

Original Article

Awareness, Treatment and Control of Pre-hypertension and Hypertension among Adults in Iran

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Abstract

Background: Hypertension is a major risk factor for non-communicable diseases. Yet, Nation-wide prevalence and trend reports in developing countries are sparsely available.

Methods: Data from three cycles of Survey of Risk Factors of Non-communicable Diseases (SuRFNCD) 2005 – 2011 were aggregated. In 2011, 8218 adults aged 25 – 70 years were enrolled. For trend analysis 68850, 4184, and 7416 adults aged 25 – 64 years were included from 2005, 2007, and 2011 surveys, respectively. Hypertension was defined as systolic blood pressure (SBP) \geq 140 mmHg, diastolic blood pressure (DBP) \geq 90 mmHg, or receiving anti-hypertensive medication. Pre-hypertension was defined as SBP between 120 – 139 or DBP between 80 – 89 mmHg. The status of awareness, non-pharmacologic treatment (management), pharmacologic treatment, and control (SBP < 140 mmHg, and DBP < 90 mmHg) among hypertensive individuals were also determined.

Results: 25.6% (95%CI: 23.5 – 27.5) of the adults aged 25 – 70 years had hypertension and 39.8% (95%CI: 37.8 – 41.9) had pre-hypertension. The prevalence of hypertension was greater among older adults ($P < 0.001$), women ($P = 0.013$), and urban-dwellers ($P = 0.027$). In 2005 – 2011, the proportion of adults with hypertension (25.7% to 24.1%) and pre-hypertension (45.5% to 40.4%) significantly decreased. In 2011, rates for awareness, management, treatment, and control among hypertensives were 43.2% (95%CI: 40.0 – 46.4), 40.3% (95%CI: 37.0 – 43.6), 34.8% (95%CI: 31.5 – 38.2), and 38.6% (95%CI: 33.1 – 44.2), respectively. Over time, status of awareness, management, treatment and control was significantly improved and was more salient among men ($P < 0.05$ for all analyses).

Conclusions: The prevalence of hypertension and pre-hypertension is gradually declining. Despite improvements in awareness, management, treatment and control, these decline rates are still low and initiative strategies need to be implemented to further improve the current status.

Keywords: Hypertension, hypertension awareness, hypertension control, hypertension treatment, nation-wide survey, pre-hypertension

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Introduction

High blood pressure is an independent causative factor for cardiovascular diseases (CVD) and accounts for 21% of total mortality in low- and middle-income countries.^{1,2} Apart from its role in CVD, hypertension has also been implicated in renal disease,³ and dementia.⁴

In 2000, 26.4% of the world's adult population, representing 972 million individuals with hypertension.⁵ Even if the incidence of hypertension remains constant, it is predicted that by 2025 this figure will grow by 60%, affecting 1.56 billion individuals globally.⁵ Most of this increase is attributed to an upsurge in the proportion of hypertensive adults in developing countries where an 80% rise is predicted. High blood pressure has been claimed to be responsible for 395000 deaths annually in the United States.⁶

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Results from recent surveys in the Middle East and North Africa (MENA) and Asia-Pacific regions have revealed that up to 60% of deaths due to stroke, and hypertension accounted for 66% of CVD deaths.^{7,8} In 2005, high systolic blood pressure was the leading cause of death accounting for 80,000 deaths in Iran.⁹

To date, there is an apparent lack of nation-wide surveys reporting prevalence and trends in hypertension in Middle Eastern countries.^{10,11} To address this knowledge gap, the Surveillance of Risk Factors of Non-Communicable Diseases (SuRFNCD) in Iran began in 2005 and two other surveys have been conducted since (2007 and 2011). Herein, we update our previous reports of prevalent pre-hypertension, and hypertension among Iranian adults^{12,13} using the data collected in SuRFNCD-2011. By aggregating data gathered over three cycles of the survey, we also present the first report on seven-year trends in prevalence, awareness, treatment, and control of hypertension in Iran.

Methods

Design and participants 2005 and 2007 surveys

SuRFNCD-2007 was designed using a multistage random cluster sampling and included the data of 5 287 Iranian individuals aged

15 – 64 years ($n = 4233$ for adults aged 25 – 64 years). Details of survey design can be found elsewhere.¹³ The SuRFNCD-2005 sample size ($n = 70981$) was calculated large enough to be representative of each province, apart from representing the country as a unit.¹² After excluding pregnant women and subjects with missing values, a total of 68850 and 4184 participants were included for trend analysis from SuRFNCD-2005 and -2007, respectively. The protocol of blood pressure assessment was similar in all three surveys and is described below.

2011 survey

The SuRFNCD-2011 used a randomized multistage cluster sampling method to represent all non-hospitalized and non-institutionalized Iranian population and comprised of 11867 individuals aged 6 – 70 years. The sampling was carried out between May 22nd and June 20th, 2011 in four steps. At the first step, individual counties, or a group of neighboring counties were designated as primary sampling units (PSUs). Fifty PSUs were then selected by employing the random sampling method with probability proportionate to size (PPS). All cities and counties in a selected PSU were then listed as secondary sampling units (SSUs) and 12 SSUs were selected in each PSU. At the third stage, households in each SSU were listed according to 10-digit postal codes, of which 20 were chosen randomly. In the final stage, two sampling individuals were then selected among eligible members of each household, using two sets of Kish tables for individuals < 55 and ≥ 55 years. The label ‘non-response’ was applied if a sampling individual was not available after three attempts or refused to participate. After excluding participants aged 6 – 24 years ($n = 3532$), and pregnant women ($n = 159$), final analyses were performed on the remaining 8218 individuals between 25 and 70 years and 7416 individuals between 25 and 64 years, who had at least one systolic and diastolic BP reading and had provided valid responses to survey questions regarding the high blood pressure.

In SuRFNCD 2005, 2007, and 2011, before conducting interviews, an informed consent form was read by the administering interviewer, and acceptance or refusal to participate was formally recorded. Methods and procedures regarding human subjects in all cycles of SuRFNCD were conducted in accordance with the guidelines described in the declaration of Helsinki. The methodology of the survey was also approved by the ethics committee of the Center for Disease Control (CDC) in Iran.

Physical Examination

Three measurements of blood pressure (BP), five minutes apart, were obtained by trained health-staff using the standard mercury sphygmomanometers (2005), and calibrated Omron M7 digital sphygmomanometers (Hoofddorp, Netherlands) in 2007 and 2011, with an appropriate-sized cuff from the right arm of participants after at least 10 minutes of resting in the sitting position. In patients with three measurements, the first reading was discarded and mean BP was calculated by averaging the second and third readings. Where two readings were available, the second reading was regarded as mean BP. Finally, the first record was used as mean BP if only one reading was obtained.

Definitions

Hypertension was defined as mean systolic BP (SBP) ≥ 140 mmHg or mean diastolic BP (DBP) ≥ 90 mmHg, or current intake

of prescribed anti-hypertensive medications. Pre-hypertension was determined as mean SPB between 120 and 139 mmHg, or mean DBP between 80 and 89 in non-hypertensive participants. Stage I hypertension was defined as SBP < 160 mmHg and DBP < 100 mmHg, and stage II as SBP ≥ 160 or DBP ≥ 100 in medication-naïve hypertensive adults.¹⁴ Isolated diastolic hypertension (IDH) was defined as SBP < 140 mmHg and DBP ≥ 90 mmHg; isolated systolic hypertension (ISH) as SBP ≥ 140 mmHg and DBP < 90; and systolic-diastolic hypertension (SDH) as the presence of both SBP ≥ 140 mmHg and DBP ≥ 90 mmHg in hypertensive adults not receiving medical treatment.

Awareness was defined as having been informed about the diagnosis of hypertension by a physician or a healthcare professional. Management was defined as either non-pharmacologic treatment (i.e. diet, physical activity, and/or restriction of salt intake) or pharmacologic treatment being prescribed by a physician for diagnosed hypertension. Treatment was defined as taking any class of anti-hypertensive medication in the past two weeks. Control in the treatment was achieved if SBP < 140 mmHg and DBP < 90 mmHg in the subgroup of hypertensive individuals currently receiving anti-hypertensive medications.

Statistical analysis

Complex sample analysis was performed using Stata version 11 for Windows (Stata Corporation, College Station, Texas, United States). Iran’s population in 2011 was designated as the reference population and data from all three cycles were extrapolated to this reference, adjusting for design and non-response weights. According to the national census, in 2011, 38,199,463 adults aged 25 – 64 years and 39,793,002 adults aged 25 – 70 years resided in the country.¹⁵ Non-response weights were calculated using reference populations for age strata (25 – 34, 35 – 44, 45 – 54, 55 – 64, and 65 – 70), sex (male, female), and area of residence (urban, rural). Continuous variables (i.e. SBP and DBP) are presented as mean (95% CI) and categorical variables as proportion (95% CI). Design-based linear regression was used to test for trends and differences in SBP and DBP across age strata, sex, and area of residence. The presence of a trend in crude prevalence rates across age strata was investigated using the Cochran-Armitage test. Differences in proportions across binary categories (i.e. sex and area of residence) were assessed using design-based Chi-square test. The presence of a secular trend in mean SBP and DBP was investigated using linear regression. Secular trend analyses for proportions were done using logistic regression for complex samples. To calculate the secular trends in both linear and logistic regression models over the course of seven years (2005 – 2011), calendar year was entered into the model as the independent variable and the outcome of interest (e.g. mean SBP, prevalence of hypertension, etc.) was introduced as the dependent variable. Age, sex, and area of residence were also included in the model to adjust for their confounding effects. Based on these models, odds ratios (ORs) along with 95% CI for each outcome were calculated for every one year increase in calendar year (0 for 2005, 2 for 2007, and 6 for 2011), controlling for the confounding effects of age, sex, and area of residence (hence the term secular). It should be noted that since the age-strata of individuals aged 65 – 70 years was only included in the latest round of the survey (SuRFNCD-2011), for trend analysis across surveys, analyses were limited to individuals aged 25 – 64 years. The Jackknife

method was used to estimate variance throughout the analyses. In all analyses, $P < 0.05$ was considered statistically significant.

Results

2011 Prevalence

Mean SBP and DBP among the adult population aged 25 – 70 years were 123.4 (95% CI: 121.9 – 124.9) and 78.6 (95% CI: 77.8 – 79.4) mmHg, respectively. Prevalent pre-hypertension, and hypertension stratified by age, sex, and area of residence for 2011 are presented in Table 1. In 2011, prevalent pre-hypertension was 39.8% (95% CI: 37.8 – 41.9), which significantly decreased with advancing age ($P < 0.001$). The prevalence of pre-hypertension was significantly greater among men (46.3%; 95% CI: 43.1 – 49.5) compared with women (33.3%; 95% CI: 31.3 – 34.4).

In 2011, 10.18 (95% CI: 9.35 – 10.94) million adults, comprising 25.6% of the adult population met the criteria for diagnosis of hypertension. Prevalent hypertension was consistently incremented with advancing age ($P < 0.001$). Additionally, hypertension was more likely to be detected in women ($P = 0.013$), and in the residents of urban areas ($P = 0.027$). In medication-naïve hypertensive adults, on average, one in four individuals had a high blood pressure in the range of stage II hypertension. The percentage of IDH, ISH, and SDH were 35.3% (27.2 – 43.3), 28.8% (21.8 – 35.8) and 35.9% (31.3 – 40.4) respectively among hypertensive individuals who were not treated.

Awareness, management, treatment, and control in treatment

In 2011, the proportion of individuals aged 25 – 70 years, which were aware of their disease, was 43.2% (40.0 – 46.4) and substantially higher among advanced age groups and women ($P < 0.001$ for both, Table 2). Management and treatment rates were 40.3% (37.0 – 43.6) and 34.8% (31.5 – 38.2), respectively; again higher proportions were observed among older age categories and women ($P < 0.001$ in all analyses). Control in the treatment was achieved in 38.6% (33.1 – 44.2) of the hypertensive individuals. As depicted in Table 2, no significant age, sex, or residence predilection was identifiable ($P > 0.05$ for all analyses).

Trends in prevalence 2005-2011

Mean SBP and DBP over three cycles of SuRFNCD are delineated in the Supplementary Table 1. For the total population, a gradual increase of about 1.6 mmHg in SPB (121.2 vs. 122.8 mmHg, $P < 0.001$) and 0.9 mmHg in DBP (77.5 vs. 78.4 mmHg, $P < 0.001$) was noted. With respect to SBP, sub-population analysis showed that the change is only significant in 25 – 44 years age strata, men, and both urban/rural residents ($P < 0.05$ for all tests). For DBP on the other hand, the increase was statistically significant among 25 – 54 years, women, and both urban/rural residents ($P < 0.05$ for all tests). When analyses were repeated in patients with hypertension, an upward shift in SBP and DBP was noted (140.8 vs. 142.5 mmHg, $P = 0.002$ for SBP, and 90.5 vs. 90.6 mmHg, $P = 0.001$ in DBP).

Age-, sex-, and area of residence-adjusted trends in pre-hypertension and hypertension between 2005 and 2011 are depicted in Table 3. The proportion of 25 – 64 years adults with hypertension markedly decreased from 25.7% (95% CI: 25.3 – 26.0) in 2005 to 24.1% (22.2 – 26.0) in 2011 [OR (95% CI): 0.98 (0.97 – 0.99), $P = 0.011$]. A steep decline of 11.6% in prevalent hypertension was observed among men ($P < 0.001$),

and the prevalent hypertension in women remained relatively unchanged ($P = 0.134$). Compared with urban adults, rural residents experienced a steeper decline in prevalent hypertension (12.3% vs. 4.0%). Over time, the prevalence of pre-hypertension decremented significantly by 11.2% [OR (95% CI): 0.96 (0.95 – 0.97), $P < 0.001$]. Subgroup analyses revealed that this decrease is significant across all age groups, men/women, and urban/rural residents (Table 3).

Awareness, management, treatment and control in treatment

Between 2005 and 2011, the percentage of awareness increased from 31.0% (95% CI: 30.4 – 31.7) to 40.6% (95% CI: 37.5 – 43.8; $P < 0.001$). The proportion of management increased from 28.3% (95% CI: 27.7 – 28.9) to 37.5% (95% CI: 34.2 – 40.8; $P < 0.001$) prominently among older adults and men. Similar trends were detectable with regard to the percentage of treatment, which increased from 25.2% (95% CI: 24.7 – 25.8) to 31.9% (95% CI: 28.6 – 35.3) over seven years ($P < 0.001$). An upward shift in proportion of the controlled individuals was also observed, where controlled hypertension increased from 28.1% (95% CI: 26.9 – 29.3) in 2005 to 39.7% (33.6 – 45.9) in 2011 ($P < 0.001$). Details of trend analysis among age, sex, and residential strata are shown in Table 4. Overall, a rise in the proportion of awareness, management, treatment, and control in the treatment was more precipitous among men. Except for control in treatment, indices for secondary prevention of hypertension in 2011 are still higher in women, nonetheless (Table 4).

Discussion

Periodic surveys of non-communicable diseases and their contributing risk factors provide data that help trace a nation's health and nutritional status. The methodology used in different cycles is principally similar, these snapshots could be brought together to unravel trends, allowing policymakers to appraise the policies currently in place, and develop targeted and cohesive strategies that have the greatest impact on reduction of risk factors.

2011 prevalence

Based on the survey findings, 10.18 (95% CI: 9.35 – 10.94) million individuals between 25 and 70 years have hypertension and an additional 15.86 (95% CI: 15.04 – 16.67) millions are diagnosed with pre-hypertension. Conjointly, about two thirds of Iranian adults have higher than normal blood pressure.

According to the data from 2005 – 2006 National Health and Nutrition Examination Surveys (NHANES),¹⁶ the proportion of pre-hypertension among adults is 29%, which is significantly lower than our prevalence of 39.9%. More recently, Gupta, et al. (2010) aggregated NHANES 1999 – 2006 data in a subset of adults with no previous history of cardiovascular diseases and reported a prevalence of 36.3% for pre-hypertension.¹⁷ The ATTICA study (2001 – 2002), a population-based survey of Greek adults, has reported prevalence rates as high as 39% for pre-hypertension among the adult population.¹⁸

Although prevalence of pre-hypertension is significantly greater among Iranian adults, hypertension prevalence is relatively lower than the United States. NHANES 2009 – 2010 showed that 28.6% of adults 18 years or over have hypertension.¹⁹ Similar prevalence reports for hypertension have been garnered from both developed and developing countries. A meta-analysis of epidemiologic

Table 1. Prevalence of pre – hypertension, stage I, stage II, and total hypertension among Iranian adults (25 – 70 years) in 2011

| | Pre – hypertension ^a | | | Hypertension stages ^b | | | Total hypertension ^a | | | |
|--------------------------|---------------------------------|--|-----------------------|----------------------------------|--------------------|-----------------------|---------------------------------|---------------------------|-----------------------|-----------|
| | Population Number ^c | Estimated Number ^c (95% CI) | Prevalence % (95% CI) | Stage I hypertension | | Stage II hypertension | | Estimated Number (95% CI) | Prevalence % (95% CI) | P – value |
| | | | | Prevalence % (95% CI) | P – value | Prevalence % (95% CI) | P – value | | | |
| All | 39.79 | 15.86 (15.04 – 16.67) | 39.8 (37.8 – 41.9) | 74.5 (71.6 – 77.4) | 25.5 (22.6 – 28.4) | 10.18 (9.35 – 10.94) | 25.6 (23.5 – 27.5) | | | |
| Age Group | | | | | | | | | | |
| 25 – 34 yrs | 15.63 | 6.72 (6.30 – 7.14) | 43.0 (40.3 – 45.7) | 81.7 (76.1 – 87.2) | 18.3 (12.7 – 23.9) | 1.61 (1.36 – 1.86) | 10.3 (8.7 – 11.9) | | | |
| 35 – 44 yrs | 10.47 | 4.65 (4.26 – 5.04) | 44.4 (40.7 – 48.1) | 74.9 (69.8 – 79.9) | 25.1 (20.1 – 30.1) | 2.11 (1.79 – 2.41) | 20.1 (17.1 – 23.1) | | | |
| 45 – 54 yrs | 7.55 | 2.66 (2.42 – 2.90) | 35.2 (32.0 – 38.4) | 77.1 (71.2 – 82.9) | 22.9 (17.1 – 28.8) | 3.09 (2.82 – 3.37) | 40.9 (37.3 – 44.6) | | <0.001 | |
| 55 – 64 yrs | 4.54 | 1.42 (1.30 – 1.53) | 31.2 (28.6 – 33.8) | 67.3 (63.1 – 71.5) | 32.7 (28.5 – 36.9) | 2.39 (2.24 – 2.54) | 52.7 (49.4 – 55.9) | | | |
| 65 – 70 yrs | 1.60 | 0.41 (0.35 – 0.48) | 26.1 (21.9 – 30.3) | 65.3 (56.6 – 74.1) | 34.7 (25.9 – 43.4) | 0.98 (0.90 – 1.06) | 61.5 (56.5 – 66.5) | | | |
| Sex | | | | | | | | | | |
| Men | 19.96 | 9.24 (8.60 – 9.88) | 46.3 (43.1 – 49.5) | 77.5 (73.9 – 81.1) | 22.5 (18.9 – 26.1) | 4.75 (4.21 – 5.29) | 23.8 (21.1 – 26.5) | | 0.013 | |
| Women | 19.83 | 6.62 (6.21 – 6.82) | 33.3 (31.3 – 34.4) | 71.4 (67.1 – 75.7) | 28.6 (24.3 – 32.9) | 5.43 (5.04 – 5.83) | 27.4 (25.4 – 29.4) | | | |
| Area of residence | | | | | | | | | | |
| Urban | 29.45 | 11.86 (11.16 – 12.55) | 40.3 (37.9 – 42.6) | 75.5 (72.3 – 78.7) | 24.5 (21.3 – 27.7) | 7.79 (7.16 – 8.42) | 26.4 (24.3 – 28.6) | | 0.027 | |
| Rural | 10.34 | 4.00 (3.73 – 4.26) | 38.6 (36.1 – 41.2) | 71.4 (66.2 – 76.6) | 28.6 (23.4 – 33.7) | 2.39 (2.11 – 2.67) | 23.1 (20.4 – 25.8) | | | |

^a Prevalence calculated among total Iranian adult population (25 – 70 yrs); ^b Prevalence calculated among adult population (25 – 70 yrs) not being treated for hypertension; ^c In millions

Table 2. Proportion of awareness, management, treatment, and control among hypertensive Iranian adults (25 – 70 years): 2011

| | Awareness ^a % (95% CI) | P-value | Management ^a % (95% CI) | P-value | Treatment ^a % (95% CI) | P-value | Control in Treatment ^b % (95% CI) | P-value |
|--------------------------|-----------------------------------|---------|------------------------------------|---------|-----------------------------------|---------|--|---------|
| All | 43.2 (40.0 – 46.4) | | 40.3 (37.0 – 43.6) | | 34.8 (31.5 – 38.2) | | 38.6 (33.1 – 44.2) | |
| Age Group | | | | | | | | |
| 25 – 34 yrs | 15.9 (9.4 – 22.4) | | 11.0 (6.6 – 15.5) | | 6.4 (2.6 – 10.1) | | 49.9 (29.1 – 70.8) | |
| 35 – 44 yrs | 28.4 (23.1 – 33.8) | | 26.2 (20.7 – 31.7) | | 20.1 (14.6 – 25.5) | | 40.1 (25.3 – 54.8) | |
| 45 – 54 yrs | 47.9 (41.6 – 54.2) | <0.001 | 45.0 (39.5 – 50.5) | <0.001 | 39.1 (33.2 – 45.0) | <0.001 | 42.9 (33.3 – 52.6) | 0.078 |
| 55 – 64 yrs | 58.7 (55.4 – 62.0) | | 55.6 (52.6 – 58.9) | | 50.4 (46.9 – 53.8) | | 35.6 (31.5 – 39.7) | |
| 65 – 70 yrs | 67.6 (61.9 – 73.2) | | 66.1 (60.4 – 71.8) | | 62.3 (56.5 – 68.1) | | 33.1 (27.8 – 38.4) | |
| Sex | | | | | | | | |
| Men | 32.4 (28.5 – 36.2) | <0.001 | 29.0 (24.8 – 33.1) | <0.001 | 24.3 (20.3 – 28.4) | <0.001 | 43.2 (33.6 – 52.8) | 0.143 |
| Women | 52.7 (49.0 – 56.4) | | 50.1 (46.4 – 53.8) | | 44.0 (40.1 – 48.0) | | 36.4 (31.0 – 41.8) | |
| Area of Residence | | | | | | | | |
| Urban | 44.1 (40.3 – 47.8) | 0.226 | 41.0 (37.2 – 44.7) | 0.288 | 35.8 (32.0 – 39.5) | 0.119 | 38.9 (32.2 – 45.5) | 0.796 |
| Rural | 40.6 (35.8 – 45.3) | | 38.0 (33.2 – 42.8) | | 31.8 (27.2 – 36.4) | | 37.7 (31.2 – 44.2) | |

^a Proportion calculated among all hypertensive population; ^b Proportion calculated among treated hypertensive population

Table 3. Secular trends in prevalence of total hypertension and pre- hypertension among Iranian adults (25 – 64 years): 2005 – 2011

| | 2005 | | | 2007 | | | 2011 | | | P-value | Secular trend OR (95% CI) |
|---------------------------|-----------------------------------|---|--------------------------|------------------------------|--------------------------|------------------------------|--------------------------|------------------------------|--------------------------|---------|------------------------------|
| | Population Number ^a | Estimated Number ^a (95% CI) | Prevalence % (95% CI) | Estimated Number (95% CI) | Prevalence % (95% CI) | Estimated Number (95% CI) | Prevalence % (95% CI) | Estimated Number (95% CI) | Prevalence % (95% CI) | | |
| Total hypertension | | | | | | | | | | | |
| All | 38.20 | 9.80 (8.30 – 9.93) | 25.7 (25.3 – 26.0) | 9.54 (9.05 – 10.01) | 25.0 (23.7 – 26.2) | 9.20 (8.48 – 9.93) | 24.1 (22.2 – 26.0) | | | < 0.001 | 0.98 (0.97 – 0.99) |
| Age Groups | | | | | | | | | | | |
| 25 – 34 yrs | 15.64 | 2.00 (1.92 – 2.08) | 12.8 (12.3 – 13.3) | 1.70 (1.41 – 2.00) | 10.9 (9.0 – 12.8) | 1.61 (1.36 – 1.86) | 10.3 (8.7 – 11.9) | | | 0.001 | 0.96 (0.94 – 0.98) |
| 35 – 44 yrs | 10.47 | 2.35 (2.28 – 2.41) | 22.4 (21.8 – 23.0) | 2.40 (2.14 – 2.66) | 22.9 (20.4 – 25.4) | 2.11 (1.79 – 2.42) | 20.1 (17.1 – 23.1) | | | 0.096 | 0.98 (0.96 – 1.00) |
| 45 – 54 yrs | 7.55 | 2.93 (2.87 – 2.98) | 38.8 (38.0 – 39.5) | 2.90 (2.67 – 3.13) | 38.4 (35.4 – 41.4) | 3.09 (2.82 – 3.37) | 40.9 (37.3 – 44.6) | | | 0.220 | 1.01 (0.99 – 1.03) |
| 55 – 64 yrs | 4.54 | 2.52 (2.49 – 2.56) | 55.6 (54.9 – 56.4) | 2.54 (2.40 – 2.68) | 56.0 (52.8 – 59.1) | 2.39 (2.24 – 2.54) | 52.6 (49.4 – 55.9) | | | 0.023 | 0.98 (0.97 – 1.00) |
| Sex | | | | | | | | | | | |
| Men | 19.20 | 4.91 (4.82 – 4.99) | 25.6 (25.1 – 26.0) | 4.44 (4.11 – 4.78) | 23.1 (21.4 – 24.9) | 4.34 (3.84 – 4.84) | 22.6 (20.0 – 25.2) | | | < 0.001 | 0.96 (0.95 – 0.98) |
| Women | 19.00 | 4.89 (4.81 – 4.98) | 25.7 (25.3 – 26.2) | 5.10 (4.75 – 5.43) | 26.8 (25.0 – 28.6) | 4.86 (4.48 – 5.24) | 25.6 (23.6 – 27.6) | | | 0.134 | 0.99 (0.98 – 1.00) |
| Area of Residence | | | | | | | | | | | |
| Urban | 28.33 | 7.36 (7.25 – 7.48) | 26.0 (25.6 – 26.4) | 7.52 (7.08 – 7.96) | 26.5 (25.0 – 28.1) | 7.06 (6.46 – 7.68) | 24.9 (22.8 – 27.1) | | | 0.009 | 0.98 (0.97 – 1.00) |
| Rural | 9.87 | 2.44 (2.39 – 2.50) | 24.7 (24.2 – 25.3) | 2.02 (1.83 – 2.22) | 20.5 (18.5 – 22.5) | 2.14 (1.87 – 2.41) | 21.7 (19.0 – 24.4) | | | < 0.001 | 0.96 (0.94 – 0.98) |
| Pre – hypertension | | | | | | | | | | | |
| All | 38.20 | 17.39 (17.23 – 17.53) | 45.5 (45.1 – 45.9) | 15.42 (14.82 – 16.04) | 40.4 (38.8 – 42.0) | 15.45 (14.67 – 16.23) | 40.4 (38.4 – 42.5) | | | < 0.001 | 0.96 (0.95 – 0.97) |
| Age Groups | | | | | | | | | | | |
| 25 – 34 yrs | 15.64 | 7.41 (7.29 – 7.52) | 47.4 (46.6 – 48.1) | 6.46 (5.99 – 6.93) | 41.3 (38.3 – 44.3) | 6.72 (6.30 – 7.15) | 43.0 (40.3 – 45.7) | | | < 0.001 | 0.97 (0.95 – 0.98) |
| 35 – 44 yrs | 10.47 | 5.13 (5.05 – 5.20) | 49.0 (48.2 – 49.7) | 4.54 (4.23 – 4.85) | 43.3 (40.4 – 46.3) | 4.65 (4.26 – 5.04) | 44.4 (40.7 – 48.1) | | | < 0.001 | 0.97 (0.95 – 0.98) |
| 45 – 54 yrs | 7.55 | 3.31 (3.25 – 3.37) | 43.9 (43.1 – 44.6) | 3.05 (2.83 – 3.28) | 40.5 (37.5 – 43.5) | 2.66 (2.42 – 2.90) | 35.2 (32.0 – 38.4) | | | < 0.001 | 0.94 (0.93 – 0.96) |
| 55 – 64 yrs | 4.54 | 1.54 (1.51 – 1.57) | 33.9 (33.2 – 34.6) | 1.37 (1.24 – 1.50) | 30.2 (27.3 – 33.1) | 1.42 (1.30 – 1.53) | 31.2 (28.6 – 33.8) | | | 0.003 | 0.98 (0.96 – 0.99) |
| Sex | | | | | | | | | | | |
| Men | 19.20 | 9.84 (9.73 – 9.95) | 51.3 (50.7 – 51.8) | 8.98 (8.54 – 9.43) | 46.8 (44.5 – 49.1) | 9.01 (8.39 – 9.62) | 46.9 (43.7 – 50.1) | | | < 0.001 | 0.97 (0.96 – 0.98) |
| Women | 19.00 | 7.55 (7.43 – 7.66) | 39.7 (39.1 – 40.3) | 6.44 (6.02 – 6.86) | 33.9 (31.7 – 36.1) | 6.44 (6.04 – 6.84) | 33.9 (31.8 – 36.0) | | | < 0.001 | 0.96 (0.94 – 0.97) |
| Area of Residence | | | | | | | | | | | |
| Urban | 28.33 | 13.00 (12.86 – 13.14) | 45.9 (45.4 – 46.4) | 11.59 (11.02 – 12.12) | 40.9 (38.9 – 42.8) | 11.58 (11.02 – 12.24) | 40.9 (38.5 – 43.2) | | | < 0.001 | 0.96 (0.95 – 0.98) |
| Rural | 9.87 | 4.39 (4.32 – 4.46) | 44.5 (43.8 – 45.2) | 3.83 (3.56 – 4.11) | 38.9 (36.1 – 41.6) | 3.87 (3.61 – 4.13) | 39.2 (36.6 – 41.8) | | | < 0.001 | 0.96 (0.94 – 0.98) |

^a in millions

Table 4. Secular trends in proportion of awareness, management, treatment, and control among hypertensive Iranian adults (25 – 64 years): 2005 – 2011

| | 2005 | 2007 | 2011 | P-value | Secular trend OR (95% CI) |
|--|--------------------|--------------------|--------------------|---------|---------------------------|
| Awareness^a % (95% CI) | | | | | |
| All | 31.0 (30.4 – 31.7) | 34.3 (31.6 – 36.9) | 40.6 (37.5 – 43.8) | < 0.001 | 1.06 (1.04 – 1.08) |
| Age Groups | | | | | |
| 25 – 34 yrs | 13.0 (11.5 – 14.4) | 9.2 (3.9 – 14.5) | 15.9 (9.4 – 22.4) | 0.599 | 1.02 (0.95 – 1.10) |
| 35 – 44 yrs | 21.8 (20.5 – 23.1) | 24.1 (18.7 – 29.5) | 28.4 (23.1 – 33.8) | 0.043 | 1.05 (1.00 – 1.10) |
| 45 – 54 yrs | 37.2 (36.0 – 38.3) | 40.2 (35.3 – 45.1) | 47.9 (41.6 – 54.2) | < 0.001 | 1.07 (1.04 – 1.11) |
| 55 – 64 yrs | 46.4 (45.4 – 47.4) | 53.8 (49.6 – 58.0) | 58.7 (55.4 – 62.0) | < 0.001 | 1.09 (1.07 – 1.11) |
| Sex | | | | | |
| Male | 19.9 (19.1 – 20.7) | 25.9 (22.4 – 29.4) | 30.4 (26.5 – 34.3) | < 0.001 | 1.09 (1.05 – 1.12) |
| Female | 42.1 (41.1 – 43.1) | 41.6 (37.7 – 45.4) | 49.7 (46.0 – 53.5) | 0.001 | 1.04 (1.01 – 1.06) |
| Area of Residence | | | | | |
| Urban | 31.9 (31.1 – 32.6) | 32.7 (29.6 – 35.7) | 41.4 (37.6 – 45.2) | < 0.001 | 1.05 (1.03 – 1.08) |
| Rural | 28.5 (27.5 – 29.5) | 40.1 (34.8 – 45.4) | 38.0 (33.0 – 43.0) | < 0.001 | 1.07 (1.03 – 1.11) |
| Management^a % (95% CI) | | | | | |
| All | 28.3 (27.7 – 28.9) | 33.9 (31.2 – 36.5) | 37.5 (34.2 – 40.8) | < 0.001 | 1.06 (1.04 – 1.08) |
| Age Groups | | | | | |
| 25 – 34 yrs | 10.6 (9.3 – 11.9) | 13.1 (6.8 – 19.3) | 11.0 (6.7 – 15.5) | 0.673 | 1.01 (0.95 – 1.09) |
| 35 – 44 yrs | 19.2 (18.0 – 20.5) | 22.0 (16.8 – 27.2) | 26.2 (20.7 – 31.7) | 0.016 | 1.06 (1.01 – 1.11) |
| 45 – 54 yrs | 34.0 (32.9 – 35.2) | 38.9 (34.0 – 43.7) | 45.0 (39.5 – 50.5) | < 0.001 | 1.08 (1.05 – 1.11) |
| 55 – 64 yrs | 43.6 (42.6 – 44.6) | 53.3 (49.1 – 57.6) | 55.6 (52.6 – 58.9) | < 0.001 | 1.09 (1.07 – 1.11) |
| Sex | | | | | |
| Male | 17.9 (17.2 – 18.6) | 27.0 (23.3 – 30.7) | 26.8 (22.7 – 31.0) | < 0.001 | 1.09 (1.05 – 1.12) |
| Female | 38.6 (37.6 – 39.5) | 39.9 (36.2 – 43.7) | 47.0 (43.2 – 50.8) | < 0.001 | 1.05 (1.02 – 1.07) |
| Area of Residence | | | | | |
| Urban | 29.1 (28.4 – 29.9) | 32.4 (29.3 – 35.4) | 38.1 (34.2 – 41.9) | < 0.001 | 1.06 (1.03 – 1.08) |
| Rural | 25.6 (24.6 – 26.6) | 39.5 (34.2 – 44.8) | 35.6 (30.6 – 40.7) | < 0.001 | 1.08 (1.05 – 1.12) |
| Treatment^a % (95% CI) | | | | | |
| All | 25.2 (24.7 – 25.8) | 28.3 (25.8 – 30.7) | 31.9 (28.6 – 35.3) | < 0.001 | 1.04 (1.02 – 1.06) |
| Age Groups | | | | | |
| 25 – 34 yrs | 8.9 (7.7 – 10.1) | 8.8 (3.5 – 14.1) | 6.4 (2.6 – 10.1) | 0.192 | 0.95 (0.88 – 1.03) |
| 35 – 44 yrs | 16.0 (14.8 – 17.2) | 15.2 (10.7 – 19.7) | 20.1 (14.6 – 25.5) | 0.243 | 1.03 (0.98 – 1.09) |
| 45 – 54 yrs | 30.4 (29.2 – 31.5) | 33.8 (29.1 – 38.5) | 39.1 (33.2 – 45.0) | < 0.001 | 1.06 (1.03 – 1.10) |
| 55 – 64 yrs | 40.5 (39.5 – 41.5) | 47.2 (43.0 – 51.5) | 50.4 (46.9 – 53.8) | < 0.001 | 1.07 (1.05 – 1.09) |
| Sex | | | | | |
| Male | 15.6 (14.9 – 16.3) | 21.5 (18.2 – 24.8) | 22.2 (18.3 – 26.2) | < 0.001 | 1.07 (1.03 – 1.10) |
| Female | 34.8 (33.9 – 35.8) | 34.1 (30.6 – 37.7) | 40.5 (36.5 – 44.6) | 0.026 | 1.03 (1.00 – 1.05) |
| Area of Residence | | | | | |
| Urban | 26.2 (25.5 – 26.9) | 27.7 (24.8 – 30.5) | 32.7 (28.9 – 36.5) | 0.001 | 1.04 (1.02 – 1.06) |
| Rural | 22.3 (21.3 – 23.2) | 30.4 (25.6 – 35.2) | 29.3 (24.8 – 33.7) | 0.003 | 1.05 (1.02 – 1.09) |
| Control in treatment^b % (95% CI) | | | | | |
| All | 28.1 (26.9 – 29.3) | 34.2 (29.4 – 39.1) | 39.7 (33.6 – 45.9) | < 0.001 | 1.10 (1.07 – 1.13) |
| Age Groups | | | | | |
| 25 – 34 yrs | 53.9 (46.7 – 61.1) | 48.3 (17.1 – 79.6) | 49.9 (29.1 – 70.8) | 0.625 | 0.96 (0.82 – 1.13) |
| 35 – 44 yrs | 38.7 (34.8 – 42.7) | 23.9 (10.2 – 37.7) | 40.1 (25.3 – 54.8) | 0.748 | 0.98 (0.89 – 1.08) |
| 45 – 54 yrs | 26.7 (24.8 – 28.7) | 44.6 (36.1 – 53.2) | 42.9 (33.3 – 52.6) | < 0.001 | 1.13 (1.08 – 1.19) |
| 55 – 64 yrs | 21.1 (19.8 – 22.4) | 27.1 (21.5 – 32.7) | 35.6 (31.5 – 39.7) | < 0.001 | 1.13 (1.09 – 1.16) |
| Sex | | | | | |
| Male | 28.4 (26.2 – 30.7) | 31.5 (23.5 – 39.4) | 46.3 (35.1 – 57.4) | < 0.001 | 1.15 (1.08 – 1.22) |
| Female | 28.0 (26.5 – 29.5) | 35.8 (29.7 – 41.8) | 36.6 (30.5 – 42.6) | < 0.001 | 1.08 (1.04 – 1.12) |
| Area of Residence | | | | | |
| Urban | 28.5 (27.0 – 29.9) | 34.6 (29.0 – 40.3) | 39.5 (32.1 – 46.9) | < 0.001 | 1.09 (1.06 – 1.13) |
| Rural | 26.9 (24.6 – 29.1) | 32.8 (24.0 – 41.7) | 40.7 (32.6 – 48.7) | < 0.001 | 1.12 (1.06 – 1.19) |

^a Proportion calculated among all hypertensive population; ^b Proportion calculated among treated hypertensive population

surveys, conducted between 1980 and 2002, estimated that 26.4% of the world's adult population are diagnosed with hypertension.⁵ Pooled analysis of prevalence reports from developing countries showed a higher rate of 32.2% and 30.5% in men and women, respectively.¹¹ Similar to these findings, the results of InterASIA study conducted in China declared a prevalence rate of 27.2% in 2000 – 2001.²⁰ For the Middle East region, nationally representative surveys are sparse. A 1995 report from Egypt indicated a prevalence rate of 26.3% for adults aged 25 years or above.²¹ A prevalence of 31.8% among adults aged 18 years or above has been documented in a PatenT study of Turkey (2003).¹⁰ In a 2004 – 2008 survey, Malekzadeh, et al. reported a prevalence rate of 42.7% among 40 – 75 year old participants in the Golestan Cohort Study (GCS), conducted in Golestan, a province in northern Iran.²² While their study sample characteristics (age and urban/rural ratio of the subjects) are not as same as the country's population, the reported prevalence rate is comparable with our findings in the similar age groups.

According to NHANES data, among US hypertensive adults, ISH predominates; about two thirds (64.9%) of untreated hypertensive individuals have their hypertension diagnosed solely on the basis of SBP.²³ Conversely, in SuRFNCD 2011, hypertension subtypes were equally distributed across untreated individuals and no subtype assumed predominance.

2005 – 2011 trends

In the 2005 – 2011 period, despite absolute increments in mean SBP and DBP in the general population, the prevalence of pre-hypertension and hypertension decreased by 6.1% ($P < 0.001$), and 11.2% ($P < 0.001$), respectively.

Contrary to the observed trend in Iran, hypertension among US adults is becoming more prevalent. Egan, et al. (2008), using 20 years of NHANES data, demonstrated an upward shift in hypertension rates from 23.9% in 1988 to 29% in 2008.²⁴ Despite this significant increase in proportion of individuals with high blood pressure in the US, mean values for SPB have remained constant (120.0 mmHg in 1988 vs. 120.9 mmHg in 2008), and DBP values have decreased (72.9 mmHg in 1988 and 70.6 mmHg in 2008).²⁴ On the other hand, in the same period, mean SBP and DBP values in patients with hypertension have significantly decreased (SBP: 143.0 mmHg vs. 135.2 mmHg; DBP: 80.4 mmHg vs. 74.1 mmHg).²⁴ Again, these finding contrast with our observation of slight increase of about 1.7 mmHg in SBP, and 0.1 mmHg in DBP of hypertensive adults (SBP: 140.8 mmHg vs. 142.5 mmHg, $P = 0.002$; DBP: 90.5 mmHg vs. 90.6 mmHg, $P = 0.001$). Although SBP values between Iran and US adult population are essentially similar, Iranian hypertensive adults have, on average, 15 – 20 mmHg higher DBP levels compared with their US counterparts, which probably reflects lower success in blood pressure control.

Increasing trends have also been observed in China. Over a ten-year period (1991 – 2001), prevalent hypertension has increased from 20.2% to 28.6% in men, and from 19.1% to 25.8% in women.²⁰ Contrary to these reports, trends in Czech Republic between 1985 and 2000 presented a significant decline of about 8.0% (47.1% vs. 39.1%) in a population survey of mostly rural participants.²⁵

Between 2005 and 2011, the proportion of awareness increased from 31.0% to 40.6%; management from 28.3% to 37.5%; treatment from 25.2% to 31.9% and finally, controlled hypertension

rose from 28.1% to 39.7% among treated hypertensive adults. In concert with our findings, 1988 – 2008 analysis of NHANES data also documented a steady rise in hypertension awareness, treatment, and control.²⁴ However, it should be noted that in spite of similar patterns in Iran and US, our proportion of individuals with adequate care for hypertension is yet extremely low. In the United States, people with hypertension are twice as likely to be aware of their disease (81.9% vs. 40.6%).¹⁹ While three fourth of hypertensive adults in US receive medical treatment for their condition,¹⁹ rate of treatment among Iranian hypertensive adults is limited to one in every three individuals. Similar inference could be drawn with respect to control in treatment (53.3% in the US as opposed to 31.9% in Iran).¹⁹ According to a comparative analysis of five European countries and Canada, hypertension awareness in Iran resembles that of England (35.8%), Germany (36.5%), and Spain (38.9%).²⁶ Moreover, our rates also closely resemble those obtained from the pooled analysis of studies from developing countries.¹¹

Patterns with respect to age and sex

In the present study, the mean level of blood pressure increased with advancing age ($P < 0.001$ for SBP and DBP). This increase translates into higher proportion of hypertension in older age categories (10.3% among 25 – 34 years vs. 61.5% among 65 – 70 years, $P < 0.001$) accompanied by a lower prevalence of pre-hypertension (43.0% among 25 – 34 years vs. 26.1% among 65 – 70 years, $P < 0.001$). Furthermore, our results indicated that the percentage of awareness, management and treatment consistently increments when moving from younger to older age categories ($P < 0.001$ in all analyses), which is compatible with NHANES.^{16,19,24} On the other hand, an inverse pattern was detected regarding the control in treated individuals (49.9% among 25 – 34 years vs. 33.1% among 65 – 70 years, $P = 0.078$).

Our data also documented a number of disparities between sexes. Women were more likely to have hypertension (27.4% vs. 23.8%, $P = 0.013$), whilst pre-hypertension tended to be more prevalent among men (46.3% vs. 33.3%, $P < 0.001$). Additionally, the decreasing trend in hypertension prevalence was significant only for men ($P < 0.001$), but not women ($P = 0.134$). The greater prevalence of hypertension among women has been replicated in some countries. Analysis of the worldwide data, has shown that of the eight regions included, four (including the Middle East) have a higher prevalence in women and the other four have higher rates for men.⁵ Similar pattern have also been recognized in Turkey,¹⁰ Egypt,²¹ but not US.^{19,27}

Hypertension in women was more likely to be known, managed, and medicated ($P < 0.001$ in all cases); surprisingly, better control rates were achieved in men, though did not reach statistical significance (46.3% vs. 36.6%, $P = 0.101$). These findings are generally in accord with US reports^{24,27} and highlight the fact that despite better access to care for women, improvement rates along with achievement of blood pressure targets are superior in men.

In SuRFNCD, blood pressure is measured sequentially three times in one visit. The first reading is discarded since it is usually higher than the latter two measurements, and its use erratically overestimates blood pressure.^{24,28} Assessment of blood pressure in only one occasion is likely to represent an overestimation of the real values and fails to account for the within-individual variability that is detected by repeated visits.²⁹

In conclusion, despite improvements in the prevalence and control

of hypertension over the past seven years, *status quo* is far from satisfactory and preventive strategies for the general population as well as targeted strategies aimed at high risk populations remain a national priority. At a primary level, preventive efforts should include programs that encourage engagement in physical activity, consumption of fruit and vegetable, intake of ingredients rich in potassium; while discouraging alcohol intake and sodium-rich diets.³⁰ Available reports indicate that 55% of Iranian adults have either no or low level of physical activity and about 87% consume lower-than-recommended amount of fruits and vegetables.^{31,32} More aggressive screening programs, especially in younger adults are demanded. Finally, effective pharmacological treatment according to established guidelines¹⁴ in diagnosed cases, especially in women, will likely lead to an improved control of hypertension and prevention of associated morbidity and mortality.

Conflicts of interest and source of funding

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References

- Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJ. Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. *The Lancet*. 2006; 367: 1747 – 1757.
- Disease and injury regional estimates.Cause-specific mortality: regional estimates for 2008 [Internet]. Available from: URL: http://www.who.int/healthinfo/global_burden_disease/estimates_regional/en/. (Accessed Date: May 2016).
- Wright JT Jr, Bakris G, Greene T, Agodoa LY, Appel LJ, Charleston J, et al. Effect of blood pressure lowering and antihypertensive drug class on progression of hypertensive kidney disease: Results from the ask trial. *JAMA*. 2002; 288: 2421 – 2431.
- Qiu C, Winblad B, Fratiglioni L. The age-dependent relation of blood pressure to cognitive function and dementia. *Lancet Neurology*. 2005; 4: 487.
- Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. *Lancet*. 2005; 365: 217 – 223.
- Danaei G, Ding EL, Mozaffarian D, Taylor B, Rehm J, Murray CJ, et al. The preventable causes of death in the United States: comparative risk assessment of dietary, lifestyle, and metabolic risk factors. *PLoS Medicine*. 2009; 6: e1000058.
- Tran J, Mirzaei M. The population attributable fraction of stroke associated with high blood pressure in the Middle East and North Africa. *Journal of the Neurological Sciences*. 2011; 308: 135 – 138.
- Martiniuk AL, Lee CM, Lawes CM, Ueshima H, Suh I, Lam TH, et al. Hypertension: Its prevalence and population-attributable fraction for mortality from cardiovascular disease in the Asia-Pacific region. *Journal of Hypertension*. 2007; 25: 73 – 79.
- Farzadfar F, Danaei G, Namdaritabar H, Rajaratnam JK, Marcus JR, Khosravi A, et al. National and subnational mortality effects of metabolic risk factors and smoking in Iran: A comparative risk assessment. *Popul Health Metr*. 2011; 9: 55.
- Altun B, Arici M, Nergizoglu G, Derici Ü, Karatan O, Turgan Ç, et al. Prevalence, awareness, treatment and control of hypertension in Turkey (the PatenT study) in 2003. *Journal of Hypertension*. 2005; 23: 1817 – 1823.
- Pereira M, Lunet N, Azevedo A, Barros H. Differences in prevalence, awareness, treatment and control of hypertension between developing and developed countries. *J Hypertens*. 2009; 27: 963 – 975.
- Esteghamati A, Abbasi M, Alikhani S, Gouya MM, Delavari A, Shishehbor MH, et al. Prevalence, awareness, treatment, and risk factors associated with hypertension in the Iranian population: The national survey of risk factors for noncommunicable diseases of Iran. *Am J Hypertens*. 2008; 21: 620 – 626.
- Esteghamati A, Meysamie A, Khalilzadeh O, Rashidi A, Haghazali M, Asgari F, et al. Third national Surveillance of Risk Factors of Non-Communicable Diseases (SuRFNCD-2007) in Iran: methods and results on prevalence of diabetes, hypertension, obesity, central obesity, and dyslipidemia. *BMC Public Health*. 2009; 9: 167.
- Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, et al. Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. *Hypertension*. 2003; 42: 1206 – 1252.
- Peccin S, De Castro J, Furlanetto TW, Furtado A, Brasil B, Czepielewski M. Ultrasonography: Is it useful in the diagnosis of cancer in thyroid nodules? *Journal of Endocrinological Investigation*. 2002; 25: 39 – 43.
- Ostchega Y, Yoon SS, Hughes J, Louis T. Hypertension awareness, treatment, and control-continued disparities in adults: United States, 2005 – 2006. *NCHS Data Brief*. 2008: 1 – 8.
- Gupta AK, McGlone M, Greenway FL, Johnson WD. Prehypertension in disease-free adults: A marker for an adverse cardiometabolic risk profile. *Hypertens Res*. 2010; 33: 905 – 910.
- Chrysohoou C, Pitsavos C, Panagiotakos DB, Skoumas J, Stefanadis C. Association between prehypertension status and inflammatory markers related to atherosclerotic disease: The ATTICA Study. *Am J Hypertens*. 2004; 17: 568 – 573.
- Yoon SS, Burt V, Louis T, Carroll MD. Hypertension among adults in the United States, 2009 – 2010. *NCHS Data Brief*. 2012: 1 – 8.
- Gu D, Reynolds K, Wu X, Chen J, Duan X, Muntner P, et al. Prevalence, awareness, treatment, and control of hypertension in china. *Hypertension*. 2002; 40: 920 – 927.
- Ibrahim MM, Rizk H, Appel LJ, el Aroussy W, Helmy S, Sharaf Y, et al. Hypertension prevalence, awareness, treatment, and control in Egypt. Results from the Egyptian National Hypertension Project (NHP). NHP Investigative Team. *Hypertension*. 1995; 26: 886 – 890.
- Malekzadeh MM, Etemadi A, Kamangar F, Khademi H, Golozar A, Islami F, et al. Prevalence, awareness and risk factors of hypertension in a large cohort of Iranian adult population. *J Hypertens*. 2013; 31: 1364 – 1371; discussion 71.
- Franklin SS, Jacobs MJ, Wong ND, L'Italien GJ, Lapuerta P. Predominance of isolated systolic hypertension among middle-aged and elderly US hypertensives: Analysis based on National Health and Nutrition Examination Survey (NHANES) III. *Hypertension*. 2001; 37: 869 – 874.
- Egan BM, Zhao Y, Axon RN. US trends in prevalence, awareness, treatment, and control of hypertension, 1988 – 2008. *JAMA*. 2010; 303: 2043 – 2050.
- Cifkova R, Skodova Z, Lanska V, Adamkova V, Novozamska E, Petrzilkova Z, et al. Trends in blood pressure levels, prevalence, awareness, treatment, and control of hypertension in the Czech population from 1985 to 2000/01. *J Hypertens*. 2004; 22: 1479 – 1485.
- Wolf-Maier K, Cooper RS, Kramer H, Banegas JR, Giampaoli S, Joffres MR, et al. Hypertension treatment and control in five European countries, Canada, and the United States. *Hypertension*. 2004; 43: 10 – 17.
- Cutler JA, Sorlie PD, Wolz M, Thom T, Fields LE, Roccella EJ. Trends in hypertension prevalence, awareness, treatment, and control rates in United States adults between 1988–1994 and 1999–2004. *Hypertension*. 2008; 52: 818 – 827.
- Bovet P, Gervasoni JP, Ross AG, Mkamba M, Mtasiwa DM, Lengeler C, et al. Assessing the prevalence of hypertension in populations: are we doing it right? *J Hypertens*. 2003; 21: 509 – 517.
- Birkett NJ, Donner AP, Maynard MD. Assessing hypertension control in the community: the need for follow-up measurements to ensure clinical relevance. *CMAJ*. 1987; 136: 595 – 600.
- Whelton PK, He J, Appel LJ, Cutler JA, Havas S, Kotchen TA, et al. Primary prevention of hypertension: clinical and public health advisory from The National High Blood Pressure Education Program. *JAMA*. 2002; 288: 1882 – 1888.
- Esteghamati A, Khalilzadeh O, Rashidi A, Kamgar M, Meysamie A, Abbasi M. Physical activity in Iran: results of the third national surveillance of risk factors of non-communicable diseases (SuRFNCD-2007). *J Phys Act Health*. 2011; 8: 27 – 35.
- Esteghamati A, Noshad S, Nazeri A, Khalilzadeh O, Khalili M, Nakhjavani M. Patterns of fruit and vegetable consumption among Iranian adults: A SuRFNCD-2007 study. *Br J Nutr*. 2012; 108: 177 – 181.

Supplementary Table 1. Secular trends in mean systolic and mean diastolic blood pressure among Iranian adults (25 – 64 years): 2005 – 2011

| | 2005 | 2007 | 2011 | P-value |
|---|-----------------------|-----------------------|-----------------------|---------|
| General Population | | | | |
| Mean Systolic Blood Pressure (95% CI) | | | | |
| All | 121.2 (121.1 – 121.3) | 122.2 (121.7 – 122.7) | 122.8 (121.3 – 124.2) | < 0.001 |
| Age Group | | | | |
| 25 – 34 yrs | 114.9 (114.7 – 115.1) | 115.5 (114.8 – 116.3) | 117.1 (115.8 – 118.5) | < 0.001 |
| 35 – 44 yrs | 119.7 (119.5 – 119.9) | 121.7 (120.8 – 122.7) | 121.5 (119.9 – 123.0) | < 0.001 |
| 45 – 54 yrs | 127.6 (127.4 – 127.9) | 127.7 (126.5 – 128.8) | 128.9 (126.6 – 131.1) | 0.060 |
| 55 – 64 yrs | 135.5 (135.2 – 135.9) | 136.8 (135.4 – 138.1) | 135.0 (133.1 – 136.9) | 0.666 |
| Sex | | | | |
| Men | 122.3 (122.2 – 122.5) | 124.1 (123.4 – 124.7) | 124.5 (123.0 – 125.9) | < 0.001 |
| Women | 120.0 (119.8 – 120.2) | 120.2 (119.5 – 121.0) | 121.1 (119.4 – 122.8) | 0.163 |
| Area of Residence | | | | |
| Urban | 121.3 (121.1 – 121.4) | 122.3 (121.7 – 122.9) | 123.0 (121.5 – 124.5) | < 0.001 |
| Rural | 120.9 (120.7 – 121.1) | 121.6 (120.7 – 122.5) | 122.1 (119.9 – 124.4) | 0.029 |
| Mean Diastolic Blood Pressure (95% CI) | | | | |
| All | 77.5 (77.4 – 77.6) | 80.2 (79.9 – 80.6) | 78.4 (77.7 – 79.2) | < 0.001 |
| Age Group | | | | |
| 25 – 34 yrs | 74.4 (74.2 – 74.5) | 76.4 (75.8 – 77.1) | 75.5 (74.7 – 76.2) | < 0.001 |
| 35 – 44 yrs | 77.3 (77.1 – 77.5) | 81.3 (80.6 – 82.0) | 78.7 (77.7 – 79.7) | < 0.001 |
| 45 – 54 yrs | 80.7 (80.6 – 80.9) | 83.4 (82.7 – 84.2) | 81.5 (80.2 – 82.7) | < 0.001 |
| 55 – 64 yrs | 83.1 (82.9 – 83.3) | 85.3 (84.5 – 86.1) | 82.8 (81.8 – 83.9) | 0.422 |
| Sex | | | | |
| Men | 78.5 (78.4 – 78.7) | 79.8 (79.3 – 80.3) | 78.1 (77.2 – 79.1) | 0.302 |
| Women | 76.4 (76.3 – 76.5) | 80.6 (80.1 – 81.2) | 78.7 (77.9 – 79.5) | < 0.001 |
| Area of Residence | | | | |
| Urban | 77.7 (77.6 – 77.8) | 80.6 (80.2 – 81.0) | 78.9 (78.1 – 79.7) | < 0.001 |
| Rural | 76.8 (76.7 – 77.0) | 79.1 (78.5 – 79.8) | 77.1 (75.9 – 78.2) | 0.048 |
| Adults with Hypertension | | | | |
| Mean Systolic Blood Pressure (95% CI) | | | | |
| All | 140.8 (140.5 – 141.1) | 142.7 (141.7 – 143.8) | 142.5 (140.5 – 144.5) | 0.002 |
| Age Group | | | | |
| 25 – 34 yrs | 131.6 (130.9 – 132.2) | 134.8 (132.2 – 137.4) | 136.5 (133.5 – 139.4) | < 0.001 |
| 35 – 44 yrs | 136.7 (136.2 – 137.2) | 140.8 (138.6 – 143.0) | 139.7 (137.2 – 142.2) | < 0.001 |
| 45 – 54 yrs | 143.7 (143.2 – 144.2) | 143.1 (141.3 – 145.0) | 143.3 (140.6 – 146.0) | 0.564 |
| 55 – 64 yrs | 148.3 (147.9 – 148.7) | 149.4 (147.7 – 151.0) | 148.0 (146.2 – 149.8) | 0.972 |
| Sex | | | | |
| Men | 139.4 (139.1 – 139.7) | 142.7 (141.3 – 144.2) | 142.9 (140.5 – 145.3) | < 0.001 |
| Women | 142.2 (141.8 – 142.6) | 142.7 (141.1 – 144.2) | 142.1 (139.9 – 144.3) | 0.385 |
| Area of Residence | | | | |
| Urban | 140.4 (140.1 – 140.7) | 141.8 (140.6 – 143.0) | 141.9 (139.6 – 144.2) | 0.064 |
| Rural | 142.0 (141.5 – 142.4) | 146.2 (144.1 – 148.4) | 144.5 (142.4 – 146.7) | 0.002 |
| Mean Diastolic Blood Pressure (95% CI) | | | | |
| All | 90.5 (90.3 – 90.6) | 93.9 (93.2 – 94.5) | 90.6 (89.4 – 91.7) | 0.001 |
| Age Group | | | | |
| 25 – 34 yrs | 90.2 (89.8 – 90.6) | 93.0 (91.3 – 94.8) | 91.00 (89.2 – 92.8) | 0.048 |
| 35 – 44 yrs | 90.5 (90.2 – 90.8) | 96.6 (95.3 – 97.9) | 93.0 (91.7 – 94.2) | < 0.001 |
| 45 – 54 yrs | 90.9 (90.6 – 91.2) | 93.5 (92.3 – 94.6) | 89.6 (88.0 – 91.2) | 0.220 |
| 55 – 64 yrs | 90.1 (89.8 – 90.4) | 92.2 (91.3 – 93.2) | 89.5 (88.1 – 90.9) | 0.975 |
| Sex | | | | |
| Men | 90.6 (90.4 – 90.8) | 93.7 (92.8 – 94.5) | 89.7 (88.2 – 91.1) | 0.920 |
| Women | 90.3 (90.1 – 90.5) | 94.0 (93.1 – 94.9) | 91.4 (90.2 – 92.6) | < 0.001 |
| Area of Residence | | | | |
| Urban | 90.5 (90.3 – 90.7) | 93.5 (92.8 – 94.2) | 90.8 (89.5 – 92.0) | 0.003 |
| Rural | 90.3 (90.0 – 90.5) | 95.2 (93.7 – 96.6) | 89.9 (88.4 – 91.4) | 0.145 |