



## Prevalence of high blood pressure in Iranian adults based on the 2017 ACC/AHA guideline

Mostafa Hosseini<sup>1</sup>, Mehdi Yaseri<sup>1</sup>, Hadi Asady<sup>2,3</sup>, Ahmed Elejo Musa<sup>4</sup>, Jalil Koochpayezadeh<sup>5</sup>, Ali Rafei<sup>6</sup>, Koorosh Etemad<sup>6,7</sup>, Mohammad Mehdi Gouya<sup>6</sup>, Fereshteh Asgari<sup>6</sup>, Mahmoud Yousefifard\*<sup>8</sup>

Received: 21 Aug 2018

Published: 2 Apr 2019

### Abstract

**Background:** In 2017, American College of Cardiology (ACC) and the American Heart Association (AHA) presented a new guideline for assessing blood pressure in adults. This study aimed to assess the prevalence of hypertension in Iranian adults based on ACC/AHA 2017 guideline.

**Methods:** Data from 9801 Iranian adults (59.2% women) aged between 20–69 years were obtained from the sixth round of National Surveillance of Risk Factors of Non-Communicable Diseases (SuRFNCD) performed in 2011. Blood pressure was classified as normal, elevated blood pressure, and stage 1 and 2 hypertension using a weighted analysis and 2017 ACC/AHA guidelines. Data were presented as prevalence and 95% confidence interval (95% CI). All analyses were performed in Stata/SE 14.0.

**Results:** Overall prevalence of hypertension in Iranian men was 52.0%. Also, 32.9% (95% CI: 29.9-36.0) and 19.1% (95% CI: 16.9-21.6) of men had stage 1 and 2 hypertension, respectively. In addition, 44.3% of women had hypertension, of whom 26.3% (95% CI: 24.5 - 28.2) had stage 1 and 18.0% (95% CI: 16.1-20.1) stage 2 hypertension. Furthermore, 16.5% (95% CI: 14.4-18.9) and 9.6% (95% CI: 7.86-11.7) of men and women had elevated blood pressure, respectively.

**Conclusion:** The findings of this study indicated that adopting the 2017 ACC/AHA guidelines showed a higher prevalence of adult hypertension (48.2%) in Iran. In this study, the prevalence of hypertension in men was higher than in women, which was steadily increased by age in older adults in both sexes.

**Keywords:** Adult hypertension, ACC/AHA guidelines, Prevalence, Iran, High blood pressure

**Conflicts of Interest:** None declared

**Funding:** Tehran University of Medical Sciences

\*This work has been published under CC BY-NC-SA 1.0 license.

Copyright© Iran University of Medical Sciences

**Cite this article as:** Hosseini M, Yaseri M, Asady H, Elejo Musa A, Koochpayezadeh J, Rafei A, Etemad K, Gouya MM, Asgari F, Yousefifard M. Prevalence of high blood pressure in Iranian adults based on the 2017 ACC/AHA guideline. *Med J Islam Repub Iran.* 2019 (2 Apr);33:26. <https://doi.org/10.47176/mjiri.33.26>

### Introduction

Hypertension is one of the major health concerns in developing countries, especially among the adult population (1-3). It has been predicted that by the year 2025, 75% of hypertensive patients will be from developing countries

(4). In 2017, a new guideline for prevention, detection, evaluation, and management of high blood pressure in adults was published by the American College of Cardiology and the American Heart Association (ACC/AHA) (5).

**Corresponding author:** Dr Mahmoud Yousefifard, [yousefifard.m@iums.ac.ir](mailto:yousefifard.m@iums.ac.ir)

1. Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
2. Department of Occupational Health Engineering, School of Health, Isfahan University of Medical Sciences, Isfahan, Iran
3. Social Determinants of Health Research Center, Saveh University of Medical Sciences, Saveh, Iran
4. Department of Medical Physics and Biomedical Engineering, Tehran University of Medical Sciences, International Campus, Tehran, Iran
5. Department of Community Medicine, Iran University of Medical Sciences, Tehran, Iran
6. Center for Disease Control, Ministry of Health and Medical Education, Tehran, Iran
7. Department of Epidemiology, School of Public Health, Shahid Beheshti University of Medical Sciences, Tehran, Iran
8. Physiology Research Center, Faculty of Medicine, Iran University of Medical Sciences, Tehran, Iran

#### ↑What is “already known” in this topic:

In 2017, American College of Cardiology (ACC) and the American Heart Association (AHA) presented a new guideline for assessment of blood pressure in adults. However, the prevalence of hypertension in Iranian population is unclear according to the ACC/AHA 2017 guideline.

#### →What this article adds:

The findings of this study indicated that adopting the 2017 ACC/AHA guidelines showed a higher prevalence of adult hypertension (48.2%) in Iran. Prevalence of hypertension in men was higher than in women. This prevalence was steadily increased by age in older adults in both sexes.

In their guideline, blood pressure (BP) was classified in 4 categories of normal, elevated, and stage 1 and 2 hypertension.

In the new definition of ACC/AHA, the threshold for the definition of elevated blood pressure and hypertension is 10 mmHg lower than the definition of the Joint National Committee for Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC 7, 2004) guideline (6). This new classification can identify people who are prone to hypertension at an early stage of the disease, which reduces the burden of disease and improves the effectiveness of preventive measures.

As a result of these new guidelines, there have been obvious changes in the prevalence of hypertension among adults around the globe. For instance, in a study by Muntner et al, the proportion of adults in the US with high BP increased from 31.9% to 45.6% (7). In another study, Khara et al found an increase in the prevalence of hypertension by 26.8% in the US and 45.1% in China in adults aged 45 to 75 years (8).

Iran is a developing middle Eastern country with a population of over 80 million, with diverse cultures, socioeconomic status, and lifestyle, which are all factors that affect hypertension (9). According to a 2011 survey, 25.8% and 27.6% of Iranian men and women had hypertension, respectively (2). For most Iranian adults, diet is a major risk factor followed by high BP and overweight (10). Hence, the aim of this study was to assess the impact of diet on the prevalence of hypertension in Iranian adults using the new ACC/AHA guidelines. This will go a long way to better guide future health policy interventions in managing hypertension.

## Methods

### Study design and participants

In this cross-sectional study, data from 9801 Iranian adults aged 20–69 years were obtained from the sixth round of National Surveillance of Risk Factors of Non-Communicable Diseases (SuRFNCD) performed in 2011 by the Iranian Center for Disease Control and Prevention (11). Institutionalized people (such as soldiers and hospitalized patients) and nomadic tribes were excluded from the study. Data were obtained through a nationwide survey across all 31 provinces of non-hospitalized and non-institutionalized population of Iran. Briefly, a 4-stage-sampling scheme was used to collect data on 6- to 70-year-old Iranians. Provinces were taken as primary sampling units (first stage) and villages or cities as secondary sampling units (second stage) in this survey. Then, random 10-digit postal codes were selected from each secondary sampling unit (third stage). Finally, the participants were selected using KISH method (fourth stage).

Ethical Committee of Tehran University of Medical Sciences approved the protocol of the present study. In this study, the researchers adhered to Helsinki declaration.

### Measurement and classification of blood pressure

In National Surveillance of Risk Factors of Non-Communicable diseases, blood pressure measurements were done twice with 1-minute interval, and their average values were used to reduce bias. Mercury sphygmomanometer was used to measure BP after a relaxation period of 5 minutes. A 40% arm length covering 80% to 100% of the full arm was used as the bladder width. Afterwards, the cuff was deflated by positioning the stethoscope on the brachial artery as well as increasing the bladder pressure by 30 mmHg. Systolic blood pressure (SBP) was determined by the first Korotkoff (K1) sound, while the fifth represented the diastolic blood pressure (DBP) (1).

From the SuRFNCD 2011 dataset, information on demographic characteristics (age and sex) and BP measurements of those aged 20–69 years was extracted to classify participants as having either normal, elevated, or stage 1 or 2 hypertension. These classifications were based on the 2017 ACC/AHA guidelines on prevention, diagnosis, evaluation, and management of hypertension in adults (Table 1).

### Statistical analysis

The number and percentage of individuals were computed according to gender and age groups. Because of the sampling scheme, weighted analysis was employed and the individual's sampling weights were computed by multiplying the selection probabilities in each step of the survey. The prevalence of blood pressure categories and its associated 95% confidence intervals (95% CIs) within the age groups were estimated for men and women using complex sample survey analysis. All analyses were performed in Stata/SE 14.0 (StataCorp, College Station, TX, USA).

## Results

In this study, data on 9801 participants, 3999 (40.8%) men and 5802 (59.2%) women, were assessed. Participants' age ranged from 20 to 69 years. The number (percentage) of study population according to age groups and sex is given in Table 2.

Using the ACC/AHA categories, the prevalence of stage 1 and 2 hypertension was found to be 29.6% and 18.6%, respectively, in Iranian adults (The overall prevalence of hypertension was 48.2%). Furthermore, 13.1% of the participants had elevated hypertension while only 38.7% had normal blood pressure.

Table 3 shows the prevalence of hypertension in Iranian

Table 1. New blood pressure categories in adults according to ACC/AHA guidelines

Category	Definition
Normal	SBP<120 mmHg and DBP<80 mmHg
Elevated	SBP between 120-129 mmHg and DBP<80 mmHg
Hypertension	
- Stage 1	SBP between 130-139 mmHg or DBP between 80-89 mmHg
- Stage 2	SBP≥140 mmHg or DBP ≥90 mmHg

SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure

**Table 2.** Sample size according to age and sex; SuRFNCD-2011

Years	Age (group)	Men n (%)	Women n (%)	Total N (%)
20-24		618 (50.3)	757 (49.7)	1375 (100.0)
25-29		552 (52.0)	803 (48.0)	1355 (100.0)
30-34		418 (48.1)	606 (51.9)	1024 (100.0)
35-39		307 (50.4)	478 (49.6)	785 (100.0)
40-44		300 (51.4)	469 (48.6)	769 (100.0)
45-49		212 (49.3)	435 (50.7)	647 (100.0)
50-54		303 (50.9)	549 (49.1)	852 (100.0)
55-59		630 (50.2)	633 (49.8)	1263 (100.0)
60-65		382 (46.5)	575 (53.5)	957 (100.0)
65-69		277 (47.9)	497 (52.1)	774 (100.0)
Total		3999 (40.8)	5802 (59.2)	9801 (100.0)

**Table 3.** Prevalence\* [95% confidence interval] of new blood pressure categories in Iranian men; SuRFNCD-2011

Age group (years)	Normal n (%) [95%CI]*	Elevated n (%) [95%CI]	Hypertension		Total (%)
			Stage 1 n (%) [95%CI]	Stage 2 n (%) [95%CI]	
20-24	234 (36.3) [31.5, 41.4]	126 (20.5) [17.0, 24.4]	189 (33.2) [29.0, 37.6]	69 (10.1) [7.36, 13.6]	618 (100.0)
25-29	198 (38.9) [33.4, 44.8]	103 (18.4) [13.6, 24.5]	186 (32.6) [27.6, 38.0]	65 (10.0) [7.0, 14.1]	552 (100.0)
30-34	158 (37.7) [31.8, 44.0]	64 (14.8) [12.0, 18.2]	140 (34.3) [28.7, 40.4]	56 (13.2) [9.8, 17.5]	418 (100.0)
35-39	100 (35.8) [26.6, 46.2]	54 (17.2) [12.1, 23.9]	100 (31.5) [25.1, 38.7]	53 (15.5) [11.9, 20.0]	307 (100.0)
40-44	82 (25.4) [20.5, 31.0]	47 (15.8) [11.0, 22.0]	114 (39.6) [32.1, 47.5]	57 (19.3) [14.3, 25.4]	300 (100.0)
45-49	58 (24.2) [18.0, 31.7]	23 (12.2) [7.98, 18.4]	70 (31.6) [26.2, 37.7]	61 (31.9) [25.4, 39.1]	212 (100.0)
50-54	49 (16.0) [11.7, 21.5]	28 (8.3) [5.14, 13.2]	100 (31.2) [24.7, 38.5]	126 (44.5) [37.4, 51.9]	303 (100.0)
55-59	115 (18.2) [14.9, 22.2]	81 (12.5) [9.9, 15.7]	182 (29.1) [25.0, 33.7]	252 (40.1) [36.0, 44.4]	630 (100.0)
60-64	63 (17.6) [12.8, 23.7]	62 (18.1) [13.7, 23.5]	104 (27.7) [21.7, 34.7]	153 (36.7) [30.8, 43.0]	382 (100.0)
65-69	35 (12.4) [8.06, 18.6]	25 (8.8) [5.5, 13.7]	71 (25.1) [17.6, 34.5]	146 (53.7) [44.1, 63.0]	277 (100.0)
Total	1092 (31.5) [28.4, 34.7]	613 (16.5) [14.4, 18.9]	1256 (32.9) [29.9, 36.0]	1038 (19.1) [16.9, 21.6]	3999 (100.0)

\*Weighted analysis; CI: Confidence interval.

men according to age groups. Based on the results, 52.0% of the male population were estimated to be hypertensive. Of them, 32.9% (95% CI: 29.9-36.0) and 19.1% (95% CI: 16.9-21.6) had stage 1 and 2 hypertension, respectively. The prevalence of stage 2 hypertension was higher in older men (45 years and older) compared to the younger age groups. However, the prevalence of stage 1 hypertension was not significantly different across age groups.

Table 4 shows the prevalence of hypertension in Iranian women according to age groups. Overall, about 44.3% of the female population had hypertension. Of them, 26.3% (95% CI: 24.5-28.2) had stage 1 and 18.0% (95% CI: 16.1-20.1) stage 2 hypertension. Similar to the men, the prevalence of stage 2 hypertension also increased in women with age. Moreover, the prevalence of stage 1 hypertension was close across age groups except for 20-24 age

**Table 4.** Prevalence\* [95% confidence interval] of new blood pressure categories in Iranian women; SuRFNCD-2011

Age group (years)	Normal n (%) [95%CI]*	Elevated n (%) [95%CI]	Hypertension		Total (%)
			Stage 1 n (%) [95%CI]	Stage 2 n (%) [95%CI]	
20-24	513 (68.4) [63.4, 73.1]	72 (10.0) [7.31, 13.7]	146 (18.3) [15.1, 22.0]	26 (3.3) [2.08, 5.07]	757 (100.0)
25-29	464 (56.5) [51.7, 61.3]	61 (8.2) [5.83, 11.3]	220 (27.7) [23.3, 32.7]	58 (7.6) [5.9, 9.7]	803 (100.0)
30-34	304 (47.8) [42.2, 53.5]	58 (9.2) [6.36, 13.3]	166 (30.5) [25.2, 36.4]	78 (12.4) [9.6, 15.9]	606 (100.0)
35-39	207 (44.1) [38.2, 50.1]	44 (8.2) [5.54, 12.1]	137 (28.6) [24.8, 32.7]	90 (19.1) [14.9, 24.1]	478 (100.0)
40-44	153 (33.7) [28.3, 39.5]	57 (11.4) [8.24, 15.7]	137 (28.4) [24.2, 33.0]	122 (26.5) [21.8, 31.9]	469 (100.0)
45-49	118 (25.6)	49 (10.9)	131 (31.5)	137 (31.9)	435 (100.0)

*Table 4. Ctd*

50-54	113 (20.5) [16.6, 25.1]	57 (10.4) [7.02, 15.1]	168 (32.2) [24.7, 40.8]	211 (36.8) [29.5, 44.9]	549 (100.0)
55-59	110 (16.6) [13.3, 20.5]	58 (8.8) [6.25, 12.2]	181 (29.5) [25.7, 33.6]	284 (45.1) [39.7, 50.6]	633 (100.0)
60-64	91 (16.2) [12.5, 20.7]	53 (9.5) [6.73, 13.1]	159 (28.5) [23.7, 33.8]	272 (45.9) [41.6, 50.2]	575 (100.0)
65-69	64 (13.3) [9.76, 17.9]	45 (9.4) [6.71, 13.0]	131 (26.6) [21.1, 33.0]	257 (50.7) [44.3, 57.0]	497 (100.0)
Total	2137 (46.1) [42.8, 49.5]	554 (9.6) [7.86, 11.7]	1576 (26.3) [24.5, 28.2]	1535 (18.0) [16.1, 20.1]	5802 (100.0)

\*Weighted analysis; CI: Confidence interval.

group, which was slightly lower. The comparison between the prevalence of stage 1 and 2 hypertension across the age groups in both sexes showed a higher prevalence in men (Tables 3 and 4).

The prevalence of elevated BP, stage 1 and 2 hypertension, for men and women is presented in Figure 1. The prevalence of elevated BP in men has decreased from 20 years (20.5%) to 65 years (8.8%). However, in women, the prevalence of elevated BP remained roughly constant

in 20-69 age group. The prevalence of stage 1 hypertension in men and women almost follows the same pattern. This prevalence remains roughly constant in both sexes aged 20-69 years. Only an increase in the prevalence of stage 1 hypertension occurs in men aged 40-44 years.

Prevalence of stage 2 hypertension was different in men and women. The prevalence of stage 2 hypertension was 10.1% in men aged 20 to 24 years, which increased to 44.5% in 50-54 age groups. However, this prevalence

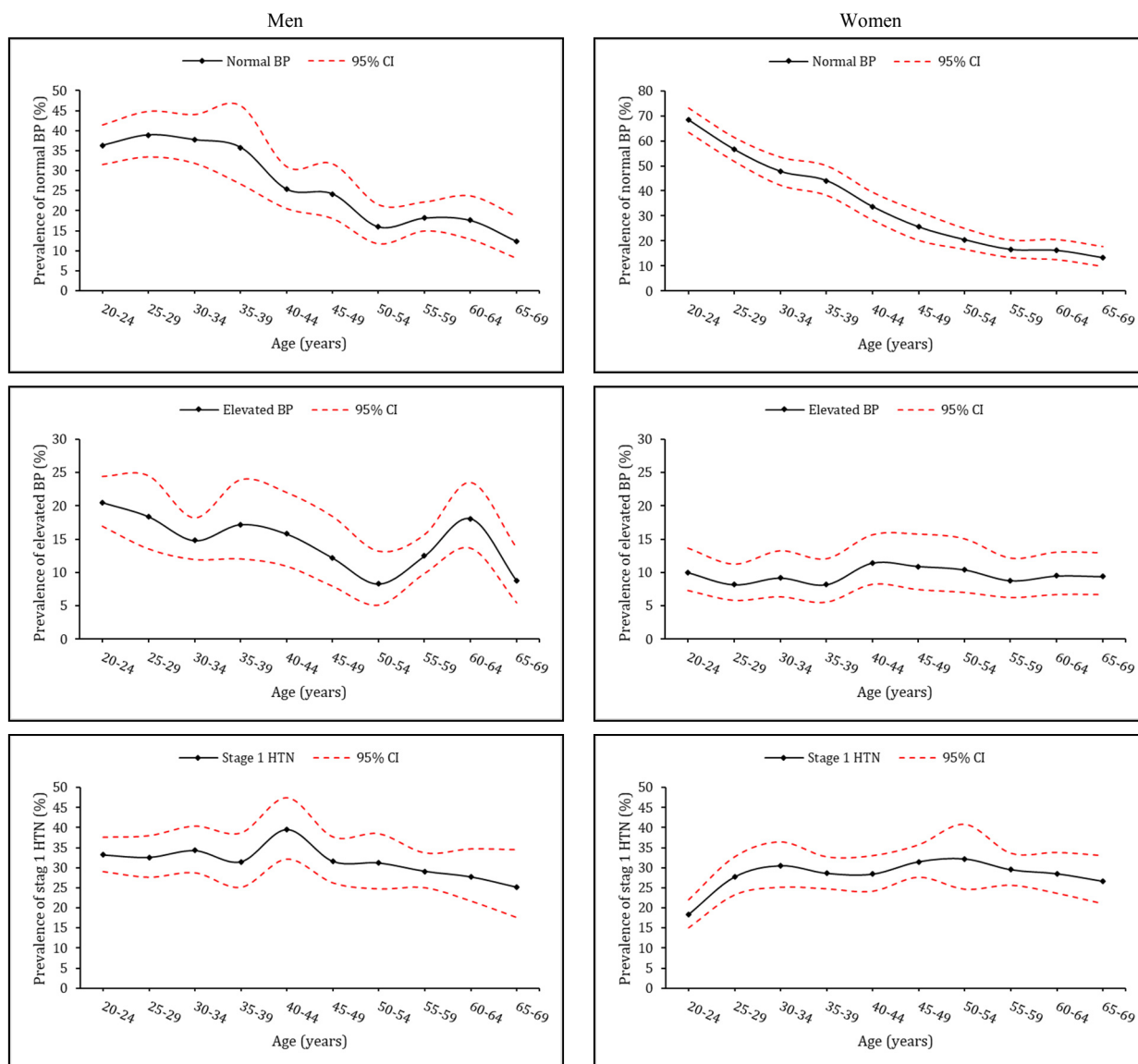


Fig. 1. Prevalence of normal blood pressure (BP), elevated BP and stage 1 and 2 hypertension (HTN) with 95% confidence interval (95% CI) according to age group and sex

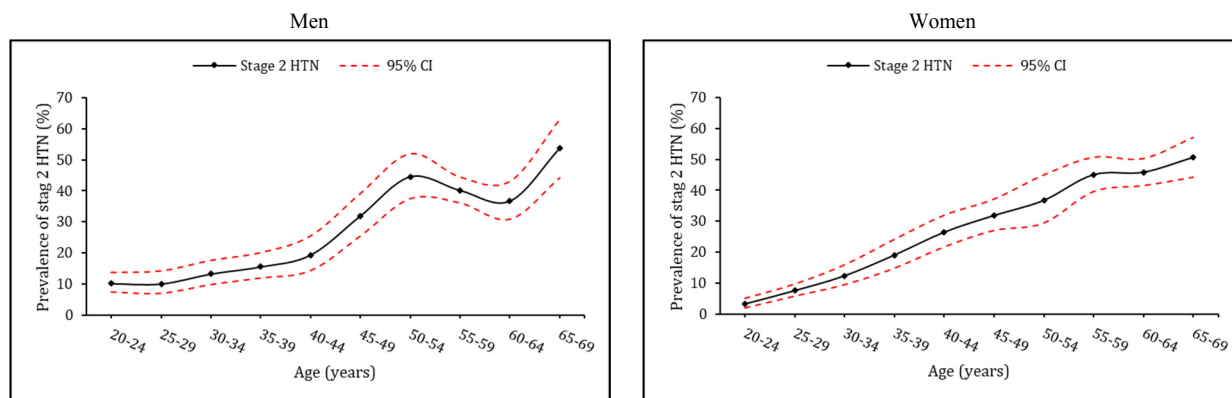


Fig. 1. Ctd

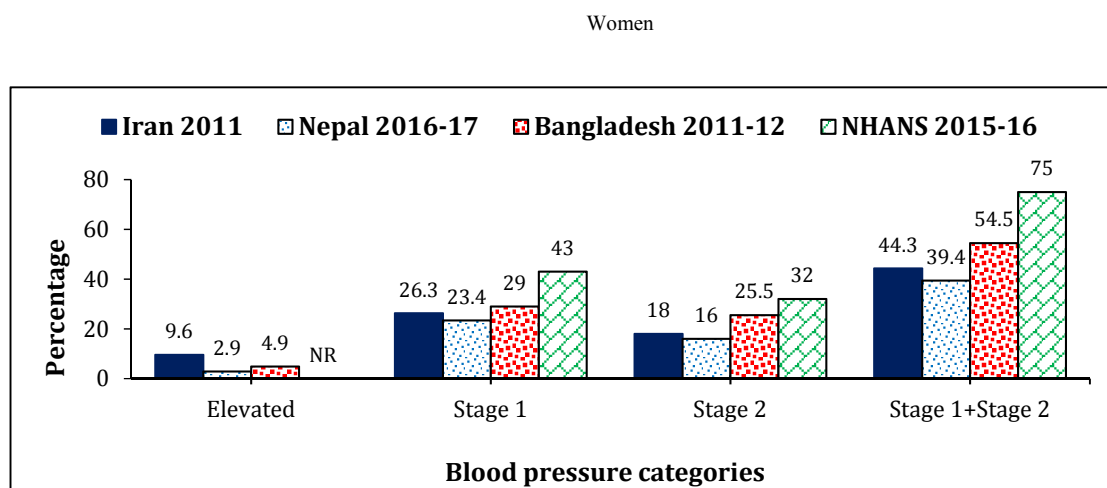
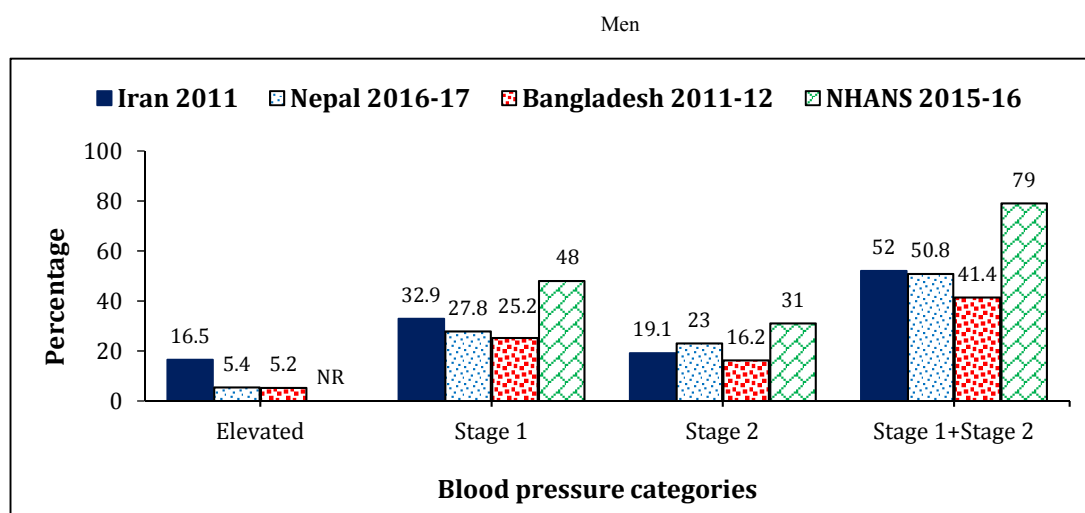


Fig. 2. The prevalence of hypertension in Iranian, American, Bangladeshi, and Nepali adults based on sex using the new ACC/AHA guidelines. NR: Not reported.

decreased to 40.1% and 36.7% in 55-59 and 60-64 age groups, respectively. Then, it increased to 53.7% in those aged 65-69 years. Unlike men, in women, the prevalence of stage 2 hypertension had a steady increase in women. The prevalence of stage 2 hypertension was 3.3% in women aged 20-24 years, which raised to 45.1% in 55-59 age group and 50.7% in 65-69 age group.

### Discussion

For the first time, the findings of this study, based on ACC/AHA guidelines, showed that the prevalence of hypertension in men and women is higher than previous estimates in Iran. Overall prevalence of hypertension in Iranian men and women was 52.0% and 44.3%, respectively. By contrast, according to the JNC-7 guidelines, the preva-



lence of hypertension in men and women was 25.8% and 27.6%, respectively (2). In addition, about 16.5% of men and 9.6% of women were categorized as having elevated blood pressure who are prone to hypertension. The prevalence of hypertension in men and women follows a different pattern according to age. The prevalence of hypertension in women up to the age of 55 years was lower than men, while in ages older than 55, the prevalence was similar in both sexes.

The ACC/AHA guideline presented in 2017 caused considerable changes in the report of prevalence of hypertension in communities. In the United States, the prevalence of stage 1 and 2 hypertension was 48% and 31% in men and 43% and 32% in women, respectively (5). According to the findings of this study, the prevalence of hypertension in the United States is far higher than the Iranian population. The prevalence of stage 1 and stage 2 hypertension in Iranian men and women was 32.9%, 19.1%, and 26.3% and 18%, respectively. These values were similar to those in other Asian countries such as Nepal (12) and Bangladesh (13), with the prevalence of stage 1 hypertension in men varying from 25.2% and 27.8% and in women from 23.4% to 29%, respectively. This range for stage 2 hypertension was 16.2% to 23% and 25.5% to 16%, respectively (Fig. 2).

Identifying at-risk individuals is highly important in primary prevention. Therefore, the AHA / ACC 2017 guideline defined a more sensitive cutoff for elevated blood pressure than JNC-7 report. In Iran, 16.5% of men and 9.6% of women have been classified as having elevated blood pressure, which is higher than Nepal (5.4% in men and 2.9% in women) and Bangladesh (5.2% in men and 4.9% in women) (Fig. 2). It seems that the prevalence of hypertension in Iran is higher than low-income countries and lower than high-income countries.

The reason for the difference in the prevalence of hypertension in men and women by age can be attributed to their physiological differences. At premenopausal ages (50 years or less), estrogen secretion causes women to have lower blood pressure than men. However, at menopause, the decrease in the level of estrogen reduces its protective effect on blood pressure (14).

Zero or 5 end-digit preference is one of the most common errors in most large-scale surveys (15). The prevalence of this error is very high in the assessment of BP. For example, in a study on 16 433 individuals in China, the prevalence of zero end-digit preference was found to be 52.5% and 63.5% for SBP and DBP, respectively (16). These values were 64% and 62%, respectively, in another study in New Zealand (17). However, in SuRFNCD 2011 in Iran, which was used in this study, zero end-digit preference was only 16.1%. Using a national data from Iran is one of the strengths of this research. In addition, this study was one of the few reports in a developing country which used ACC/AHA 2017 guideline to assess hypertension. Also, in the analysis of the present data in estimation of new BP categories in adults, the weighted analysis of the data was undertaken because of sampling scheme. This strategy provided a more accurate estimate of the prevalence of hypertension.

One of the limitations of the present study was the use of data collected in 2011, as the blood pressure status in Iran may have changed since then. However, in a previous study, it was found that the prevalence of hypertension in Iran over 1999, 2003, 2007, and 2011 did not change significantly (2). Therefore, one might assume that even the amount of change from 2011 up to now (2018), is negligible and the results of this study can be used by health authorities in the country.

## Conclusion

This study revealed that adopting the 2017 ACC/AHA guidelines provided a new prevalence of adult hypertension (48.2%) in Iran. In this study, men were more hypertensive compared to women. In addition, the prevalence was higher in older adults irrespective of sex. This new prevalence is higher compared to that of previous studies which were done based on the JNC-7 guidelines. To decrease this alarming increase, urgent measures, such as effective health policies, healthy and positive change in lifestyle, proper diet, regular exercise, sensitization and awareness programs, and regular medical check-ups are highly recommended.

## Acknowledgment

This research has been supported by Tehran University of Medical Sciences & health Services grant (Grant number: 97-02-27-38625).

## Conflict of Interests

The authors declare that they have no competing interests.

## References

- Hosseini M, Baikpour M, Yousefifard M, Fayaz M, Koohpayehzadeh J, Ghelichkhani P, et al. Blood pressure percentiles by age and body mass index for adults. *EXCLI J*. 2015;14:465.
- Hosseini M, Yousefifard M, Baikpour M, Rafei A, Fayaz M, Heshmat R, et al. Twenty-year dynamics of hypertension in Iranian adults: age, period, and cohort analysis. *J Am Soc Hypertens*. 2015;9(12):925-34.
- Hosseini M, Ataei N, Aghamohammadi A, Yousefifard M, Taslimi S, Ataei F. The relation of body mass index and blood pressure in Iranian children and adolescents aged 7–18 years old. *Iran J Public Health*. 2010;39(4):126.
- Ibrahim MM, Damasceno A. Hypertension in developing countries. *Lancet* 2012;380(9841):611-9.
- Whelton PK, Carey RM, Aronow WS, Casey DE, Collins KJ, Himmelfarb CD, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol*. 2018;71(19):e127-e248.
- Rao MV, Qiu Y, Wang C, Bakris G. Hypertension and CKD: Kidney Early Evaluation Program (KEEP) and National Health and Nutrition Examination Survey (NHANES), 1999-2004. *Am J Kidney Dis*. 2008;51(4):S30-S7.
- Muntner P, Carey RM, Gidding S, Jones DW, Taler SJ, Wright JT, Jr., et al. Potential US Population Impact of the 2017 ACC/AHA High Blood Pressure Guideline. *Circulation*. 2018;137(2):109-18.
- Khera R, Lu Y, Lu J, Saxena A, Nasir K, Jiang L, et al. Impact of 2017 ACC/AHA guidelines on prevalence of hypertension and eligibility for antihypertensive treatment in United States and China: nationally representative cross sectional study. *BMJ (Clinical research ed)*. 2018;362:k2357.
- Haghdoust AA, Sadeghirad B, Reza zadehkermani M. *Epidemiology*

- and heterogeneity of hypertension in Iran: a systematic review. *Arch Iran Med.* 2008;11(4):444-52.
10. Mohammadi M, Mirzaei M. Population-attributable fraction of hypertension associated with obesity, abdominal obesity, and the joint effect of both in the Central Provinces of Iran. *J Epidemiol Glob Health.* 2017;7(1):71-9.
  11. Koohpayehzadeh J, Etemad K, Abbasi M, Meysamie A, Sheikhbahaei S, Asgari F, et al. Gender-specific changes in physical activity pattern in Iran: national surveillance of risk factors of non-communicable diseases (2007–2011). *Int J Public Health.* 2014;59(2):231-41.
  12. Al Kibria GM, Swasey K, Angela K, Mirbolouk M, Sakib MN, Sharmeen A, et al. Estimated change in prevalence of hypertension in Nepal following application of the 2017 ACC/AHA guideline. *JAMA Network Open.* 2018;1(3):e180606-e.
  13. Al Kibria GM, Swasey K, Choudhury A, Burrowes V, Stafford KA, Uddin SI, et al. The new 2017 ACC/AHA guideline for classification of hypertension: changes in prevalence of hypertension among adults in Bangladesh. *J Hum Hypertens.* 2018:1.
  14. Hinton Jr AO, He Y, Xia Y, Xu P, Yang Y, Saito K, et al. Estrogen receptor- $\alpha$  in the medial amygdala prevents stress-induced elevations in blood pressure in females. *Hypertension.* 2016;67(6):1321-30.
  15. Yaseri M, Afarideh M, Hosseini M, Youseffard M, Rafei A, Koohpayehzadeh J, et al. Zero and Five End-Digit Preference and Blood Pressure Quality of Care Revisited. *Arch Iran Med.* 2017;20(10):633-9.
  16. Wang Y, Wang Y, Qain Y, Zhang J, Tang X, Sun J, et al. Longitudinal change in end-digit preference in blood pressure recordings of patients with hypertension in primary care clinics: Minhang study. *Blood Press Monit.* 2015;20(2):74-8.
  17. Broad J, Wells S, Marshall R, Jackson R. Zero end-digit preference in recorded blood pressure and its impact on classification of patients for pharmacologic management in primary care - PREDICT-CVD-6. *Br J Gen Pract.* 2007;57(544):897-903.