



# Hypertension prevalence in Iran's elderly according to new criteria: the Tehran Geriatric Eye Study

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## Abstract

**Purpose** To determine the prevalence of hypertension in a population above 60 years of age and its relationship with demographic and anthropometric factors.

**Methods** A cross-sectional population-based study was conducted in 2019. Using a multistage random cluster sampling, 160 clusters were selected from 22 districts of Tehran. All participants were interviewed to collect demographic, anthropometric, and socioeconomic information. Then, systolic (SBP) and diastolic (DBP) blood pressures were measured under standard conditions twice, 10 min apart. A third measurement was performed if the two measurements showed a difference of  $\geq 10$  mmHg in SBP or  $\geq 5$  mmHg in DBP. Hypertension was defined as a SBP  $> 130$  mmHg or a DBP  $> 80$  mmHg (new criteria), being a known case of hypertension, or use of blood pressure lowering medications.

**Results** Of 3791 invitees, 3310 participated in the study (87.3%). The mean age of the participants was  $68.25 \pm 6.54$  years (60–97 years). The prevalence of hypertension was 81.08% (95% CI: 79.57–82.59) in the whole sample; 82.96% (95% CI: 81.02–84.91) in females, and 79.15% (95% CI: 76.6–81.69) in males. The prevalence of hypertension ranged from 75.47% (95% CI: 72.65–78.29) in the age group 60–64 years to 88.40% (95% CI: 83.71–93.08) in the age group  $\geq 80$  years. The prevalence of hypertension unawareness was 32.84% (95% CI: 30.82–34.86). The highest and lowest prevalence of hypertension was seen in illiterate subjects (89.41%) and those with a university education (77.14%), respectively. According to the multiple logistic regression analysis, older age, lower education level, obesity and overweight, neck circumference, and diabetes were significantly associated with the prevalence of hypertension.

**Conclusion** A significant percentage of Iranian elderly have hypertension and one of every 3 affected individuals is unaware of their disease. Considering the population aging in Iran, urgent and special attention should be paid to the elderly population. Caring for the elderly, informing families, and using non-traditional screening methods are recommended by families at the first level and policymakers at the macro level.

**Keywords** Geriatrics · Hypertension · Cross-sectional study · Iran

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## Introduction

Hypertension (HTN) remains the most common cardiovascular disease and a modifiable cause of mortality [1, 2]. According to recent studies, more than 1 billion people in the world suffer from HTN problems; this statistic has almost doubled compared to 1990 [2]. The importance of global HTN increasing prevalence has made it one of the NCD goals to achieve a 25% reduction in the prevalence of HTN by 2025 compared to 2010 [3].

The prevalence of HTN varies across the world according to age, ethnicity, race, and demographics [2, 3]. Previous studies have shown a prevalence of 39.1% in Latin America, 31.5% in Europe and Central Asia, and 26.9% in the Middle East and North Africa [4].

The HTN has a strong, linear, and independent association with the increased risk of cardiovascular disease (CVD) and chronic kidney disease (CKD) and accounts for 40% of cardiovascular mortalities [3, 5, 6]. Moreover, diabetes and hypercholesterolemia correlate with the HTN prevalence and double its risk [7, 8].

The overall prevalence of HTN is about 65.6% in the older population above 65 years of age [4]. The systolic (SBP) and diastolic (DBP) blood pressure increase with age until the 6th decade when SBP dominates thereafter. Therefore, isolated systolic hypertension (ISH) is the most common form of HTN in the elderly population [9]. The highest burden of HTN-related CVD and its cardiovascular complications like congestive heart failure and MI is related to the middle-aged and elderly populations, and the morbidity of HTN is two times higher in the elderly compared to the youth [3, 10].

Another important aspect of HTN is the percentage of people that are aware of their disease and seek treatment to reduce comorbidities. The latest report from the World Health Organization indicates that about 46% of patients with HTN are unaware of their disease. Although the awareness rate is expected to increase in the elderly population due to frequent check-ups, more than half of them are still unaware of their disease [11, 12].

Literature suggests an accelerated trend in the HTN prevalence in developing versus developed countries with  $\frac{3}{4}$  of the world's hypertensive population living in LMIC (low and middle-income countries) in the next decade [13, 14]. On the other hand, the American Heart Association (AHA) changed the definition of HTN from  $DBP \geq 90$  mmHg and  $SBP \geq 140$  mmHg to  $DBP \geq 80$  mmHg and  $SBP \geq 130$  mmHg in 2017. The new definition has resulted in an increase in the prevalence of HTN [1, 3, 10].

The prevalence of HTN in the Iranian elderly has received less attention in previous studies. Most epidemiological studies on HTN conducted in Iran had a wide age

range including young and middle-aged individuals, with the elderly comprising a small proportion of the whole sample. Accordingly, a review article reported an estimated 42% prevalence of HTN in the Iranian elderly population [15]. It has been shown that HTN is related to kidney problems, aortic stiffness, and heart diseases in the Iranian population. Moreover, HTN has been shown to reduce the quality of life [18].

Considering the above, evaluating the prevalence of HTN in the elderly population is of great importance. Moreover, no study has evaluated the prevalence of HTN in the Iranian elderly population according to the new guideline. The present study aimed to determine the prevalence of HTN in the Iranian elderly population  $\geq 60$  years and its relationship with demographic and anthropometric factors.

## Materials and methods

A cross-sectional population-based study was conducted on the urban elderly population ( $\geq 60$  years) of Tehran, the capital of Iran in 2019. The sampling was done using the multi-stage stratified random cluster sampling approach. For this purpose, the 22 municipality districts of Tehran were considered strata, and the population aged 60 years and above in each district was obtained from the National Statistics Center. Next, the block map of each district was prepared and each block was defined as a cluster. A total of 160 clusters were randomly selected from all 22 districts such that the number of clusters in each district was proportional to the population of districts (proportion to size). After identifying the clusters, a sampling team was sent to their addresses and the first house on the southwest side of each block was considered as the cluster head. The next households were selected by moving counter-clockwise and all individuals aged 60 years and above were invited to participate in the study after explaining the objective of the study and ensuring the confidentiality of data. Upon willingness to participate, informed consent was obtained from the volunteer, and an ID card was issued. If a household was not present at the time of sampling, another visit was scheduled (preferably in the same afternoon). All study participants were transferred to the examination site free of charge at a predetermined time.

At the examination site, the study participants were interviewed to gather demographic, socioeconomic, and anthropometric data as well as case history information including surgical and medication history. Blood samples were collected for laboratory analysis of blood sugar (BS) and HbA1C. Moreover, the history of diabetes or using blood sugar-lowering agents was inquired. Then, SBP and DBP were measured under standard conditions twice, 10 min

apart, and the average values were recorded. A third measurement was performed if the two measurements differed by  $\geq 10$  mmHg in SBP or  $\geq 5$  mmHg in DBP. In this case, the average of two closer values was recorded.

## Definition

Diabetes was defined as a BS  $> 200$  mg/dL, HbA1C  $> 6.4\%$ , a positive history of diabetes, or a history of using blood glucose lowering medications reported by the person. The HTN was defined as a SBP  $> 130$  mmHg or a DBP  $> 80$  mmHg (new criteria), being a known case of HTN based on the participant's self-report, or use of blood pressure lowering drugs [15].

## Statistical analysis

SBP and DBP were reported as mean and 95% confidence interval (CI). The prevalence of HTN and HTN unawareness was also presented as mean and 95% CI. The effect of cluster sampling was considered for standard error calculation. All estimates were standardized for Tehran population using direct standardization method. Simple and multiple logistic regression models were used to investigate relationships.

## Ethical issues

The tenets of the Declaration of Helsinki were followed in all stages of the study. The study protocol was approved by Shahid Beheshti University of Medical Sciences. Informed consent was obtained from all participants (Ethics code: IR.SBMU.RETECH.REC.1400.318).

## Results

Of 3791 invitees, 3310 participated in the study (87.3%). Blood pressure measurement and evaluation of medication and HTN history were performed for 3264 participants of whom 1896 (58.1%) were female. The mean age of the subjects was  $68.25 \pm 6.54$  years (60–97 years). Table 1 shows the mean and 95% CI of SBP and DBP by age and sex in hypertensive, non-hypertensive, and all participants as well as those who were unaware of their blood pressure status. In all subjects, SBP and DBP increased significantly with age after adjusting for sex, education level, body mass index, smoking status, and income ( $p < 0.001$ ). Moreover, blood pressure was significantly higher in women ( $p < 0.001$ ) compared to men after adjusting for age, education level, body mass index, and income in all participants, hypertensive subjects, and those who were unaware of their HTN.

Table 2 presents prevalence of HTN in all and hypertension unaware subjects according to age and sex. The prevalence of HTN was 81.08% (95% CI: 79.57–82.59) in all participants, was significantly higher in women than in men ( $p < 0.001$ ), and increased significantly with age from 75.47% (95% CI: 72.65–78.29) in the age group 60–64 years to 88.4% (95% CI: 83.71–93.08) in individuals  $\geq 80$  years in both sexes ( $p < 0.001$ ). After 64 years of age, the prevalence of HTN increased with a steeper slope in women ( $p < 0.001$ ) (Table 2). According to Tables 2 and 32.84% (95% CI: 30.82–34.86) of the participants were unaware of their HTN; this percentage was higher in males compared to women but it changes with age were not linear. The overall prevalence of HTN according to the former criteria (SBP  $> 140$  mmHg or a DBP  $> 90$  mmHg) was 67.83% (95% CI: 66.03–96.63). Table 3 presents the prevalence of HTN in all participants by age and sex according to the former HTN criteria.

Table 4 presents the prevalence of HTN according to education level, body mass index, and economic status. The highest and lowest prevalence of HTN was observed in illiterate subjects and those with a university education, respectively ( $p < 0.001$ ). Moreover, the prevalence of HTN increased with an increase in body mass index from 59.39% (95% CI: 37.24–81.53) in underweight participants to 86.8% (95% CI: 84.86–88.75) in obese ones. According to Table 4, the prevalence of HTN unawareness was significantly higher in illiterates compared to other education groups. Moreover, in terms of body mass index, the highest and lowest prevalence of HTN unawareness was related to underweight and obese individuals, respectively.

Simple and multiple logistic regression models were used to investigate the association of HTN prevalence with demographic and anthropometric variables (Table 5). According to the results of the multiple model, an older age, lower education level, overweight and obesity, neck circumference, and diabetes were significantly associated with the prevalence of HTN. Moreover, according to the results of multiple regression analysis, male sex (OR = 0.57; 95% CI: 0.48–0.67,  $p < 0.001$ ), higher education level (OR = 0.66; 95% CI: 0.47–0.93,  $p = 0.019$ ), and diabetes (OR = 0.50; 95% CI: 0.42–0.60,  $p < 0.001$ ) were significantly related to unawareness of HTN.

## Discussion

HTN is the most important modifiable factor in geriatric disabilities. Therefore, considering population aging in Iran, its prevalence in the elderly population would have a great impact on the burden imposed on the health system. On the other hand, since the AHA changed the definition of HTN in

**Table 1** The mean and 95% CI of Systolic and Systolic blood pressure in all subjects, non-hypertensive, hypertensive, and those that were unaware of their hypertensive status according to age and sex

		Systolic	Systolic
		Mean(95%CI)	Mean(95%CI)
All Subjects	Total	138.9(138.0-139.8)	79.0(78.5–79.5)
	male	139.4(138.1-140.6)	80.9(80.2–81.6)
	female	138.4(137.4-139.5)	77.2(76.4–77.9)
	60–64	134.6(133.4-135.9)	79.9(79.2–80.6)
	65–69	138.0(136.5-139.5)	79.5(78.7–80.3)
	70–74	140.9(139.3-142.6)	78.8(77.9–79.7)
	75–79	140.8(138.3-143.2)	77.3(75.8–78.7)
	>=80	147.4(144.7-150.1)	77.6(75.8–79.4)
	Non-hypertensive	Total	117.4(116.7-118.2)
male		117.4(116.4-118.4)	70.9(70.2–71.6)
female		117.5(116.4-118.5)	68.8(67.5–70.2)
60–64		116.8(115.5-118.1)	71.4(70.7–72.1)
65–69		116.7(115.3-118.1)	69.9(68.9–71.0)
70–74		118.4(116.4-120.3)	69.0(67.6–70.3)
75–79		117.9(115.4-120.5)	68.6(66.8–70.3)
>=80		121.0(117.7-124.4)	65.7(60.2–71.2)
Hypertensive		Total	143.9(143.0-144.8)
	male	145.1(143.9-146.4)	83.5(82.8–84.2)
	female	142.7(141.6-143.9)	78.9(78.1–79.6)
	60–64	140.4(139.1-141.8)	82.7(81.9–83.5)
	65–69	143.0(141.5-144.5)	81.7(80.8–82.6)
	70–74	145.2(143.3-147.1)	80.6(79.6–81.6)
	75–79	144.9(142.4-147.4)	78.8(77.2–80.5)
	>=80	150.8(148.1-153.5)	79.2(77.1–81.2)
	Unaware of their hypertensive	Total	143.5(142.5-144.6)
male		144.4(143.1-145.7)	85.2(84.3–86.0)
female		142.3(140.8-143.8)	81.1(80.2–82.1)
60–64		140.5(138.9-142.0)	84.5(83.5–85.5)
65–69		142.6(141.0-144.2)	84.2(82.9–85.4)
70–74		144.8(142.6-147.0)	82.5(81.0–84.0)
75–79		146.2(143.1-149.2)	81.7(79.3–84.2)
>=80		150.4(146.3-154.5)	82.1(79.4–84.8)

2017, the present study is the first study of the HTN prevalence in a large sample of Iranian elderly population using the new definition.

The prevalence of HTN based on the former criteria was 67.83% in the present study, which was similar to a global average prevalence of 65.6% in the elderly population in previous studies [4]. The prevalence of HTN in the present study was similar to a study conducted by Ghaffari et al., in 2016 [16]. However, the present study showed a significant difference from other studies performed by Cheraghi et al., [17] and Jamshidi et al., [18] in the same year; these discrepancies could be due to differences in the population demographics like mean age, HTN definition, lifestyle, and living place. Table 6 presents a summary of previous studies.

According to Table 6, the prevalence of HTN varies between 16.9% and 73.8% according to the age distribution and HTN definition. The prevalence of HTN was higher in the present study compared to previous studies, which

seems to be mainly due to the definition of HTN and age range of the study participants.

With the introduction of the new HTN definition in 2017, the prevalence of HTN in different countries underwent drastic changes; this change was much greater in the general population and especially in the youth. According to the new guidelines, the prevalence of HTN has increased by 13 to 25% in the United States [53], China [54], Nepal [55], India [56], and South Korea [57], and this increase was more pronounced in countries with younger populations such as Nepal and India compared to South Korea and the United States. This increase was less in elderly populations so that using the revised guideline increased the prevalence of HTN by 12% in the USA, 11.9% in China, and 13.25% in Iran (present study) [58, 59]. Moreover, the increased prevalence due to guideline revision was more in men in the present study, which is in line with the results of studies investigating the effect of the guideline revision on the prevalence of HTN [50, 51]. Furthermore, many people that are

**Table 2** The prevalence of hypertension in all and hypertension unaware subjects according to age and sex

All subjects			
	Total	Male	Female
	%(95%CI)	%(95%CI)	%(95%CI)
Total	81.08(79.57–82.59)	79.15(76.60–81.69)	82.96(81.02–84.91)
Age 60–64	75.47(72.65–78.29)	75.20(70.13–80.26)	75.73(72.85–78.62)
65–69	81.11(78.50–83.72)	78.60(74.35–82.86)	83.52(80.36–86.68)
70–74	84.18(81.36–86.99)	81.92(77.64–86.20)	86.35(82.84–89.87)
75–79	84.74(80.86–88.62)	80.59(74.73–86.45)	88.83(83.46–94.21)
>=80	88.40(83.71–93.08)	85.44(79.89–91.00)	91.39(82.51–100.27)
Unawareness hypertension			
	Total	Male	Female
	%(95%CI)	%(95%CI)	%(95%CI)
Total	32.84(30.82–34.86)	38.89(35.98–41.81)	26.95(24.61–29.29)
Age 60–64	36.84(33.33–40.34)	42.93(37.39–48.47)	30.95(27.37–34.53)
65–69	28.95(25.81–32.10)	32.03(26.87–37.20)	26.00(22.36–29.64)
70–74	31.96(28.07–35.85)	39.29(33.52–45.07)	24.89(20.42–29.36)
75–79	30.53(24.76–36.30)	41.63(34.39–48.87)	19.58(12.05–27.10)
>=80	32.89(26.46–39.32)	37.94(28.72–47.16)	27.76(17.45–38.07)

**Table 3** The prevalence of hypertension according former criteria (SBP> 140 mmHg or a DBP> 90 mmHg) of hypertension by age and gender

	Total	Male	Female
	%(95%CI)	%(95%CI)	%(95%CI)
Total	67.83(66.03–69.63)	64.43(61.61–67.26)	71.13(68.73–73.53)
Age 60–64	58.49(55.42–61.56)	56.06(50.85–61.27)	60.84(57.28–64.4)
65–69	68.96(65.84–72.09)	65.97(60.72–71.22)	71.84(68.16–75.51)
70–74	71.07(67.8–74.34)	66.54(61.78–71.29)	75.45(70.93–79.96)
75–79	74.05(69.41–78.69)	68.74(61.94–75.53)	79.3(72.37–86.22)
>=80	80.39(75.03–85.75)	76.68(70.03–83.34)	84.15(74.26–94.04)

hypertensive according to the new guideline are unaware of their disease and therefore do not receive proper treatment.

HTN awareness has decreased according to the former guideline and compared to a study by Ghaffari et al. in 2016 [16]. Since this disease may be completely asymptomatic before complications occur, patients may visit a physician and become aware of their disease when complications have already developed.

**Table 4** The prevalence of hypertension according to education level, body mass index, and economic status

		HTN prevalence	Unawareness hypertension
		%(95%CI)	%(95%CI)
Education level	Illiterate	89.41(85.32–93.49)	35.67(30.53–40.80)
	Primary school	81.39(78.82–83.97)	31.98(28.81–35.14)
	Secondary School	82.22(78.74–85.70)	31.37(27.35–35.39)
	High school	76.72(73.68–79.77)	34.13(30.45–37.80)
Economic status	College	77.14(72.03–82.24)	31.19(25.59–36.79)
	Lowest	85.63(83.41–87.85)	31.65(28.33–34.97)
	Low	78.17(73.92–82.42)	38.44(33.82–43.05)
	High	79.61(76.57–82.65)	31.75(27.93–35.57)
Body mass index	Highest	77.47(74.37–80.57)	32.26(28.58–35.94)
	Underweight	59.39(37.24–81.53)	47.10(22.23–71.98)
	Normal	73.33(69.50–77.16)	39.05(34.60–43.50)
	Overweight	81.31(79.07–83.54)	33.16(30.30–36.02)
	Obese	86.80(84.86–88.75)	27.72(25.13–30.31)

The present study found a direct relationship between weight and HTN, which was already reported in different age groups [52–56]. Obesity is associated with many diseases and comorbidities and can therefore cause several problems for these people and exacerbate cardiovascular complications. Moreover, there is a substantial difference in HTN awareness between normal weight and obese subjects, which may be due to a higher frequency of comorbidities in obese people resulting in more frequent visits to physicians and consequently becoming aware of HTN [57]. This reason can also apply to diabetics and their higher awareness of their HTN status [58]. HTN awareness also had a direct association with the education level, which is consistent with previous studies [11, 59, 60]. HTN awareness also had a direct relationship with sex and was markedly higher in Iranian elderly females. This sex-related difference in HTN awareness has also been reported from other countries, which may be due to postmenopausal hormonal changes and an increase in HTN-related diseases in women [61, 62].

Optimal blood pressure control is key factor in controlling its complications. In the present study, only 49.4% of the elderly subjects that used blood pressure lowering drugs had controlled HTN. Although this rate was similar to reports from other countries like Brazil [63], the comorbidities associated with uncontrolled HTN can impose heavy burdens on the health system. Evidence suggests that self-care, which is directly related to education level and economic status, has a very important role in HTN control besides drug use [64]. The self-care quality is lower in patients with uncontrolled HTN compared to patients with controlled HTN [65]. On the other hand, although patient education or regular home blood pressure monitoring are useful ways to improve self-care, the patients become frustrated over time and do not adhere to these solutions [66].



**Table 5** The association of hypertension with some variables according simple and multiple logistic regression

Independent variables		simple and		multiple	
		OR(95%CI)	p-value	OR(95%CI)	p-value
Age	Year	1.04(1.02–1.06)	<0.001	1.04(1.02–1.06)	<0.001
Sex	Female/male	1.28(1.03–1.59)	0.024		
Education level	Illiterate	1			
	Primary school	0.52(0.33–0.83)	0.006	0.58(0.36–0.93)	0.025
	Guidance School	0.55(0.33–0.9)	0.018	0.62(0.37–1.02)	0.058
	High school	0.39(0.25–0.62)	<0.001	0.52(0.33–0.84)	0.007
	College	0.40(0.24–0.68)	0.001	0.55(0.32–0.93)	0.027
BMI	Underweight	1		1	
	Normal	1.88(0.74–4.8)	0.185	1.78(0.74–4.30)	0.198
	Overweight	2.97(1.17–7.55)	0.022	2.72(1.12–6.62)	0.028
	Obese	4.5(1.78–11.38)	0.002	4.00(1.65–9.68)	0.002
Smoking	Yes/no	0.63(0.48–0.83)	0.001	0.69(0.53–0.90)	0.007
	Anthropometry indices	Waist Circumference	1.04(1.03–1.05)	<0.001	
Wrist Circumference		1.09(1.02–1.18)	0.014		
Hip Circumference		1.03(1.02–1.04)	<0.001	0.94(0.86–1.03)	0.217
Neck circumference		1.06(1.03–1.09)	<0.001	1.07(1.03–1.11)	0.002
Diabetes	Yes/no	2.00(1.57–2.55)	<0.001	1.80(1.4–2.31)	<0.001
Economic status	Lowest	1		1	
	Low	0.60(0.45–0.8)	<0.001	0.73(0.54–0.99)	0.043
	High	0.66(0.51–0.84)	<0.001	0.81(0.63–1.05)	0.106
	Highest	0.58(0.44–0.75)	<0.001	0.84(0.64–1.11)	0.215

Self-care improvement becomes even more difficult in the elderly considering their other comorbidities, which may a reason for the high prevalence of HTN in elderly people that use drugs.

Anthropometric indices have long been used as risk factors for HTN in screenings, and their relationship with HTN has been proven. We also compared these indicators between people with and without HTN. In the present study, we also introduced neck circumference as a different anthropometric factor in people with HTN. In recent years, some studies have shown a direct relationship between HTN and neck circumference [67]. Furthermore, some evidence has shown that neck circumference can be a precise tool to check the risk of cardiovascular complications in people with HTN [68] and even the general population of adults and the elderly [69]. Some papers have mentioned neck circumference as a better indicator than waist circumference to determine the risk of cardiovascular diseases [70, 71]. Overall, neck circumference can be used as a simple screening tool for HTN in the elderly, especially in areas with less facilities.

The strong points of this study were a large sample from a metropolis (Tehran city) and using the revised guideline for HTN diagnosis. A limitation of this study was that the effect of a limited number of variables on HTN was investigated. Another limitation is the lack of reporting of pre-HTN cases, which should be noted. However, due to the use of the new guideline and lower diagnostic threshold, a significant part of pre-HTN cases were probably considered. Similar studies with large sample sizes should be conducted to evaluate HTN prevalence in the middle-aged population using the revised criteria.

The prevalence of HTN was high in the Iranian elderly population. Considering the high prevalence of HTN unawareness and poor HTN control, it can be associated with high mortality and morbidity rates. It is very important to find solutions to improve HTN control and awareness considering population ageing in Iran; otherwise, HTN inevitable complications can result in a significant health burden in this population.

**Table 6** The summary of other studies according to prevalence of hypertension

First Author	Country	Year	Age	Criteria(Systol/diastol)	Prevalence (%)
Ataklte [19]	Sub-Saharan Africa	2015	60<	140/90	44.00
Awoke [20]	Ethiopia	2012	55<	140/90	44.09
Guo [21]	United States	2010	60<	140/90	66.70
Gupta [22]	Haryana	2020	60<	140/90	50.30
Hasan [23]	Bangladesh	2021	60<	140/100	41.80
Kaze [24]	Africa	2017	55<	140/90	55.20
Picon [14]	Brazil	2013	60<	140/90	68.00
Supiyev [25]	Kazakhstan	2015	50–75	140/90	70.00
Vallée [26]	France	2015	65–74	140/90	68.80
Wang [27]	China	2014	60<	140/90	58.20
Muli [28]	Germany	2020	65–94	140/90	73.80
Sheng [29]	China	2013	60<	140/90	59.40
Picon [14]	Brazil	2013	60<	140/90	68.00
You [30]	China	2018	65–74	130/80	66.18
Kang [31]	Korea	2019	60–69	140/90	49.70
Islam [32]	Bangladesh	2020	60<	140/90	16.90
Kozłowska [33]	Poland	2019	65<	140/90	74.00
Radhakrishnan [34]	India	2013	60<	140/100	59.00
Pilleron [35]	Africa	2017	65<	140/90	61.10
Son [36]	Vietnam	2012	65–75	140/90	56.20
Fan [37]	China	2014	65–74	140/90	66.30
Supiyev [25]	Kazakhstan	2015	50–75	140/90	70.00
Abebe [38]	Ethiopia	2015	65<	140/90	54.20
Xu [39]	China	2016	60–74	140/90	44.80
Senanayake [40]	Sri Lanka	2019	70<	140/90	61.80
Polonia [41]	Portugal	2014	64<	140/90	74.90
Dereje [42]	Hosanna	2020	65<	140/90	62.90
Zhang [43]	China	2017	60–69	140/90	68.50
Godet-Mardirossian [44]	France	2012	65–74	140/90	67.30
Murphy [45]	Ireland	2015	65–74	140/90	73.90
Banegas [46]	Spain	2015	60–69	140/90	62.20
O'Flynn [47]	Ireland	2016	60<	140/90	60.00
Zhang [48]	China	2013	60–69	140/90	41.50
Ben [49]	Tunisian	2012	65–74	140/90	59.30

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**Data Availability** The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

## Declarations

**Competing interests** We declare no competing interests.

**Ethics approval and consent to participate** The tenets of the Declaration of Helsinki were considered in all stages of the study. The protocol of the study was approved by Shahid Beheshti University of Medical Sciences. Informed consent was obtained from all participants (Ethics code: IR.SBMU.RETECH.REC.1400.318).

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