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UNDIAGNOSED HYPERGLYCAEMIA AND HYPERTENSION AS INDICATORS OF THE VARIOUS RISK FACTORS OF FUTURE CARDIOVASCULAR DISEASE AMONG POPULATION OF SERBIAN STUDENTS

NEDIJAGNOSTIKOVANA HIPERGLIKEMIJA I HIPERTENZIJA KAO INDIKATOR RAZLIČITIH FAKTORA RIZIKA ZA BUDUĆE KARDIOVASKULARNE BOLESTI MEĐU POPULACIJOM STUDENATA SRBIJE

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Summary

Background: A number of risk behaviours, such as smoking, overweight, excessive alcohol intake, insufficient physical activity, excessive and frequent intake of salt, reduced fruit and vegetable intake, increased fat intake, which constitute living habits of an individual can influence the occurrence of hypertension and hyperglycaemia. The changing of these lifestyles can reduce the risk of developing prehypertension and prediabetes.
Methods: The survey was conducted at student's campuses. The respondents were subjected to the height, weight, blood glucose and blood pressure. Respondents filled in previously created questionnaire that was approved by the Ethics Committee for Biomedical Research Faculty of Pharmacy, University of Belgrade.
Results: The percentage of respondents with a glucose value above the reference value was 14.6% (n=19), 2.4% (n=3) had values greater than 7 mmol/L without being diagnosed with diabetes, and accordingly, 2.4% (n=3) had elevated HbA1c values (above 42 mmol/mol or 6.0%). The percentage of respondents with elevated systolic and diastolic blood pressure was 14.9% and 7.4% respectively. Regarding calculated risk scores, they showed parallel increase with increas-

Kratak sadržaj

Uvod: Neki bihevioralni faktori rizičnih ponašanja, kao što su pušenje, gojaznost, preterani unos alkohola, nedovoljna fizička aktivnost, preterano i često konzumiranje soli, smanjen unos voća i povrća, povećan unos masti, a koji predstavljaju životne navike pojedinca mogu da utiču na pojavu hipertenzije i hiperglikemije. Promena ovih životnih stilova može da smanji rizik od razvoja prehipertenzije i predijabetesa.
Metode: Istraživanje je sprovedeno u studentskim domovima. Ispitanicima je merena visina, težina, nivo glukoze u krvi i krvni pritisak. Ispitanici su popunjavali namenski kreiran upitnik koji je odobren od strane Etičkog komiteta za biomedicinska istraživanja Farmaceutskog fakulteta Univerziteta u Beogradu.
Rezultati: Procenat ispitanika sa vrednošću glukoze iznad referentne vrednosti iznosio je 14,6% (n = 19), dok 2,4% (n = 3) imaju vrednost veću od 7 mmol/L bez dijagnostikovanog dijabetesa, i shodno tome, 2,4% (n = 3) ima povišen HbA1c (iznad 42 mmol/mol odnosno 6,0%). Procenat ispitanika sa povišenim sistolnim i dijastolnim krvnim pritiskom bio je 14,9% odnosno 7,4%. Što se tiče izračunatih skorova rizika, pokazali su paralelno povećanje sa povećanjem BMI (HPS), sistolnog i dijastolnog pritiska (OHS), i koncentracije glukoze (OPS).

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ing of BMI (HPS), systolic and diastolic pressure (OHS), and glucose concentration (OPS).
Conclusions: When analysing all the factors that could cause the later development of diabetes, which is associated with hypertension as well, it is observed that the student population is very much exposed to those factors. The results of this study cannot be representative for the general population of students, but they can provide recommendations for further research.

Keywords: lifestyles, prediabetes, prehypertension, students

Zaključak: Kada se analiziraju svi faktori koji bi mogli da izazovu kasniji razvoj dijabetesa, koji je povezan sa hipertenzijom, uočeno je da je studentska populacija veoma izložena ovim faktorima. Rezultati ove studije ne mogu biti reprezentativni za opštu populaciju studenata, ali oni mogu da daju preporuke za dalja istraživanja.

Ključne reči: životni stilovi, predijabetes, prehipertenzija, studenti

Introduction

According to the epidemiological data, cardiovascular disease (CVD) causes one third of the deaths, where 45% of heart disease related deaths is caused by hypertension, while 51% is caused by stroke (1). In low and middle-income countries (such as Serbia), hypertension prevalence is higher than in high-income countries (2). The most common cardiovascular risk factors referred in the clinical guidelines are hypertension, age, diabetes mellitus, the level of total and LDL cholesterol, family history of CVD, body mass index (BMI) and smoking. However, the insufficient physical activity, inadequate diet and chronic stress are also of a significant importance (3). A number of risk behaviours, such as smoking, overweight, excessive alcohol intake, insufficient physical activity, excessive and frequent intake of salt, reduced fruit and vegetable intake, increased fat intake, which constitute living habits of an individual can influence the occurrence of hypertension and hyperglycaemia. Changing such lifestyle can reduce the risk of developing hypertension (4). Changing the factors previously mentioned can reduce the risk of developing hyperglycaemia. According to American Diabetes Association, prediabetes represents important risk factor for future diabetes and CVD. Diabetes is preventable disease and attributable risk of 91% for lifestyle factors (including physical activity, healthy diet, smoking, alcohol consumption, and weight loss) (5). Low-risk lifestyle has an important role at preventing prediabetes and diabetes (6). In this study, we tested hyperglycaemia prevalence in ordinary student population in Serbia, analysing their glucose and HbA1c concentration and relationship between its glucose status and other traditional risk factors and life-style determinants for cardiovascular disease existence.

Materials and Methods

The survey was conducted at student's campuses to cover different faculties. All students who are in the study period (January – June 2015) have been informed about possibility to participate in the research. Research is part of preventive health education and students who were involved in research had no diagnosed hyperglycaemia, hypertension or any other health-related complication or problem. The respondents were subjected to the height, weight, blood glucose and blood pressure. Respondents filled in previously created questionnaire that was approved by the Ethics Committee for Biomedical Research Faculty of Pharmacy, University of Belgrade. Parts of the questionnaire have been created based on the framework of the World Health Organization research oversight of chronic, non-communicable diseases (7, 8). All participants were familiar with the objectives of the research and gave informed consent to participate in research.

Trained health workers employed in primary health care level measured the blood pressure and determined glucose concentration by using portable glucometers (*Accu-Chek Active; Roche Diabetes Care GmbH; Mannheim, Germany):* Reference values for systolic and diastolic blood pressure were taken as recommended by the association European Society of Hypertension: normal systolic blood pressure was <130 mmHg and/or diastolic<85 mmHg (9). Respondents were divided in the two groups according to their age, under 25 and over 25 years. BMI was calculated as the quotient of body weight (measured in kilograms) to square of height (measured in meters). BMI scores were then classified into four categories: BMI less than 18.5 is considered as underweight, BMI 18.5–24.9 as normal, BMI 25–29.9 as overweight and BMI 30 or higher as obese (2). Biochemical parameter HbA1c which shows long-term glucose control in blood was calculated by the *on-line* calculator from blood glucose concentration (10). The distribution parameters are checked by Kolmogorov-Smirnov Test and only those variables with normal distribution sum view are entered into the calculation of scores.

Mean values and standard deviations for calculation of Z score values were obtained from the reference range for the BMI, systolic and diastolic blood pressure, glucose and HbA1c. Using Z score value of the BMI, the systolic and diastolic blood pressure, glucose levels and HbA1c levels, the scores were calculated according to the following formulas:

Obesity-Pressure Score OPS = BMI+AVERAGE (systolic and diastolic blood pressure)

Obesity-Hyperglycaemia Score OHS = BMI+AVERAGE(glucose and HbA1c)

Pressure-Hyperglycaemia Score PHS = AVERAGE (systolic and diastolic blood pressure)+AVERAGE (glucose and HbA1c).

Obesity-Pressure-Hyperglycaemia Score OPHS= BMI +AVERAGE (systolic and diastolic blood pressure)+ AVERAGE (glucose and HbA1c).

Based on the scores' values the subjects were divided into two groups: without risk ($<75^{th}$ percentile) and with risk ($>75^{th}$ percentile).

Descriptive statistics were used to display the socio-demographic characteristics of the study participants. Percentages were used to show the categorical variable, and the mean value and standard deviation for continuous variables. Mann-Whitney Test and Kruskal-Wallis Test are used for statistical significance between groups. Pearson's Chi-square test was used to discover if there is a relationship between two categorical variables. IBM SPSS Statistics version 22.0 (IBM Corporation, 2013) was used for data analysis.

Results

The study included 189 students. There were more females (61.9%). Most were students from the third (27.5%) and fourth (26.1%) year of study. The percentage of respondents with elevated systolic and diastolic blood pressure was 14.9% and 7.4% respectively. Mean values as well as minimum-maximum values for these parameters, and its comparison in gender sub-groups are depicted in the *Table I*.

Table I Age and lifestyle indicators in relation to gender.

Mean±SD (min-max) or N(%)	Total	Gender		P value
		Male N=72	Female N=117	
Age	22.1±1.6 (19–27)	22.1±1.8 (19–27)	21.9±1.5 (19–27)	0.204
Smoking status (smokers)	24 (12.7%)	9 (4.8)	15 (7.9)	0.940
Level of physical activity (once a week or less)	58 (30.7)	19 (10.1)	39 (20.6)	0.002
Coffee consumption (yes)	126 (66.7)	40 (21.2)	86 (45.5)	0.014
Alcohol consumption (once a week)	8 (4.2)	3 (1.6)	5 (2.6)	0.080
Consumption of Snacks (yes)	106 (56.1)	49 (25.9)	57 (30.2)	0.695
Stress (every day)	39 (20.6)	11 (5.8)	28 (14.8)	<0.001
Body Mass Index (BMI) (kg/m^2)	22.135±2.486 (17.2–30.0)	23.66±2.17 (18.10–30.04)	20.74±1.88 (17.24–27.04)	0.256
Systolic Blood Pressure (mmHg)	114.01±13.752 (80–160)	121.28±11.78 (90–160)	109.71±12.96 (80–150)	<0.001
Diastolic Blood Pressure (mmHg)	72.79±8.633 (50–100)	75.81±7.99 (60–100)	70.99±8.50 (50–100)	0.038

P from Student t test comparison by gender

Table II Glucose status parameters in study subjects and according to gender.

Parameter	All students	Male	Female	P
Glucose (mmol/L)	5.1±0.8 (3.9–8.1)	5.2±0.7 (3.9–7.1)	5.0±0.8 (3.9–8.1)	0.119
HbA1c (mmol/mol)	28.6±6.4 (4.5–49.8)	29.2±6.5 (4.5–42.9)	28.1±6.4 (4.5–49.8)	0.164
HbA1c (%)	4.8±0.5 (4.1–6.7)	4.9±0.5 (4.1–6.1)	4.8±0.5 (4.1–6.7)	0.164

P from Student t test comparison by gender

Table III Average values of three cardiovascular risk scores regarding obesity, hypertension and hyperglycaemia status.

Risk Score	Percentile 50th (25th–75th) min – max	Gender		P
		Male	Female	
OPS – BMI, systolic/diastolic blood pressure	–5.80 (–10.54 - –2.67)-20.60–12.49	–5.55 ± 7.01	–6.66±6.74	0.499
OHS – BMI, glucose, HbA1c	–0.51 (–1.02 - 1.70)-3.10–4.37	–0.10±1.59	0.43±1.97	0.125
HPS – systolic/diastolic blood pressure, glucose, HbA1c	–5.93 (-9.84 - –2.46)–19.48–14.04	–5.72±6.75	-6.87±6.44	0.623
OPHS – BMI, systolic/diastolic blood pressure, glucose, HbA1c	–5.90 (–10.46 - –2.19)–21.41–14.65	–5.68±7.13	-6.55±7.13	0.625

P value from the Student t test

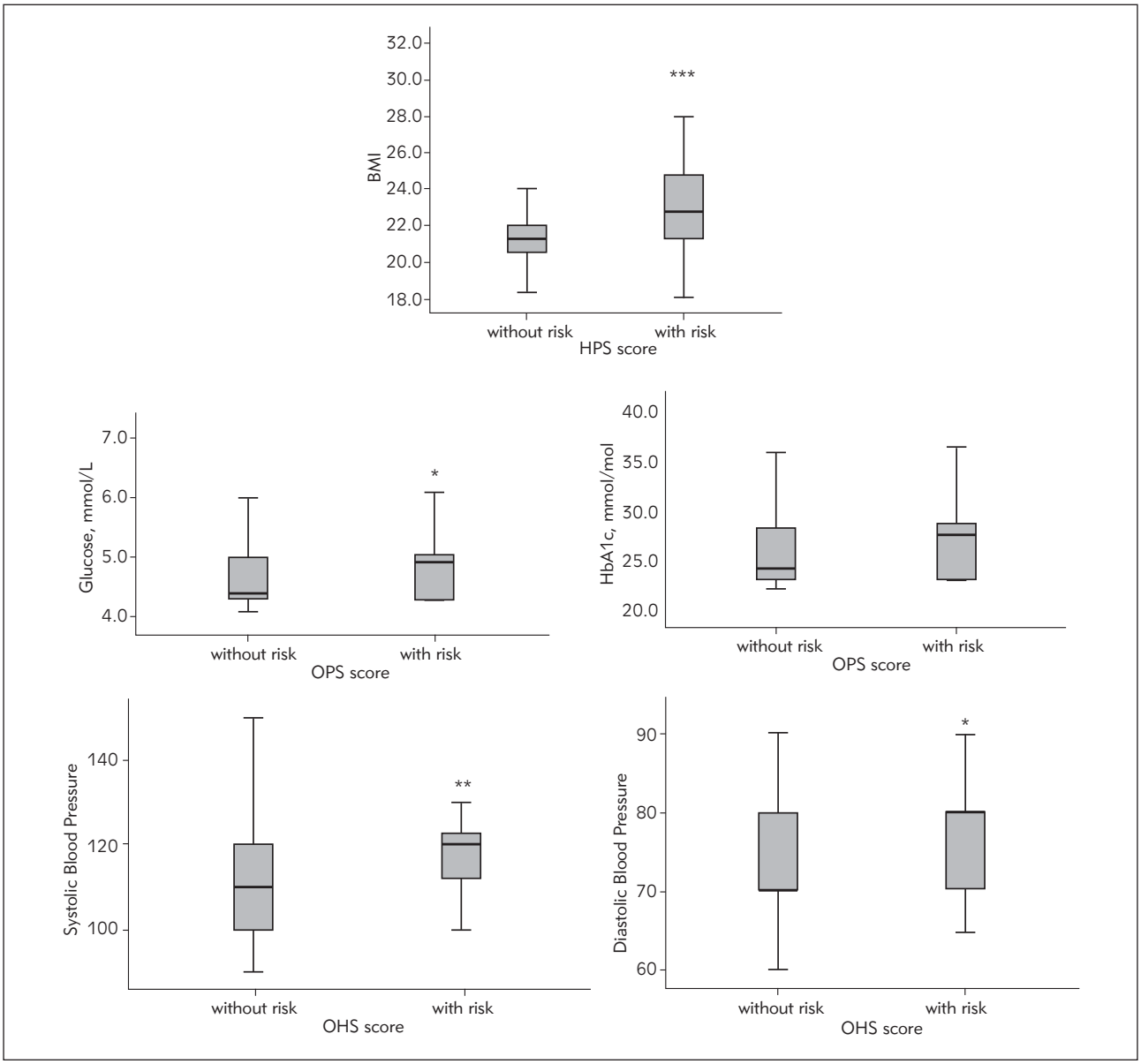

Figure 1 BMI, glucose status parameters and systolic and diastolic blood pressure in the risk score subgroups (scores are calculated from the other two variables).

*<0.05; **<0.01; ***<0.001 according to Mann-Whitney U test

Female group showed significantly less subjects who have physical activity more frequently than once a week, and at the same time, they consumed more coffee than their male counterparts. Girls also had more frequent stress than boys, but boys had significantly higher systolic as well as diastolic blood pressure. Other life-style indicators, so as continuous variables measured here were not different between boys and girls.

The main purpose of our study was to estimate the prevalence of the hyperglycaemia in apparently healthy students' population. The percentage of respondents with a glucose value above the reference value was 14.6% (n=19), 2.4% (n=3) had values greater than 7 mmol/L without being diagnosed with diabetes, and accordingly, 2.4% (n=3) had elevated HbA1c values (above 42 mmol/mol or 6.0%). *Table II* presents glucose status parameters as means ± SDs and ranges (minimum-maximum).

We noticed that in the population involved by our study there were subjects with fasting glucose concentration clearly above upper reference limit and diabetes mellitus type 2 diagnosis cut-off value (higher than 7.0 mmol/L). There was no difference between male and female participants.

In order to assess summary risk for cardiovascular disease development in later life in otherwise healthy young persons, we have calculated risk scores as a sum of different separate traditional CV risk factors. Cardiovascular risk scores calculated as a sum of Z score values of different combination two or three factors i.e. BMIz, (glucose/HbA1c) z and (systolic/ diastolic blood pressure values) z are presented at the Table III (values are presented also for the female and male groups, respectively). Z score statistics calculation gives lower values for the smaller particular risk (even negative values), but some students also had positive values, much above reference boundaries from the general population, which could suggest distinct risk in apparently healthy, asymptomatic people. There was no difference in calculated cardiovascular risk scores between female and male groups.

We have divided our study subjects according to 75^{th} percentile value for any of the three scores (obesity-hyperglycaemia, obesity-hypertension, hyperglycaemia-hypertension) and in these sub-groups compared systolic and diastolic pressure, glucose and HbA1c, BMI, respectively. Results are presented at the *Figure 1*.

Our results showed significantly higher BMI values in subjects with the highest HP score (hyperglycaemia-pressure combination), $P<0.001$. Systolic ($P<0.01$) and diastolic ($P<0.05$) pressure were significantly higher in subjects with the OH score (obesity-hyperglycaemia combination) higher than 75^{th} percentile value for the whole group of subjects. Glucose ($P<0.05$) and HbA1c ($P=0.056$) were higher in subjects with highest OP score (obesity-pressure combination).

In order to find possible connection between calculated cardiovascular risk scores values and other risk factors related to life-style of the subjects in our study we have compared age, level of physical activity, smoking status, coffee and alcohol consumption in subgroups according to 75^{th} percentile value as a risk cut-off value for every risk score, respectively. Results are presented in the *Table IV*.

Total cardiovascular risk score, calculated in our current study (OPH score) showed relationship with age and physical activity level (older students and those with less frequent physical activity had significantly higher OPH score), and also marginally significance for the coffee consumption (students who drink more coffee also had higher total risk score (OPH). The same life-style indicators (age, physical activity and coffee consumption) were also significantly higher in 75^{th} percentile subgroups for the HP score (hyperglycaemia-pressure combination). Score combined from obesity and hyperglycaemia (OH score) was related to age (older students had higher OHS). OP score (combination of obesity and blood pressure) was significantly higher in students who had less physical activity.

Next step in our analysis was estimation of socio-demographic and life-style indicators influence on the hyperglycaemia and blood pressure values. We assumed as a risk values those higher than upper limit of reference boundaries (for glucose >6 mmol/L, systolic BP >130 mmHg, diastolic BP >85 mmHg), and compared subject's distribution according to above-mentioned parameters in hyperglycaemia and hypertension risk sub-groups. Results are presented as number and % of subjects at the *Tables V* (hyperglycaemia) and VI (hypertension). Data shown as number (%) of subjects according to distinct criterion, P from χ^2 test.

This part of analysis confirmed that many younger subjects had glucose below upper limit of reference values, whereas older ones had almost equal distribution of subjects within and above reference value. The other socio-demographic and life-style indicators didn't show significant relation with glycaemia status.

Results regarding hypertension risk and socio-demographic variables and life-style indicators demonstrated significantly higher number of female subjects with systolic blood pressure values within reference limits, compared to male subjects. Other estimated variables which could be also part of overall cardiovascular risk were not significantly connected with hypertension status.

Table IV Distribution of demographic and lifestyle indicators in different risk scores' subgroups.

Factors		OPS		OHS		PHS		OPHS	
		0/1	P value	0/1	P value	0/1	P value	0/1	P value
Sex	male	59/19	0.840	66/12	0.068	57/21	0.808	59/19	0.840
	female	82/29		77/34		84/27		82/29	
Faculty	Faculty of Pharmacy	72/25	0.922	74/23	0.428	63/33	0.211	74/23	0.428
	Faculty of Transport and Traffic Engineering	22/7		22/7		22/7		22/7	
	Faculty of Veterinary Medicine	10/3		10/3		13/0		10/3	
	Faculty of Political Sciences	10/2		10/2		10/2		10/2	
	Faculty of Organizational Sciences	18/5		20/3		22/2		20/3	
Smoking status	yes	15/5	0.847	20/0	0.089	13/7		13/7	0.659
	no	127/42		122/47		129/40	0.659	129/40	
Age	at 25 years	130/37	0.061	132/35	0.048	132/35	0.011	132/35	0.011
	over 25 years	12/10		10/12		12/10		10/12	
Consumption of Snacks	yes	114/23	0.684	121/16	0.697	109/27	0.461	112/25	0.565
	no	45/7		48/4		46/7		45/7	
Level of physical activity	once a week or less	49/8	0.032	47/10	0.069	47/10	0.032	49/8	0.032
	2-3 times a week	45/18		50/13		45/18		45/18	
	4-5 times a week	39/8		35/12		40/7		39/8	
	daily	10/12		10/12		10/12		10/12	
Coffee Consumption	before breakfast	29/17	0.080	32/14	0.402	25/20	0.024	27/18	0.093
	after breakfast	65/10		62/13		65/10		64/12	
	don't drink coffee	45/20		45/20		49/17		48/17	
	before and after breakfast	3/0		3/0		3/0		3/0	
Stress	every day	27/12	0.394	30/8	0.325	27/12	0.161	28/10	0.569
	once a week	64/15		54/25		67/12		64/15	
	once a month	33/17		38/12		32/18		33/17	
	never under stress	18/3		20/2		17/5		17/5	
Alcohol Consumption	once a week	13/25	0.719	6/32	0.172	19/19	0.762	19/19	0.909
	once a month	44/32		44/32		50/25		44/32	
	several times a year	19/13		13/19		19/13		19/13	
	don't drink	19/25		6/38		19/25		19/25	

P value from the Student t test

Table V Relationship between socio-demographic and life-style indicators and hyperglycaemia indices.

Factor				P values	
		Group without risk	Group with risk	For groups	For Glucose value
Sex	male	36 (32.73)	9 (8.18)	0.455	0.159
	female	48 (43.64)	17 (15.45)		
Age	at 25 years	79 (70.54)	20 (17.86)	0.038	0.011
	over 25 years	8 (7.14)	5 (4.46)		
Faculty	Faculty of Pharmacy	43 (38.05)	15 (13.27)	0.291	0.713
	Faculty of Transport and Traffic Engineering	13 (11.50)	4 (3.54)		
	Faculty of Veterinary Medicine	7 (6.19)	1 (0.88)		
	Faculty of Political Sciences	7 (6.19)	0 /		
	Faculty of Organizational Sciences	12 (10.62)	2 (1.77)		
Smoking status	yes	10 (8.85)	2 (1.77)	0.731	0.948
Consumption of Snacks	yes	47 (56.63)	13 (11.50)	0.666	0.984
Level of physical activity	once a week or less	29 (25.66)	5 (4.42)	0.086	0.163
Coffee Consumption	yes	56 (49.56)	19 (16.81)	0.222	0.754
Stress	every day	16 (14.16)	7 (6.19)	0.814	0.289
Alcohol Consumption	once a week	5 (16.67)	1 (3.33)	0.051	0.286

Table VI Relationship between socio-demographic and life-style indicators and hypertension indices.

Factor		Systolic/diastolic blood pressure N (%)		P values	
		Group without risk	Group with risk	For groups	For systolic/diastolic blood pressure value
Sex	male	31 (28.18)/40 (36.36)	14 (12.73)/5 (4.54)	0.008/0.197	0.100/0.058
	female	58 (52.73)/62 (56.36)	7 (6.36)/3 (2.73)		
Age	at 25 years	81 (72.32)/92 (82.14)	18 (16.07)/7 (6.25)	0.671/0.935	0.304/0.820
	over 25 years	10 (8.93)/12 (10.71)	3 (2.68)/1 (0.89)		
Faculty	Faculty of Pharmacy	50 (44.25)	8 (7.08)	0.508/0.569	0.014/0.666
	Faculty of Transport and Traffic Engineering	12 (10.62)/53 (46.90)	5 (4.42)/5 (4.42)		
	Faculty of Veterinary Medicine	6 (5.31)/16 (14.16)	2 (1.77)/1 (0.88)		
	Faculty of Political Sciences	6 (5.31)/8 (7.08)	1 (0.88)/0/		
	Faculty of Organizational Sciences	12 (10.62)/6 (5.31)	2 (1.77)/1 1 (0.88)		
Smoking status	yes	9 (7.96)/10 (8.85)	3 (2.65)/2 (1.77)	0.749/0.381	0.995/0.631
Consumption of Snacks	yes	51 (61.45)/58 (9.88)	9 (10.84)/2 (2.41)	0.463/0.825	0.633/0.141
Level of physical activity	once a week or less	31 (27.43)/33 (29.20)	3 (2.65)/1 (0.88)	0.253/0.089	0.787/0.004
Coffee Consumption	yes	52 (46.02)/70 (61.95)	12 (10.62)/4 (3.54)	0.741/0.387	0.764/0.802
Stress	every day	17 (15.04)/20 (17.70)	6 (5.31)/3 (2.65)	0.059/0.363	0.081/0.195
Alcohol Consumption	once a week	5 (16.67)/4 (13.33)	1 (3.33)/2 (6.67)	0.365/0.526	0.629/0.260

Discussion

According to the Final report and key results of the Republic of Serbia population health research from 2013 conducted by the Institute of Public Health of Serbia »Dr Milan Jovanovic Batut«, 7.6% of the population had been diagnosed with diabetes and 33.2% of adults had high blood pressure (35.2% in women and 26.6% in men) (11).

Further efforts are required to create an effective strategy of identifying young people who are at high risk for developing of diabetes (12). American Diabetes Association has developed a questionnaire, which identifies the respondents at a high risk of undiagnosed diabetes combining the risk factors based on the data obtained from them (13). As for the risk scores calculation the existing patient information are used. This can be a useful practice tool, so that only those at the highest risk are offered with the diagnostic tests, resulting in significant cost savings (13).

Arterial hypertension is considered the most common non-transmissible disease, but there are still insufficiently invested resources in the prevention programs for the early detection of this disease (14). There are numerous methods of assessment of the cardiovascular risk such as QRISK, CVD risk score, Framingham CVD algorithm, Scottish score and Hu's healthy lifestyle intervention (HHLi) (15). In the »Framingham Heart Study«, the authors are stating that the calculated risk of hypertension in relation to the age of the respondents with the normal blood pressure, in males aged 55 to 65 years and in females aged 80 to 85 years of age, was approximately 90%, suggesting that no one is completely safe from hypertension (16). Prevention through changing the risky behaviour and lifestyles is very important.

There is a proven link between smoking and cardiovascular disease. Acute tobacco consumption is associated with just a temporary increase in blood pressure, which drops back after 30 minutes. Yet, the chronic tobacco use increases the incidence of hypertension (17). The attention should be paid especially to the increased risk due to the combined consumption of tobacco (cigarettes) and alcohol. According to the WHO reports, the consumption of alcohol is the highest in the European Region, roughly twice the global average (17, 18). Alcohol consumption is directly linked to the high blood pressure. As the consumption increases, so does the blood pressure. Studies have shown that there is a linear correlation between alcohol intake and blood pressure. In one study, it was found that heavy drinkers (3–4 drinks per day or more) have higher systolic and diastolic blood pressure than those who do not drink, by 17.6 mmHg and 10.9 mmHg respectively (17).

Physical inactivity is also regarded as one of the major risk factors for the hypertension development (from 5% to 13%) (16). Moderate physical activity is considered more effective in the prevention of hypertension than high-intensity physical activities. The physical activity is most efficient when combining high and moderate intensity of activity (16).

Several studies revealed the influence of the coffee intake on the blood pressure level, but primarily on the temporary basis. However, it was observed that the coffee intake (over 2 cups a day) led to lower HDL values, especially in women (16). Results of a meta-analysis from 2009 showed that the individuals who were more often exposed to the stress were 21% more likely to develop high blood pressure in comparison to those who were under less stress (16). Another factor can also be the sleep disorder, since the sleep is one of the most important stress relieving measures (16).

In many countries, salt intake has been reduced from 9–12 g per day to 5–6 g per day. The effect of a long-term intake of the salt in high concentrations is reflected in the manifestation of a greater risk for the hypertension development in elderly population (16). Direct positive correlation between obesity and hypertension is demonstrated. It is estimated that the control of obesity can eliminate 48% of the hypertension risk in white population (16).

On the other hand, screening programs for diabetes mellitus are related mainly to the aging population, exceeding the age of 45 (19). According to the register of diabetes in Serbia there were 221 newly sick-listed people aged up to 29 years diagnosed with type one diabetes in 2015 (20).The optimal screening interval for hypertension is unknown. For now, it is recommended to check the blood pressure level every two years for people with the blood pressure below 120/80 mmHg, or once a year for people with blood pressure in the range of 120–139/80–89 mmHg (9). This data clearly indicates that the prevention and screening program for chronic diseases such as hypertension and diabetes need to be implemented much earlier.

Obtained risk score results have also the advantage over the individual values of BMI, blood pressure or glucose. They include the combinations of existing factors, but future research should focus on the identification of new factors that could make risk scores sensitive to identification of the young adults groups at risk for developing diabetes and hypertension (12).

Men have higher pressure (systolic and diastolic). A glucose is not significantly different between sex, but again it is higher in men (*Table I* and *II*). Early detection and proper managing of the risk factors that may cause the occurrence of hypertension and/or hyperglycaemia prevents cardiovascular system disease related to mortality.

Students are busy with specific duties and responsibilities, hence they often neglect the importance of regular and proper diet, eating fast food instead. Uni-

versities' curriculums do not include physical activity, which leaves students with fewer opportunities for exercising. Unhealthy diet and lack of exercise leads to obesity. The American Academy of Pediatrics recommends proper nutrition and exercise, as the first-line defence from obesity, related to prediabetes and hypertension among young people (21–24). In our study, physical activity significantly affects diastolic blood pressure values (*Table VI*).

Studies have shown that hypertension is significantly correlated with the age (increases with age), gender (more frequent in males), place of living (more frequent in urban areas), alcohol consumption, physical activity, BMI (25). Some studies have shown that although respondents have adequate knowledge about high blood pressure risk factors, they do not adhere to healthy lifestyles (26, 27). However, there are situations where people are lacking the awareness of how to reduce the risk of hypertension. The pharmacists have the key role in those situations, as pharmacists are often the only link between the Healthcare system and the patients. The results of our research have shown that the influence of stress on the systolic blood pressure values has marginal significance, but the age significantly affects the blood glucose level.

Conclusion

When analysing all the factors that could cause the later development of diabetes, which is associated with hypertension as well, it is observed that the student population is very much exposed to those factors. Hypertension is the most significant risk factor for cardiovascular disease and mortality. The incidence is increasing in most countries, and lifestyle habits are considered to be decisive for this development. Obesity, physical inactivity, unhealthy diet, increased salt intake, smoking and psychosocial stress are of different importance to the development of diabetes and hypertension. Most occurrences of prediabetes and prehypertension at this age is still undiagnosed and untreated.

The results of this study cannot be representative for the general population of students, but they can provide recommendations for further research. Students are considered to be healthy population, but the interventions targeting young people are necessary in order to influence their future life habits.

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Conflict of interest statement

The authors stated that they have no conflicts of interest regarding the publication of this article.

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