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ORIGINAL ARTICLE

Hypertension among Tunisian adults: results of the TAHINA project

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We performed a national survey to determine the prevalence, awareness, treatment and control of hypertension, one of the main cardiovascular risk factors, among the adult population in Tunisia. A total of 8007 adults aged 35–70 years were included in the study. Blood pressure (BP) measurements were taken by physicians with a mercury sphygmomanometer, and standard interviewing procedures were used to record medical history, socio-demographic and cardiovascular disease (CVD) risk factors. Hypertension was defined as a systolic BP $\geqslant$140 mm Hg and/or diastolic BP $\geqslant$90 mm Hg or current treatment with antihypertensive drugs. The prevalence of hypertension was 30.6%, higher in women (33.5%) than in men (27.3%). Multiple logistic regression analyses identified a higher age, urban area, higher body mass index, type 2 diabetes and family history of CVD as important correlates to the prevalence of hypertension. Only 38.8% of those with hypertension were aware of their diagnosis, of which 84.8% were receiving treatment. BP control was achieved in only 24.1% of treated hypertensive persons. Women were more aware than men (44.8 *vs.* 28.8%), but the rates of treatment and control of hypertension did not differ between the two genders. Higher age, being female, lower education level and urban area emerged as important correlates of hypertension awareness. The study highlights the hypertension problem in a middle-income developing country. There is an urgent need for a comprehensive integrated population-based intervention program to ameliorate the growing problem of hypertension in Tunisians.
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INTRODUCTION

Hypertension is as prevalent in many developing countries as in the developed world.[1] More than a quarter of the world's adult population is already hypertensive, and this number is projected to increase to 1.56 billion people by 2025.[2,3] Hypertension remains the major treatable risk factor for cardiovascular disease (CVD), which is responsible for 30% of all deaths worldwide.[4,5] A large number of clinical trials have shown that tight control of blood pressure (BP) can considerably reduce cardiovascular risk[6,7] and sequelae such as stroke, myocardial infarction, sudden cardiac death, peripheral vascular disease and renal insufficiency.[8–10]

Tunisia is among several developing countries facing an epidemiological transition with associated increases in chronic disease. This transition has been compounded by powerful environmental and behavioral changes, including adopting new dietary habits and a sedentary lifestyle, the stress of increasing urbanization and the associated working conditions, all leading to increases in major CVD risk factors.[11] Increases in CVD risk factors, notably the emergence of increased hypertension and related complications in developing countries, are generally following the same patterns as those identified in the developed world.[1]

Although the exact causes and mechanisms of hypertension are not known, it is generally believed that both genetic[12,13] and environmental factors, such as dietary salt, adiposity, cigarette smoking and mental stress were involved in determining the levels of BP and the prevalence of hypertension.[14–16] Knowledge of the prevalence of hypertension and the extent to which it is being detected, treated and controlled are essential to understand the magnitude of the problem and how well it is being addressed. In Tunisia, there were limited data about the prevalence of hypertension,[11,17,18] with no national estimates and no information about the levels of awareness, treatment and control of hypertension. We therefore carried out this study to estimate the prevalence, awareness, treatment and control of hypertension. We also examined the association of socio-demographic characteristics and known risk factors for high BP on the prevalence, awareness, treatment and control of hypertension in a general population.

METHODS

Study population

We performed a large nationally representative survey in the entire population. The survey conducted in Tunisia was integrated in a collaborative project

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funded by the European Commission to study epidemiological Transition and Health Impact in North Africa. The survey was cross-sectional from April 2004 to September 2005 and the target population was adult men and women between the ages of 35–74 years. A nationally representative, stratified, two-tier cluster sample of households was selected according to the seven administrative regions of Tunisia. The sampling frame was derived by the Tunisian National Institute of Statistics from the database of the 2004 census of the population; in each stratum 47 census districts were selected, with a probability proportional to size in number of eligible households (that is featuring at least one 35–74 year old household resident). At the second stage, 25 eligible households were sampled in each district; then for each household, all household residents from the targeted age range were to be included during the implementation of the field survey. The overall response rate was 79.5%, rates were generally lower in urban than rural areas. All applicable institutional and governmental regulations concerning the ethical use of human volunteers were respected during this study. The protocol of the survey was reviewed and approved by the Ministry of Health and the Tunisian National Council of Statistics (visa no 5/2005). After being thoroughly informed on the purpose, requirement and procedures of the survey, all participants gave their free informed consent.

During the home visit, the physicians had to complete the questionnaire, and to measure the arterial BP, weight and height. Information on socio-demographic characteristics including age, gender, education, occupation, living situation as the area, the housing, having a partner, family size and health insurance, cigarette smoking, alcohol consumption, and family medical history of CVD and stroke was collected. The interview included questions related to the diagnosis and treatment of type 2 diabetes and hypertension. Information on the awareness of, and drug treatment and lifestyle modification for, hypertension was also obtained.

Education was classified into four categories: level 0, illiterate; level 1, low-level education ($\leqslant$6 years of schooling); level 2, intermediate-level education (7–13 years of schooling); and level 3, higher education ($\geqslant$14 years of schooling). Regarding smoking, individuals were classified based on whether the responds was a non-smoker, an ex-smoker or a current smoker. Those who were smoking at the time of the examination were defined as current smokers and those who had smoked in the past but no longer smoke were defined as ex-smokers. In all subjects, height and weight were measured in light clothing and body mass index was calculated as body weight (kg) divided by the square of the height (m^2). Obesity was defined as body mass index $\geqslant 30\,kg\,m^{-2}$ according to the World Health Organization.[19]

BP measurement

BP measurements were done by trained physicians using a standardized mercury sphygmomanometer after the subject had rested for at least 5 min in a seated position. Two separate readings were taken at least three minutes apart. The average of the two readings was used to classify hypertension status.

Hypertension was defined as an average systolic BP (SBP) $\geqslant$140 mm Hg, an average diastolic BP (DBP) $\geqslant$90 mm Hg, and/or self-reported current treatment for hypertension with antihypertensive medication.[20] Awareness of hypertension was defined as self-report of any prior diagnosis of hypertension by a health care professional among the population defined as having hypertension. Treatment of hypertension was defined as use of a prescription medication for management of high BP at the time of the interview. Control of hypertension was defined as pharmacological treatment of hypertension associated with an average SBP $<$140 mm Hg and an average DBP $<$90 mm Hg.

We classified BP according to the Sixth Joint National Committee on prevention, detection, evaluation and treatment of high BP.[20] This classification defines four categories of BP: optimal (SBP $<$120 and DBP $<$80), normal (SBP $<$130 and DBP $<$85), high-normal (SBP 130–139 and DBP 85–89), the forth category defined as hypertension was divided in three stages, Stage I (SBP 140–159 or DBP 90–99), Stage II (SBP 160–179 or DBP 100–109) and Stage III (SBP $\geqslant$180 or DBP $\geqslant$110). Our study protocol conforms to ethical guidelines of Helsinki declaration.

Statistical analysis

All statistical analyses were conducted using the SPSS 11.5 (SPSS, Chicago, IL, USA) statistical package. Continuous variables are presented as means values $\pm$s.d. The prevalence of hypertension and the frequencies of awareness, treatment and control were assessed on the basis of 10-year age groups. Differences in baseline characteristics between groups were analyzed by Student's *t*-test and χ^2 test for continuous variables and categorical variables, respectively. We calculated odds ratio together with their 95% approximate confidence intervals as estimators of the relative risk of hypertension for various characteristics of the study population. Univariate logistic regression analyses were used to determine crude odds ratio. To study the association of selected socio-demographic factors and other risk factors with the prevalence of hypertension, we performed a multivariate logistic regression model with hypertension status as the dichotomous outcome (dependent variable) and with age, gender, educational level, marital status, residence area, smoking, obesity, diabetes mellitus and family history of CVD as the independent variables. Additionally, we performed a multivariate logistic regression analysis to investigate the factors associated with increased awareness of hypertension among individuals identified as hypertensive in our survey. The significance threshold was set at $P<0.05$.

RESULTS

Sample characteristics

Descriptive characteristics of the study population are given in Table 1. The mean age of the sample was 49.6 $\pm$ 9.7 years. There was no significant difference in mean age between men and women (49.5 $\pm$ 9.6 years *vs.* 49.6 $\pm$ 9.8 years, respectively). The mean body mass index of the study population was 27.1 $\pm$ 7.2 $kg\,m^{-2}$, higher in women than in men (28.4 $\pm$ 8.5 $kg\,m^{-2}$ *vs.* 25.2 $\pm$ 4.3 $kg\,m^{-2}$). About 40% of the population was illiterate; the rate of illiteracy was higher in women than in men (57 *vs.* 24.5%). Generally, men had higher education levels than women: 10.7% of men and 3% of women were classified in the highest educational groups. The majority (94.3% of men and 82.7% of women) had a partner, and the proportion of widowed or divorced was higher among women (14.3%) than among men (2.6%). 16.8% had national insurance, 45.1% had private insurance and 38.1% had no health insurance. Smoking rate was 20% (46.0% in men *vs.* 1.1% in women, $P<0.001$) and that of self-reported diabetes was 6.4%. More than one-fourth of the sample (26.8%) had obesity (36.1% in women *vs.* 14.4% in men, $P<0.001$) and 12.1% had a family history of CVD.

Prevalence of hypertension

Table 2 displayed the estimated hypertension prevalence by socio-demographic characteristics. Overall, 30.6% of the adults, 35–74 years old had hypertension. The prevalence of hypertension was higher among women (33.1%) than in men (27.3%) (P=0.002) and rose with age for both men and women, but the increase with age was more important in women. Hypertension was more prevalent among the illiterate group in comparison with the lower and intermediate or higher education level groups, and this association was clearly pronounced among women. A greater prevalence of hypertension was observed in urban area (32.3%) as compared with the rural area (28.3%), and that was true for men and for women. Hypertension was more prevalent among widowed/divorced subjects (41.3%) compared with those married (29.6%) or single (22.7%). The prevalence of hypertension was significantly higher in men and women who were obese (46.3 *vs.* 24.9%), diabetic (62.7 *vs.* 28.3%) or reported a family history of CVD (33.8 *vs.* 30.1%) compared with those without these risk factors. However, current smokers had less hypertension rate (22.8%) than did ex-smokers (33.5%) and non-smokers (32.5%). In all population, except for education, the difference in the prevalence of hypertension remained statistically significant for other studied risk factors when adjusting for age (data not shown).

Table 1 Descriptive characteristics of the study population

	All population (n=*8007*)	*Men* (n=*3417*)	*Women* (n=*4590*)
Age n (%)			
35–44	3153 (39.4)	1384 (40.5)	1769 (38.5)
45–54	2612 (32.6)	1077 (31.5)	1535 (33.4)
55–64	1405 (17.5)	581 (17.0)	824 (18.0)
65–74	837 (10.5)	375 (11.0)	462 (10.1)
Mean ± s.d. (years)	49.6 ± 9.7	49.6 ± 9.8	49.5 ± 9.6
BMI (kg m^{-2})	27.1 ± 7.2	25.2 ± 4.3	28.4 ± 8.5
SBP (mm Hg)	127 ± 19.7	126.2 ± 17.6	128.5 ± 21.0
DBP (mm Hg)	76.1 ± 12.2	75.7 ± 11.7	76.4 ± 12.5
Education level n (%)			
Illiterate	3443 (43.1)	833 (24.5)	2610 (57.0)
Lower/intermediate	4036 (50.6)	2204 (64.8)	1832 (40.0)
Higher	501 (6.3)	365 (10.7)	136 (3.0)
Residence area n (%)			
Urban	4635 (57.9)	2022 (59.2)	2613 (56.9)
Rural	3372 (42.1)	1395 (40.8)	1977 (43.1)
Marital status n (%)			
Single	238 (3.0)	104 (3.1)	134 (2.9)
Married	6974 (87.7)	3206 (94.3)	3768 (82.7)
Widowed/divorced	742 (9.3)	89 (2.6)	653 (14.3)
Health insurance coverage n (%)			
None	2743 (38.1)	1055 (34.0)	1688 (41.3)
National	1208 (16.8)	591 (19.0)	617 (15.1)
Private	3246 (45.1)	1460 (47.0)	1786 (43.7)
Smoking status n (%)			
Current smoker	1605 (20.0)	1542 (46.0)	48 (1.1)
Ex- smoker	835 (10.4)	804 (24.0)	21 (0.5)
Non-smoker	5400 (67.4)	1006 (30.0)	4354 (98.4)
Obesity n (%)	2084 (26.8)	480 (14.4)	1604 (36.1)
Self-reported diabetes n (%)	513 (6.4)	202 (5.9)	311 (6.8)
Family history of CVD n (%)	965 (12.1)	397 (11.7)	568 (12.4)

Abbreviations: BMI, body mass index; CVD, cardiovascular disease; DBP, diastolic blood pressure; SBP, systolic blood pressure.

Table 2 Prevalence of hypertension by socio-demographic and various CVD risk factors

	All population n *(%)*	*Men* n *(%)*	*Women* n *(%)*
Overall age (years)	2428 (30.6)	920 (27.3)	1508 (33.1)
35–44	473 (15.1)	219 (16.0)	254 (14.5)
45–54	791 (30.6)	279 (26.3)	512 (33.6)
55–64	670 (48.1)	231 (40.3)	439 (53.5)
65–74	494 (59.3)	191 (51.1)	303 (66.0)
P-value	<0.001	<0.001	<0.001
Education level			
Illiterate	1293 (37.8)	267 (32.4)	1026 (39.5)
Lower/intermediate	999 (25.0)	565 (25.0)	461 (24.9)
Higher	125 (25.4)	82 (29.5)	16 (16.3)
P-value	<0.001	<0.001	<0.001
Residence area			
Urban	1479 (32.3)	567 (28.5)	912 (35.2)
Rural	949 (28.3)	353 (25.5)	596 (30.3)
P-value	<0.001	0.04	<0.001
Marital status			
Single	54 (22.7)	13 (12.5)	41 (30.6)
Married	2050 (29.6)	872 (27.5)	1178 (31.5)
Widowed/divorced	303 (41.3)	31 (35.6)	272 (42.0)
P-value	<0.001	0.001	<0.001
Smoking status			
Current smoker	362 (22.8)	349 (22.6)	13 (27.1)
Ex- smoker	276 (33.5)	265 (33.0)	11 (52.4)
Non-smoker	1743 (32.5)	299 (29.7)	1444 (33.2)
P-value	<0.001	<0.001	0.11
Obesity			
Yes	960 (46.3)	220 (46.0)	740 (46.4)
No	1416 (24.9)	683 (23.9)	733 (25.9)
P-value	<0.001	<0.001	<0.001
Self-reported diabetes			
Yes	319 (62.7)	103 (51.8)	216 (69.7)
No	2091 (28.3)	809 (25.7)	1282 (304)
P-value	<0.001	<0.001	<0.001
Family history of CVD			
Yes	323 (33.8)	127 (32.3)	196 (34.9)
No	2085 (30.1)	784 (26.5)	1301 (32.7)
P-value	0.01	0.01	0.01

Abbreviation: CVD, cardiovascular disease.

The results of multivariate logistic regression analysis that examined the cross-sectional correlates of hypertension are presented in Table 3. A higher body mass index, oldest age, urban area, type 2 diabetes and family history of CVD were associated with increased odds of being hypertensive. Gender, education level, marital status and smoking were not associated with the prevalence of hypertension.

BP distribution

Gender- and age-specific estimates of the distribution of BP are presented in Table 4. Overall, 57.2% of men and 53.2% of women had optimal or normal BP (SBP <130 and DBP <85), whereas 17.5% of men and 16.6% of women had high normal BP. The prevalence of stage I, II, and III hypertension was 16.8, 6 and 2.5% in men and 18.3, 8 and 4% in women, respectively.

Awareness, treatment and control of hypertension

The percentages of participants with hypertension who were aware of their hypertensive status, who were being treated with antihypertensive medications and who had their hypertension controlled are shown in Table 5. The general rate of awareness was 38.8% higher in women (44.8%) than in men (28.8%), increasing with age in both genders. Urban residents (40.8%) were more aware than rural residents (35.6%). Among those who were aware of their hypertension status, 84.8% had reported that they were treated. The rate was similar for men (85.3%) and women (84.6%) and increased with age for both genders. Hypertensive individuals in urban areas were more treated than those in rural areas. Among treated hypertensives, only 24.1% had achieved control of their BP to <140/90 mm Hg with no differences noted by gender or area of residence.

Table 3 Crude and adjusted odds ratio of hypertension by socio-demographic and various CVD risk factors

	Unadjusted[a] *OR (95%CI)*	P-*value*[a]	*Adjusted*[b] *OR (95%CI)*	P-*value*[b]
Age (years)				
35–44	1		1	
45–54	2.47 (2.17–2.81)	<0.001	2.29 (2.00–2.63)	<0.001
55–64	5.19 (4.49–5.99)	<0.001	4.73 (4.01–5.75)	<0.001
65–74	8.16 (6.89–9.67)	<0.001	7.61 (6.23–9.29)	<0.001
Gender				
Men	1		1	
Women	1.31 (1.19–1.45)	<0.001	1.00 (0.84–1.18)	0.96
Education level				
Higher	1		1	
Lower/intermediate	1.78 (1.44–2.21)	<0.001	1.02 (0.79–1.32)	0.84
Illiterate	0.98 (0.79–1.21)	0.86	0.87 (0.68–1.11)	0.27
Residence area				
Rural	1		1	
Urban	1.20 (1.09–1.33)	<0.001	1.13 (1.01–1.27)	0.03
Marital status				
Single	1		1	
Married	1.43 (1.05–1.95)	0.02	1.16 (0.82–1.63)	0.39
Widowed/divorced	2.41 (1.72–3.37)	<0.001	1.15 (0.78–1.68)	0.46
Smoking status				
Current smoker	1		1	
Ex- smoker	1.70 (1.41–2.05)	<0.001	1.10 (0.90–1.36)	0.32
Non-smoker	1.63 (1.43–1.86)	<0.001	1.08 (0.89–1.31)	0.40
Obesity				
No	1		1	
Yes	2.59 (2.33–2.88)	<0.001	2.83 (2.50–3.20)	<0.001
Self-reported diabetes				
No	1		1	
Yes	4.24 (3.52–5.11)	<0.001	2.46 (2.00–3.20)	<0.001
Family history of CVD				
No	1		1	
Yes	1.18 (1.03–1.37)	0.019	1.87 (1.33–2.62)	<0.001

Abbreviations: CI, confidence interval; CVD, cardiovascular disease; OR, odds ratio.
[a]Univariate logistic regression.
[b]Multivariate logistic regression analysis including hypertension as dependent variable and age, gender, educational level, residence area, marital status, smoking, obesity, diabetes and family history of CVD as independent variables.

The results of multivariate logistic regression analyses examining the association of selected variables with awareness of hypertension status are presented in Table 6. A higher age, being female, a lower education level and an urban area were positively associated with increased awareness of hypertension.

DISCUSSION

Transition and Health Impact in North Africa was the first study to assess CVD risk factors and document the prevalence, awareness, treatment and control of hypertension in a nationally representative sample of residents of Tunisia, an Eastern Mediterranean country experiencing a crucial epidemiologic transition. Nearly 31% of the country's residents were found to have prevalent hypertension. This rate exceeds that reported in other developing countries in the region (for example, Egypt (26.3%), Cameroon (15%), Ghana (29.4%)),[21–23] as well as that reported in developed countries in Asia (for example, China (20%), Pakistan (20.7%), Saudi Arabia (26.1%), Malaysia (27.8%)).[24–27] The rate remains lower than that in the developed countries of Europe (for example, Italy (38%), United Kingdom (42%), Spain (47%), Romania (44.9%), Germany (55%)) and the United States (56%)).[28,29] Our findings further substantiate the results of sustained and integrated economical, social and health development in Tunisia. There is variability in the global prevalence of hypertension. This heterogeneity has been attributed to several factors, including urbanization with its associated changes in lifestyle, racial ethnic differences, nutritional status and birth weight.[29] The differences in prevalence between ethnic groups could be attributed also to their genetic makeup and/or different socio-environmental factors. When examining the data in the literature, we note the heterogeneity of different studies with regard to the sampling method (stratified sampling or selection during clinical visits), age of subjects enrolled, number of visits for the measurements of BP, adaptation of cuff size for the arm circumference or the period of time when the survey has been done.

Similar to other studies,[21,24,26] our results demonstrated that hypertension was more prevalent among women than men and increased with age for both genders, though the increase was more pronounced among women than men. Hormonal factors, postmenopausal weight gain, and a different risk profile might account for the higher age-specific prevalence rates of hypertension among women compared with men. In contrast to our study, other studies have reported that the prevalence of hypertension was higher in men than in women.[4,27]

In regard to the area of residence, hypertension was more prevalent in the urban area compared with rural area. Several studies from different continents have documented the higher prevalence of hypertension in the urban *vs.* rural population.[3,22,30] Urbanization often is associated with increased income and adoption of an unhealthy lifestyle. With urbanization and increased income, there is a desire for modern conveniences, such as the adoption of unhealthy food habits with the transition from traditional rural diets (with a low glycemic index and a higher fiber content) to a diet rich in salt, saturated fats and poor-quality carbohydrates (such as fast foods).[29] An increased psychological stress, which is inevitable with urbanization, also is associated with hypertension. Our findings generally confirm those of other studies where hypertension prevalence was associated with lower education, unmarried, obesity, diabetes and family history of CVD.[27,31,32]

Our findings importantly document low awareness of hypertension among those with elevated BP. In our study, only 38.8% reported having been told by a health care provider that they had high BP. Comparison with other developing countries is variable with some reporting higher awareness rates (for example, Sub-Saharan Africa (40%), China (42.6%) and India (54%)) and others with lower awareness rates (for example, Malaysia (34.6%), Pakistan (35%), Egypt (37.5%)).[27,29] Subgroup analyses demonstrated that women were more aware of their hypertensive status than men, a finding that was consistent in surveys in other countries.[24,27] This finding is probably related to the better access of women to the health care centers. Women generally frequent health care facilities at a higher rate than do men. Awareness of hypertension increased with age in both genders. Rural residents with hypertension in our sample were less likely than urban residents to be aware of their condition. An explication of the higher rate of hypertension awareness observed

Table 4 Distribution of subjects by systolic and diastolic blood pressures, gender and age

			Normotensive or controlled hypertensive			*Hypertensive*		
			Optimal	*Normal*	*High normal*	*Stage I*	*Stage II*	*Stage III*
		SBP (mm Hg)	*<120*	*<130*	*130–139*	*140–159*	*160–179*	*⩾180*
		DBP (mm Hg)	*<80*	*<85*	*85–89*	*90–99*	*100–109*	*⩾110*
Gender	*Age (years)*	*N*	*%*	*%*	*%*	*%*	*%*	*%*
Men								
	35–44	1356	30.4	38.6	15.5	12.2	2.5	0.8
	45–54	1052	24.5	32.5	18.7	15.0	6.9	2.3
	55–64	567	16.4	27.3	18.7	24.3	9.0	4.2
	65–74	369	14.6	20.6	19.2	27.4	11.9	6.2
	Total	3344	24.4	32.8	17.5	16.8	6.0	2.5
Women								
	35–44	1747	40.3	33.4	12.8	10.2	2.7	0.6
	45–54	1509	22.9	26.6	19.4	19.4	8.3	3.4
	55–64	815	11.8	20.2	19.4	26.5	12.6	9.4
	65–74	465	6.4	17.5	17.3	30.9	18.4	9.4
	Total	4527	26.0	27.2	16.6	18.3	8.0	4.0

Abbreviations: DBP, diastolic blood pressure; SBP, systolic blood pressure.

Table 5 Prevalence rates of awareness among hypertensives, of treatment among aware, and of control among treated by socio-demographic factors

	All population			*Men*			*Women*		
	Aware n *(%)*	*Treated* n *(%)*	*Controlled* n *(%)*	*Aware* n *(%)*	*Treated* n*(%)*	*Controlled* n *(%)*	*Aware* n *(%)*	*Treated* n *(%)*	*Controlled* n *(%)*
Overall age (years)	941 (38.8)	798 (84.8)	189 (24.1)	265 (28.8)	226 (85.3)	60 (27.5)	676 (44.8)	572 (84.6)	129 (22.8)
35–44	92 (19.5)	65 (70.7)	22 (34.4)	28 (12.8)	19 (67.9)	6 (31.6)	64 (25.2)	46 (71.9)	16 (35.6)
45–54	282 (35.7)	227 (80.5)	62 (27.6)	74 (26.5)	59 (79.7)	22 (37.3)	208 (40.6)	168 (80.8)	40 (24.1)
55–64	319 (47.6)	277 (86.8)	52 (19.3)	81 (35.1)	73 (90.1)	12 (17.6)	238 (54.2)	204 (85.7)	40 (19.8)
65–74	248 (50.2)	229 (92.3)	53 (23.6)	82 (42.9)	75 (91.5)	20 (27.8)	166 (54.8)	154 (92.8)	33 (21.6)
P-value	<0.001	<0.001	0.03	<0.001	0.006	0.09	<0.001	<0.001	0.14
Education level									
Illiterate	575 (44.5)	493 (85.7)	102 (20.8)	84 (31.5)	75 (8.3)	14 (19.2)	491 (47.9)	418 (85.1)	88 (21.1)
Lower/intermediate	317 (31.7)	263 (83.0)	72 (28.5)	142 (25.9)	117 (82.4)	34 (30.4)	175 (38.8)	146 (83.4)	38 (27.0)
Higher	48 (38.4)	42 (87.5)	15 (36.6)	39 (39.4)	34 (87.2)	12 (36.4)	9 (34.6)	8 (88.9)	3 (37.5)
P-value	<0.001	0.47	0.01	0.01	0.34	0.11	0.003	0.81	0.21
Residence area									
Urban	603 (40.8)	524 (86.9)	133 (26.0)	168 (29.6)	147 (87.5)	46 (32.9)	435 (47.7)	377 (86.7)	87 (23.5)
Rural	338 (35.6)	274 (81.1)	56 (20.5)	97 (27.5)	79 (81.4)	24 (17.9)	241 (40.4)	195 (80.9)	42 (21.5)
P-value	0.01	0.01	0.08	0.48	0.18	0.01	0.006	0.04	0.01
Marital status									
Single	18 (33.3)	12 (66.7)	4 (36.4)	4 (30.8)	3 (75.0)	1 (50.0)	14 (34.1)	9 (64.3)	3 (33.3)
Married	764 (37.3)	643 (84.2)	157 (24.7)	252 (28.9)	215 (85.3)	56 (26.8)	512 (43.5)	428 (83.6)	101 (23.7)
Widowed/divorced	148 (48.8)	133 (89.9)	28 (21.4)	7 (22.6)	6 (85.7)	3 (50.0)	141 (51.8)	127 (90.1)	25 (20.0)
P-value	<0.001	0.02	0.46	0.73	0.84	0.35	0.01	0.01	0.52

in urban residents is that health care centers and medical doctors tend to be concentrated in urban area. Moreover, in rural area community clinics are staffed by young doctors, who do a mandatory one-year service and they are likely to be less experienced in the proper management of hypertension.

Of those who were aware, a high proportion (84.8%) reported taking medication for treatment of their hypertension though only 24.1% had achieved BP control to <140/90 mm Hg as a result of treatment. Rates of treatment and control of hypertension did not differ among the two sexes. Several explanations for the low rate of controlled hypertension can be considered in the Tunisian context. First, hypertensive subjects don't pay attention to diet. Salt intake, obesity and sedentary lifestyle are common among hypertensive patients as well as in general population.[14,31,33] Second, patients may

Table 6 Crude and adjusted odds ratio of awareness of having hypertension by socio-demographic factors

	Unadjusted[a]		*Adjusted*[b]	
	OR (95%CI)	P-*value*[a]	*OR (95%CI)*	P-*value*[b]
Age (years)				
35–44	1		1	
45–54	2.29 (1.75–3.00)	<0.001	2.20 (1.67–2.89)	<0.001
55–64	3.76 (2.86–4.94)	<0.001	3.71 (2.77–4.96)	<0.001
65–74	4.17 (3.13–5.56)	<0.001	4.36 (3.17–6.00)	<0.001
Gender				
Men	1		1	
Women	2.00 (1.68–2.39)	<0.001	2.05 (1.67–2.51)	<0.001
Education level				
Higher	1		1	
Lower/intermidiate	1.28 (0.88–1.87)	0.19	1.03 (0.83–1.28)	0.76
Illiterate	0.74 (0.50–1.09)	0.13	1.59 (1.04–2.45)	0.03
Residence area				
Rural	1		1	
Urban	1.24 (1.05–1.47)	0.011	1.24 (1.04–1.50)	0.01
Marital status				
Single	1		1	
Married	1.18 (0.67–2.10)	0.55	1.33 (0.73–2.41)	0.34
Widowed/divorced	1.92 (1.05–3.53)	0.03	1.36 (0.73–2.56)	0.32

Abbreviations: CI, confidence interval; OR, odds ratio.
[a]Univariate logistic regression.
[b]Multivariate logistic regression analysis including awareness of hypertension as dependent variable and age, gender, educational level, residence area and marital status as independent variables.

not take medications out of fear of drug interactions, perceived lack of effectiveness, adverse effects, misunderstanding regarding necessity, the absence of symptoms associated with hypertension or concerns about costs.[34] Patients who report better general communication with their doctor, better instructions on how to take a medication and who receive more medication information are more likely to take medications as prescribed.[35] Third, the lack of access to antihypertensive medications, which often occurs in the public health facilities, could explain a part of the low rate of hypertension control.

Limitations of our study include the cross-sectional study design, which made it hard to judge causal relations. As BP was measured at one visit; this might result in an overestimation of hypertension because of white coat hypertension and underestimation of controlled hypertension among those treated. A possible misclassification of risk status may exist. In particular, we could not exclude the misclassification of smoking status in women because of socially unacceptable norms of smoking among women. Information about diet and salt intake was not included in this study because of time constraints and the unavailability of a validated food frequency questionnaire.

In conclusion, the prevalence of hypertension is high in both men and women. Hypertension is not only a concern of the urban population, but also a matter of debate in rural areas. Most of the hypertensives were not aware of their BP, and the treatment rate was poor, as was the control of hypertension in those treated. As Tunisia is a country in epidemiological transition, it faces the daunting prospect of an even higher prevalence in the future. Therefore, a comprehensive program and concerted efforts needs to be put into place if improvement is to be achieved. The development of affordable screening programmes should be accompanied by an evaluation of the efficacy, acceptability and affordability of low cost treatment regimes. Basic health workers can be trained for the detection of hypertension, followed by strengthening of public health surveillance. Private practitioners also have an important role in opportunistic screening and treatment of this disease. The efforts of the health care system must be combined with population efforts directed at reducing the average BP by reducing obesity, increasing physical activity and decreasing salt intake, fat-rich foods, tobacco and alcohol consumption.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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1 World Health Organization. *World Health Report 2002 Reducing Risks Promoting Healthy Life*. WHO: Geneva, 2002.
2 Chockalingam A, Campbell NR, Fodor JG. Worldwide epidemic of hypertension. *Can J Cardiol* 2006; **22**: 553–555.
3 Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. *Lancet* 2005; **365**: 217–223.
4 Wolf-Maier K, Cooper RS, Banegas JR, Giampaoli S, Hense HW, Joffres M, Kastarinen M, Poulter N, Primatesta P, Rodríguez-Artalejo F, Stegmayr B, Thamm M, Tuomilehto J, Vanuzzo D, Vescio F. Hypertension prevalence and blood pressure levels in 6 European countries, Canada, and the United States. *JAMA* 2003; **289**: 2363–2369.
5 World Health Organization. *World health report mental health: new understanding, new hope*. WHO: Geneva, 2000, pp 144–149.
6 Whelton PK. Epidemiology and the prevention of hypertension. *J Clin Hypertens* 2004; **6**: 636–642.
7 Wolf-Maier K, Cooper RS, Kramer H, Banegas JR, Giampaoli S, Joffres MR, Poulter N, Primatesta P, Stegmayr B, Thamm M. Hypertension treatment and control in five European countries, Canada, and the United States. *Hypertens* 2004; **43**: 10–17.
8 Guidelines Committee. European Society of Hypertension-European Society of Cardiology guidelines for the management of arterial hypertension. *J Hypertens* 2003; **21**: 1011–1053.
9 Albert CM, Chae CU, Grodstein F, Rose LM, Rexrode KM, Ruskin JN, Stampfer MJ, Manson JE. Prospective study of sudden cardiac death among women in the United States. *Circulation* 2003; **107**: 2096–2101.
10 Ishizaka N, Ishizaka Y, Toda E, Hashimoto H, Nagai R, Yamakado M. Hypertension is the most common component of metabolic syndrome and the greatest contributor to carotid arteriosclerosis in apparently healthy Japanese individuals. *Hypertens Res* 2005; **28**: 27–34.
11 Ghannem H, Hadj Fredj A. Prevalence of cardiovascular risk factors in the urban population of Soussa in Tunisia. *J Pub Health Med* 1997; **19**: 392–396.
12 Ben Ali S, Kallel A, Ftouhi B, Sediri Y, Feki M, Slimane H, Jemaa R, Kaabachi N. The -2548G/A LEP polymorphism is associated with blood pressure in Tunisian obese patients. *Blood Press* 2008; **17**: 278–283.
13 Jemaa R, Ben Ali S, Kallel A, Feki M, Elasmi M, Taieb SH, Sanhaji H, Omar S, Kaabachi N. Association of a 27-bp repeat polymorphism in intron 4 of endothelial constitutive nitric oxide synthase gene with hypertension in a Tunisian population. *Clin Biochem* 2009; **42**: 852–856.
14 Anderson CA, Appel LJ, Okuda N, Brown IJ, Chan Q, Zhao L, Ueshima H, Kesteloot H, Miura K, Curb JD, Yoshita K, Elliott P, Yamamoto ME, Stamler J. Dietary sources of sodium in China, Japan, the United Kingdom, and the United States, women and men aged 40 to 59 years: the INTERMAP study. *J Am Diet Assoc* 2010; **110**: 736–745.
15 Matsui Y, Kario K, Ishikawa J, Hoshide S, Eguchi K, Shimada K. Smoking and antihypertensive medication: interaction between blood pressure reduction and arterial stiffness. *Hypertens Res* 2005; **28**: 631–638.
16 Roemmich JN, Feda DM, Seelbinder AM, Lambiase MJ, Kala GK, Dorn J. Stress-induced cardiovascular reactivity and atherogenesis in adolescents. *Atherosclerosis* 2011; **215**: 465–470.
17 Jemaa R, Kafsi MN, Kallel A, Mechmeche R, Zaouali RM, Haouala H, Elasmi M, Gueddiche M, Slimane L, Belhani A, Kaabachi N, Mebazaa A. Distribution of cardiovascular risk factors in a Tunisian cohort of 6901 coronary patients. *Arch Mal Coeur Vaiss* 2004; **97**: 20–24.
18 Elasmi M, Feki M, Sanhaji H, Jemaa R, Haj Taeib S, Omar S, Mebazaa A, El Ati J, Hsairi M, Kaabachi N. Prevalence of conventional cardiovascular risk factors in the Great Tunis population. *Rev Epidemiol Sante Publique* 2009; **57**: 87–92.

19 World Health Organisation. *Physical status: the use and interpretation of anthropometry: report of a WHO Expert Committee WHO Technical Report Series*. WHO: Geneva, 1995, No 854, pp 321–344.
20 Joint National Committee on Detection, Evaluation and Treatment of High Blood Pressure. The sixth report of the Joint National Committee on the detection, evaluation and treatment of high blood pressure (JNC VI). *Arch Intern Med* 1997; **24**: 2413–2446.
21 Ibrahim MM, Rizk H, Appel LJ, el Aroussy W, Helmy S, Sharaf Y, Ashour Z, Kandil H, Roccella E, Whelton PK. Hypertension prevalence, awareness, treatment, and control in Egypt. Results from the Egyptian National Hypertension Project (NHP). NHP investigative team. *Hypertension* 1995; **26**: 886–890.
22 Mbanya JC, Minkoulou EM, Salah JN, Balkau B. The prevalence of hypertension in rural and urban Cameroon. *Int J Epidemiol* 1998; **27**: 181–185.
23 Agyemang C. Rural and urban differences in blood pressure and hypertension in Ghana, West Africa. *Public Health* 2006; **120**: 525–533.
24 Wu Y, Huxley R, Li L, Anna V, Xie G, Yao C, Woodward M, Li X, Chalmers J, Gao R, Kong L, Yang X. Prevalence, awareness, treatment, and control of hypertension in China: data from the China National Nutrition and Health Survey 2002. *Circulation* 2008; **118**: 2679–2686.
25 Ahmad K, Jafar TH. Prevalence and determinants of blood pressure screening in Pakistan. *J Hypertens* 2005; **23**: 1979–1984.
26 Al-Nozha MM, Abdullah M, Arafah MR, Khalil MZ, Khan NB, Al-Mazrou YY, Al-Maatouq MA, Al-Marzouki K, Al-Khadra A, Nouh MS, Al-Harthi SS, Al-Shahid MS, Al-Mobeireek A. Hypertension in Saudi Arabia. *Saudi Med J* 2007; **28**: 77–84.
27 Rampal L, Rampal S, Azhar MZ, Rahman AR. Prevalence, awareness, treatment and control of hypertension in Malaysia: a national study of 16,440 subjects. *Public Health* 2008; **122**: 11–18.
28 Dorobantu M, Darabont RO, Badila E, Ghiorghe S. Prevalence, awareness, treatment, and control of hypertension in Romania: results of the SEPHAR study. *Inter J Hypertens* 2010 (doi:10.4061/2010/970694).
29 Mittal BV, Singh AK. Hypertension in the developing world: challenges and opportunities. *Am J Kidney Dis* 2010; **55**: 590–598.
30 Addo J, Smeeth L, Leon DA. Hypertension in sub-Saharan Africa: a systematic review. *Hypertension* 2007; **50**: 1012–1018.
31 Arici M, Turgan C, Altun B, Sindel S, Erbay B, Derici U, Karatan O, Erdem Y, Hasanoglu E, Caglar S. Hypertension incidence in Turkey (HinT): a population-based study. *J Hypertens* 2010; **28**: 240–244.
32 Epstein M, Sowers JR. Diabetes mellitus and hypertension. *Hypertens* 1992; **19**: 403–418.
33 Hypertension Study Group. Prevalence, awareness, treatment and control of hypertension among the elderly in Bangladesh and India: a multicentre study. *Bull World Health Organ* 2001; **79**: 490–500.
34 Goff SL, Mazor KM, Meterko V, Dodd K, Sabin J. Patients' beliefs and preferences regarding doctors' medication recommendations. *J Gen Intern Med* 2008; **23**: 236–241.
35 Schneider J, Kaplan SH, Greenfield S, Li W, Wilson IB. Better patient doctor relationships are associated with higher reported adherence to antiretroviral therapy in HIV patients. *J Gen Intern Med* 2004; **19**: 1096–1103.