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ASSESSMENT OF ARTERIAL BLOOD PRESSURE, GLYCEMIA AND BODY MASS INDEX IN A STUDENT POPULATION

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Abstract. *Cardiometabolic risk factors, including blood pressure, glycemia and body mass index (BMI), play a significant role in the development of cardiovascular and metabolic diseases. The aim of this study was to assess these parameters among students and examine the associations among them. This cross-sectional study included 63 students enrolled in the Radiologic Technology programme at the Academy of Applied Preschool Teaching and Health Studies in Ćuprija, Republic of Serbia. Body weight, height, blood pressure and fasting glycemia were measured. The association between BMI and the other parameters was examined using correlation analysis. Statistical significance was set at $p < 0.05$. The study included 46 female and 17 male students, with a mean age of 20.0 ± 0.1 years. The mean BMI was 23.6 ± 4.1 kg/m², while 24 participants (38.1%) had a BMI ≥25 kg/m². The mean systolic blood pressure was 117.1 ± 8.5 mmHg, the mean diastolic blood pressure was 74.9 ± 8.4 mmHg and the mean glycemia was 5.12 ± 0.98 mmol/L. Elevated blood pressure values (≥130 and/or ≥85 mmHg) were recorded in 22.2% of participants, while glycemia ≥5.6 mmol/L was observed in 11.1%. A weak, statistically significant positive correlation was found between BMI and diastolic blood pressure ($r = 0.26$; $p = 0.038$) whereas the correlation with systolic blood pressure was not statistically significant ($r = 0.23$; $p = 0.073$). No association was found between BMI and glycemia ($r = 0.004$; $p = 0.973$). Students with a BMI ≥25 kg/m² had significantly higher diastolic blood pressure than the other participants (77.7 ± 7.7 mmHg vs. 73.2 ± 8.4 mmHg; $p = 0.033$). The results indicate that increased BMI is associated with higher diastolic blood pressure even in younger populations, highlighting the importance of early monitoring of cardiometabolic risk factors.*

Keywords: *body mass index (BMI), blood pressure, glycemia, students, cardiometabolic risk factors*

Introduction

Cardiometabolic risk factors, including excess body weight, elevated blood pressure

and impaired glucose metabolism, play a significant role in the development of cardiovascular diseases and type 2 diabetes mellitus [1–5]. Although these conditions generally become clinically evident during middle and older adulthood, their early manifestations and risk factors may already be present in young adults [6–8].

Body mass index (BMI) is a simple and widely used anthropometric measure of nutritional status. According to the World Health Organization (WHO) classification, a BMI ≥25 kg/m² is classified as overweight, whereas a BMI of ≥30 kg/m² is classified as obesity [1]. Although BMI does not allow assessment of body fat distribution, its association with arterial hypertension, type 2 diabetes mellitus and other cardiometabolic disorders has been confirmed in numerous epidemiological studies [2,4,5].

An increase in BMI is associated with higher systolic and diastolic blood pressure levels. The mechanisms underlying this association include increased sympathetic nervous system activity, activation of the renin-angiotensin-aldosterone system, sodium retention, insulin resistance, endothelial dysfunction and chronic low-grade inflammation associated with excess adipose tissue [6,7]. Consequently, excess body weight is considered one of the most important modifiable risk factors for the development of arterial hypertension [3,6,7].

In contrast to blood pressure, the association between BMI and glycemia may not be clearly evident in metabolically healthy young adults. During the early stages of weight gain, glucose regulation may remain preserved owing to a compensatory increase in insulin secretion, whereas disturbances in glucose regulation typically develop only after prolonged insulin resistance [2,9]. Nevertheless, excess body weight during young adulthood is a significant predictor of the subsequent development of prediabetes, type 2 diabetes mellitus and other cardiometabolic disorders [2,5,9].

The student population constitutes an appropriate group for investigating early cardiometabolic changes because risk factors during this stage of life are predominantly related to lifestyle factors, physical activity and dietary habits, whereas chronic diseases remain relatively uncommon. Studies conducted among students and young adults have demonstrated that BMI is frequently associated with blood pressure, while the association between BMI and glycemia appears to be less consistent [8,10–12].

The aim of this study was to assess blood pressure, glycemia and BMI among students and examine the association between BMI and variations in these parameters.
It was hypothesized that students would predominantly exhibit normal blood pressure and glycemia, with a possible association between BMI and variations in these parameters.

Methods

The study was conducted as a cross-sectional study and included 63 students enrolled in the Radiologic Technology program at the Academy of Applied Preschool Teaching and Health Studies in Ćuprija, Republic of Serbia. Body height and weight were measured in all participants and BMI was calculated from these measurements. Systolic and diastolic blood pressure, as well as glycemia, were also assessed. Body weight and height were determined using an Omron digital scale with an integrated stadiometer (Omron Healthcare, Japan). Glycemia was measured in the morning after an overnight fast of at least 8 hours to ensure reliable and clinically relevant fasting glycemia measurements. A capillary blood sample was collected and glycemia was determined using an Accu-Chek Guide glucometer (Roche Diagnostics, Germany). Blood pressure was measured in the seated position following a resting period. Measurements were performed using the auscultatory method with a manual aneroid sphygmomanometer (Prizma, Republic of Serbia). Data were analysed using descriptive statistics. The association between BMI and the remaining parameters was evaluated using correlation analysis. Statistical significance was set at $p < 0.05$.

Results

The basic characteristics of the study population are presented in Table 1, while the descriptive statistics for the investigated parameters are shown in Table 2.

Table 1. Basic characteristics of the study participants.

Parameter	**Value**
Number of participants	63
Female, n (%)	46 (73.0%)
Male, n (%)	17 (27.0%)
Age (years)	20.0 ± 0.1
BMI (kg/m²)	23.6 ± 4.1
Systolic blood pressure (SBP) (mmHg)	117.1 ± 8.5
Diastolic blood pressure (DBP) (mmHg)	74.9 ± 8.4
Glycemia (mmol/L)	5.12 ± 0.98

Table 2. Descriptive statistics of the study variables.

Parameter	**Mean ± SD**	**Median (IQR)**	**Min–Max**
BMI (kg/m²)	23.6 ± 4.1	22.9 (20.9–25.8)	17.2–35.4
SBP (mmHg)	117.1 ± 8.5	116 (111–123)	98–142
DBP (mmHg)	74.9 ± 8.4	74 (70–80)	56–96
Glycemia (mmol/L)	5.12 ± 0.98	4.9 (4.6–5.3)	3.8–8.4

A total of 63 students were included in the study, of whom 46 (73.0%) were female and 17 (27.0%) were male. The mean age of the participants was 20.0 ± 0.1 years. The mean BMI was 23.6 ± 4.1 kg/m². A BMI ≥25 kg/m² was recorded in 24 students (38.1%), with 19 participants classified as overweight and 5 as obese.

The mean systolic blood pressure was 117.1 ± 8.5 mmHg and the mean diastolic blood pressure was 74.9 ± 8.4 mmHg. Elevated blood pressure (≥130 and/or ≥85 mmHg) was recorded in 14 students (22.2%). The mean glycemia was 5.12 ± 0.98 mmol/L, while glycemia ≥5.6 mmol/L was recorded in 7 students (11.1%).

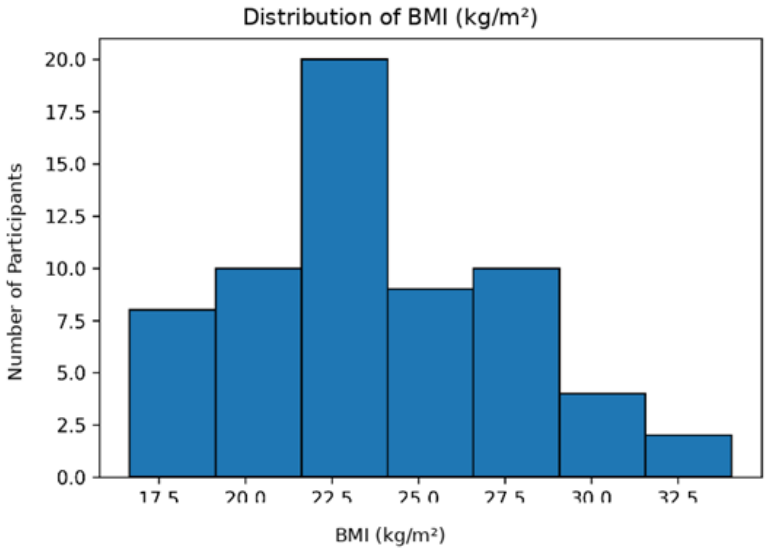

Figure 1. Histogram showing the distribution of body mass index (BMI) among the study participants.

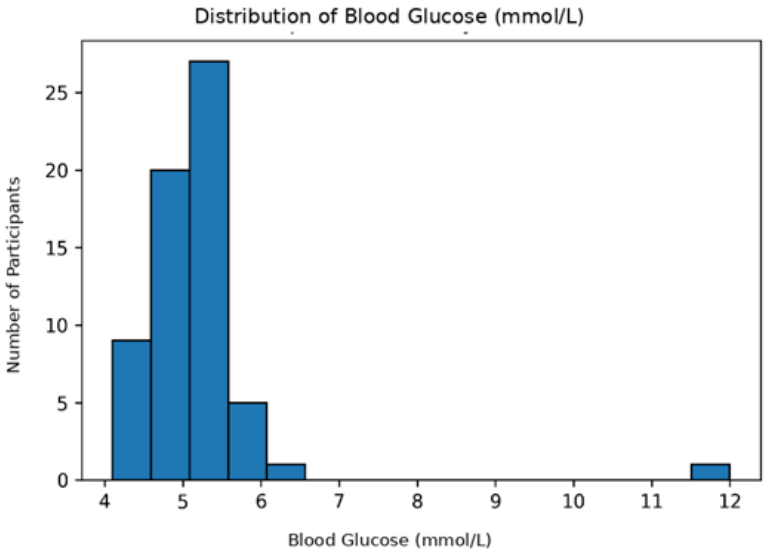

Figure 2. Histogram showing the distribution of glycemia among the study participants.

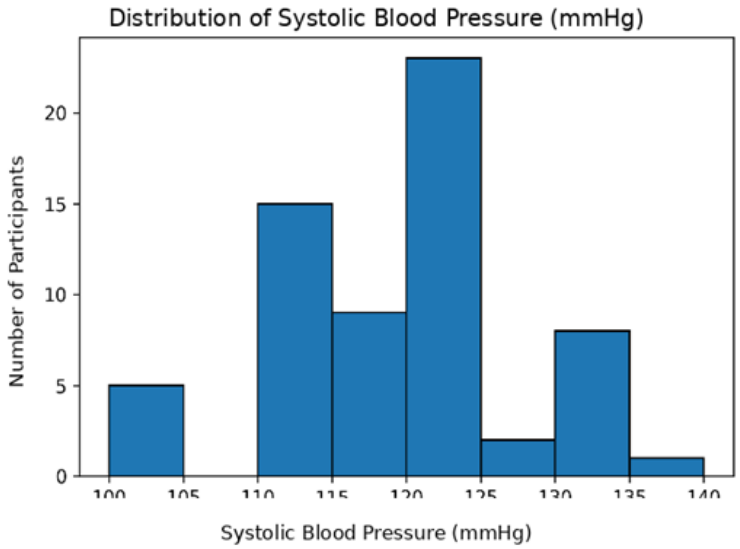

Figure 3. Histogram showing the distribution of systolic blood pressure among the study participants.

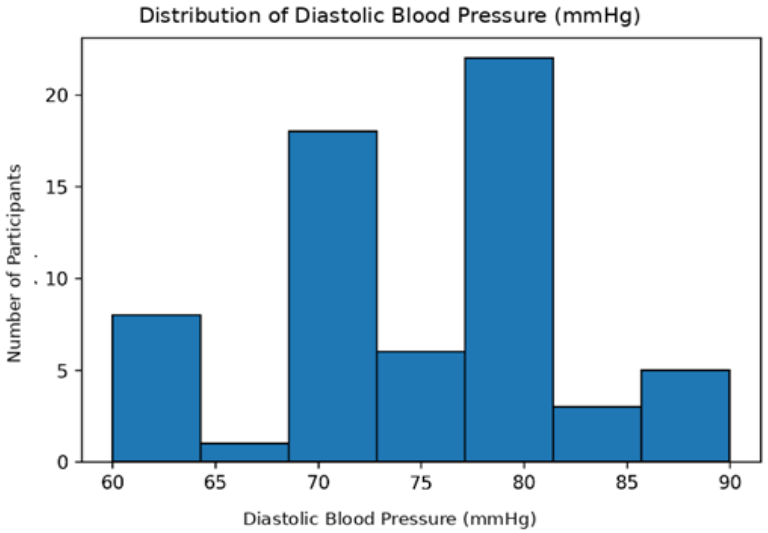

Figure 4. Histogram showing the distribution of diastolic blood pressure among the study participants.

Correlation analysis revealed a weak positive association between BMI and systolic blood pressure ($r = 0.23$; $p = 0.073$), which did not reach statistical significance. A weak but statistically significant positive correlation was found between BMI and diastolic blood pressure ($r = 0.26$; $p = 0.038$). No association was found between BMI and glycemia ($r = 0.004$; $p = 0.973$). These associations are presented in Figures 5–7.

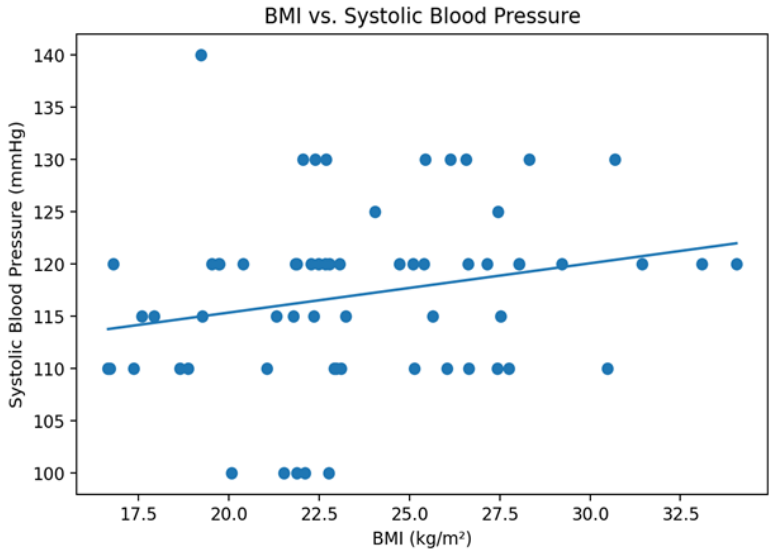

Figure 5. Association between body mass index (BMI) and systolic blood pressure among the study participants.

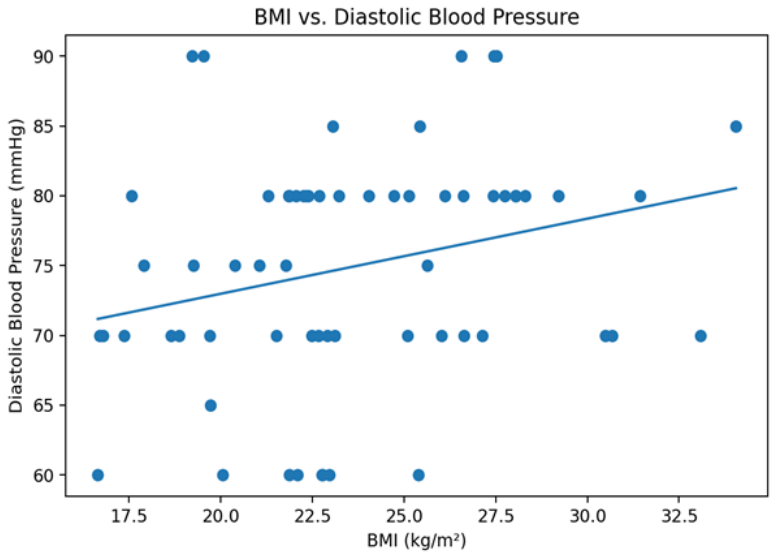

Figure 6. Association between body mass index (BMI) and diastolic blood pressure among the study participants.

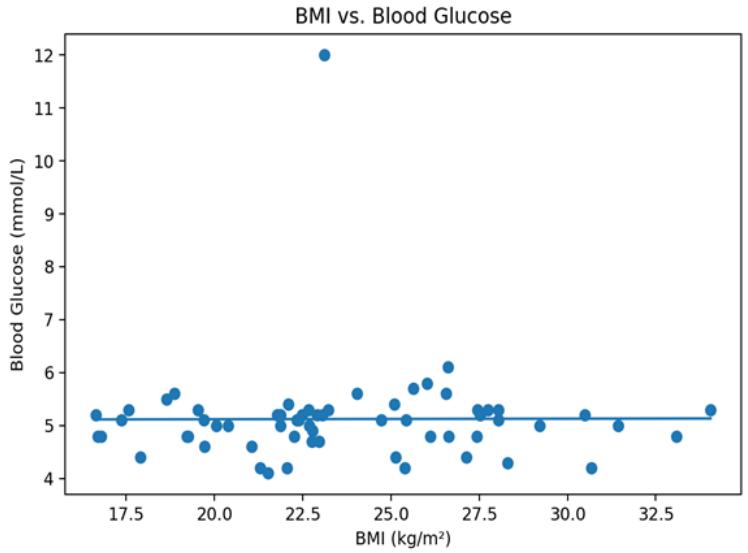

Figure 7. Association between body mass index (BMI) and glycemia among the study participants.

Students with a BMI ≥25 kg/m² had significantly higher diastolic blood pressure than those with a BMI <25 kg/m² (77.7 ± 7.7 vs. 73.2 ± 8.4 mmHg; p = 0.033), whereas the difference in systolic blood pressure did not reach statistical significance (119.4 ± 7.1 vs. 115.6 ± 9.0 mmHg; p = 0.073). The distributions by sex and BMI categories are presented in Figures 8–10.

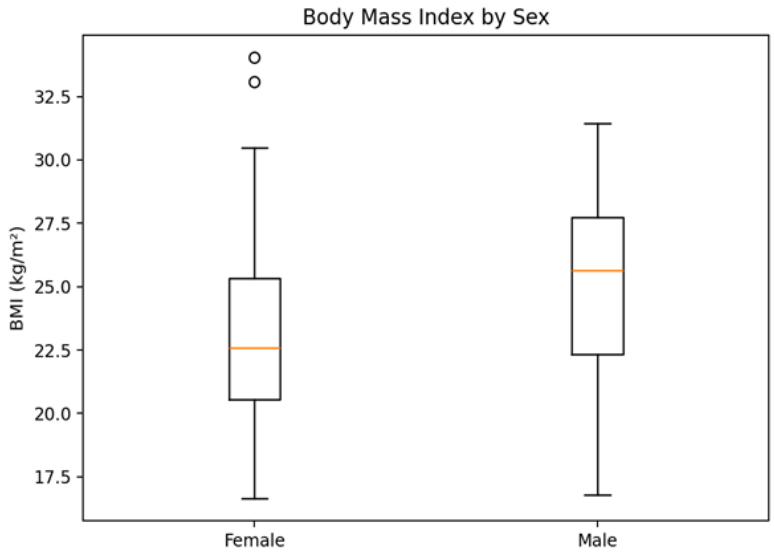

Figure 8. Distribution of body mass index (BMI) by sex.

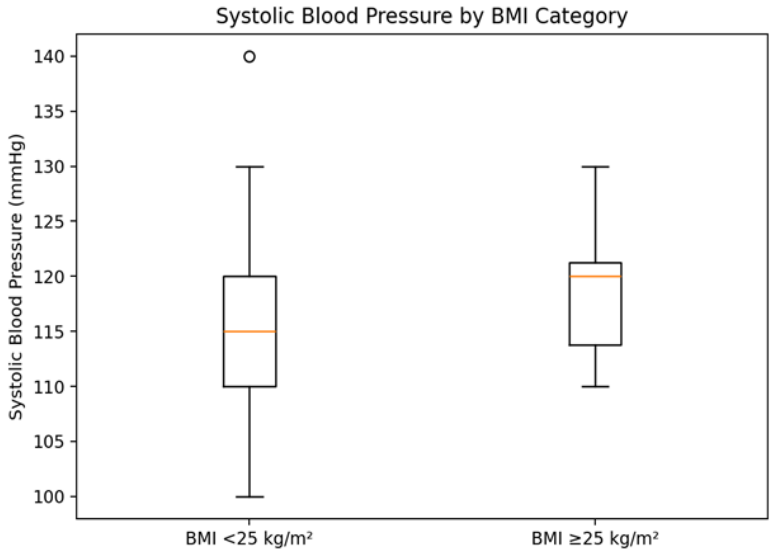

Figure 9. Distribution of systolic blood pressure by BMI groups (BMI <25 and BMI ≥25).

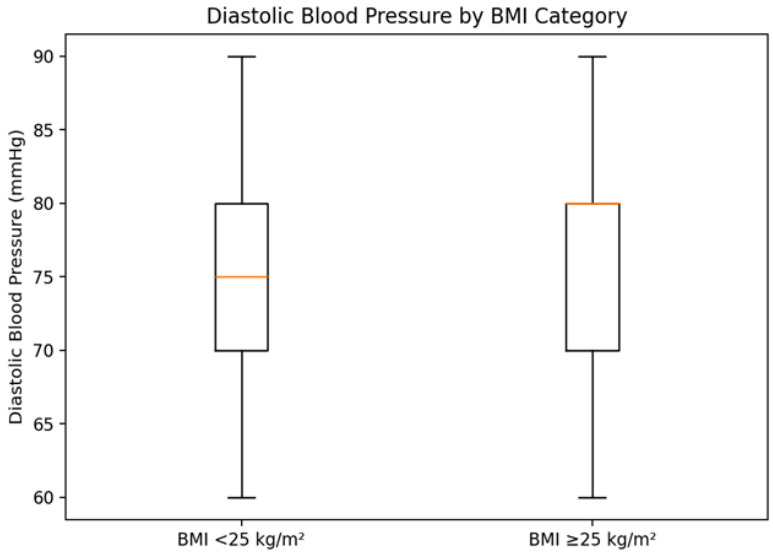

Figure 10. Distribution of diastolic blood pressure by BMI categories (BMI <25 kg/m² and BMI ≥25 kg/m²).

Discussion

The results of this study demonstrated that blood pressure and glycemia in the study population were generally within the expected range for young adults. The mean BMI indicated that most participants had normal body weight. However, a considerable proportion had a BMI ≥25 kg/m² and were classified as overweight, while a smaller

number of participants met the criteria for obesity. These findings are consistent with recent epidemiological data indicating an increasing prevalence of overweight and obesity among younger age groups [1,4,5].

In the study, a weak positive association was observed between BMI and systolic blood pressure although it did not reach statistical significance. In contrast, a weak but statistically significant positive correlation was found between BMI and diastolic blood pressure. Moreover, students with a BMI $\geq$25 kg/m² had higher mean diastolic pressure than those with a BMI <25 kg/m². These findings suggest that the impact of increased body weight on blood pressure may already be detectable in young adults, even before the development of overt arterial hypertension [6–8,10].

The findings are consistent with previous studies demonstrating an association between BMI and blood pressure in young adults and students. In a population-based study of young adults, Khan et al. reported that increasing BMI was associated with higher systolic and diastolic blood pressure [10]. Similarly, in a study conducted among medical students, Song et al. found that BMI was associated with blood pressure as well as other indicators of functional status [8]. These findings support the assumption that excess body weight may already be associated with a less favourable hemodynamic profile during the student years.

The pathophysiological association between BMI and blood pressure is explained by several interconnected mechanisms. Obesity leads to an increase in circulating blood volume, increased cardiac output, activation of the sympathetic nervous system and the renin-angiotensin-aldosterone system, as well as sodium retention and increased vascular stiffness [6,7]. These changes may precede clinically overt hypertension, which may explain the modest increase in blood pressure observed in young individuals with an elevated BMI.

Unlike blood pressure, no significant association between BMI and fasting glycemia was found in the study. This finding was expected in a population of young and generally healthy participants, in whom pancreatic beta-cell function is usually preserved and disturbances in glucose regulation have not yet developed [2,9]. Similar findings have been reported in some studies involving student populations, whereas other studies have demonstrated a weak positive association between BMI and fasting glycemia [11,12]. These discrepancies may be explained by differences in participants' age, the prevalence of obesity, ethnic composition, dietary habits, physical activity levels and glycemia measurement methodology.

Although the absence of an association between BMI and fasting glycemia in the study suggests preserved glucose regulation in most participants, it does not diminish the importance of monitoring body weight in young adults. The prolonged presence of excess body weight increases the risk of insulin resistance, prediabetes and type 2 diabetes mellitus, particularly when accompanied by physical inactivity, unhealthy dietary habits and a family history [2,5,9].

The public health significance of this study lies in the fact that the measurement of body weight, height, blood pressure and glycemia represents a simple, accessible and cost-effective screening approach. The use of these measurements in the student population may facilitate the early identification of individuals at increased cardiometabolic risk and enable the timely implementation of preventive measures, including education on healthy eating, increased physical activity and the maintenance of a normal body weight [1–4].

The study has several limitations. It was conducted at a single educational institution and included a relatively small sample of participants, which limits the generalizability of the findings. In addition, the cross-sectional study design does not allow conclusions to be drawn regarding causal relationships between BMI, blood pressure and glycemia. Further studies should include a larger number of participants, multiple educational institutions and additional parameters such as waist circumference, waist-to-height ratio, physical activity, dietary habits, lipid profile and insulin levels.

Overall, the findings of the study indicate that early markers of cardiometabolic risk may be detected even in young, apparently healthy individuals. Although BMI was not associated with glycemia, it demonstrated a positive association with blood pressure, particularly diastolic blood pressure. These findings emphasize the importance of early monitoring of body weight and blood pressure in the student population.

Conclusion

The students generally exhibited normal blood pressure and glycemia values. BMI was not associated with glycemia but demonstrated a weak positive association with blood pressure, particularly diastolic blood pressure. These findings underscore the importance of early monitoring of body weight and blood pressure, even among young, apparently healthy individuals.

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STANJE ARTERIJSKOG PRITISKA, GLIKEMIJE I INDEKSA TELESNE MASE U POPULACIJI STUDENATA

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Sažetak. *Kardiometabolički faktori rizika, uključujući arterijski pritisak, glikemiju i indeks telesne mase (BMI), značajni su za razvoj kardiovaskularnih i metaboličkih oboljenja. Cilj istraživanja bio je da se procene vrednosti ovih parametara kod studenata i ispita njihova međusobna povezanost. Istraživanje je sprovedeno kao studija preseka koja je obuhvatila 63 studenta smera Radiološki tehničar Akademije vaspitačko-medicinskih strukovnih studija u Ćupriji. Izmereni su telesna masa, visina, arterijski pritisak i glikemija natašte, a povezanost BMI sa ostalim parametrima ispitana je korelacionom analizom. Statistička značajnost definisana je na nivou $p < 0,05$. U istraživanju je učestvovalo 46 studentkinja i 17 studenata, prosečne starosti 20,0 ± 0,1 godina. Prosečan BMI iznosio je 23,6 ± 4,1 kg/m², dok su 24 ispitanika (38,1%) imala BMI ≥25 kg/m². Prosečan sistolni arterijski pritisak iznosio je 117,1 ± 8,5 mmHg, dijastolni 74,9 ± 8,4 mmHg, a glikemija 5,12 ± 0,98 mmol/L. Povišene vrednosti arterijskog pritiska (≥130 i/ili ≥85 mmHg) registrovane su kod 22,2% ispitanika, dok je glikemija ≥5,6 mmol/L utvrđena kod 11,1%. Utvrđena je slaba, statistički značajna pozitivna korelacija između BMI i dijastolnog arterijskog pritiska ($r = 0,26$; $p = 0,038$), dok korelacija sa sistolnim pritiskom nije bila statistički značajna ($r = 0,23$; $p = 0,073$). Nije utvrđena povezanost BMI sa glikemijom ($r = 0,004$; $p = 0,973$). Studenti sa BMI ≥25 kg/m² imali su značajno viši dijastolni pritisak od ostalih ispitanika (77,7 ± 7,7 prema 73,2 ± 8,4 mmHg; $p = 0,033$). Rezultati ukazuju da je povećan BMI povezan sa višim dijastolnim arterijskim pritiskom već u mlađoj populaciji, što naglašava značaj ranog praćenja kardiometaboličkih faktora rizika.*

Ključne reči: indeks telesne mase (BMI), arterijski pritisak, glikemija, studenti, kardiometabolički faktori rizika