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, preteran 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 hiperglykemije. 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 dijagnostikованог 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 kravnim 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).
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

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:

\[
\text{Obesity-Pressure Score} \, \text{OPS} = \text{BMI} + \text{AVERAGE} \, \text{(systolic and diastolic blood pressure)}
\]
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 (<75th percentile) and with risk (>75th 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.

| Mean±SD (min-max) or N(%) | Total | Gender | P value |
|--------------------------|-------|--------|---------|
| 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/m²) | 22.13±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    |
|----------------------------------------------------------------------------|--------------------------------------|---------------------------------------------|------|
| OPS – BMI, systolic/diastolic blood pressure                               | –5.80 (–10.54 – –2.67)–20.60–12.49    | Male: –5.55 ± 7.01                            | 0.499|
|                                                                           |                                      | Female: –6.66±6.74                           |      |
| OHS – BMI, glucose, HbA1c                                                 | –0.51 (–1.02 – 1.70)–3.10–4.37       | Male: –0.10±1.59                             | 0.125|
|                                                                           |                                      | Female: 0.43±1.97                            |      |
| HPS – systolic/diastolic blood pressure, glucose, HbA1c                   | –5.93 (-9.84 – –2.46)–19.48–14.04     | Male: –5.72±6.75                             | 0.623|
|                                                                           |                                      | Female: –6.87±6.44                           |      |
| OPHS – BMI, systolic/diastolic blood pressure, glucose, HbA1c             | –5.90 (–10.46 – –2.19)–21.41–14.65    | Male: –5.68±7.13                             | 0.625|
|                                                                           |                                      | Female: –6.55±7.13                           |      |

P value from the Student t test

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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 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 75th percentile value for any of the three scores (obesity-hyperglycaemia, obesity-hypertension, hyperglycaemia-hypertension) and in these sub-groups compared systolic and diastolic blood 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-hypertension), and in these sub-groups compared systolic and diastolic blood pressure, glucose and HbA1c, BMI, respectively. Results are presented at the Figure 1.

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 75th 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 75th 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 χ² 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 lifestyle 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 | 0/1 | 0/1 | 0/1  |
| Sex                              |     |     |     |      |
| male                             | 59/19 | 66/12 | 57/21 | 59/19 |
| female                           | 82/29 | 77/34 | 84/27 | 82/29 |
| Faculty                          |     |     |     |      |
| Faculty of Pharmacy              | 72/25 | 74/23 | 63/33 | 74/23 |
| 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 | 20/0 | 13/7 | 13/7 |
| no                               | 127/42 | 122/47 | 129/40 | 129/40 |
| Age                              |     |     |     |      |
| at 25 years                      | 130/37 | 132/35 | 132/35 | 132/35 |
| over 25 years                    | 12/10 | 10/12 | 10/12 | 10/12 |
| Consumption of Snacks            |     |     |     |      |
| yes                              | 114/23 | 121/16 | 109/27 | 112/25 |
| no                               | 45/7 | 48/4 | 46/7 | 45/7 |
| Level of physical activity       |     |     |     |      |
| once a week or less              | 49/8 | 47/10 | 47/10 | 49/8 |
| 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 | 32/14 | 25/20 | 27/18 |
| 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 | 30/8 | 27/12 | 28/10 |
| 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 | 6/32 | 19/19 | 19/19 |
| 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                   | 0.038    | 79 (70.54)         | 20 (17.86)      | 0.111      |                   |
| over 25 years                 | 0.011    | 8 (7.14)           | 5 (4.46)        |            |                   |
| **Faculty**                   |          |                    |                 |            |                   |
| Faculty of Pharmacy           | 0.291    | 43 (58.05)         | 15 (13.27)      | 0.713      |                   |
| Faculty of Transport and Traffic Engineering | 0.111    | 13 (11.50)         | 4 (3.54)        |            |                   |
| Faculty of Veterinary Medicine | 0.014    | 7 (6.19)           | 1 (0.88)        |            |                   |
| Faculty of Political Sciences | 0.820    | 7 (6.19)           | 0 (0)           |            |                   |
| Faculty of Organizational Sciences | 0.018    | 12 (10.62)         | 2 (1.77)        |            |                   |
| **Smoking status**            |          |                    |                 |            |                   |
| yes                           | 0.731    | 10 (8.85)          | 2 (1.77)        | 0.948      |                   |
| Consumption of Snacks         |          |                    |                 |            |                   |
| yes                           | 0.984    | 47 (56.63)         | 13 (11.50)      | 0.814      |                   |
| **Level of physical activity**|          |                    |                 |            |                   |
| once a week or less           | 0.163    | 29 (25.66)         | 5 (4.42)        |            |                   |
| **Coffee Consumption**        |          |                    |                 |            |                   |
| yes                           | 0.754    | 56 (49.56)         | 19 (16.81)      | 0.289      |                   |
| Stress                        |          |                    |                 |            |                   |
| every day                     | 0.289    | 16 (14.16)         | 7 (6.19)        | 0.018      |                   |
| **Alcohol Consumption**       |          |                    |                 |            |                   |
| once a week                   | 0.261    | 5 (16.67)          | 1 (3.33)        | 0.051      |                   |

### 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) | 5 (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 (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.

References

1. World Health Organization. A global brief on hypertension-Silent killer, global public health crisis. World Health Organization; 2013.

2. Khanal MK, Dhungana RR, Bhandari P, Gurung Y, Paudel KN. Prevalence, associated factors, awareness, treatment, and control of hypertension: Findings from a cross sectional study conducted as a part of a community based intervention trial in Surkhet, Mid-western region of Nepal. PLOS ONE 2017; 12(10): e0185806.

3. Ministry of Health Republic of Serbia. Arterijska hipertenzija – Nacionalni vodić za lekare u primarnoj zdravstvenoj zaštiti. Beograd: Srpsko lekarsko društvo; 2005.

4. Pavletić Perić M, Vukasović-Mikulić S, Rački S. Arterijska hipertenzija. Medicina fluminensis 2010; 46(4): 376–89.

5. Li Y, Wang DD, Ley SH, Vasanti M, Howard AG, He Y, et al. Time Trends of Dietary and Lifestyle Factors and Their Potential Impact on Diabetes Burden in China. Diabetes Care 2017; 40(12): 1685–94.

6. Yuen A, Sugeng Y, Weiland TJ, Jelinek GA. Lifestyle and medication interventions for the prevention or delay of type 2 diabetes mellitus in prediabetes: a systematic review of randomised controlled trials. Australian and New Zealand Journal of Public Health 2010; 34(2): 172–8.

7. World Health Organization. The WHO STEPwise approach to Surveillance of noncommunicable diseases (STEPS). Geneva: World Health Organization, 2003.

8. World Health Organization. The WHO STEPwise approach to chronic disease risk factor surveillance. Geneva: World Health Organization, 2005.

9. Ministarstvo zdravlja Republike Srbije. Nacionalni vodić dobre kliničke prakse – Arterijska hipertenzija 2012.

10. Diabetes.co.uk. Convert HbA1c to Average Blood Sugar Level. Available from: http://www.diabetes.co.uk/hba1c-to-blood-sugar-level-converter.html.

11. Ministarstvo zdravlja i Institut za javno zdravlje »Dr Milan Jovanović Batut«. Rezultati istraživanja zdravlja stanovništva Srbije 2013. godine. Beograd: 2014.

12. Mainous AG, Diaz VA, Everett CJ. Assessing Risk for Development of Diabetes in Young Adults. Annals of Family Medicine 2007; 5(5): 425–9.

13. Park PJ, Griffin SJ, Sargeant L, Wareham NJ. The Performance of a Risk Score in Predicting Undiagnosed Hyperglycemia. Diabetes Care 2002; 25(6): 984–8.
14. Kirčanski-Obrenović B, Dimković S. Globalni pristup lečenju arterijske hipertenzije. Medicinski glasnik Instituta za štitastu žezdu i metabolizam »Zlatibor«. 2007; 12(21): 7–15.

15. Hu C-S, Wu Q-H, Hu D-Y, Tkebuchava T. Novel strategies halt cardiovascular, diabetes, and cancer strips. Chronic Diseases and Translational Medicine 2017; 3(3): 159–64.

16. Samadian F, Dalili N, Jamalian A. Lifestyle Modifications to Prevent and Control Hypertension. Iran J Kidney Dis 2016; 10(5): 237–63.

17. World Health Organization-Regional Office for Europe. High blood pressure – country experiences and effective interventions utilized across the European Region. Copenhagen, Denmark: 2013.

18. Collart F, de Timary P, Dom G, Dor BD, Duprez D, Lengele JP, et al. Alcohol-induced hypertension: an important healthcare target in Belgium. Acta Clinica Belgica 2015; 70(6): 389–95.

19. Ministarstvo zdravlja Republike Srbije. Nacionalni vodič dobre kliničke prakse DIABETES MELLITUS. Beograd: Agencija za akreditaciju zdravstvenih ustanova Srbije; 2012.

20. Institute of Public Health of Serbia »Dr Milan Jovanovic Batut«. Health Statistical Yearbook of Republic of Serbia 2016. Belgrade: Institute of Public Health of Serbia »Dr Milan Jovanovic Batut« 2017.

21. Stiefel EC, Field L, Replogle W, McIntyre L, Igboechi O, Savio FH. The Prevalence of Obesity and Elevated Blood Pressure in Adolescent Student Athletes From the State of Mississippi. Orthopaedic Journal of Sports Medicine 2016; 4(2): 2325967116629568.

22. Klisic A, Kavaric N, Soldatovic I, Bjelakovic B, Kotur-Stevuljevic J. Relationship between cardiovascular risk score and traditional and nontraditional cardiometabolic parameters in obese adolescent girls. J Med Biochem 2016; 35: 282–92.

23. Dželalija DD, Spasić SS, Kotur-Stevuljevic JM, Bogavac-Stanojevic NB. Cardiovascular risk factors in 7–13 years old children from Vojvodina (Serbia). J. Med Biochem 2016; 35: 293–301.

24. Hashim AA, Ali SA, Emara IA, El-Hefnawy MH. CTX correlation to disease duration and adiponectin in Egyptian children with T1DM. J Med Biochem 2016; 35; 34–42.

25. Oommen AM, Abraham VJ, George K, Jose VJ. Prevalence of risk factors for non-communicable diseases in rural & urban Tamil Nadu. The Indian Journal of Medical Research 2016; 144(3): 460–71.

26. Puhalo Sladoje D, Kisić B, Mićić D. The monitoring of protein markers of inflammation and serum lipid concentration in obese subjects with metabolic syndrome. J Med Biochem 2017; 36; 366–74.

27. Shamsi A, Nayeri ND, Esmaili M. Life experiences of patients before having hypertension: a qualitative study. Electronic Physician 2017; 9(3): 3925–33.

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