Original Article

Changes in hypertension prevalence, awareness, treatment, and control rates in Turkey from 2003 to 2012

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Objectives: The study aimed to assess the current epidemiology of hypertension, including its prevalence, the awareness of the condition and its treatment and control, in Turkey to evaluate changes in these factors over the last 10 years by comparing the results with the prevalence, awareness, treatment, and control of hypertension in Turkey (PatenT) study data (2003), as well as to assess parameters affecting awareness and the control of hypertension.

Methods: The PatenT 2 study was conducted on a representative sample of the Turkish adult population ($n = 5437$) in 2012. Specifically trained staff performed the data collection. Hypertension was defined as mean SBP or DBP at least 140/90 mmHg, previously diagnosed disease or the use of antihypertensive medication. Awareness and treatment were assessed by self-reporting, and control was defined as SBP/DBP less than 140/90 mmHg.

Results: Although the prevalence of hypertension in the PatenT and PatenT 2 surveys was stable at approximately 30%, hypertension awareness, treatment, and control rates have improved in Turkey. Overall, 54.7% of hypertensive patients were aware of their diagnosis in 2012 compared with 40.7% in 2003. The hypertension treatment rate increased from 31.1% in 2003 to 47.4% in 2012, and the control rate in hypertensives increased from 8.1% in 2003 to 28.7% in 2012. The rate of hypertension control in treated patients improved between 2003 (20.7%) and 2012 (53.9%). Awareness of hypertension was positively associated with older age, being a woman, residing in an urban area, a history of parental hypertension, being a nonsmoker, admittance by a physician, presence of diabetes mellitus, and being obese or overweight; it was inversely associated with a higher amount of daily bread consumption. Factors associated with better control of hypertension were younger age, female sex, residing in an urban area, and higher education level in Turkey.

Conclusion: Although some progress has been made in recognizing hypertension from 2003 to 2012, there is still a large population of untreated or inadequately treated hypertensives in Turkey. Strengthening of population-based efforts to improve the prevention, early detection, and treatment of hypertension is needed.

Keywords: awareness, control, hypertension, prevalence, treatment, Turkey

Abbreviations: ACE, angiotensin-converting enzyme; ARBs, angiotensin receptor blockers; BP, blood pressure; CAA, central-acting agents; CCBs, calcium channel blockers; PatenT, prevalence, awareness, treatment, and control of hypertension in Turkey

INTRODUCTION

T he 2010 WHO report on noncommunicable diseases asserts that while over 80% of cardiovascular deaths occur in low and middle-income countries [1], hypertension and its cardiovascular complications have become a major public health concern in many developing countries following an epidemiological transition from communicable acute diseases to noncommunicable chronic diseases over the past three decades [2,3]. Turkey is a developing Eurasian country located in the Eastern Mediterranean region. According to the results of the Turkish Address-Based Population Registration System, Turkey has a population of approximately 76 million people, with a characteristic dominance of young age (50% of the population is under the age of 30 years) [4]. Despite having a relatively young population, cardiovascular diseases are

among the most prevalent causes of death in Turkey, as in the rest of the world [5,6]. Although the prevalence of cardiovascular risk factors has been studied since 1995 in several large population-based surveys and regional studies in Turkey, most of these have been based on nationally unrepresentative populations [7–16]. The Turkish Society of Hypertension and Renal Diseases conducted a 2003 population-based cross-sectional epidemiological survey on a representative sample of the Turkish adult population aimed at determining the distribution of blood pressure (BP) and the prevalence, awareness, treatment, and control of hypertension in Turkey (PatenT Study, $n = 4910$). In this study, the overall age and sex-adjusted prevalence of hypertension was 31.8% [17]. In Turkey, dramatic structural changes have been observed in the healthcare system over the past decade. Since 2003, the Ministry of Health, aiming to improve primary and secondary levels of the healthcare system, has implemented the 'Health Transformation Program'. A family practitioner program and health insurance coverage were introduced nationwide. Access to healthcare centers increased in all regions of the country [18,19]. Based on the accumulated data from previous epidemiologic studies, the possible effects of public health projects, and the dramatic transformation of the healthcare system in Turkey over the past decade, it is crucial to understand the trends of these changes and their effects on the rates of hypertension during this specific period.

The study aimed to assess the current epidemiology of hypertension, including its prevalence, awareness of the condition, treatment, and control of hypertension in Turkey (the PatenT 2 study, 2012), to evaluate changes in these factors over the last 10 years by comparing the results with those from the first PatenT study data (2003), as well as to assess parameters affecting awareness and the control of hypertension.

MATERIALS AND METHODS

Research population and sampling

The PatenT 2 study was designed, directed, and fully supported by the Turkish Society of Hypertension and Renal Diseases. The Ankara University School of Medicine Ethical Committee for Clinical Studies approved the study protocol, and individuals provided written informed consent before enrollment.

The designs of both the PatenT [17] and PatenT 2 studies were similar. Briefly, sample selection was similar for both PatenT studies and was based on a multistratified proportional sampling procedure to select a nationally representative sample of the adult population over 18 years of age. For each study, data collection and BP measurements were conducted in households of the participants by trained research staff (general practitioners, family physicians, health officers, laboratory technicians, biologists, nurses, and emergency medical technicians). During the home visits of each survey, a standard face-to-face interview questionnaire was administered to collect data on social demographics and behavioral characteristics. Additionally, a minimum of three consecutive BP measurements were taken at time intervals of at least 2 min using calibrated sphygmomanometers (mercury in PatenT and automated oscillometric in PatenT

2) with appropriately sized cuffs, after the participants rested for 5 min in a sitting position with support under their back and arms. The same descriptions were used in both studies to define hypertension, and awareness, treatment, and control of hypertension [17].

The PatenT 2 study, a population-based, cross-sectional national survey, was conducted on a representative sample of the Turkish adult population ($n = 5437$, age $\geq$18 years) in 2012. For randomized population sampling, a multistage stratified proportional sampling method was used with proportionate representation of the Turkish adult population. The stratification criteria used for sample selection included the territorial regions of Turkey (26 cities from 12 EUROSTAT NUTS 2 regions and seven provinces of Turkey); age groups (18–29 years, 30–39 years, 40–49 years, 50–59 years, 60–69 years, 70–79 years, and $\geq$80 years); locality type (rural/urban); and sex-specific groups. Strata were selected via a proportional sampling method according to postal code listings in urban areas and town and village listings 80 km away from city centers in rural areas. Each stratum had a size proportional to the selected city or village population. Age and sex sampling for each stratum were performed via a quota-sampling method to determine the required sample size according to the estimated prevalence of hypertension in each age group.

The participation rate for the PatenT 2 study was 73.5% (82.3% in rural areas, 70.5% in urban areas), which represents the proportion of household owners agreeing to participate in the survey. The face-to-face interview questionnaire was administered to everyone living in the participating households except for pregnant women, terminally ill patients, those with cognitive dysfunction, those with amputated limbs, and visitors coming from outside the particular area of study. A total of 5437 individuals [2704 men (49.7%) and 2733 women (50.3%), 74.3% urban and 25.7% rural residents] were randomly selected from 26 cities, and all completed the face-to-face interview questionnaire and BP and anthropometric measurements over 92 days (from February 2012 to May 2012).

Data collection

In total, 30 health professionals (health officers, laboratory technicians, biologists, nurses, and emergency medical technicians) were involved in the field study. A survey team comprised two to three health professionals. All of the health professionals attended a training course to familiarize themselves with the survey and measurement techniques before the survey was administered. During this 3-day course, they were specifically informed of the purposes of the study, study protocol, technique for the administration of the face-to-face interview questionnaire, and method for filling out the forms. The health professionals were trained in standardized BP measurement and anthropometric measurement protocols. They were also given detailed instructions on the technique for electronically transferring the collected data to the study center through the internet using a newly developed program for the iPad 2 (Apple, Cupertino, California, USA).

Each team was given the same model of an automatic oscillometric BP measuring device (Omron M3 Intellisense, HEM-7051-E; Tokyo, Japan), two cuffs (22–32 m and

33–42 cm), a weighing machine (scale), and a measuring tape. In addition, each team had an iPad 2 that was used to transfer the collected data electronically via the internet to the main computer at the study center. The iPad 2 was also used to track the coordinates of the research staff and to transmit the results of the BP measurements and pictures of pill bottles/boxes. All of the collected data, forms, coordinates, and photographs were transmitted to the study center using the GSM 3G wireless network. In the study center, two supervisors were responsible for the quality control of the collected data. The specific coordinates were also corroborated to confirm participation.

During the home visits, the research staff administered a standard face-to-face interview questionnaire to collect data on social demographics and behavior characteristics, including age, sex, place of residence, educational level, drinking status, smoking status, physical activity status, family history of hypertension, history of diabetes mellitus, as well as the diagnosis, awareness, and treatment of hypertension. Individuals were asked to show all their prescription medications to the health professionals. Pill bottles/boxes were reviewed and photographed, and medication names and dosage information were recorded. Antihypertensive medication classes included angiotensin-converting enzyme (ACE) inhibitors, α-blockers, aldosterone receptor blockers, angiotensin receptor blockers (ARBs), β-blockers, calcium channel blockers (CCBs), central-acting agents (CAAs), and diuretics (Ds). Single-pill combinations were classified into their component classes. The measurements conducted included height, weight, waist and arm circumferences, and BP.

Measurements and definitions

SBP, DBP, heart rate, weight, height, and waist and arm circumferences were measured according to standard protocols. BMI was also calculated. Obesity and overweight were defined as BMIs of at least 30 and 25–29.9 kg/m², respectively. Abdominal obesity was defined as a waist circumference of more than 102 and 88 cm in men and women, respectively [20].

Individuals with a positive smoking status were considered to be current smokers of at least one cigarette/day in the last month. Excessive alcohol intake (regular) was categorized to be more than 30 g of alcohol per day [21]. Regular physical activity was defined as daily physical activity of at least one 30-min walk. The amount of bread consumption was categorized as less than 1 bread/day, 1–2 breads/day, 3–5 breads/day and more than 5 breads/day. As the research staff filled out the questionnaire, BP measurements were completed according to the recommendations at the time the study was performed [22]. None of the participants had alcohol or tea/coffee intake or had smoked at least 30 min prior to the measurement. Initially, each participant's BP was measured after 5 min of rest in a sitting position with his/her back supported under both arms using appropriately sized cuffs. If the reading was higher in one arm, that arm was used for the following measurements. At least three consecutive BP measurements were obtained, with a time interval of at least 2 min between each measurement according to the recommendations of the European Society of Hypertension. If the difference between the last two measurements was less than 5 mmHg, the arithmetic mean of the second and third BP measurements was noted as the visit BP. A fourth or multiple additional measurements were obtained when there was a difference of at least 5 mmHg between the last two measurements. When the difference between the last two measurements was less than 5 mmHg, the arithmetic mean of the last two BP measurements was recorded as the visit BP.

Hypertension was defined as an average SBP of at least 140 mmHg, average DBP of at least 90 mmHg, previously diagnosed disease, and/or the use of antihypertensive medication, regardless of the BP readings. An awareness of hypertension was described as any previous diagnosis of hypertension by a health professional among the participants identified as having hypertension. Treatment of hypertension was defined as the use of antihypertensive medication at the time of the interview. Control of hypertension was defined as SBP less than 140 mmHg and DBP less than 90 mmHg. The control rates among patients receiving antihypertensive medication were also recorded.

Statistical analysis

Stata version 11 (StataCorp, College Station, Texas, USA) and predictive analytical software (PASW statistics 18, 2009; Quarry Bay, Hong Kong, China) were used for the analysis. A type-I error level of less than 5% was used to infer statistical significance, and that of less than 10% was used to indicate covariate should be kept in multivariate models. The variables were investigated using visual (histograms, probability plots) and analytical (Kolmogorov–Simirnov/Shapiro–Wilk tests) methods to determine whether they were normally distributed. The univariate analyses to identify variables associated with sex differences, presence of hypertension, hypertension awareness, and hypertension control, as well as the analyses repeated within sex strata, used the χ^2-square, Fisher's exact, Student's *t* and Mann–Whitney U tests, where appropriate. Interactions between pairs of independent variables were assessed using the Breslow–Day test for homogeneity of the odds ratio and by visually analyzing the differences in risk ratios among different strata. For the multivariate analysis, the factors identified as potentially important by the univariate analyses were further entered into logistic regression analysis using backward selection to determine independent predictors of awareness of hypertension and control of hypertension, separately. When a significant interaction was retained during selection, all related main effects were also kept in the model. Changes in Nagelkerke r^2 values were used to evaluate changes in model fit when different forms of the independent variables were used. Multicollinearity was assessed by analyzing correlations, associations between independent variables, the correlation matrix of the parameter estimates from the model, and the variation inflation factors. Hosmer–Lemeshow and Pearson goodness of fit statistics were used to evaluate model fit.

RESULTS

The results of the first PatenT study have been published elsewhere [17] and will be further discussed only in the

context of comparison with the recent PatenT 2 study, the results of which are presented below.

Characteristics of the PatenT 2 study participants

The main demographic and clinical characteristics of the study population are shown in Supplementary Digital Table 1, http://links.lww.com/HJH/A598. A total of 5437 participants [2733 women (50.3%) and 2704 men (49.7%)] were included in the PatenT 2 study (74.3% urban and 25.7% rural residents). The mean age was 42.51 ± 15.87 years (range, 18–92 years). Significant differences between women and men were found with respect to sociodemographic parameters and medical history (for the details, see Supplementay Digital Table 1, http://links.lww.com/HJH/A598).

A total of 1650 PatenT 2 study participants (30.3%) [882 women (32.3%) and 768 men (28.4%)] were hypertensive. The main demographic and clinical characteristics of the hypertensive population are shown in Table 1. Briefly, hypertensive women were older and more obese, with lower levels of physical activity compared with hypertensive men, and the prevalences of a history of diabetes mellitus and parental hypertension among hypertensive women were higher than those among hypertensive men ($P < 0.001$). Overall, hypertensive men were more educated than women, were more frequently smokers, and exhibited a greater degree of alcohol intake ($P < 0.001$). The rates of consumption of a salt-restricted diet (self-reported) and regular physical activity were extremely low among hypertensive participants in Turkey. The mean SBP was higher among hypertensive

men (148.6 ± 18.0 mmHg) compared with hypertensive women (142.5 ± 21.2 mmHg). The mean DBP was also higher among the men (82.3 ± 12.0 mmHg) compared with the women (78.93 ± 12.38 mmHg) ($P < 0.001$). Among the entire hypertensive group, 205 of the 1650 participants (12.5%) had never undergone measurement of their BP, and the nonmeasurement rate was higher among hypertensive men (15.4%) compared with women (9.9%) (Table 1).

Specific distribution of blood pressure levels by age and sex and the prevalence of hypertension among PatenT 2 study participants

The distributions of SBP and DBP according to age and sex are shown in Fig. 1a and b. The mean SBP was 124.9 ± 19.2 mmHg among women, it increased with age in both sexes, and it was higher among men (129.5 ± 17.4 mmHg) than women in all age groups except the 70 to 79-year-old and at least 80-year-old groups (Fig. 1a). The mean DBP was again higher among men in all age groups except the 70 to 79-year-old group (Fig. 1b).

The overall age and sex-adjusted prevalence of hypertension in Turkey was 30.3% in 2012 and was higher among women compared with men (32.3 vs. 28.4%, $P = 0.002$). The prevalence of hypertension increased with age, and in every age group from 40 to more than 80 years, women had a higher age-specific rate of hypertension than men (Fig. 2). There was no difference in the prevalence of hypertension among rural and urban inhabitants (32.5 vs. 29.6%, $P > 0.05$) (data not shown).

TABLE 1. Demographic and clinical characteristics of the PatenT 2 study participants with HT (−) and HT (+)

Parameters	Women HT (−), $n = 1851$	Women HT (+), $n = 882$	Men HT (−), $n = 1936$	Men HT (+), $n = 768$	P^a	P^b
Age (years) (mean ± SD)	36.23 ± 12.42	56.89 ± 13.52	37.26 ± 13.43	54.38 ± 14.26	<0.001	0.003
Living area					0.038	0.492
Urban, n (%)	1413 (76.3)	645 (73.1)	1431 (73.9)	550 (71.6)		
Rural, n (%)	438 (23.7)	237 (26.7)	505 (26.1)	218 (28.4)		
Level of education					<0.001	<0.001
Illiterate, n (%)	73 (3.9)	119 (13.5)	9 (0.5)	8 (1.0)		
Literate, n (%)	154 (8.3)	156 (17.7)	25 (1.3)	47 (6.1)		
Primary school, n (%)	821 (44.4)	439 (49.8)	754 (38.9)	384 (50.0)		
Secondary school, n (%)	206 (11.1)	51 (5.8)	367 (19.0)	120 (15.6)		
High school, n (%)	368 (19.9)	72 (8.2)	531 (27.4)	143 (18.6)		
University, n (%)	219 (11.8)	44 (5.0)	245 (12.7)	64 (8.3)		
Unknown, n (%)	10 (0.5)	1 (0.1)	5 (0.3)	2 (0.3)		
History of parental HT, n (%) (self-reported)	939 (50.7)	493 (55.9)	833 (43.0)	354 (46.1)	0.002	<0.001
History of DM, n (%) (self-reported)	93 (5.1)	197 (22.6)	84 (4.4)	119 (15.7)	<0.001	<0.001
Current smoker, n (%) (self-reported)	450 (24.3)	97 (11.0)	1110 (57.3)	331 (43.1)	<0.001	<0.001
Current excessive alcohol user, n (%) (self-reported)	1 (0.1)	0 (0.0)	35 (1.8)	17 (2.2)	0.783	<0.001
Regular physical activity, n (%) (self-reported)	148 (8.2)	39 (4.5)	320 (16.7)	94 (12.5)	<0.001	<0.001
Salt-restricted diet, n (%) (self-reported)	36 (1.9)	27 (3.1)	17 (0.9)	12 (1.6)	0.007	0.076
BMI (kg/m^2) (mean ± SD)	26.51 ± 5.39	31.50 ± 5.96	25.97 ± 4.33	28.43 ± 4.52	<0.001	<0.001
Abdominal obesity, n (%)	806 (43.9)	695 (79.2)	400 (20.9)	331 (43.6)	<0.001	<0.001
BP nonmeasurement, n (%)	418 (22.7)	87 (9.9)	560 (29.2)	118 (15.4)	<0.001	<0.001
SBP (mmHg) (mean ± SD)	116.59 ± 10.69	142.51 ± 21.27	121.97 ± 9.58	148.66 ± 18.04	<0.001	<0.001
DBP (mmHg) (mean ± SD)	69.79 ± 8.58	78.93 ± 12.38	71.15 ± 8.52	82.30 ± 12.01	<0.001	<0.001

BP, blood pressure; DM, diabetes mellitus; HT, hypertension; PatenT, prevalence, awareness, treatment, and control of hypertension in Turkey.
[a]P, all HT (−) vs. all HT (+).
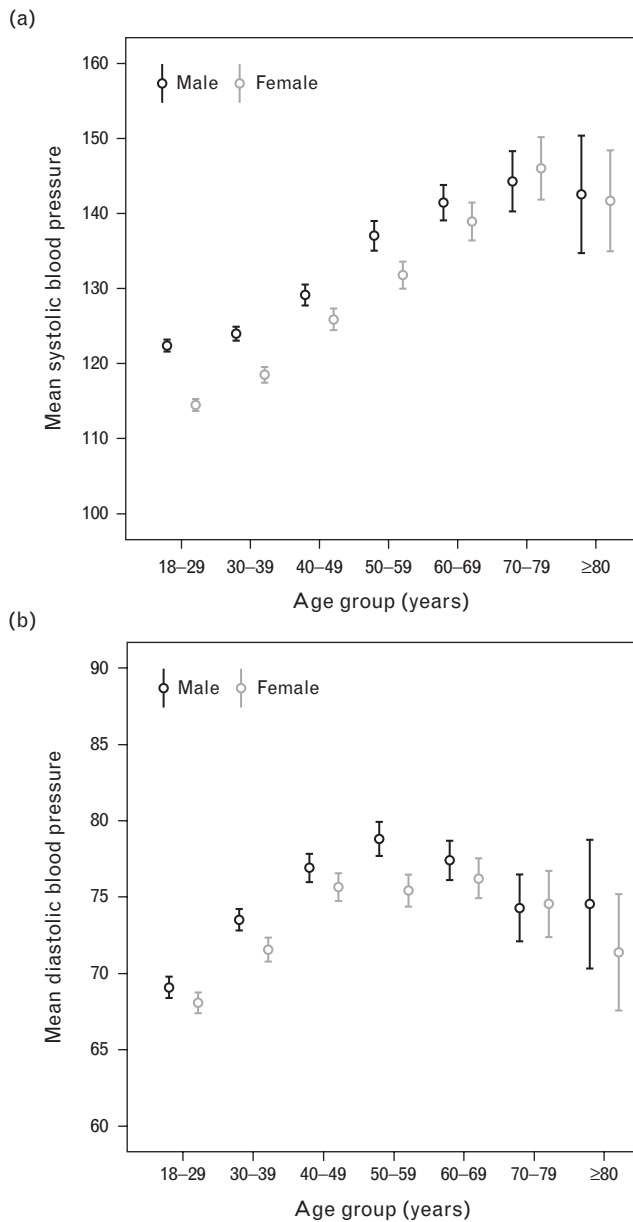[b]P, women (HT+) vs. men (HT+).

(a)

(b)

FIGURE 1 Distribution of (a) SBP and (b) DBP according to participants' age and sex in Turkey.
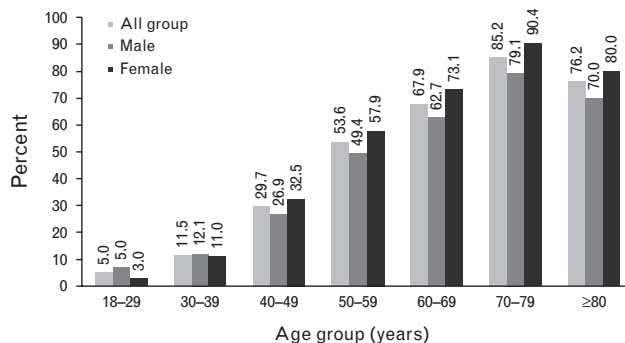

FIGURE 2 Prevalence of hypertension in Turkey according to age and sex.

Distribution of blood pressure levels among normotensive and hypertensive PatenT 2 study participants

The distribution of BP (according to the European Society of Hypertension/European Society of Cardiology 2013 categories) among normotensives and hypertensives is presented in Supplementary Figures 1 and 2, http://links. lww.com/HJH/A598, respectively. The distribution of BP among normotensives indicated that 48.7% had optimal BP (SBP < 120 mmHg and DBP < 80 mmHg), whereas 30.6 and 20.6% had normal (SBP 120–129 mmHg and/or DBP 80–84 mmHg) or high-normal (SBP 130–139 mmHg and/or DBP 85–89 mmHg) BP, respectively (see Supplementary Figure 1, http://links.lww.com/HJH/A598).

In the hypertensive group, 28.7% of participants had measurements below 140/90 mmHg (controlled hypertension); 50.9% had grade 1 hypertension (SBP 140–159 mmHg and/or DBP 90–99 mmHg), 15.3% had grade 2 hypertension (SBP 160–179 mmHg and/or DBP 100–109 mmHg), and 5.8% had grade 3 hypertension (SBP ≥ 180 mmHg and/or DBP ≥ 110 mmHg) during the study (see Supplementary Figure 2, http://links. lww. com/HJH/A598).

Age and sex-specific distributions of awareness, treatment, and control rates among hypertensives in Turkey in 2012

The age and sex-specific distributions of awareness, treatment, and control of treated hypertension in the PatenT 2 study are presented in Supplementary Figure 3A–D, http://links.lww.com/HJH/A598. Among the 1650 participants with hypertension, 902 (54.7%) (66.9% women and 40.6% men, *P* < 0.001) participants were aware of their diagnosis, whereas only 47.4% (59.6% women and 33.5% men, *P* < 0.001) were receiving pharmacological treatment, and only 28.7% (37.3% women and 18.9% men, *P* < 0.001) had their BP under control. The study participants who were aware and treated had a control rate of 53.9% (56.2% women and 49.2% men, *P* > 0.05). The awareness rate increased with increasing age, but men were less aware than women in each age group. In all age groups, the women had higher proportions of treatment and control rates of hypertension compared with the men, except at age 70+ years (see Supplementary Figure 3A–D, http://links. lww.com/HJH/A598).

Antihypertensive treatment among hypertensive participants in the PatenT 2 study

Of the 1650 hypertensive participants, only 779 (47.4%) [523 (59.6%) women and 256 (33.5%) men, *P* < 0.001] were receiving antihypertensive treatment. The majority were being treated with two or more drugs (1 drug: 37.6% vs. 2 drugs: 43.9% vs. 3 or more drugs: 18.5%). In patients receiving monotherapy, the most frequently prescribed drugs included ACE-I (12.3%), CCBs (8.9%), ARBs (8.7%), β-blockers (5.3%), and diuretics (2.3%). In the entire treated group, the two most commonly used antihypertensive drugs were ARBs and diuretics (ARBs: 45.8% vs. diuretics: 42% vs. β-blockers: 29.5% vs. ACEi: 27.4% vs. CCB: 25.4% vs. α-blocker: 0.4% vs. CAA 2/779%). The most preferred

single-pill combinations were ARBs + diuretics and ACEi + diuretics (30 and 7.9%, respectively) (data not shown).

Changes in the prevalence, awareness, treatment, and control of hypertension between 2003 and 2012 in Turkey

Although there was no significant change in the prevalence of hypertension in Turkey between 2003 and 2012 (31.8 vs. 30.3%), from a statistical perspective, hypertension awareness, treatment, and control rates have improved in the country (Table 2). Overall, 54.7% of hypertensive patients were aware of their diagnosis in 2012, compared with 40.7% in 2003. The pharmacological treatment rate increased from 31.1% in 2003 to 47.4% in 2012, and the control rate in hypertensives increased from 8.1% in 2003 to 28.7% in 2012. The rate of hypertension control in treated patients improved significantly between 2003 (20.7%) and 2012 (53.9%).

Although 32.2% of the entire group had never undergone measurement of their BP in 2003, the nonmeasurement rate was 21.9% among PatenT 2 participants ($P < 0.001$). Along with this unacceptable nonmeasurement rate, another striking finding from the PatenT 2 study was that 15.5% of the individuals had never undergone measurement of their BP, even when they had been admitted to a healthcare facility for any reason in Turkey (data not shown).

There was an increase in the use of antihypertensive drugs between 2003 and 2012. In the PatenT study (2003), 50.2% of hypertensive participants were receiving monotherapy, 39.9% were taking two drugs, and 9.9% were taking at least three drugs. In the PatenT 2 study (2012), these rates were 37.6, 43.9, and 18.5%, respectively ($P < 0.001$). Although there was a decrease in the use of monotherapy, the proportion of patients taking at least 2 classes of antihypertensive medication increased from 49.8 to 62.4% between 2003 and 2012 (data not shown).

Factors associated with the awareness and control of hypertension in Turkey

Awareness of hypertension was positively associated with older age, being a woman, residing in an urban area, a history of parental hypertension, being a nonsmoker, admittance by a physician, presence of diabetes mellitus, and being obese or overweight; awareness of hypertension was inversely associated with a higher amount of daily bread consumption in a multivariate logistic regression model that controlled for sex, age, educational level, residence, household income, the amount of daily bread consumption, physical activity, parental history of hypertension, smoking, admittance by a physician, presence of diabetes mellitus, and being obese or overweight (Table 3).

Factors associated with a better control of hypertension included younger age, female sex, residing in an urban area and a higher educational level in a model that controlled for sex, age, educational level, place of residence, level of physical activity, parental history of hypertension, admittance by a physician, presence of diabetes mellitus, and being obese or overweight (Table 4).

TABLE 2. Changes in prevalence, awareness, treatment, and control of hypertension in adults in Turkey

| | PatenT Study – 2003 n = 4910 | | | | | | PatenT 2 Study – 2012 n = 5437 | | | | | | P |
	Female, n = 2891	95% CI	Male, n = 2019	95% CI	Total, n = 4910	95% CI	Female, n = 2733	95% CI	Male, n = 2704	95% CI	Total, n = 5437	95% CI	PatenT vs. PatenT 2
Prevalence, n (%)	1151 (36.1)	34.7–37.8	653 (27.5)	25.7–29.3	1804 (31.8)[a]	30.6–33.0	882 (32.3)	30.6–34.1	768 (28.4)	26.7–30.1	1650 (30.3)	29.1–31.5	0.123
Awareness, n (%)	552 (48.0)	45.1–50.9	182 (27.9)	24.5–31.3	734 (40.7)	38.4–43.0	590 (66.9)	63.8–70.0	312 (40.6)	37.1–44.1	902 (54.7)	52.3–57.1	<0.001
Treatment, n (%)	426 (37.0)	34.2–39.8	135 (20.7)	17.6–23.8	561 (31.1)	29.0–33.2	523 (59.6)	56.4–62.9	256 (33.5)	30.2–36.9	779 (47.4)	45.0–49.8	<0.001
Control, n (%)	94 (8.2)	6.6–9.8	52 (8.0)	5.9–10.1	146 (8.1)	6.8–9.4	329 (37.3)	34.1–40.5	145 (18.9)	16.1–21.7	474 (28.7)	26.5–30.9	<0.001
Treated and controlled, n (%)	74 (17.4)	13.8–21.0	42 (31.1)	23.3–38.9	116 (20.7)	17.3–24.1	294 (56.2)	52.0–60.5	126 (49.2)	43.1–55.3	420 (53.9)	50.4–57.4	<0.001

CI, confidence interval; PatenT, prevalence, awareness, treatment, and control of hypertension in Turkey.
[a]Age and sex-adjusted prevalence.

TABLE 3. Factors associated with the awareness of hypertension in the PatenT 2 study

	P	Odds ratio	95%CI
Age (being in a higher age group, truncated at 70+)	<0.001	1.733	1.536–1.955
Sex (being a woman)	<0.001	1.914	1.438–2.548
Place of residence (living in an urban place)	0.030	1.370	1.032–1.820
Daily bread consumption (every full bread)	<0.001	0.762	0.666–0.871
Smoking (being a nonsmoker)	0.003	1.601	1.170–2.191
Presence of diabetes mellitus (yes)	<0.001	3.637	2.482–5.328
BMI (being overweight or obese)	<0.001	2.219	1.548–3.181
Parental history of hypertension (yes)	<0.001	5.729	2.548–12.880
Admittance by a physician (yes)	<0.001	8.723	3.895–19.535
Interaction of parental history of hypertension and admittance by a physician	0.008	0.114	0.023–0.565

CI, confidence interval; PatenT, prevalence, awareness, treatment, and control of hypertension in Turkey.

DISCUSSION

In a representative population of adults in Turkey, the 2012 prevalence of hypertension was 30.3% and was higher in women than in men (32.3 vs. 28.4%, $P = 0.002$). The present study also showed that the prevalence of hypertension from 2003 to 2012 in a representative population of adults in Turkey was relatively stable (31.8 vs. 30.3%, $P > 0.05$) and that among the patients with hypertension, awareness rates increased from 40.7% in 2003 to 54.7% in 2012, treatment rates increased from 31.1% in 2003 to 47.4% in 2012, and control rates increased from 8.1% in 2003 to 28.7% in 2012 ($P < 0.001$). Although the BP nonmeasurement rate was 32.2% in 2003, 21.9% of the adult population in 2012 had still never undergone measurement of their BP. We also showed that the independent predictors of awareness of hypertension included increasing age, being a woman, residing in an urban area, a history of parental hypertension, being a nonsmoker, admittance by a physician, the presence of diabetes mellitus, being obese or overweight and lower daily bread consumption. The factors associated with the better control of hypertension included younger age, female sex, residing in an urban area and higher educational level in Turkey.

We found the national prevalence of hypertension to be 30.3%, which is similar to the percentage of 31.3% previously recorded in Turkey in 2003. The prevalence of hypertension among adults varies widely but is consistently high (23–52%) among middle-income countries [23,24]. Pereira *et al.* [25] reported that there were no significant differences in the mean prevalence rates of hypertension between developed and developing countries, apart from a higher prevalence in men in developed nations. According to early regional BP studies in the 1990s and reports from national surveys in Turkey, the prevalence of hypertension in the Turkish adult population did not change substantially [10,14,16,17].

According to the results of Address-Based Population Registration System, the Turkish adult population is relatively young, and approximately 50% of the population is below the age of 30 years, whereas only 10.9% is above the age of 65 years. In the PatenT 2 study, consistent with the universal data, the prevalence of hypertension increased with age, reaching 60–70% after the age of 60 years. However, a split analysis showed that 40% of hypertensives were above 60 years of age. The remaining 55% of hypertensives in the middle age group are bearing the burden of hypertension, despite an age-related increase in prevalence. Regarding prevention, it is also important to note that 35.8% of the normotensive adult population and 14.6% of the normotensive young adult population (18–29 years) had normal or high-normal BP results. A major preventive effort should be initiated to encourage those in Turkey with a high risk of hypertension, mainly young adults, to adopt health-promoting lifestyle modifications.

In the PatenT 2 study, the prevalence of hypertension among women was higher than that among men, and this difference between men and women was present in all age groups except for those under 40 years. This finding is consistent with previous reports from Turkey [8,12,13,15,17]. Recent data from the United States and other developed countries show a nearly equal prevalence of hypertension among men and women overall, in addition to showing that hypertension is more common in men than women among those younger than 45 years of age; however, the situation is reversed in those aged 65 years and older [25,26]. With the population aging, it is expected that in Turkey, hypertension will become much more common in women than in men in the near future.

Although Turkey has a relatively young population, cardiovascular disease is the leading cause of death in the country, as in the rest of the world [27]. Among both male and female participants of the PatenT 2 study, hypertension was associated with an increased frequency of well

TABLE 4. Factors associated with the control of hypertension in the PatenT 2 study

	P	Odds ratio	95%CI
Age (being in a higher age group, truncated at 70+)	0.001	0.789	0.688–0.904
Sex (being a woman)	0.014	1.497	1.086–2.062
Place of residence (living in an urban place)	0.058	1.388	0.988–1.948
Education (being in a higher level)	0.041	1.138	1.005–1.288

CI, confidence interval; PatenT, prevalence, awareness, treatment, and control of hypertension in Turkey.

known risk factors, such as self-reported parental hypertension, smoking, diabetes, obesity, and a sedentary lifestyle. During the past 10 years, the mean BMI increased by $1.1 \, kg/m^2$ in women and by $1.57 \, kg/m^2$ in men in Turkey. The prevalence of obesity also increased from 20.5 to 28.7%. High salt consumption (18.01 g/day) is also a major health problem in Turkey [28]. Bread is an important component of meals in this country (400 g/day per person) [29], and average bread consumption results in 7.28 g/day of salt intake, which exceeds the current recommended amount for both the general population and people with hypertension. Campaigns focused on sodium restriction, along with efforts to increase public awareness of the adverse health effects of salt consumption and obesity will therefore be extremely important in preventing and controlling hypertension. To reduce the cardiovascular risk, preventive efforts should be planned to encourage lifestyle modifications, including losing weight, maintaining a healthy diet with low sodium content, conducting regular moderate physical activity, and smoking cessation in our population as in the most parts of the world.

According to the results of the PatenT 2 study, 54.7% of hypertensive patients were aware of their diagnosis in 2012, compared with 40.7% in 2003. The low rate of hypertension awareness is the most important difference between developed and developing countries. Compared with other national surveys in these countries carried out in adults since the year 2000, the rates of PatenT are similar to those found in most other developing countries in the Arab world [30,31] and Southern Europe [32–34], but they are lower than the rates in developed countries such as the United States [35], Canada [36], England [37], and Denmark [38]. For example, the awareness of hypertension was approximately 80% in the USA, 82.5% in Canada, 63.5% in England, and 69.9% in Denmark, with control rates of 64.4, 79, 52, and 73.6%, respectively. Along with the fairly stable prevalence rate of hypertension, during the last decade, awareness, treatment, and control rates of hypertension have partially improved in Turkey. Several factors may have played a role in these improvements in Turkey. First, access to the healthcare system and to drugs has improved with the radical changes in the healthcare system with the implementation of a Health Transformation Program by the Ministry of Health since 2003 [18]. Second, educational activities and campaigns implemented by national medical societies may have an impact on the educational levels of doctors, nurses, and other health professionals.

The most important finding from the PatenT studies was the alarmingly high percentage of people who had never undergone measurement of their BP. Although the BP nonmeasurement rate was 32.2% in 2003, 21.9% of the adult population in 2012 had still never undergone measurement of their BP. The nonmeasurement rate is less than 2% in developed countries [39,40]. Even in the hypertensive group, 12.5% of the participants had never undergone BP measurement, and the nonmeasurement rate among the PatenT 2 study participants was higher among hypertensive men (15.4%) compared with women (9.9%). Along with this unacceptably high nonmeasurement rate, another striking finding of the PatenT 2 study was that 15.5% of individuals had never undergone measurement of

their BP even while admitted to a healthcare facility for any reason in Turkey. As the BP of nearly one-fifth of the Turkish adult population (age >18 years) has never been measured, this very high 'nonmeasurement' rate must be decreased to raise the awareness of hypertension.

As reported in other studies [41–45], the PatenT 2 study revealed a higher rate of hypertension awareness among women compared with men, along with a better control rate of hypertension in women. In our results, women were more likely to have ever had their BP measured compared to men. As previously suggested by others, higher rates of awareness in women may be related to the privileged relationship women have with healthcare facilities because of maternal and childcare-oriented programs as well [41,46]. In both situations, higher awareness could result in higher treatment seeking behavior in women. Our finding agrees with reports from other studies, which indicated that older adults were much more aware of hypertension than younger individuals [41,47,48]. Contrary to the previous reports [25,41], we found that older age had a negative impact on the control of hypertension. As one of the main factors analyzed in this study, a family history of hypertension was positively associated with awareness of hypertension in our population. Similar to previous studies [49–51], we found that residing in an urban area, being a nonsmoker, admittance by a physician, the presence of diabetes mellitus, and being obese or overweight were positively associated with awareness of hypertension. In contrast, a higher level of daily bread consumption was negatively associated with awareness of hypertension in our study. The other factors associated with the better control of hypertension included residing in an urban area and higher educational level in Turkey. The associations between education level and hypertension awareness and control are not consistent. Some reports showed an inverse association or no association between education level and hypertension awareness or control [52,53]. In our results, although there was no association between awareness of hypertension and education level, a higher level of education had a borderline effect on better control of hypertension.

The study has both strengths and limitations. The strengths include the population-based multistage stratified sampling design, allowing a reasonable generalization of our findings to the Turkish adult population. This study also has the capacity to focus on the trends observed in the epidemiological data for hypertension in the past decade. The major limitation of the study was its cross-sectional design based on a single study visit. Other limitations of the study were the lack of data on blood tests, such as those for plasma creatinine, lipids, fasting plasma glucose and HbA1c, and lack of echocardiography results, all of which would have strengthened the characterization of the participants and reduced the reliance on potentially inaccurate self-reported data.

In conclusion, the PatenT 2 study showed that the prevalence of hypertension among Turkish adults remained stable between 2003 and 2012, but the rates of awareness, treatment, and control of hypertension improved significantly. Although some progress has been made in recognizing hypertension as a major public health

issue, our findings still highlight the need for a specific national program to improve the detection and control of hypertension in this country. This national initiative should develop well organized programs, guidelines, and policies to facilitate hypertension prevention, detection, awareness, and treatment. Factors associated with awareness and control of hypertension in our analyses could guide the implementation of targeted intervention aimed at increasing these rates in Turkey.

REFERENCES

1. World Health Organization. *Global status report on noncommunicable diseases 2010*. Geneva: World Health Organization; 2011.
2. World Health Organization. Cardiovascular diseases in developing countries. *World Health Stat Q* 1993; 46:90–1599.
3. Dodu SRA. Emergence of cardiovascular diseases in developing countries. *Cardiology* 1988; 75:56–64.
4. Address Based Population Registration System. http://tuikapp.tuik.gov.tr/adnksdagitapp/adnks.zul [Accessed 25 May, 2015].
5. The Ministry of Health, Department of Health Research. Turkey burden of disease study. http://ekutuphane.sagem.gov.tr/kitap.php?id=153&k=turkey_burden_of_disease_study. [Accessed 25 May 2015]
6. Turkish Statistical Institute. *Causes of death statistics* 2012; http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=15847. [Accessed 25 May 2015].
7. Mahley RW, Palaoğlu KE, Atak Z, Dawson-Pepin J, Langlois AM, Cheung V, *et al*. Turkish Heart Study: lipids, lipoproteins, and apolipoproteins. *J Lipid Res* 1995; 36:839–859.
8. Sönmez HM, Başak O, Camci C, Baltaci R, Karazeybek HS, Yazgan F, *et al*. The epidemiology of elevated blood pressure as an estimate for hypertension in Aydin, Turkey. *J Hum Hypertens* 1999; 13:399–404.
9. Onat A. Risk factors and cardiovascular disease in Turkey. *Atherosclerosis* 2001; 156:1–10.
10. Satman I, Yilmaz T, Sengül A, Salman S, Salman F, Uygur S, *et al*. Population-based study of diabetes and risk characteristics in Turkey: results of the Turkish diabetes epidemiology study (TURDEP). *Diabetes Care* 2002; 25:1551–1556.
11. Onal AE, Erbil S, Ozel S, Aciksari K, Tumerdem Y. The prevalence of and risk factors for hypertension in adults living in Istanbul. *Blood Press* 2004; 13:31–36.
12. Erem C, Hacihasanoglu A, Kocak M, Deger O, Topbas M. Prevalence of prehypertension and hypertension and associated risk factors among Turkish adults: Trabzon Hypertension Study. *J Public Health (Oxf)* 2009; 31:47–58.
13. Sariişik A, Oğuz A, Uzunlulu M. Control of hypertension in Turkey–is it improving? The Kocaeli 2 study. *Turk Kardiyol Dern Ars* 2009; 37 (Suppl 6):13–16.
14. Süleymanlar G, Utaş C, Arinsoy T, Ateş K, Altun B, Altiparmak MR, *et al*. A population-based survey of Chronic REnal Disease in Turkey: the CREDIT study. *Nephrol Dial Transplant* 2011; 26:1862–1871.
15. Doğan N, Toprak D, Demir S. Hypertension prevalence and risk factors among adult population in Afyonkarahisar region: a cross-sectional research. *Anadolu Kardiyol Derg* 2012; 12:47–52.
16. Satman I, Omer B, Tutuncu Y, Kalaca S, Gedik S, Dinccag N, *et al*. Twelve-year trends in the prevalence and risk factors of diabetes and prediabetes in Turkish adults. *Eur J Epidemiol* 2013; 28:169–180.
17. Altun B, Arici M, Nergizoğlu G, Derici U, Karatan O, Turgan C, *et al*. Prevalence, awareness, treatment and control of hypertension in Turkey (the PatenT study) in. *J Hypertens* 2005; 23:1817–1823.
18. Ministry of Health. *Health Transformation Program, Ankara, Turkey* 2003; http://www.saglik.gov.tr/TR/belge/1-2906/saglikta-donusum-programi.html. [Accessed 25 May 2015].
19. Atun R, Aydın S, Chakraborty S, Sümer S, Aran M, Gürol I, *et al*. Universal health coverage in Turkey: enhancement of equity. *Lancet* 2013; 382:65–99.
20. World Health Organization. *Report of a WHO consultation on obesity*. Geneva: WHO Press; 1997.
21. Briasoulis A, Agarwal V, Messerli FH. Alcohol consumption and the risk of hypertension in men and women: a systematic review and meta-analysis. *J Clin Hypertens (Greenwich)* 2012; 14:792–798.
22. Mancia G, De Backer G, Dominiczak A, Cifkova R, Fagard R, Germano G, *et al*. 2007 Guidelines for the management of arterial hypertension: the Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *J Hypertens* 2007; 25:1105–1187.
23. Basu S, Millett C. Social epidemiology of hypertension in middle-income countries: determinants of prevalence, diagnosis, treatment, and control in the WHO SAGE study. *Hypertension* 2013; 62:18–26.
24. Ibrahim MM, Damasceno A. Hypertension in developing countries. *Lancet* 2012; 380:611–619.
25. 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.
26. Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Borden WB, *et al*. Heart disease and stroke statistics-2013 update: a report from the American heart association. *Circulation* 2013; 127:143–152.
27. Akgün S, Rao C, Yardim N, Basara BB, Aydin O, Mollahaliloglu S, Lopez AD. Estimating mortality and causes of death in Turkey: methods, results and policy implications. *Eur J Public Health* 2007; 17:593–599.
28. Erdem Y, Arici M, Altun B, Turgan C, Sindel S, Erbay B, *et al*. The relationship between hypertension and salt intake in Turkish population: SALTURK study. *Blood Press* 2010; 19:313–318.
29. Akpolat T, Kadi R, Utaş C. Hypertension, salt, and bread. *Am J Kidney Dis* 2009; 53:1103.
30. Maziak W, Rastam S, Mzayek F, Ward KD, Eissenberg T, Keil U. Cardiovascular health among adults in Syria: a model from developing countries. *Ann Epidemiol* 2007; 17:713–720.
31. Saeed AA, Al-Hamdan NA, Bahnassy AA, Abdalla AM, Abbas MA, Abuzaid LZ. Prevalence, awareness, treatment, and control of hypertension among Saudi adult population: a national survey. *Int J Hypertens* 2011; 2011:174135.
32. Llisterri JL, Rodriguez-Roca GC, Escobar C, Alonso-Moreno FJ, Prieto MA, Barrios V, *et al*. Treatment and blood pressure control in Spain during. *J Hypertens* 2012; 30:2425–2431.
33. Tocci G, Rosei EA, Ambrosioni E, Borghi C, Ferri C, Ferrucci A, *et al*. Blood pressure control in Italy: analysis of clinical data from 2005–2011 surveys on hypertension. *J Hypertens* 2012; 30:1065–1074.
34. Macedo ME, Lima MJ, Silva AO, Alcantara P, Ramalhinho V, Carmona J. Prevalence, awareness, treatment and control of hypertension in Portugal: the PAP study. *J Hypertens* 2005; 23:1661–1666.
35. Guo F, He D, Zhang W, Walton RG. Trends in prevalence, awareness, management, and control of hypertension among United States adults, 1999 to 2010. *J Am Coll Cardiol* 2012; 60:599–606.
36. McAlister FA, Wilkins K, Joffres M, Leenen FH, Fodor G, Gee M, *et al*. Changes in the rates of awareness, treatment and control of hypertension in Canada over the past two decades. *CMAJ* 2011; 183:1007–1013.
37. Falaschetti E, Chaudhury M, Mindell J, Poulter N. Continued improvement in hypertension management in England: results from the health survey for England. *Hypertension* 2009; 53:480–486.
38. Kronborg CN, Hallas J, Jacobsen IA. Prevalence, awareness, and control of arterial hypertension in Denmark. *J Am Soc Hypertens* 2009; 3:19–24.
39. Joffres MR, Ghadirian P, Fodor JG, Petrasovits A, Chockalingam A, Hamet P. Awareness, treatment, and control of hypertension in Canada. *Am J Hypertens* 1997; 10:1097–1102.
40. Hajjar I, Kotchen TA. Trends in prevalence, awareness, treatment, and control of hypertension in the United States. *JAMA* 2003; 290:199–206.

41. Polonia J, Martins L, Pinto F, Nazare J. Prevalence, awareness, treatment and control of hypertension and salt intake in Portugal: changes over a decade. The PHYSA study. *J Hypertens* 2014; 32:1211–1221.

42. Meng XJ, Dong GH, Wang D, Liu MM, Lin Q, Tian S, *et al.* Prevalence, awareness, treatment, control, and risk factors associated with hypertension in urban adults from 33 communities of China: the CHPSNE study. *J Hypertens* 2011; 29:1303–1310.

43. Jo I, Ahn Y, Lee J, Shin KR, Lee HK, Shin C. Prevalence, awareness, treatment, control and risk factors of hypertension in Korea: the Ansan study. *J Hypertens* 2001; 19:1523–1532.

44. Gupta R, Deedwania PC, Achari V, Bhansali A, Gupta BK, Gupta A, *et al.* Normotension, prehypertension, and hypertension in urban middle-class subjects in India: prevalence, awareness, treatment, and control. *Am J Hypertens* 2013; 26:83–94.

45. Wagner A, Sadoun A, Dallongeville J, Ferrières J, Amouyel P, Ruidavets JB, Arveiler D. High blood pressure prevalence and control in a middle-aged French population and their associated factors: the MONA LISA study. *J Hypertens* 2011; 29:43–50.

46. Damasceno A, Azevedo A, Silva-Matos C, Prista A, Diogo D, Lunet N. Hypertension prevalence, awareness, treatment, and control in Mozambique: urban/rural gap during epidemiological transition. *Hypertension* 2009; 54:77–83.

47. Gee ME, Bienek A, McAlister FA, Robitaille C, Joffres M, Tremblay MS, *et al.* Factors associated with lack of awareness and uncontrolled high blood pressure among Canadian adults with hypertension. *Can J Cardiol* 2012; 28:375–382.

48. Sivén SS, Niiranen TJ, Aromaa A, Koskinen S, Jula AM. Social, lifestyle and demographic inequalities in hypertension care. *Scand J Public Health* 2015; 43:246–253.

49. Lloyd-Sherlock P, Beard J, Minicuci N, Ebrahim S, Chatterji S. Hypertension among older adults in low- and middle-income countries: prevalence, awareness and control. *Int J Epidemiol* 2014; 43:116–128.

50. Rahman MM, Gilmour S, Akter S, Abe SK, Saito E, Shibuya K. Prevalence and control of hypertension in Bangladesh: a multilevel analysis of a nationwide population-based survey. *J Hypertens* 2015; 33:465–472.

51. 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.

52. Agyemang C, van Valkengoed I, Koopmans R, Stronks K. Factors associated with hypertension awareness, treatment and control among ethnic groups in Amsterdam, the Netherlands: the SUNSET study. *J Hum Hypertens* 2006; 20:874–881.

53. Guessous I, Bochud M, Theler JM, Gaspoz JM, Pechère-Bertschi A. 2009 Trends in prevalence, unawareness, treatment and control of hypertension in Geneva, Switzerland. *PLoS One* 2012; 7:e39877.

Reviewers' Summary Evaluations

Reviewer 2

Strengths and limitations of the study: A large study population that is randomly selected. Standardized procedures.

Limitations: the cross-sectional design and lack of blood samples to characterize the study population further.