

## INCREASED BLOOD PRESSURE DURING PUBERTY

Božidar Stojiljković<sup>1</sup>, Ljubiša Lilić<sup>2</sup>, Sladjana Milošević<sup>2</sup>

Blood pressure is continuously increasing and increases with the child's age, that is, with the growth and development of the child.

The change in pressure value in puberty appears due to complex morphological and physiological changes in the organism under the influence of hormones.

With this work we have proven that blood pressure has a significant increase in children from 11 to 14 years compared to the previous period. We used the results of the systematic examination of school children of the 5<sup>th</sup>, 6<sup>th</sup> and 7<sup>th</sup> grade in the city of Niš. A total of 2333 children of both sexes were analyzed. The blood pressure was measured in a seated position three times at a time interval of 5 minutes. For statistical processing, the highest value was taken. The greatest differences in blood pressure, diastolic pressure, occurred in boys compared to girls in the fifth grade, while girls had a higher diastolic pressure than boys in the sixth and seventh grades of primary school ( $p < 0.001$ ). Regarding morphological characteristics, girls had significantly higher body height values than boys in the sixth grade ( $p < 0.005$ ), while boys had higher values of both body height and body weight in the seventh grade ( $p < 0.001$ ). In the period of puberty, there are numerous changes in all systems and organs, blood pressure varies significantly, and therefore it has to be measured and controlled more frequently for the detection and prevention of arterial hypertension in children.

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**Key words:** blood pressure, puberty, increase, sexes, arterial hypertension

<sup>1</sup>General Hospital Leskovac, Department of Neurology, Serbia  
<sup>2</sup>University of Kosovska Mitrovica, Faculty of Sport and Physical Education Leposavić, Serbia

Contact: Božidar Stojiljković  
Rade Končara 9, 16000 Leskovac, Serbia  
E-mail: drbozidarstojiljkovic@gmail.com

that occur under the influence of hypophysis hormones and gonads. As the whole organism grows, the cardiovascular system develops normally, the heart, lungs and abdominal organs grow, and blood pressure rises to a value of 120/70 mmHg, which is the average of the blood pressure in adolescence (2, 3, 9).

### *The goal of the work*

With this work we tried to prove that blood pressure in children from 11 to 14 years undergoes significant changes, that is, that its value significantly increases compared to the previous period.

### **Materials and methods**

We conducted systematic examinations of school children in the three primary schools of the city of Niš, pupils of the fifth, sixth and seventh grades. There were in total 2333 children with approximately equal representation of both sexes. In addition to anthropometric measurements (body height and body mass), blood pressure measurements in the sitting position were also carried out, three times in a space of 5 minutes. The highest value was obtained for statistical processing. For comparison of the obtained values in boys and girls, Student's t-test was used. All results are presented in tabular and graphical form.

### **Introduction**

Arterial blood pressure in children is a variable that increases with the age of the child, that is, with the growth and development of a child (1). From normal values at birth of 75/55 mmHg, blood pressure records a constant increase until puberty and adolescence. The highest increase of about 20 mmHg occurs during the first six weeks of life (5). A further rise in blood pressure is gradual and is approximately 5 mmHg for periods of three years to puberty and adolescence when for the same period blood pressure increases about 8 mmHg (4, 6, 8). In the period of puberty there are complex morphological and physiological changes in the body of boys and girls

**Results**

The obtained results were statistically processed and graphically presented.

The mean values of the systolic (SV) and diastolic (FDIS) pressure, as well as anthropometric measurements of body height (AVIS) and body weight (AMAS) in boys of the fifth grade are shown in the Table 1. Also, the minimum (MIN) and maximum (MAX) values obtained in the systematic examination of children, as well as the values of the standard

deviation (SD) and the coefficient of variation (CV) used in the student's t-test are presented.

Table 2 shows us the mean values of systolic and diastolic pressure in boys of the sixth grade, as well as the values of body height and mass.

Table 3 shows the mean values of systolic and diastolic pressure in boys of the seventh grade, mean systolic pressure is 117.2 mmHg, and diastolic 71.17 mmHg, as well as body height and body weight.

**Table1.** An overview of the blood pressure and anthropometric measures in the fifth grade boys

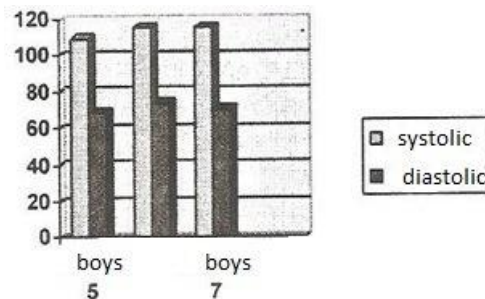
	SV	SD	MIN	MAX	CV
FSIS	109.46	11.64	80	155	10.63
FDIS	68.71	9.13	45	100	13.28
AVIS	150.94	7.37	134	179	4.88
AMAS	43.49	10.07	28	88	23.69

**Table2.** An overview of the blood pressure and anthropometric measures in the sixth grade boys

	SV	SD	MIN	MAX	CV
FSIS	115.51	9.7	90	170	8.39
FDIS	70.6	7.66	55	100	10.59
AVIS	156.32	8.42	130	179	5.38
AMAS	46.79	9.84	28	75	21.03

**Table 3.** An overview of the blood pressure and anthropometric measures in the seventh grade boys

	SV	SD	MIN	MAX	CV
FSIS	117.21	11.06	90	150	9.59
FDIS	71.17	10.18	50	100	14.5
AVIS	163.84	8.58	141	187	5.23
AMAS	53.02	12.41	30	90	23.4



**Graph 1.** An overview of the systolic and diastolic blood pressure values in boys from the fifth to the seventh grade

Graph 1 shows a graphical overview of the values of systolic and diastolic blood pressure in the boys from the fifth to the sixth grade.

Table 4 shows the mean values of systolic and diastolic pressure in girls of the fifth grade, mean systolic pressure is 107.28 mmHg, and diastolic 66.22 mmHg, as well as body height and body weight.

Table 5 shows the mean values of systolic and diastolic pressure in girls of the sixth grade, mean

systolic pressure is 115.75 mmHg, and diastolic 74.1 mmHg, as well as body height and body weight.

Table 6 shows the mean values of systolic and diastolic pressure for the girls of the seventh grade, the mean value of systolic pressure is 116.5 mmHg, and of diastolic 75.07 mmHg, as well as the body height and body weight values.

Graph 2 shows a graphical overview of the values of systolic and diastolic blood pressure in the girls from the fifth to the sixth grade.

**Table 4.** An overview of the blood pressure and anthropometric measures in the fifth grade girls

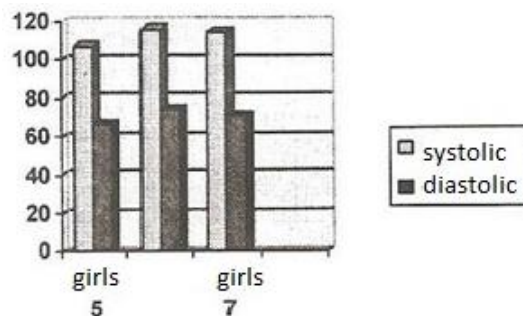
	SV	SD	MIN	MAX	CV
FSIS	107.28	11.17	80	145	10.41
FDIS	66.22	9.5	50	90	14.34
AVIS	150.71	7.1	132.5	172.5	4.71
AMAS	41.21	9.6	22	76	23.29

**Table 5.** An overview of the blood pressure and anthropometric measures in the sixth grade girls

	SV	SD	MIN	MAX	CV
FSIS	115.75	9.39	90	160	8.11
FDIS	74.1	7.18	50	90	9.68
AVIS	157.37	7.84	136	176	4.98
AMAS	48.58	9.44	28	72	19.84

**Table 6.** An overview of the blood pressure and anthropometric measures in the seventh grade girls

	SV	SD	MIN	MAX	CV
FSIS	116.5	12	85	180	10.48
FDIS	75.07	9.69	40	100	13.63
AVIS	161.42	6.4	140.7	182	3.96
AMAS	51.26	10.48	29	115	20.05



**Graph 2.** An overview of the systolic and diastolic blood pressure values in girls from the fifth to the seventh grade

In Tables 7, 8 and 9 we can see the values of the student's t-test (T-test) and the p-value, or calculated probability (p) in boys and girls according to grades for the tested parameters. It is noted that there were statistically significant differences in the values of systolic and diastolic pressure in boys and girls in the fifth grade. The boys had, statistically, significantly higher systolic pressure (109.41 mmHg), as well as diastolic blood pressure (68.71 mmHg) in comparison to girls, and this difference was statistically significant ( $p < 0.001$ ). The boys of this age had statistically significantly higher body weight (43.49 kg) than girls and these differences were statistically significant ( $p < 0.001$ ).

Girls in the sixth grade had statistically significantly higher values of diastolic pressure (74.1 mmHg) compared to boys of that age and these

differences were statistically significant ( $p < 0.001$ ).

Further, girls had statistically significantly higher body weight (48.58 kg) and height (157.35 cm) compared to boys and this difference was statistically significant ( $p < 0.001$ ).

In pupils of the seventh grade, it is noted that the girls had statistically significant higher values of diastolic blood pressure (75.7 mmHg) compared to boys ( $p < 0.001$ ). The boys of the seventh grade had statistically significantly higher values of body height (163.84 cm) and body weight (53.2 kg) than girls and this difference was statistically significantly higher.

**Table 7.** Statistical results of boys and girls in the fifth grade

	T-test	p
FSIS	3.631	$p < 0.001$
FDIS	5.078	$p < 0.001$
AVIS	0.64	$p = 0.546$
AMAS	2.472	$p < 0.001$

**Table 8.** Statistical results of boys and girls in the sixth grade

	T-test	p
FSIS	0.534	$p = 0.593$
FDIS	23.800	$p < 0.001$
AVIS	2.452	$p < 0.05$
AMAS	1.557	$p = 0.120$

**Table 9.** Statistical results of boys and girls in the seventh grade

	T-test	p
FSIS	1.169	$p = 0.243$
FDIS	5.504	$p < 0.001$
AVIS	12.957	$p < 0.001$
AMAS	10.224	$p < 0.001$

## Discussion

In this paper, on the sample of 2333 boys and girls, pupils of the fifth, sixth and seventh grade of the primary school, the changes in arterial blood pressure during the puberty period were examined.

Tables 1, 2, 3, 4, 5 and 6 show the differences between the sexes when it comes to measured variables, that is, differences between boys and girls of the pubertal sample in systolic and diastolic pressure, body height and body mass. It can be seen that the biggest differences between boys and girls are observed when it comes to diastolic pressure.

Boys had significantly higher diastolic pressure than girls in the fifth grade ( $t = 5.078$ ;  $p < 0.001$ ), while girls had higher diastolic blood pressure than boys in the sixth ( $t = 23.800$ ;  $p < 0.001$ ) and the seventh grade of primary school ( $t = 5.504$ ;  $p < 0.001$ ). When it comes to systolic pressure, there were differences between boys and girls only during the fifth grade of primary school where boys have significantly higher values than girls ( $t = 3.631$ ;  $p < 0.001$ ). In terms of morphological characteristics, girls had significantly higher body height than boys in the sixth grade ( $t = 2.452$ ;  $p < 0.005$ ), while boys had higher body weight values in the fifth ( $t = 2.472$ ;  $p < 0.005$ ) as well as body height and body height mass in the seventh grade ( $t = 12.957$ ;  $p < 0.001$ ;  $t = 10.224$ ;  $p < 0.001$ ). The results obtained were expected and in accordance with previous research in this area, which supports the fact that there are significant differences in arterial blood pressure and morphological characteristics between boys and girls of pubertal age (4-6, 8).

It is possible to notice the tendency for boys to have higher values of systolic and diastolic blood pressure than girls during the fifth grade of the primary school, that is, at the onset of puberty, while later, during the growing up period, there is a sudden increase in pressure (especially diastolic) in girls, and they have significantly higher diastolic pressure

values than boys, while in terms of systolic pressure boys and girls have roughly similar values in the sixth and seventh grade. It has also been shown that the biggest difference between boys and girls is in the values of diastolic pressure in the sixth grade period. When it comes to morphological characteristics, it can be concluded that girls have higher values of body height than boys while boys have a greater body mass than girls at the beginning of puberty, and with aging, this difference in the boys' favor increases with respect to body height.

### Conclusion

By comparing blood pressure values in boys and girls per grade, we have come to the conclusion that there is a statistically significant difference in blood pressure values of systolic and diastolic in boys and girls of the fifth and sixth grade, which proves that in the period between 11 and 13 years there is a significant increase in the value of blood pressure. Therefore, in the period of puberty, in addition to numerous changes in all systems and organs, there is a change in blood pressure, which is why blood pressure in this period must be measured and controlled more frequently to detect and prevent arterial hypertension in children.

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Originalni rad

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doi:10.5633/amm.2019.0201**POVIŠEN KRVNI PRITISAK TOKOM PUBERTETA***Božidar Stojiljković<sup>1</sup>, Ljubiša Lilić<sup>2</sup>, Slađana Milošević<sup>2</sup>*<sup>1</sup>Opšta bolnica Leskovac, Klinika za neurologiju, Leskovac, Srbija<sup>2</sup>Univerzitet Kosovska Mitrovica Fakultet za sport i fizičko vaspitanje Leposavić, Srbija

*Kontakt:* Božidar Stojiljković  
Rade Končara 9, 16000 Leskovac, Srbija  
E-mail: drbozidarstojiljkovic@gmail.com

Krvni pritisak beleži neprestani porast i povišava se sa starošću deteta, odnosno sa rastom i razvojem deteta.

Do promene vrednosti pritiska u pubertetu dolazi zbog složenih morfoloških i fizioloških promena u organizmu pod uticajem hormona.

Ovim radom dokazali smo da krvni pritisak ima značajan porast od 11. do 14. godine deteta u odnosu na prethodni period. Koristili smo rezultate sistematskog pregleda školske dece grada Niša, učenika 5, 6. i 7. razreda. Analizirano je 2333 deteta oba pola. Krvni pritisak meren je u sedećem položaju tri puta u razmaku od 5 minuta. Za statističku obradu uzimana je najviša vrednost. Najveće razlike krvnog pritiska, dijastolni pritisak, sreću se kod dečaka u odnosu na devojčice u petom razredu, dok devojčice imaju veći dijastolni pritisak od dečaka u šestom i sedmom razredu osnovne škole ( $p < 0,001$ ). Što se tiče morfoloških karakteristika, devojčice imaju značajno veće vrednosti telesne visine od dečaka u šestom razredu ( $p < 0,005$ ), dok dečaci imaju veće vrednosti telesne visine i telesne mase u sedmom razredu ( $p < 0,001$ ). U periodu puberteta postoje brojne promene u svim sistemima i organima, krvni pritisak značajno varira i zbog toga se mora češće meriti i kontrolisati radi detekcije i sprečavanja arterijske hipertenzije kod dece.

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**Ključne reči:** *krvni pritisak, pubertet, veći, pol, arterijska hipertenzija*