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Prehypertension and hypertension prevalence and risk factors among adult population in Republic of Serbia: A cross-sectional study

Prevalencija i faktori rizika od prehipertenzije i hipertenzije kod odrasle populacije u Republici Srbiji: studija preseka

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Abstract

Background/Aim. Prehypertension and hypertension are an important public health problem worldwide and although they can be modified, they are often a risk for cardiovascular diseases. The aim of this study was to determine the prevalence of prehypertension and hypertension and associated risk factors in the adult population (15+ years) of Serbia. **Methods.** The cross-sectional study covered 14,623 adult respondents, but 14,422 volunteered to measure their blood pressure according to a pre-defined protocol. A stratified two-stage national representative random sampling approach was used for the selection of the survey sample. **Results**. In 2013, 17.7% of Serbian population, aged 15 and over, was normotensive, every third (33.1%) person had prehypertension, and every second (49.3%) had hypertension. The standardized prevalence of prehypertension and hypertension was 40.6% and 34.5%, respectively; 57.8% of the hypertensive population were receiving medical treatment. Among those receiving medical treatment, 35.2% (36.4% males and 33.2% females) had a blood pressure within the normal range. According to the results of multivariate logistic regression analysis, independently significant risk factors for hypertension compared to persons with normotension were older age (50 and more) ($p < 0.001$), overweight ($p < 0.001$) and obesity ($p < 0.001$), moderate ($p < 0.001$) and large ($p < 0.001$) waist circumference in both sexes, and nonurban place of residence in females ($p = 0.006$). In females, independently significant risk factors for prehypertension compared to persons with normotension were older age (50 and more) ($p < 0.001$), overweight ($p < 0.001$) and obesity ($p < 0.001$), moderate ($p < 0.001$) and large ($p < 0.001$) waist circumference, but high level of physical activity was significantly protective ($p = 0.014$). In males, overweight ($p < 0.001$) and obesity ($p < 0.001$) were independently significant risk factors for prehypertension. **Conclusion.** Serbia belongs to countries with a high prevalence of prehypertension and hypertension. Our results emphasize the need for a new public health strategy for the prevention, detection and treatment of prehypertension and hypertension.

Key words:
adults; age factors; cardiovascular diseases; hypertension; obesity; overweight; prehypertension; risk factors; prevalence; sex factors.

Apstrakt

Uvod/Cilj. Prehipertenzija i hipertenzija su važni javnozdravstveni problemi širom sveta. Mada se na njih može uticati, oni su skoro uvek faktori rizika od kardiovaskularnih bolesti. Cilj istraživanja bio je da se utvrde prevalencija i faktori rizika prehipertenzije i hipertenzije kod odrasle populacije (15+ godina) u Srbiji. **Metode.** Studijom preseka obuhvaćeno je 14 623 odraslih ispitanika, od kojih je 14 422 pristalo na merenje krvnog pritiska u kućnim uslovima. Korišćen je stratifikovani dvoetapni reprezentativni slučajni uzorak stanovništva Srbije. **Rezultati.** U 2013, 17,7% odraslih osoba, uzrasta 15+ godina bilo je normotenzivno, svaka treća (33,1%) osoba imala je prehipertenziju, a svaka druga (49,3%) hipertenziju. Standardizovana prevalencija prehipertenzije bila je 40,6%, hipertenzije 34,5%, a 57,8% hipertenzivnih osoba bilo je na antihipertenzivnoj terapiji. Među osobama koje su bile na medikamentnoj terapiji 35,2% (36,4% muškaraca i 33,2% žena) imalo je krvni pritisak unutar normalnih vrednosti. Prema rezultatima multivarijantne logističke regresione analize, značajni nezavisni faktori rizika od hipertenzije, u odnosu na osobe sa normotenzijom, bili

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su životno doba (50+ godina) ($p < 0,001$), prekomerna težina ($p < 0,001$) i gojaznost ($p < 0,001$), umereno veliki ($p < 0,001$) i velik ($p < 0,001$) obim struka kod osoba oba pola, a kod žena i mesto boravka van grada ($p = 0,006$). Kod žena, značajni nezavisni faktori rizika od prehipertenzije, u poređenju sa osobama sa normotenzijom, bili su starije životno doba (50 + godina) ($p < 0,001$), prekomerna težina ($p < 0,001$) i gojaznost ($p < 0,001$), umereno veliki ($p < 0,001$) i veliki ($p < 0,001$) obim struka, dok je visok stepen fizičke aktivnosti bio značajan protektivni faktor ($p = 0,014$). Kod muškaraca, prekomerna težina ($p < 0,001$) i gojaznost ($p < 0,001$) bili su značajni nezavisni faktori rizika od prehipertenzije. **Zaključak.** Srbija pripada zemljama sa visokom prevalencijom prehipertenzije i hipertenzije. Naši rezultati naglašavaju potrebu za novom javnozdravstvenom strategijom za prevenciju, otkrivanje i lečenje osoba sa prehipertenzijom i hipertenzijom.

Ključne reči:
odrasle osobe; životno doba, faktor; kardiovaskularne bolesti; hipertenzija; gojaznost; telesna masa, prekomerna; prehipertenzija; faktori rizika; prevalenca; pol, faktor.

Introduction

Prehypertension (PreHTN) and hypertension (HTN) are an important public health problem worldwide and although they can be modified, they are often a risk for cardiovascular diseases (CVD), cerebrovascular diseases (stroke) and kidney diseases in the terminal phase [1, 2]. It is estimated that approximately 40% of adult population of the world have diagnosed HTN, which makes an average of 9.4 million people who die annually [1]. HTN is responsible for approximately half of the deaths from CVD and stroke. PreHTN elevates the risks of CVD (RR = 1.55), coronary heart disease (RR = 1.50) and stroke (RR = 1.71) [3].

In the adult population aged 25 and over, the age-standardized prevalence of HTN is the highest in underdeveloped countries and developing countries (Africa – 46%), while the lowest is in developed countries of the world (North America – 35%). The majority of people with undiagnosed, untreated and uncontrolled HTN lives in low- and middle-income countries with insufficiently developed health systems [1].

PreHTN prevalence and HTN prevalence are attributed to the growth and aging of the population and risk behaviors such as malnutrition, overweight, harmful use of alcohol, smoking tobacco, insufficient physical activity, high cholesterol, diabetes and long-term stress exposure [4–6].

However, little is known about the epidemiology of PreHTN and HTN in the adult population of Serbia. The aim of the study was to determine the prevalence of PreHTN and HTN and associated risk factors in the adult population (15+ years) of Serbia.

Methods

Data for this cross-sectional study were obtained from the National Survey of the Population of Serbia in 2013 that was carried out by the Ministry of Health of Serbia and the Institute of Public Health of Serbia "Dr Milan Jovanović Batut". The research was carried in the period October 7th, 2013 to December 30th, 2013. The study population included adults ≥ 15 years old, permanent residents of the Republic of Serbia. Exclusion criteria were: age below 15 years, persons who lived in collective households and/or institutions (institutions of social protection, nursing homes, prisons, and psychiatric institutions), residents of Kosovo and Metohija region (under the UN Mission), persons who were mentally unable to participate in the survey and examinees for whom there were no data for the requested variables.

Sampling design

This cross-sectional study was performed in line with recommendations of EUROSTAT, The European Health Interview Survey wave 2, and Methodological Manual [7, 8]. For obtaining the sample of households and examinees, a stratified two-stage national representative random sampling approach was used. In Serbia, 4 administrative areas were identified: Vojvodina, Belgrade, Šumadija and Western Serbia and Eastern and South Serbia. A further stratum classification was urban vs. other area of residence. In the first stage of 2-stage sampling, census circles were selected (total, 670 census circles: Belgrade – 162, Vojvodina – 187, Šumadija and Western Serbia – 179 and Eastern and South Serbia – 142) by probability proportional sampling. In the second stage, households were selected by a linear method of sampling, with a random beginning and an equal selection interval, by random sampling without replacement. In the second stage, households were selected by a linear method of sampling, with a random beginning and an equal selection interval, by random sampling without replacement. The 2011 Serbian population census framework was used for the selection of clusters. From every census circle 10 households were selected (total, 6,700 households). Out of 6,700 households planned, a sample of 6,500 households was accepted to be include in this study (the household response rate – 97.0%). Out of 16,474 registered members of households aged 15 and over, 14,623 agreed to be interviewed (response rate of 88.8%). Out of the adult household members, 14,422 adult respondents whom blood pressure (BP) were measured at home were included in our study (response rate of 98.6%).

The research was approved by the Ethics Committee of The Faculty of Medicine, University of Belgrade (29/IV-16) and the Ethics Committee of the Institute for Public Health of Serbia "Dr Milan Jovanović Batut" (1567/1).

Instruments and variables

The research of health of the population in Serbia was conducted by collecting data with three questionnaires (household questionnaire, personal health questionnaire and

self-completing questionnaire) for population above 15 years. The questionnaires were written according to the recommendations of Eurostat Working Group on Public Health Statistics of the European Commission [7]. Variables included in analysis from those questionnaires were: gender (male/female), age (≤ 49, 50–59 and 60 and more years), place of residence (town/the other; a town is a territorial unit established by the law, which is an economic, administrative, geographic and cultural center and has more than 100,000 inhabitants; other territorial units, according to the stated law and administrative-legal criteria, do not fulfill these conditions) and duration of daily physical activity – walking and/or riding a bicycle (low: 10–29 min/daily; moderate: 30–59 min/daily; high: 60 and more min/daily) [8].

Measurements

After the interview with the households, previously trained persons carried out objective measurements according to defined standardized procedures. A digital BP monitor with suitable cuffs was used for measuring BP. BP was measured by automatic upper arm BP monitor, three times with pauses of at least one min. For the categorization of the level of BP, the average value of all three measurements was used and information of treated HTN over the last 4 weeks. According to the classification of the World Health Organization (WHO) [9], the examinees without antihypertensive therapy over the last 4 months were classified according to values of BP into the following categories: normal blood pressure (systolic BP – SBP and diastolic BP – DBP: < 120 and < 80 mmHg); PreHTN (SBP/DBP: 120–139 and/or 80–89 mmHg); and HTN (SBP/DBP: ≥ 140 and/or ≥ 90 mmHg). All persons who used antihypertensive therapy over the last 4 weeks were included in the category of hypertensive individuals. Among the subjects with HTN, 45.9% (1,532) of men and 68.3% (2,571) of women was on antihypertensive treatment. In population who knew that they had HTN, only 85.3% of females and 75.2% of males used antihypertensive therapy over the last 4 weeks.

Anthropometric measurements were carried out according to standard international procedures. Body height was measured with the portable height measuring rod, body mass with the electronic scale for medical usage with decimal scale, and the waist circumference (WC) with the nonelastic strip for measuring, which is 205 cm long. Body mass index (BMI), as the measure of weight [10], which was obtained as the ratio of body mass and the squared body height (m^2), was classified according to the criteria of WHO: underweight – BMI < 18.5 kg/m^2, normal weight – BMI 18.5–24.9 kg/m^2, overweight (pre-obesity) – BMI 25.0–29.9 kg/m^2, obesity – BMI ≥ 30.0 kg/m^2.

WC was measured at the midpoint between the lower border of the rib cage and the iliac crest by using a flexible inch tape. The following cut off values of WC were used to assess the abdominal obesity for women: normal < 80 cm, moderate 80–87 cm, large ≥ 88 cm; and for men: normal < 94 cm, moderate 94–101 cm, large ≥ 102 cm [11].

Statistical analysis

Prevalence rates with appropriate 95% confidence intervals (CI) were estimated for 3 categories of BP according to age, place of residence, BMI, WC and physical activity, but separately for males and females participants. The prevalence of normotensive, PreHTN and HTN subjects were age and sex standardized according to the 2010 world population using the direct method [12].

In statistical analysis of data, Pearson χ^2 test, univariate logistic regression analysis (ULRA) and multivariate logistic regression analysis (MLRA) were used. χ^2 test was used to find statistically significant differences according to sex and between BP categories according to categories of age, place of residence, BMI, WC and physical activity, but separately for males and females participants.

Association between categories of BP and health related factors were analyzed with ULRA and MLRA. Variables that according to ULRA had p value ≤ 0.1 were included into the model of MLRA. The dependent variables formed two different multivariable models – PreHTN and HTN, each of them vs. normal BP as referent category, separately for males and females. Independent variables were: age, place of residence, BMI, WC and physical activity. They were reported with odds ratios and their 95% CI, along with probability p. The computer program SPSS for Windows, version 20.0 (US Government of Commercial Computer Software, Chicago, USA, 2012) was used in statistical analysis of the data. Statistical hypotheses were tested on the level of statistical significance from 0.05.

Results

The cross-sectional study included 14,422 participants (6,652 – 46.1% of men and 7,770 – 53.9% of women) (response rate 98.6%). The largest percentage of our sample of the population consisted of people under the age of 50 (49.1% of males and 46.0% of females), from urban place of residence (55.1% of males and 57.4% of females), with overweight and obesity (62.8% of males and 54.0% of females) and with moderately and large WC (58.5% of males and 70.5% of females) (Table 1). About 40% of men and about 50% of women did not perform physical activity sufficiently (i.e. the physical activity they performed was shorter than 30 min per day). People with HTN, for both sexes, were more often an older, from nonurban place of residence, with overweight and obesity, with large WC and low physical activity in relation to normotensive and PreHTN individuals.

Among people with hypertension (7,104), only 57.8% used antihypertensive therapy over the last 4 weeks. Among those receiving medical treatment, only 35.2% (36.4% males and 33.2% females) had a BP within the normal range. Users of medical treatment for HTN were more often females (62.7%), elderly people (60 and older – 68.9%), people from urban areas (56.0%), with overweight and obesity (78.3%), with moderate and large WC (85.9%) and with low physical activity (less than 30 min per day) (52.4%).

Table 1

Blood pressure (BP) categories according to baseline characteristics of study participants by gender

Characteristics	Males (n = 6,652), n (%)				Females (n = 7,770), n (%)			
	normal BP (n = 671)	prehypertension (n = 2,643)	hypertension (n = 3,338)	all (n = 6,652)	normal BP n = 1,879)	prehypertension (n = 2,125)	hypertension (n = 3,766)	all (n = 7,770)
Age (years)								
< 50	498 (74.2)	1,849 (70.0)	917 (27.5)	3,264 (49.1)	1,620 (86.2)	1,395 (65.6)	558 (14.8)	3573 (46.0)
50–59	61 (9.1)	391 (14.8)	725 (21.7)	1,177 (17.7)	165 (8.8)	383 (18.0)	831 (22.1)	1,379 (17.7)
≥ 60	112 (16.7)	403 (15.2)	1,696 (50.8)	2,211 (33.2)	94 (5.0)	347 (16.3)	2,377 (63.1)	2,818 (36.3)
Place of residence								
urban	389 (58.0)	1,489 (56.3)	1,789 (53.6)	3,667 (55.1)	1,153 (61.4)	1,252 (58.9)	2,052 (54.5)	4,457 (57.4)
other	282 (42.0)	1,154 (43.7)	1,549 (46.4)	2,985 (44.9)	726 (38.6)	873 (41.1)	1,714 (45.5)	3,313 (42.6)
Body mass index (kg/m^2)								
underweight (< 18.50)	40 (6.1)	47 (1.8)	22 (0.7)	109 (1.7)	162 (8.7)	83 (4.0)	58 (1.6)	303 (4.0)
normal weight (18.5024.99)	367 (55.9)	1,124 (42.9)	815 (25.3)	2,306 (35.5)	1,253 (67.4)	1,069 (51.4)	831 (23.3)	3,153 (42.0)
overweight (25.00–29.99)	203 (30.9)	1,082 (41.3)	1,436 (44.6)	2,721 (41.9)	336 (18.1)	621 (29.9)	1,324 (37.1)	2,281 (30.4)
obesity (≥ 30.00)	47 (7.2)	364 (13.9)	948 (29.4)	1,359 (20.9)	108 (5.8)	305 (14.7)	1,357 (38.0)	1,770 (23.6)
Waist circumference (men/women in cm)								
normal (< 94/< 80)	427 (65.3)	1,345 (52.2)	894 (28.0)	2,192 (29.5)	1,010 (55.7)	769 (37.6)	413 (11.5)	2,192 (29.5)
moderate (94–101/ 80–87)	131 (20)	613 (23.8)	807 (25.3)	1,408 (18.9)	421 (23.2)	460 (22.5)	527 (14.7)	1,408 (18.9)
large (> 102/ > 88)	96 (14.7)	621 (24.1)	1,492 (46.7)	3,841 (51.6)	383 (21.1)	817 (39.9)	2,641 (73.8)	3,841 (51.6)
Physical activity – total time (min/per day)								
low (< 30)	215 (33.3)	924 (36.8)	1,251 (41.0)	3,414 (48.5)	766 (42.3)	918 (45.8)	1,730 (53.7)	3,414 (48.5)
moderate (30–59)	222 (34.4)	802 (32.0)	967 (31.7)	2,185 (31.0)	592 (32.7)	672 (33.5)	921 (28.6)	2,185 (31.0)
high (60+)	208 (32.2)	784 (31.2)	830 (27.2)	1,440 (20.5)	454 (25.1)	416 (20.7)	570 (17.7)	1,440 (20.5)

SBP – systolic BP; DBP – diastolic BP; normal BP (SBP < 120 mm Hg and DBP < 80 mm Hg); prehypertension (SBP = 120–139 mm Hg and/or DBP = 80–89 mm Hg); hypertension (SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg, or current treatment with antihypertensive medications).

Table 2
Crude and standardized prevalence (%) of blood pressure (BP) categories according to age and sex in adult (15+ years) population of the Republic of Serbia, 2013

Parameters	Males (n = 6,652) % (95% CI)			Females (n = 7,770) % (95% CI)			Both sexes (n = 14,422) % (95% CI)		
	normal BP (n = 671)	prehypertension (n = 2,643)	hypertension (n = 3,338)	normal BP (n = 1,879)	prehypertension (n = 2,125)	hypertension (n = 3,766)	normal BP (n = 2,550)	prehypertension (n = 4,768)	hypertension (n = 7,104)
Age (years)									
< 50*	15.3 (14.0–16.5)	56.7 (54.9–58.4)	28.1 (26.5–29.7)	45.3 (43.7–47.0)	39.0 (37.4–40.7)	15.6 (14.4–16.8)	31.0 (29.9–32.1)	47.5 (46.2–48.7)	21.6 (20.6–22.6)
50–59*	5.2 (3.9–6.5)	33.2 (30.5–35.9)	61.6 (58.8–64.4)	12.0 (10.2–13.7)	27.8 (25.4–30.2)	60.3 (57.6–62.9)	8.8 (7.7–10.0)	30.3 (28.5–32.1)	60.9 (58.9–62.8)
≥ 60*	5.1 (4.1–6.0)	18.2 (16.6–19.9)	76.7 (74.9–78.5)	3.3 (2.7–4.0)	12.3 (11.1–13.6)	84.4 (83.0–85.7)	4.1 (3.5–4.7)	14.9 (13.9–15.9)	81.0 (79.9–82.1)
Total (15+ years)	10.1 (9.3–10.9)	39.7 (38.6–40.9)	50.2 (48.9–51.4)	24.2 (23.2–25.2)	27.4 (26.3–28.4)	48.5 (47.3–49.6)	17.7 (17.0–18.3)	33.1 (32.3–33.9)	49.3 (48.4–50.1)
Standardized prevalence**	12.9 (12.5–13.3)	48.5 (48.0–48.8)	38.6 (38.2–39.2)	36.0 (35.5–36.5)	33.4 (33.0–33.8)	30.6 (30.1–31.1)	24.9 (27.7–25.1)	40.6 (40.3–40.9)	34.5 (34.0–35.0)

***p* value for χ^2 test between genders for each age category < 0.001; **Age-standardized prevalence according to the 2010 world population;**
CI – confidence interval; SBP – systolic BP; **DBP – diastolic BP; normal BP (SBP < 120 mmHg and DBP < 80 mmHg); prehypertension (SBP = 120–139 mmHg and/or DBP = 80–89 mmHg); hypertension (SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg, or current treatment with antihypertensive medications).**

Table 3
Prevalence (%) of blood pressure (BP) categories in both gender according to place of residence, body mass index (BMI), waist circumference (WC) and physical activity among adult (15+ years) population of the Republic of Serbia, 2013

Parameter	Men (n = 6,652) % (95% CI)				Women (n = 7,770) % (95% CI)				
	normal BP (n = 671)	prehypertension (n = 2,643)	hypertension (n = 3,338)	*p* value* (men)	normal BP (n = 1,879)	prehypertension (n = 2,125)	hypertension (n = 3,766)	*p* value* (women)	*p* value* (between genders)
Place of residence									
urban	11.0 (9.9–12.1)	41.4 (39.7–43.1)	47.6 (45.9–49.3)	0.031	27.7 (26.3–29.1)	28.8 (27.4–30.3)	43.5 (41.9–45.1)	< 0.001	< 0.001
other	9.9 (8.7–11.1)	39.8 (37.9–41.7)	50.3 (48.4–52.3)		23.4 (21.8–25.0)	28.3 (26.6–30.0)	48.3 (46.5–50.2)		
BMI (kg/m^2)									
underweight (< 18.50)	36.7 (27.5–45.9)	43.1 (33.6–52.6)	20.2 (12.5–27.9)	< 0.001	57.4 (51.4–63.3)	27.9 (22.5–33.4)	14.7 (10.4–19.0)	< 0.001	0.004
normal weight (18.50–24.99)	15.9 (14.4–17.5)	48.7 (46.7–50.8)	35.3 (33.3–37.3)		41.0 (39.1–42.8)	34.3 (32.5–36.1)	24.7 (23.1–26.3)		< 0.001
overweight (25.00–29.99)	7.5 (6.4–8.5)	39.8 (37.9–41.6)	52.8 (50.9–54.7)		14.8 (13.2–16.3)	28.1 (26.1–30.1)	57.1 (54.9–59.3)		< 0.001
obesity (≥ 30.00)	3.5 (2.4–4.5)	26.8 (24.4–29.2)	69.8 (67.3–72.2)		6.3 (5.0–7.6)	18.4 (16.4–20.4)	75.3 (73.1–77.5)		< 0.001
WC (men/women in cm)									
normal (< 94/< 80)	16.4 (14.9–17.9)	51.0 (49.0–53.0)	32.6 (30.8–34.5)	< 0.001	47.4 (45.2–49.6)	35.4 (33.3–37.5)	17.1 (15.5–18.8)	< 0.001	< 0.001
moderate (94–101/ 80–87)	8.8 (7.3–10.3)	39.7 (37.1–42.2)	51.5 (48.9–54.1)		31.0 (28.5–33.6)	32.8 (30.2–35.4)	36.2 (33.5–38.8)		< 0.001
large (> 102/ > 88)	4.4 (3.5–5.3)	28.7 (26.7–30.7)	67.0 (64.9–69.0)		10.6 (9.5–11.7)	22.7 (21.2–24.2)	66.7 (65.0–68.3)		< 0.001
Physical activity - total time (min/per day)									
low (< 30)	9.0 (7.8–10.3)	39.0 (37.0–41.0)	52.0 (49.9–54.0)	< 0.001	22.5 (21.0–23.9)	27.2 (25.7–28.8)	50.3 (48.5–52.1)	< 0.001	< 0.001
moderate (30–59)	11.2 (9.7–12.6)	40.6 (38.3–42.8)	48.2 (46.0–50.5)		27.4 (25.4–29.3)	30.6 (28.5–32.6)	42.1 (39.9–44.2)		< 0.001
high (60+)	11.6 (10.1–13.2)	43.1 (40.8–45.4)	45.3 (42.9–47.6)		31.8 (29.3–34.3)	28.8 (26.4–31.2)	39.4 (36.8–42.0)		< 0.001

***p* value for χ^2 test; CI – confidence interval; SBP – systolic BP; DBP – diastolic BP; normal BP (SBP < 120 mmHg and DBP < 80 mm Hg); prehypertension (SBP = 120–139 mmHg and/or DBP = 80–89 mmHg); hypertension (SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg, or current treatment with antihypertensive medications).**

Table 4

Independent risk factors for hypertension and prehypertension compared to persons with normotension among adult (15+ years) population of the Republic of Serbia, 2013: multivariate logistic regression analysis

Parameter	Men, OR (95% CI)		Women, OR (95% CI)	
	prehypertension	hypertension	prehypertension	hypertension
Age (years)				
< 50		1	1	1
50–59		5.458 (4.013–7.423)*	2.279 (1.846–2.813)*	10.437 (8.369–13.017)*
60+		7.596 (5.959–9.682)*	3.432 (2.611–4.511)*	47.394 (36.346–61.801)*
Body mass index				
underweight and normal weight	1	1	1	1
overweight	1.810 (1.499–2.185)*	2.205 (1.720–2.825)*	1.722 (1.414–2.098)*	2.637 (2.063–3.371)*
obesity	2.679 (1.931–3.717)*	5.082 (3.288–7.855)*	2.224 (1.641–3.013)*	8.048 (5.778–11.209)*
Waist circumference				
normal		1	1	1
moderate		1.716 (1.318–2.235)*	1.093 (0.915–1.307)	1.696 (1.327–2.169)*
large		2.449 (1.741–3.444)*	1.411 (1.136–1.752)*	2.403 (1.818–3.176)*
Nonurban place of residence				1.291 (1.075–1.551)*
Physical activity				
low			1	
moderate			1.002 (0.857–1.172)	
high			0.801 (0.671–.956)*	

***p*-value < 0.01 according to multivariate logistic regression analysis; OR – odds ratio; CI – confidence interval.**

In the Serbian population, aged 15 and over, in 2013, 17.7% of population was normotensive, every third (33.1%) person had PreHTN, and every second (49.3%) person had HTN (Table 2). Men had significantly higher prevalence of PreHTN, as well as HTN than women for all age groups and total, except for HTN for age group 60+ years where prevalence was higher in women. In both sexes and in total, the prevalence of HTN increased with age, while PreHTN prevalence decreased. In Serbia, the standardized prevalence of PreHTN was 40.6% (men 48.5% and women 33.4%) and 34.5% for HTN (men 38.6% and women 30.6%).

In urban population, as well as in nonurban one, prevalence of PreHTN and HTN was significantly higher in males than in females (Table 3). Among both sexes, prevalence of PreHTN was higher in urban population (41.4% of males, and 28.8% of females), while HTN prevalence was significantly higher in nonurban population (50.3% of males, and 48.3% of females).

Males had significantly higher prevalence of PreHTN and HTN for all BMI categories, except for overweight and obesity, where prevalence of HTN was higher in females. Prevalence of normotension and PreHTN decreased, while HTN increased with the increase in BMI, for both sexes. The highest prevalence of HTN was in obese category for both sexes (69.8% of males, and 75.3% of females).

Males had significantly higher prevalence of PreHTN and HTN for all WC categories. Prevalence of normotension and PreHTN significantly decreased, while HTN increased with the increase in WC, for both sexes. The highest prevalence of PreHTN was in normal WC category (51.0% of males, and 35.4% of females), while HTN prevalence was highest in large WC (67.0% of males, and 66.7% of females).

The prevalence of PreHTN and HTN was significantly higher in males for all physical activity categories. Prevalence of normotension increased while the prevalence of HTN decreased with the increase in physical activity levels, in both sexes. Prevalence of PreHTN was highest in high physical activity category for males (43.1%) and in moderate physical activity category for females (30.6%). The highest prevalence of HTN was among males (52.0%) and females (50.3%) with low physical activity.

Variables that according to ULRA had p value ≤ 0.1 were included into the model of MLRA. For normotension and HTN these variables were age, place of residence, BMI, WC, and physical activity, in both sexes. According to the results of MLRA, independently significant risk factors for HTN compared to persons with normotension were older age (50 and more), overweight and obesity, moderate and large WC in both sexes, and nonurban place of residence in females (Table 4).

Variables for normotension and PreHTN included into the model of MLRA were BMI and WC for males, and age, BMI, WC and physical activity in females. In females, independently significant risk factors for PreHTN were older age (50 and more), overweight and obesity, moderate and large WC, but high level of physical activity was significantly protective. In males, overweight and obesity were independently significant risk factors for PreHTN (Table 4).

Discussion

In the adult population of Serbia, aged 15 and over, in 2013, high prevalence of PreHTN (33.1%; standardized prevalence 40.6%) and HTN (49.3%; standardized prevalence 34.5%) were identifed. Both age-standardized prevalences were higher in men (48.5% and 38.6%, respectively) than in women (33.4% and 30.6%, respectively). Among the subjects with HTN, only 45.9% of men and 68.3% of women (57.8% of all) was on antihypertensive treatment. Among those receiving medical treatment, only 35.2% (36.4% of males and 33.2% of females) had BP within the normal range. In the United States in 2004 prevalence of antihypertensive medication use among HTN adults, 18 years and more, was 77.3%, more often among women (82.5%) and individulas 60 years and more (83.6 %) [13]. Among adult Chinese 35–75 years of age, 30.1% take medication for HTN in the period 2014–2017 [14]. In Serbia and in other developing countries prevalence of PreHTN and HTN is high and rates of awareness, treatment, and control are low [15]. Therefore, epidemiological situation of HTN in our country is alarming; there is a huge hidden burden of undiagnosed HTN subjects and that requires urgent attention. If we add those with PreHTN, the magnitude of the problem is much higher.

Worldwide age-standardized prevalence of HTN in adults, 20 years and above, in 2010, was 31.1% (31.9% in men and 30.1% in women), and it was lower in high-income countries (28.5% in both sexes, 31.6% in men and 25.3% in women) than in low- and middle-income countries (31.5% in both sexes, 31.7% in men and 31.2% in women) [16]. It was estimated that 1.4 billion people had HTN on the global level. Aproximately ¾ of individuals with HTN lived in low- and middle-income countries. In the same year, the highest prevalence for men was in Europe and Central Asia (38.8%) and for women in sub-Saharan Africa (36.3%), but the lowest for men was in South Asia and for women in high-income economies (26.9%). It is estimated that HTN prevalence has decreased in high-income countries and increased in low- and middle-income countries between 2000 and 2010 [16]. In low- and middle-income countries, aging and urbanisation with unhealthy lifestyle may play a role in the epidemic of HTN [16–18].

In some investigations, prevalence of PreHTN was also analized. For example, in the National Health and Nutrition Examination Survey the prevalence of PreHTN in disease-free US adults, over the age of 20 years, was 36.3% and was higher in men (44.8%) than in women (27.3%) [19]. Also, prevalence increased with age (31.2% for ages 20–39 years, 42.3% for ages 40–59 years and 44.2% for ages 60–69 years). But, in our study, in both sexes and in total, the prevalence of PreHTN decreased. There is growing evidence that individuals with PreHTN would have a significantly higher risk of developing HTN and CVDs within a few years [20].

In our research, as in most other studies, the prevalence of PreHTN and HTN was higher in males than in females [16, 21, 22]. The differences in the frequency of high BP between the sexes can be partly explained by biological factors that include sex hormones, chromosomal differences,

and other biological gender differences that protect women from HTN until women reach menopause and after that gender differences in HTN become smaller or nonexistent [23, 24].

In our study, according to MLRA results, independently significant risk factors for HTN compared to persons with normotension were older age (50 and more), overweight and obesity, moderate and large WC in both sexes, and nonurban place of residence in females. In females, independently significant risk factors for PreHTN were the same as for men with HTN and high level of physical activity was significantly protective factor. In males, only overweight and obesity were independently significant risk factors for PreHTN.

These results are very important because in a small number of studies independent risk factor for HTN was analyzed according to sex. Age has been recognized as a risk factor for HTN and some researchers believe that high prevalence of HTN among older people might be due to changes that occur in the blood vessels [25].

The results of this study are similar with the findings of the studies of Hu et al. [21], Dua et al. [26], Tripathy et al. [27] and Erem et al. [28] who noticed that overweight and obesity lead to PreHTN and HTN in both sexes. In addition, the prevalence of HTN appears to increase even with a relatively small increase in body weight [29]. Similarly, among postmenopausal women, the risk of developing high BP is doubled with a high BMI or high WC [30]. Deng et al. [31] and Hu et al. [21], also found that BMI and WC were positively related to the prevalence of HTN. The prevalence of PreHTN and HTN increased with an increase in BMI. The prevalence of PreHTN decreased in parallel to an increase in the prevalence of HTN. This was particularly noted in subjects up to 44 years of age. In relation to individual nutrition indicators, the WC and BMI combination proved to be superior in predicting risk factors for HTN [32].

In our study, men with PreHTN and HTN had higher prevalence of overweight (39.8% and 52.8%, respectively) and obesity (26.8 and 69.8%, respectively) than women (28.1% and 57.1%, respectively for overweight, and 18.4% and 75.3%, respectively for obesity). The prevalence of overweight and obesity in both sexes increased with an increase in BP and was the highest in people with HTN. Improved living standard has led to an increase in obesity throughout the world, especially during childhood. In the United States, 70.9% of adult men and 61.9% of women are overweight, and nearly one-third of the adult population, 31.6% of men and 33.9% of women are obese [32]. In Sub-Saharan Africa, the highest prevalence of obesity was recorded among women in South Africa (42.0%).

In our study, only in PreHTN women, high level of physical activity (60 and more min per day) was an independently significant protective factor for PreHTN development, but not for HTN. Adults who are insufficiently physically active have 20%−30% increased risk of all-cause mortality compared to those who do at least 150 min of moderate-intensity physical activity per week, or equivalent (as recommended by the WHO) [33]. In 2010, globally, 23.3% of adults (19.8% of men and 26.8% of women) were insufficiently physically active (less than 150 min of moderate-intensity physical activity per week or equivalent) [33]. Prevalence of physical inactivity is higher in high-income countries and amounts to 32.7% (27.7% of men and 37.6% of women). Physical inactivity is higher in women than in men and is more frequent in older age groups. Daily exercise of at least 30 min of physical activity can reduce BP and prevent the development of pre-HTN and HTN [33]. The mechanisms by which physical activity may reduce BP and prevent the development of PreHTN and HTN are unclear. Same animal studies suggest that aerobic exercise may prevent increases in BP by increasing insulin sensitivity and autonomic nervous system function [34], while resistance training may prevent increases in BP through beneficial alterations in vasoconstriction regulation [35].

Exploring the regional differences and an in-depth analysis of the urban and rural variations in prevalence may provide important insight into the underlying determinants of the increasing PreHTN and HTN. In most studies, living in urban areas was positively associated with HTN [36]. Urbanization influences lifestyle patterns, leading to a decrease in physical activity, changes in food consumption, and increased stress [36]. However, a small number of recent studies showed that the HTN prevalence was higher in rural areas than in urban ones. In Turkish adult population aged 20 years or more, the overall (age-standardized) prevalence of HTN was 24.9%, and was higher in rural (28.4%) than in urban areas (23.9%) [37]. Women were more likely to had HTN in rural areas than in urban areas ($p < 0.05$). In our study, similar to these results, nonurban place of residence in females was independent risk factor for HTN. In our females, prevalence of HTN was 50.3% in nonurban and 47.6% in urban place. Possible explanation for our results could be emerging urbanization in rural areas. This suggests that analyzing HTN risk factors according to gender may provide greater insight in understanding the variations in HTN development between urban and rural areas.

Noncommunicable diseases represent an upcoming epidemic for developing countries, including Serbia. In the light of this trend, the current study casts a significant light on the prevalence of HTN in our country.

Limitations of this study include: cross-sectional study design which implies that no causal conclusion about the relationship between health behavior and anthropometric parameters variables and BP values can be made; the data based on self-reporting for physical activity could lead to recall bias, which may have prevented us from accurately estimating the association between physical activity and BP categories. Some risk factors, which are important in risk assessment, were not taken into accounts, such as psychosocial factors, social class, smoking, nutrition habits and others.

Conclusion

Serbia belongs to countries with a high prevalence of prehypertension and hypertension and the prevalence of undiagnosed and untreated hypertension is high in the adult population of Serbia. Our results emphasize the need for a new public health strategy for the prevention, detection and

treatment of prehypertension and hypertension. Moreover, regular physical activity and weight reduction through education and awareness among people are the key to reducing the load of prehypertension, hypertension and cardiovascular diseases. The results of this research can help decision makers in the health system to establish interventions that will more effectively control prehypertension and hypertension in our country.

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