study in Yazd revealed 53.7% of people with HTN were aware of their disorder, 24% of them were under treatment and only 8% had controlled HTN (7). As prevalence of HTN is probably increasing in low- and middle-income countries (9) including the Iranian population (10), it is important to conduct additional studies to evaluate the trends and associated factors. In addition, population-based surveys on prevalence and risk factors of HTN are important in settings where routine health monitoring systems are not in place. Due to limited research resources in these settings, most studies are performed at subnational level; therefore, collecting data from different geographic areas may be more practical and can later be combined to illustrate more generalizable situation of HTN in a country or region. The aim of this study was to estimate the prevalence, awareness and associated factors of HTN in a central district of the Islamic Republic of Iran.

**Method**

**Study population**

The present study is part of a multi-dimensional population-based study. The details of the study design have been described previously (11). Briefly, this cross-sectional study was conducted in an urban and rural area of Yazd district in 2010–2011. The sample size was 2320 adult residents of Yazd aged 40–80 years, which were recruited with a systematic cluster sampling method. The Ethics Committee of Shahid Beheshti University of Medical Sciences approved the protocol of this study. Written informed consent was taken from the participants prior to data collection.

**Data collection**

Recruitment was performed from the living places of residents in the selected areas and those who agreed to participate were invited to an equipped clinic. A general practitioner conducted general medical assessments including blood pressure measurements. After five minutes of rest, blood pressure was taken using a standard mercury sphygmomanometer (nova-presameter®– Riester’s) in a sitting position twice at the same session and the average of measurements was recorded. Fasting blood sugar (FBS) was measured first during the home visit using a glucometer (ACCUCHEK Active meter, Roche Diagnostics, Indiana, USA) and then a complete blood test from the venous blood sample was taken after overnight fasting prior to the blood sampling at a standard laboratory to test FBS, HbA1c and lipid profile. Weight was measured with indoor clothing using stand body scale (Balas company) and standing height was measured without shoes by using measuring rod (Balas company). In addition, self-reported information on tobacco use, physical activity and education level were collected.

**Definitions**
HTN was defined according to the definitions of the Joint National Committee 7 (JNC 7) as 1) systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg (12); and 2) self-reported history of HTN and/or taking any antihypertensive medication. Non-hypertensive participants with SBP between 120 to 139 mmHg and DBP between 80 to 89 mmHg were categorized as prehypertensive. Furthermore, in patients with new HTN, a SBP from 140 to 159 mmHg and/or a DBP from 90 to 99 mmHg was classified as HTN stage I and SBP of 160 mmHg or more and/or DBP of 100 mmHg or more was classified as HTN stage II (13). In patients with known HTN, SBP lower than 140 mmHg and DBP lower 90 mmHg was regarded as controlled HTN. A summary of blood pressure definitions that were used in this study is presented in Table 1.

Diabetes mellitus was defined as two independent FBS ≥ 126mg/dl (7.0 mmol/l) and/or previous history of diabetes diagnosed by a physician and/or glucose lowering agent medication (14). Hyperlipidemia was based on lipid profile in a fasting blood sample i.e. triglyceride >150 mg/dL (1.7 mmol/L), low-density lipoprotein >130 mg/dL (3.4 mmol/L), high-density lipoprotein <35 mg/dL (0.9 mmol/L), cholesterol >150 mg/dL (3.9 mmol/L), previously diagnosed by a physician, or taking lipid lowering medication (15). BMI was calculated as weight in kilogramme over squared height in metre, and participants were classified in three groups including normal weight, overweight (25 ≤ BMI <30) and obese (30 ≤ BMI). Age of participants was recorded according to their birth certificate and it was measured as the number of full years they had lived at the time of enrolment in the study. In addition, age was categorized into four 10-year interval categories including 40–49, 50–59, 60–69 and 70–80 years old. Education was defined based on number of complete years of formal education and it was categorized as illiterate, incomplete primary education (less than 6 years), primary to secondary education (6–12 years), and higher education at a college or university. Physical activity was defined as any kind of regular exercise at least 3 times per week or having physically active occupations.

**Statistical analysis**

The sex and age standardized prevalence of HTN was calculated considering demographic composition of people aged 40–80 who lived in the survey area based on the National Census 2006. In evaluation of the relations, we considered the clustering effect by multilevel analysis within logistic regression. First, we evaluated the univariate relations in a simple multilevel logistic regression. Then, to consider the clustering effect and confounders in the evaluation of the relations, we used multilevel multivariable logistic regression. In this model age, sex, education, diabetes, smoking, BMI, hyperlipidemia, physical activity and living area were independent variables and covariates (for other variables in the model). The main outcome (dependent) variable was a binary variable with 1 for HTN and 0 for not-HTN. We used similar models for other outcome measurements including awareness, control status, and stage of HTN (Table 1). Within these models, we calculated adjusted odds ratios (presented as OR) to evaluate association of different factors with HTN and other outcomes. We considered duration of smoking and amount of smoking as quantitative variables and all other variables were considered as categorical variable in all models. P-values < 0.05 were considered statistically significant.
significant at 95% confidence intervals (CI). We used Stata, version 12.0 for statistical analysis.

**Results**

Of 2320 invited residents, 2098 participated (response rate: 90.4%) with a mean age± SD (standard deviation) of 54.1±10.0 years. Eighty-nine percent of the study population were urban dwellers and 53% were women. Among participants, 15.7% reported history of smoking and about 20% had no level of education. The mean BMI± SD in this study was 27.4±4.7 kg/m2 and nearly one-quarter of participants had a physically active lifestyle. The crude proportion of diabetes and hyperlipidemia was 25.8% (N=539) and 34.4% (N=731), respectively. Prevalence of HTN and more details of participants’ characteristics are provided in Table 2 and Table 3, respectively.

According to Table 2, the age and sex standardized prevalence of HTN and prehypertension was 52.8% (95% CI: 49.6; 56.1%) and 35.1% (95% CI: 31.9%; 38.4%), respectively. Of these, 19.5% (95% CI: 17.4; 21.7%) were newly diagnosed with HTN and among known cases, 68.5% (513 out of 749 subjects) had uncontrolled blood pressure (≥140/90).

Table 3 shows that urban dwellers had a HTN prevalence of 54.4%, while prevalence of HTN among rural residents was 67%. Prevalence of HTN among illiterates was 74.2%, while 45.7% people with more than 12 years of education had HTN. Prevalence of HTN was greater in non-smokers (58.1% vs. 43%). Among individuals with normal BMI, just 48.5% had HTN, whereas 69% of obese participants were hypertensive. Prevalence of HTN in patients with hyperlipidemia and diabetes was 69.6% and 70.1%, respectively.

By sex, prevalence of HTN was 52% in men and 59.1% in women. Prevalence of HTN was higher in women, but hypertensive men were more likely to have undiagnosed HTN. Prevalence of HTN increased with age in both sexes; for example, prevalence of HTN among men and women aged 40–49 was 33.7% and 41.4% and this prevalence increased to 69.7% for men and 89.9% for women who were 70–80 years old (Figure 1).

Detailed information of multivariable analysis is presented in Table 4. Results show that older age, obesity (OR=2.78), diabetes (OR=1.46), hyperlipidemia (OR=1.60) and living in rural area (OR=1.57) are significantly associated with HTN. In addition, older age, women (OR=2.21), people with diabetes (OR=1.63), and people with hyperlipidemia (OR=2.36) were more aware about their HTN. Uncontrolled HTN was significantly higher in age group 60–69 (OR=1.96) and people with diabetes (OR=1.61).
Age had a strong relationship with HTN, so that people aged 70–80 years had over seven fold odds of HTN compared to those aged 40–50 years [OR=7.01 (95% CI: 4.01-12.24)]. On the contrary, we did not find a significant association between HTN and the sexes, physical activity, level of education or smoking (Figure 2).

Discussion

This paper presents prevalence of HTN and its associated factors in a central district of the Islamic Republic of Iran. Age and sex standardized prevalence of HTN in this representative sample of the population aged 40–80 years in Yazd was 52.8%. Previous studies reported a wide range of HTN prevalence in the Islamic Republic of Iran ranging from 7.21% among 7–12 year old children in Ghazvin province (16) to 41.8% in 40–75 year-old residents in Golestan province (6). A systematic review of literature that combined 29 studies in the Islamic Republic of Iran in 1996–2004, reported prevalence of HTN around 50% in the population aged 55 years and over (10). A recent study in Yazd province revealed that prevalence of HTN in men and women in people aged 20–74 were 27.6% and 23.9%, respectively (7). Higher percentage of HTN in our study is probably due to the older age of study population.

HTN is a common health problem and its prevalence is increasing in low- and middle-income countries. Migration to urban areas, the aging of the population, dietary patterns and stressful lifestyles are reasons for the increasing prevalence (9). As it was also observed in the current study, age is a strong independent risk factor of HTN (17) and might have resulted in the higher prevalence of HTN in our study compared to others. A study among people aged 65 years and above in Taiwan reported prevalence of 60.4% HTN (18). Table 5 compares prevalence of HTN in different studies by sex and age.

In our study, prevalence of HTN was higher among women (Figure 1); however, the association was not significant after adjusting for confounders (Figure 2). According to WHO, total prevalence of HTN is globally higher among men (5). Similarly, studies conducted in East Asia showed higher prevalence of HTN among men (19). A systematic review in South Asia, which included 33 studies, indicated that the male sex is associated with a higher prevalence of HTN and only eight studies showed that HTN is more prevalent among women (20). Some studies in the Middle East showed prevalence of HTN among both sexes as almost identical or slightly higher among women (21). Likewise, a recent systematic review among the Iranian population revealed that prevalence of HTN is similar in both sexes (22). This difference in our study could be explained by the older age composition in our study, since we found the effect of older age on HTN was more substantial among women. It could also be explained by other factors such as vitamin D deficiency, which is fairly
common among women in the Middle East, and this vitamin plays an important role in pathophysiology of HTN (23). In addition, hormonal changes in postmenopausal women and decreased levels of oestrogen cause vasoconstriction (24).

Similar to some other studies (7), women and population aged 60 years and above were more likely to know they are hypertensive in the current study. Men are less likely to seek healthcare services. Therefore, they have a greater risk of being unaware about their health problems in some settings because they pay less attention to their medical condition or have outdoor occupations (25). Moreover, history of diabetes and hyperlipidemia showed an association with awareness of HTN in our study. Naturally, older people and those with other medical conditions are more likely to have contact with healthcare professionals during their lifespan; it could explain the higher proportion of awareness in these groups.

The current study showed that both obesity and hyperlipidemia are associated with HTN. These results are supported by other studies (26). A study in Macao Special Administrative Region (SAR) revealed that obese people have 4.5 times higher risk of HTN compared to normal weight population (27). In addition, there are studies demonstrating 78% of essential HTN in men and 65% of essential HTN in women are related to excess weight gain (28). It has also been postulated that stimulation of sympathetic activity by high dietary fat and carbohydrate (29) and obesity-induced overactivation of renin–angiotensin–aldosterone system are main biological causes of HTN in obesity and hyperlipidemia (28). These all emphasize the importance of weight control in HTN prevention.

The results revealed no significant association between physical activity and HTN. In our study, 45.2% of normotensives and 54.8% of hypertensives reported some level of exercise. A recent meta-analysis of prospective cohort studies demonstrated a decreased risk of HTN by increased recreational physical activity. However, the risk did not change by occupational physical activity (30). Physical activity may play a role in decreasing blood pressure by reducing vascular resistance and by influencing the level of activity in the catecholamine and renin angiotensin aldosterone system (31). Although having a physically active lifestyle was more common in patients with HTN, the association between exercise and HTN was not significant.

According to our results, people who live in rural area have a greater risk for HTN. The geo-political variation in the distribution of HTN is very diverse (32). In the Islamic Republic of Iran, different studies reported conflicting results. Esteghamati et al. reported higher prevalence of HTN in urban dwellers of the Iranian population in 2007 (33), while the results of a cohort study in Golestan province conducted by Malakzadeh et al. (2004–2008) showed lower risk of HTN in urban dwellers (6). In addition, some studies in the country showed no difference in
prevalence of HTN between urban and rural residents (34). Yazd province in the centre of the Islamic Republic of Iran has an arid climate and farming is less developed. Given that most people migrate to cities (35), less job opportunities, lack of welfare resources and a more stressful lifestyle could be the probable cause of higher prevalence of HTN in rural areas (35). In addition, lack of systematic programmes to promote general knowledge about appropriate lifestyles in rural areas (36) could be another reason of higher percentage of HTN.

Higher level of education has been demonstrated to reduce risk of HTN in the Islamic Republic of Iran and other countries (6,37). Education would increase people’s awareness about their health including HTN and encourage them to pay more attention to it. Although the multivariable analysis in our study showed non-significant association between HTN and education, the descriptive data (Table 3) showed a considerable higher prevalence of HTN among illiterates. It should be mentioned that about 25% of participants in this study were illiterate and only 11% had an academic education. The sample size in higher education levels might be insufficient to reveal the differences in this study.

In the current study, 17% reported that they were current smokers and we could not find any significant association between smoking and blood pressure. Nevertheless, many studies revealed that smoking increases prevalence of HTN (38). The measurement of amount of tobacco consumption is very specific and our data collection procedure did not provide an opportunity for collecting precise information. Anecdotally, smoking tobacco is generally disapproved of in the survey area, and therefore data gathering based on self-reported information may have reporting bias.

**Limitations**

This study has some limitations. First, this is a cross-sectional study and it cannot predict causality. In addition, we included people aged 40–80 years in this study, which cannot be generalized to all age groups living in the study area. Moreover, some risk factors of HTN such as alcohol consumption, psychological problems and dietary intake were not evaluated. Finally, some of our results such as smoking, education, medication and physical activity were based on self-reported information which may have reporting bias.

**Conclusion**

Hypertension is a major health problem in Yazd. The proportion of those who are not aware of their disorder and the proportion of uncontrolled blood pressure among known cases is considerable. Age, obesity, diabetes, hyperlipidemia, and living in rural area are associated with HTN. Although older age is the main inevitable risk factor of HTN, there is high potential to improve the situation through controlling manageable factors, increasing public awareness and
improving care for people with HTN.

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