Impact of 2017 ACC/AHA Guideline on Prevalence, Awareness, Treatment, Control and Risk Factors of Hypertension: a Population-based, Cross-sectional Study in Iran

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Abstract

Background: In 2017, the American College of Cardiology/American Heart Association (ACC/AHA) provided a new guideline for hypertension prevention and management. We aimed to update the prevalence, awareness, control and risk factors of hypertension based on this guideline and to estimate the number of people who are eligible for non-pharmacologic and pharmacologic intervention.

Methods: This population-based, cross-sectional study was conducted in Khuzestan, a large province in the southwest of Iran. Comprehensive information about the potential risk factors of hypertension was collected and blood pressure, blood biomarkers, and anthropometric were measured. Moreover, the dietary pattern was evaluated in 10% of the participants, using a qualitative food frequency questionnaire.

Results: A total number of 30,506 individuals aged 20-65 years was included in this study. In comparison to previous guideline (JNC8), the prevalence of hypertension in Khuzestan dramatically increased by 27.04% after implementation of ACC/AHA (15.81% vs 42.85%), which was more dominant in the male population and the 50-59 age group. The sex and age adjustment of the hypertension prevalence was estimated to be 39.40%. The number of individuals required antihypertensive treatment was slightly increased from 15.53% to 21.18%; however, the level of awareness and control dramatically dropped by 23.17% & 31.78%, respectively. All hypertension-related risk factors remained significant after applying the new guideline; however, the strength of the association was reduced in the risk factors like age, waist-hip ratio, body mass index, alcohol consumption, water pipe usage, and physical activity. Similarity, the association between hypertension and history of diabetes, and cardiovascular diseases were decreased by 38%, and 62%, respectively.

Conclusions: In the ACC/AHA guideline, a higher number of individuals with the pre-hypertension condition had been shifted into the hypertension category and the level of awareness, treatment, and control was dramatically fallen, which highlight a great need to expand the public health infrastructure for further managing the substantial increase in the public health burden of hypertension.

Background

Hypertension (HTN) is a major risk factor for non-communicable diseases such as cardiovascular diseases (CVD), stroke, and renal dysfunction. With 1.5 billion hypertensive people and 7.6 million HTN-related death, this disease remains major public health globally [1, 2]. In developing countries, the prevalence of HTN is increasing rapidly and it is estimated about three-fourths of the world's hypertensive population will be from these countries by 2025 [2]. Considering the high impact of HTN on public health, mainly on low resource settings with weak health systems, keeping updated about the prevalence of HTN as well as the attributed risk factors is essential to improve the approaches in controlling this disorder.

According to the eighth report of the joint national committee (JNC8) guideline, patients with systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg have been

diagnosed with HTN. Using this classification, the overall prevalence of HTN in Iran has been estimated to be 29.9% [3]. However, recently the 2017 American College of Cardiology (ACC)/American Heart Association (AHA) recommended $\geq 130/80$ mmHg as a new cut-off for HTN, indicating the estimations for prevalence, and the determinants of HTN are required to be updated in each region [4]. To date, few studies have evaluated the impact of suggested guideline and have reported shifting from JNC8 to 2017 ACC/AHA caused a significant increase in the prevalence of HTN and a drastic decline in awareness, treatment, and control of this disorder, which may impose a considerable impact on the health systems [5–7].

HTN is a multifactorial disease and several genetic, environmental, and behavioral factors contribute to manifest the disease [8]. Low physical activity and overweight, as well as unhealthy diet such as high salt intake, are the leading risk factors of HTN [9]; nevertheless, considerable variations between countries and even within the countries exist. Although this disease is usually asymptomatic and people are not aware of their condition, it is one of the most preventable disorder and modifications of the lifestyle could considerably prevent the progression of CVD and renal diseases in the future. In the ACC/AHA guideline, a higher number of individuals with the pre-hypertension condition had been shifted into the HTN category [4]. However, the impact of the 2017 ACC/AHA guideline on HTN-associated risk factors was not fully addressed and updating the major risk factors and their effect on HTN incidence is a prerequisite for effective prevention and awareness strategies in the future.

In Iran, CVD is the first cause of death [10]. Updating the local burden of the HTN as the major risk factor of CVD is important to set the health priority in the country. Moreover, primary prevention would have a major beneficial impact in terms of public health after defining the major risk factors of this disease. Therefore, we aimed to evaluate the prevalence of HTN according to updated guideline and evaluate the impact this guideline on awareness, treatment, and control as well as the major-associated risk factors in a large sample of participants in Khuzestan Comprehensive Health Study.

Methods

Study design and study population

This cross-sectional health survey was conducted based on the data of Khuzestan Comprehensive Health Study (KCHS). KCHS is a large population-based cross-section study with the purpose of evaluating the health status of the Iranian adults in Khuzestan. This study was performed in the period of October 2016 to November 2018 and the samples were selected using a multistage random sampling method. In the first stage of cluster sampling, the health centers and health houses within each county has been selected randomly (total 29 counties). According to the population of each county a total number of 1079 of clusters, consisted of 780 health centers in urban and 299 health houses in rural areas were chosen. Afterward, 30 individuals between 20–66 years old were selected within each cluster, using systematic random sampling.

The individuals who had been selected in the sampling process and were residents of Khuzestan province for at least one year were invited to the study by a trained staff. We excluded those with mental, psychological or physical disabilities, or if they were reluctant to participate at any stage of the study. A written informed consent was obtained from all contributors before including them in the study.

Blood Pressure and Anthropometric Measurements

The SBP and DBP were measured twice with 10-minutes interval in a seated position using analogue Riester sphygmomanometers. In addition, the participants' height and weight were measured by Seca 206 body meter measuring tape and Seca 762 mechanical flat scale, respectively.

Definitions

According to the 2017 ACC/AHA guideline, HTN was defined if the SBP level was ≥ 130 mmHg and/or the DBP level was ≥ 80 mmHg and/or the participant takes antihypertensive medication [4]. The SBP between 120–129 mmHg and DBP < 80 mmHg was considered as elevated blood pressure [4]. These thresholds were 140/90 for HTN and 120–139/80–89 for pre-hypertension based on the NCJ8 guideline [3]. Diabetes Mellitus (DM) was defined as fasting plasma glucose levels (FBS) ≥ 125 mg/dL, previously diagnosed DM, or current intake of antidiabetic agents. We documented heart disease if the participant reported any history of myocardial infarction, angiography, or any other related heart diseases. The positive family history of HTN was considered if the participant reported a history of HTN in the first-degree relatives.

Body mass index (BMI) was calculated by dividing weight (in kilograms) to height (in meters, squared) and further classified based on the WHO international BMI classification. Waist-to-hip ratio (WHR) was the ratio of waist circumference to hip circumference. The socioeconomic status was calculated by multiple correspondence analysis (MCA) with assets and was further presented in quartiles. Metabolic equivalent of task (MET) category was conducted based on the international physical activity questionnaire (IPAQ) guideline and was presented in tertial. Education was categorized according to the educational system in Iran.

Awareness was estimated based on the positive response of individual to self-reported HTN and treatment was considered if the participant takes antihypertensive medication. Moreover, the HTN control was defined in subjects with blood pressure $< 130/80$ mmHg based on the 2017 ACC/AHA or $< 90/140$ mmHg based on the JNC8 after taking anti-HTN drugs.

Laboratory measurements

After overnight fasting, 15 milliliters peripheral blood was collected from each participant and was transferred to a research lab in a 4 °C cold boxes within 3 hours. After separating the serum, the levels of FBS, total cholesterol, and high-density lipoproteins cholesterol (HDL) were measured.

Dietary Intake Assessment

The dietary habits were assessed for 2,830 of the participants, using non-quantitative food frequency questionnaire (FFQ) and the consumption of sodium, total fat, fiber, and carbohydrate were measured per week.

Statistical analysis

Using the Kolmogorov-Smirnov test, the normal distribution of the variables was evaluated. All continuous variables were presented as mean ($\pm$ standard deviation (SD)) and were compared between three independent groups (control, pre-hypertension or elevated blood pressure, HTN) using One-way ANOVA. The categorical variables were presented as absolute frequencies (percentages) and were compared with a chi-square test or Fisher's exact test, if required.

Multiple logistic regression was performed to identify the independent risk factors of pre-hypertension (or elevated blood pressure) and HTN in the studied population. The final model was adjusted with established risk factors of HTN such as sex, age, BMI, and physical activity. The graphs were presented by GraphPad Prism 7 (GraphPad Prism Software, San Diego, CA, USA) and the statistical analysis was performed using STATA/SE version 12.0 software (STATA Corp., TX, USA). p -value < 0.05 was considered as statistically significant.

Results

HTN-associated risk factors based on 2017 ACC/AHA guideline

A total number of 30,506 individuals aged 20–65 years was included in this study. Using 2017 ACC/AHA cut-off the overall prevalence of elevated blood pressure and HTN were 1,950 (6.41%) & 13,036 (42.85%), respectively, which changed to 7.09% and 39.40% after sex and age adjustment. The mean ($\pm$ SD) age was 41.71 ($\pm$ 11.89), which was significantly higher in hypertensive people compared to the controls ($P = 0.000$). In the studied population, women were prominent (64.26%); however, they were less likely to manifest HTN compared to men (50.03% vs 38.70%). Other independent protective risk factors were being Bakhtiary, getting married, having higher education level, doing more physical activity, and smoking, whereas being Arab, having high WHR and BMI, drinking alcohol, and having a family history of HTN were positively associated with an increased risk of HTN (Table 1). The risk factors associated with elevated blood pressure were age, gender, marital status, BMI, alcohol intake, physical activity, and family history of HTN.

Table 1

Adjusted odds ratios and 95% confidence intervals for association between studied variables and hypertension among Iranian: NCJ8 guideline vs 2017 ACC/AHA guideline

Variables	NCJ8 guideline				2017 ACC/AHA guideline			
	Pre-hypertension vs control		Hypertension vs control		Elevated BP vs control		Hypertension vs control	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Age group	1	0.087	1	0.000	1	0.999 0.003	1	0.001
20–29	1.07 (0.99–1.16)	0.000	1.53 (1.29–1.80)	0.000	1.00 (0.87–1.15)	0.000	1.14 (1.05–1.23)	0.000
30–39		0.000		0.000		0.000		0.000
40–49	1.51 (1.40–1.64)	0.000	4.32 (3.69–5.05)	0.000	1.26 (1.08–1.46)		1.98 (1.83–2.15)	0.000
50–59								
>60	2.11 (1.94–2.30)		11.49 (9.84–13.41)		1.67 (1.43–1.95)		3.66 (3.37–3.98)	
	2.60 (2.31–2.93)		20.22 (17.00–24.05)		1.85 (1.49–2.29)		5.49 (4.91–6.14)	
Gender	1	0.000	1	0.000	1	0.000	1	0.000
Male	0.51 (0.48–0.53)		0.59 (0.55–0.64)		0.46 (0.42–0.51)		0.53 (0.51–0.56)	
Female								
Marital status	1	0.000	1	0.448 0.914	1	0.001 0.550 0.162	1	0.004 0.467
Single	0.83 (0.76–0.90)	0.501 0.367	1.07 (0.90–1.26)	0.010	0.77 (0.66–0.90)		0.88 (0.80–0.96)	0.446
Married								
Divorced	0.92 (0.71–1.18)		1.02 (0.69–1.51)		0.87 (0.54–1.38)		0.91 (0.71–1.17)	
Widowed								
	0.92 (0.78–1.10)		1.35 (1.07–1.70)		0.79 (0.57–1.10)		1.06 (0.91–1.25)	

Variables	NCJ8 guideline				2017 ACC/AHA guideline			
	Pre-hypertension vs control		Hypertension vs control		Elevated BP vs control		Hypertension vs control	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Socioeconomic status	1	0.739	1	0.755	1	0.687	1	0.980
Q1	1.01 (0.94–1.09)	0.010	0.98 (0.89–1.09)	0.000	1.03 (0.90–1.18)	0.360	1.0 (0.93–1.07)	0.000
Q2		0.001		0.000		0.709		0.000
Q3	0.91 (0.84–0.98)		0.81 (0.73–0.90)		0.94 (0.82–1.08)		0.88 (0.82–0.94)	
Q4	0.88 (0.82–0.95)		0.78 (0.70–0.86)		0.97 (0.85–1.12)		0.83 (0.77–0.89)	
Education	1	0.077	1	0.000	1	0.616	1	0.000
Illiterate	0.93 (0.85–1.01)	0.000	0.76 (0.68–0.84)	0.000	0.97 (0.82–1.12)	0.865	0.84 (0.78–0.91)	0.000
Elementary school		0.000		0.000		0.475		0.000
Guidance school	0.82 (0.75–0.91)		0.67 (0.59–0.76)	0.000	0.98 (0.83–1.17)	0.380	0.73 (0.66–0.80)	0.000
High school	0.84 (0.77–0.91)		0.61 (0.54–0.68)		0.94 (0.80–1.11)		0.72 (0.67–0.78)	
Universities	0.78 (0.70–0.86)		0.54 (0.46–0.63)		0.92 (0.76–1.11)		0.66 (0.59–0.73)	

Variables	NCJ8 guideline				2017 ACC/AHA guideline			
	Pre-hypertension vs control		Hypertension vs control		Elevated BP vs control		Hypertension vs control	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Ethnicity	1	0.000	1	0.000	1	0.306	1	0.000
Fars	1.17 (1.09–1.26)	0.000	1.22 (1.10–1.34)	0.003	1.07 (0.94–1.23)	0.775	1.21 (1.13–1.29)	0.000
Arab		0.060 0.355		0.151 0.003		0.110 0.493		0.763 0.058
Bakhtiary	0.81 (0.75–0.88)		0.84 (0.75–0.94)		1.02 (0.88–1.19)		0.79 (0.73–0.85)	
Lor								
Others	0.90 (0.81–1.00)		1.11 (0.96–1.28)		0.85 (0.70–1.04)		0.98 (0.89–1.09)	
	0.86 (0.64–1.17)		0.45 (0.27–0.76)		0.82 (0.46–1.45)		0.75 (0.55–1.01)	
Waist-hip ratio	1	0.001	1	0.000	1	0.738	1	0.000
WHR < 0.85	1.15 (1.06–1.24)	0.000	1.43 (1.26–1.63)	0.000	1.02 (0.89–1.18)	0.820	1.23 (1.14–1.33)	0.000
0.85 ≤ WHR < 0.9		0.000		0.000		0.838		0.000
0.90 ≤ WHR < 0.95	1.24 (1.14–1.34)		1.85 (1.63–2.10)		0.98 (0.85–1.14)		1.42 (1.31–1.53)	
WHR ≥ 0.95	1.25 (1.15–1.35)		2.38 (2.11–2.69)		1.02 (0.87–1.18)		1.57 (1.45–1.70)	
BMI	1	0.000	1	0.000	1	0.008	1	0.000
Normal (18.6–25)	0.65 (0.54–0.78)	0.000	0.49 (0.374–0.70)	0.000	0.64 (0.46–0.89)	0.000	0.62 (0.52–0.74)	0.000
Underweight (≤ 18.5)	1.38 (1.29–1.48)		1.74 (1.58–1.92)		1.30 (1.15–1.46)		1.49 (1.40–1.59)	
Overweight (25.1–30)								
Obese (> 30)	1.84 (1.72–1.97)		2.93 (2.64–3.25)		1.44 (1.26–1.64)		2.23 (2.08–2.39)	

Variables	NCJ8 guideline				2017 ACC/AHA guideline			
	Pre-hypertension vs control		Hypertension vs control		Elevated BP vs control		Hypertension vs control	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Smoking	1	0.001 0.367	1	0.000 0.109	1	0.571 0.910	1	0.000
No	0.84 (0.76–0.93)		0.76 (0.66–0.89)		0.95 (0.80–1.13)		0.79 (0.72–0.88)	0.879
Current								
Former	0.93 (0.79–1.09)		1.17 (0.97–1.42)		0.98 (0.75–1.29)		0.99 (0.85–1.15)	
Alcohol	1	0.069 0.095	1	0.227 0.041	1.59 (1.08–2.35)	0.019 0.744	1	0.191 0.027
No	1.27 (0.98–1.63)		1.31 (0.84–2.03)				1.19 (0.92–1.54)	
Current					1.07 (0.71–1.62)			
Former	1.22 (0.97–1.55)		1.44 (1.01–2.07)				1.30 (1.03–1.64)	
Water pipe (hookah)	1	0.096 0.070	1	0.028 0.042	1.08 (0.85–1.37)	0.538 0.208	1	0.025 0.047
No	1.12 (0.98–1.28)		1.27 (1.03–1.58)				1.16 (1.02–1.33)	
Current					1.25 (0.88–1.79)			
Former	1.21 (0.98–1.50)		1.38 (1.01–1.87)				1.23 (1.00–1.51)	
Physical activity	1	0.000	1	0.000	0.85 (0.75–0.95)	0.004	1	0.000
T1	0.87 (0.82–0.93)	0.000	0.76 (0.69–0.82)	0.000		0.000	0.83 (0.78–0.88)	0.000
T2					0.79 (0.70–0.90)			
T3	0.88 (0.82–0.94)		0.75 (0.68–0.83)				0.85 (0.79–0.91)	
Family history BP	1	0.000	1	0.000	1.13 (1.03–1.25)	0.014	1	0.000
No	1.18 (1.12–1.25)		1.81 (1.68–1.96)				1.36 (1.29–1.43)	
Yes								

Variables	NCJ8 guideline				2017 ACC/AHA guideline			
	Pre-hypertension vs control		Hypertension vs control		Elevated BP vs control		Hypertension vs control	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
DM	1	0.000	1	0.000	1.35 (1.17–1.56)	0.000	1	0.000
No	1.36 (1.25–1.47)		1.99 (1.81–2.18)				1.62 (1.50–1.74)	
Yes								
Cardiovascular disease	1	0.260	1	0.000	1	0.510	1	0.000
No	1.08 (0.94–1.24)		2.10 (1.83–2.41)		1.08 (0.85–1.38)		1.49 (1.32–1.68)	
Yes								
Cholesterol (mg/dL)	1	0.000	1	0.000	1	0.002	1	0.000
<240	1.16 (1.07–1.25)		1.21 (1.10–1.34)		1.24 (1.08–1.42)		1.17 (1.08–1.25)	
>240								
HDL (mg/dL)	1	0.079	1	0.009	1	0.128	1	0.039
<30	0.82 (0.66–1.02)		0.68 (0.51–0.90)		0.76 (0.53–1.08)		0.80 (0.65–0.99)	
>30								
<p>Odds ratios were adjusted for age, gender, BMI, and physical activity</p> <p>JNC8: eighth report of the joint national committee, ACC/AHA: 2017 American College of Cardiology/American Heart Association</p> <p>BP: blood pressure, BMI: body mass index, CVD: cardiovascular diseases, OR: odds ratio, CI: confidence interval, Q: quartile, T: tertile</p> <p>Bold values indicate statistical significance</p>								

Among biological risk factors, a high level of cholesterol was positively associated with both elevated blood pressure and HTN, while a significant lower level of HDL was observed in the hypertensive people only (Table 1).

In the nutrient assessment, we found no significant differences in the dietary habits of hypertensive and healthy group. In the sex stratification analysis, high fat intake was associated with a two-fold increased risk of HTN among males. In addition, a lower intake of salt and carbohydrate seems to be protective against HTN in the age group of 20–29 (data not shown).

Prevalence, and the determinants of HTN: 2017 ACC/AHA versus JNC8 hypertension guidelines

According to JNC8, the overall prevalence of HTN was 15.81%, which considerably increased by 27.04% after adopting the 2017 ACC/AHA guideline (42.85%) (Fig. 1a). This difference was more dominant in male (17.8% vs 50.3%) and individuals between 50–59 years old (29.54–59.74%) (Fig. 1b). Although 3.82% of the 20–29 age group were diagnosed with HTN based on JNC8, this level increased to 26.02% by applying the new guideline.

Moreover, the association between HTN and 60–65 aged group was 20.9-fold higher than HTN and 20–29 people; nevertheless, the association reduced to 5.6-fold after declining the blood pressure cut-off point by 10 mmHg to 130/80 mmHg. According to the ACC/AHA classification, 22.17% of underweight precipitants had HTN, while only 4.75% of this group were diagnosed with HTN previously. Moreover, the magnitude of the odds ratio was reduced from 2.22–1.43% in obese participants in comparison to subjects with normal BMI level.

Among HTN-identified people, 45.94% were aware, and among those eligible for pharmacologic intervention 19.40% received anti-hyper medication, which controlled the HTN in 60.72% of subjects. Nevertheless, after implementation of 2017 ACC/AHA, the rate of awareness, treatment, and control dropped to 22.77%, 14.22%, and 28.94%, respectively (Fig. 1c).

Discussion

After implementation of the 2017 ACC/AHA guideline, the prevalence of HTN in the Khuzestan province dramatically increased by 27.04% and the level of awareness and control dropped by 23.17% & 31.78%, respectively. Accordingly, the overall prevalence of HTN was 42.85% and about 77.23% of hypertensive adult were not aware of their condition. Among those who were eligible for HTN therapy 14.22% received drug, which controlled the HTN in 28.94% of them. All hypertension-related risk factors remained significant after applying the new guideline; however, the strength of the association was reduced in the risk factors like WHR, BMI, alcohol consumption, water pipe usage and physical activity. Moreover, the association between HTN and history of DM, and CAD was reduced by 38%, and 62% respectively.

In order to reduce the major adverse of CVD events, ACC/AHA has recommended a lower threshold of SBP and DBS (130/80 mm Hg) for diagnosis of HTN compared to what had been suggested earlier (140/90 mm Hg); however, there is a debate about the proposed HTN cut-off and CVD benefit. Although some studies reported reducing the SBP to 120 mm Hg level significantly decreased the risk of CVD [11], a more substantial reduction rate was observed for 130–139 mm Hg versus < 120 mm Hg [12, 13]. Conversely, a recent systematic review and meta-analysis study found no CVD benefit from additional blood pressure lowering if the SBP at baseline was < 140 mm Hg [14] and the authors further declared implementation of this guideline caused a significant increase in the proportion of adult diagnosed with HTN, with no noticeable effect on the reducing CVD morbidity and mortality [15]. Here, we found the

number of hypertensive patients was reached to 13,036 (42.85%) from 4,809 (15.81%) and this raise has been observed in all age group, ranging from 22.2% in 20–29 age group to 30.2% in 50–59 years old subjects. A lower increased rate has been reported in other countries; 22.4% in China (> 18 years) [16], 13.7% in the USA (> 20 years)[17], and 6–11% in Sweden (25–74 years) [15], which indicates the number of people with SBP 130–140 or DBP 80–90 was higher in Iran and this country would receive greater benefit about reducing the burden of CVD in the future by implementation of ACC/AHA guideline. Moreover, a noticeable shift of HTN prevalence has been observed among male population. Although about equal number of male and female were diagnosed with HTN previously (17.79% vs 14.70%), a more significant increased rate has been found in the male sex after applying the 2017 guideline (50.30% vs 38.70%). This transformation is more correlated with the higher rate of CVD mortality among male population in Iran, which indicates the necessity of further interventional strategies in this gender.

According to the JNC8 guideline, we found 45.94% of the hypertensive subjects were aware of HTN, which is lower than the previous awareness estimates in Iran (59.2%) [4]. After adopting the 2017 ACC/AHA, the awareness rate dropped to 22.77%, which was more noticeable in the 40–49 age group (21.65%). Since 45.36% of this age group are now classified under the HTN category, a substantial call to action for public awareness is warranted. Moreover, the HTN treatment strategy has been revised in 2017 ACC/AHA and those with SBP 130–139 or DBP of 80–89 were also recommended to received anti-hypertension treatment if they are + 65 years older, or the clinical CVD or 10-year atherosclerotic cardiovascular disease risk is 10% or greater [4]. Following this guideline, many high-risk adults might be protected against the development of HTN-related chronic diseases. However, the number of people who need anti-HTN treatment has been expected to increase from 8.1 million to 15.6 million in the USA and from 74.5 million to 129.8 million in China [6], which may impose a considerable impact on the health system in these countries. In this study, 4738 (15.53%) of total sample were eligible to receive HTN therapy based on JNC8. After ACC/AHA, additional 1724 subjects with SBP 130–139 or DBP of 80–89 and history of CVD or DM become candidate for pharmacological interventions, which increase the treatment demand to 21.18%. However, our study was limited to people aged 65 and younger; therefore, estimating the real impact of treatment in our population was not feasible. Another recent study conducted in Iran estimated that the number of adults met the criteria for treatment with anti-hypertensive medication increased from 13.4 million to 17.2 million [5]. Although the increased prevalence of HTN was more noticeable in Iran, the treatment burden in this country was lower compared to China & the USA, which might be due to smaller population of 65 + years old in Iran. Therefore, the impact of treatment costs on the health system under 2017 ACC/AHA guideline seems to be acceptable. However, the HTN control in Iran is relatively poor. Among those who were eligible for pharmacologic intervention, 19.40% take anti-HTN medication, which controlled the HTN in 60.72%. Under ACC/AHA guideline, the blood pressure < 130/80 mm Hg was considered as the target cut-off; therefore, the control rate was drop by 31.78% and reached to 28.94%, which highlight a great need to expand the public health infrastructure for further managing the substantial increase in the public health burden of HTN.

Considering the 2017 ACC/AHA guideline, 6574 participants younger than 65 years old have been additionally diagnosed with HTN, who might benefit from earlier interventions. Since these group of

people are not eligible for pharmacological interventions, modification of life style and nutrients diet is critical to reduce the risk of HTN-related disorders in the future. Although the salt intake was not an independent risk factor for HTN, the mean of sodium intake was estimated to be 8.74 gr/day, which exceeds the current WHO recommendations (2 gr/day(d) of Sodium, equivalent to 5 gr/d of salt) [18]. Based on 2017 ACC/AHA, we estimated about 79.38% of hypertensive people consume salt over the threshold, 75.82 need to lose extra weight, and 76.98% are required to do more physical activity.

We further evaluated the impact of 2017 ACC/AHA guideline on HTN-associated risk factors. All independent risk factors remained significant after implementation of the new guideline; however, the magnitude of the odds ratio reduced. Age was the strongest risk factor for HTN. Based on JNC8, the association between HTN and 60–65 aged group was 20.9-fold higher than HTN and 20–29 people; nevertheless, the association was reduced to 5.6-fold after adopting the updated version of the guideline. Similarity, we found a reduced rate of odds ratio in those with WHR ≥ 0.95 and obese people, alcohol consumption and waterpipe smoking in manifesting the HTN in the future, which might influence the further awareness strategies in the populations about the effect of lifestyle risk factors on HTN development. Although this is a cross sectional-based study and a causal relationship cannot be inferred, it seems the association between HTN and history of DM, and CVD was reduced by 38%, and 62%, respectively after applying the of 2017 ACC/AHA guideline, which might indicate the benefit of 2017 guideline.

This is a cross-sectional based study; and a causal relationship cannot be inferred. Moreover, based on the HTN 2017 ACC/AHA those with SBP 130–139 or DBP of 80–89 were also recommended to received anti-hypertension treatment if they are + 65 years older. However, our study was limited to people aged 65 and younger; and further study covering all range group is required to estimate the real impact of treatment after implementation of new guideline.

Conclusion

In the ACC/AHA guideline, a higher number of individuals with the pre-hypertension condition had been shifted into the hypertension category and the level of awareness, treatment, and control was dramatically fallen, which highlight a great need to expand the public health infrastructure for further managing the substantial increase in the public health burden of hypertension.

Abbreviations

HTN

Hypertension

CVD

cardiovascular diseases

JNC8

eighth report of the joint national committee

SBP

systolic blood pressure

DBP

diastolic blood pressure

ACC

American College of Cardiology

AHA

American Heart Association

KCHS

Khuzestan Comprehensive Health Study

FBS

fasting plasma glucose levels

BMI

Body mass index

WHR

Waist-to-hip ratio

MCA

multiple correspondence analysis

MET

Metabolic equivalent of task

IPAQ

international physical activity questionnaire

HDL

high-density lipoproteins cholesterol

FFQ

food frequency questionnaire

SD

standard deviation

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The datasets from the current study are included within the article.

Competing interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Author contributions

FS: concept, design, data analysis, interpretation, writing the article, critical reviews, final approval

BCh: data collection, critical reviews, final approval

ZM: data collection, critical reviews, final approval

SS: interpretation, critical reviews, final approval

SM: data analysis, critical reviews, final approval

ZR: data collection, critical reviews, final approval

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AKSh: concept, design, interpretation, critical reviews, final approval

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Figures

Figure 1

The impact of 2017ACC/AHA and JNC8 guidelines on the prevalence of hypertension in both sex (a), and different age groups (b), and awareness, control, and treatment of hypertension (c) in a population-based, cross-sectional study in Iran.

Figure 2

An estimation on the number of people who are eligible pharmacologic intervention, who were treated with antihypertensive agents and who had controlled hypertension based on JNC8 guideline and after implementation of 2017ACC/AHA guideline in a population-based, cross-sectional study in Iran.