

PROCENA UTICAJA PREKOMERNE TELESNE TEŽINE I GOJAZNOSTI NA NASTANAK PREDHIPERTENZIJE I HIPERTENZIJE KOD DECE UZRASTA 6-15 GODINA

Marijana Jandrić-Kočić¹

¹ Dom zdravlja Krupa na Uni, Banja Luka, Republika Srpska, Bosna i Hercegovina

SAŽETAK

Uvod/Cilj: Prekomernu telesnu težinu ili gojaznost ima 41 milion dece mlađe od 5 godina i 340 miliona dece i adolescenata uzrasta od 5 do 19 godina. Gojaznost dece i adolescenata predstavlja najvažniji prediktor povišenog krvnog pritiska. Cilj istraživanja je bio da se ispita učestalost javljanja prekomerne telesne težine i gojaznosti kod dece uzrasta 6-15 godina, kao i da se proceni učestalost javljanja predhipertenzije i hipertenzije kod dece sa prekomernom telesnom težinom i gojaznošću.

Metode: Ovom studijom bilo je obuhvaćeno 85 od ukupno 86 dece iz Osnovne škole u Krupi na Uni. Podaci su prikupljeni upitnikom, a telesna težina i krvni pritisak su mereni. U statističkoj analizi podataka korišćeni su hi kvadrat test i t-test.

Rezultati: Studijom preseka je bilo obuhvaćeno 85 dece, i to 45 (52,9%) dečaka i 40 (47,1%) djevojčica prosečne starosti $10,87 \pm 2,70$ godina. Normalna uhranjenost utvrđena je kod 54 (63,5%) ispitanika, pothranjenost u 12 (14,1%), prekomerna uhranjenost kod 5 (5,9%), a gojaznost kod 14 (16,5%). Normalne vrednosti krvnog pritiska imalo je 76 (89,4%) ispitanika, predhipertenzivno stanje 5 (5,9%), arterijsku hipertenziju 4 (4,7%). Između mlađe i starije dece nije bilo značajne razlike u odnosu na stepen uhranjenosti ($p=0,477$) i visinu krvnog pritiska ($p=0,453$). Deca sa prekomernom telesnom težinom i gojaznošću bila su značajno češće sa predhipertenzijom i hipertenzijom ($p<0,001$).

Zaključak: Kod svakog petog deteta utvrđena je prekomerna uhranjenost ili gojaznost, a kod svakog desetog predhipertenzija i hipertenzija. Pravovremena promena načina ishrane i fizičke aktivnosti, kao i svih drugih životnih navika, može doprineti regulaciji ne samo telesne težine nego i regulaciji krvnog pritiska.

Ključne riječi: prekomerna telesna težina, gojaznost, predhipertenzija, hipertenzija, studija preseka, deca

Uvod

Gojaznost se, po Međunarodnoj klasifikaciji bolesti (eng. *International classification of diseases, eleventh revision*, ICD-11), svrstava u endokrine bolesti, bolesti ishrane i metabolizma (ICD-XI; E66) (1). To je hronična bolest praćena prekomernim nakupljanjem masnog tkiva i povećanjem telesne težine, a nastaje kao rezultat uticaja brojnih faktora (prekomeran kalorijski unos, fizička neaktivnost i drugo) (1-4). Svetska zdravstvena organizacija (SZO) opisuje epidemiju dečije gojaznosti kao ozbiljan javno zdravstveni izazov 21. veka (5-7). Prema podacima SZO, u vremenskom periodu od 1975. godine do 2016. godine došlo je do porasta prevalencije gojaznosti za tri puta, tako da danas 41 milion dece mlađe od 5 godina i 340 miliona dece i adolescenata uzrasta od 5 do 19 godina ima prekomernu telesnu težinu ili gojaznost (5).

Oko 31 milion dece živi u zemljama u razvoju (6). Gojaznost može imati značajan uticaj na zdravstveno stanje, blagostanje (socijalno i psihološko), samopoštovanje, akademski uspeh i kvalitet života svakog deteta (8).

Gojazna deca imaju tri puta veću verovatnoću da dobiju hipertenziju u odnosu na normalno uhranjenu decu (9). Uzroci koji vode gojaznosti su brojni, a najčešće se ističe značaj genetskih, endokrinih, bihevioralnih i sredinskih faktora (10). Kod gojazne dece sa hipertenzijom može postojati subklinička ateroskleroza sa zadebljenjem arterijskog zida i ugroženom arterijskom elastičnošću (11). Osim toga, promene u geometriji i funkciji miokarda kod ovih osoba (povećanjem leve i desne srčane komore, zadebljanjem zida leve komore, povećanjem mase leve komore) ukazuju

ASSESSMENT OF THE INFLUENCE OF OVERWEIGHT AND OBESITY ON THE DEVELOPMENT OF PREHYPERTENSION AND HYPERTENSION IN CHILDREN AGED 6-15

¹ Marijana Jandric-Kocic

¹ Health Center „Krupa na Uni“, Banja Luka, Republic of Srpska, Bosnia and Herzegovina

SUMMARY

Introduction/Aim: 41 million children under the age of 5 and 340 million children and adolescents aged 5 to 19 are overweight or obese. Obesity in children and adolescents is the most important predictor of high blood pressure. The aim of the study was to examine the incidence of overweight and obesity in primary school children aged 6 to 15 years, as well as to examine the incidence of prehypertension and hypertension in children who were overweight and obese.

Method: The study included 85 of 86 children from the Primary School „Krupa na Uni“. Data were collected with the help of a questionnaire, while body weight and blood pressure were measured. The chi-square test and t-test were used for the statistical analysis of data

Results: The cross-sectional study included 85 children, 45 (52.9%) boys and 40 (47.1%) girls with an average age of 10.87 ± 2.70 years. Normal weight was found in 54 (63.5%) subjects, underweight in 12 (14.1%), overweight in 5 (5.9%), and obesity in 14 (16.5%). 76 (89.4%) subjects had normal blood pressure values, 5 (5.9%) pre-hypertensive state, and 4 (4.7%) arterial hypertension. There was no significant difference between younger and older children regarding their nutritional status ($p=0.477$) and blood pressure levels ($p=0.453$). Children who were overweight and obese had prehypertension and hypertension significantly more often ($p<0.001$).

Conclusion: Every fifth child was overweight or obese, while prehypertension and hypertension were found in every tenth child. The timely change of diet and physical activity could contribute to the regulation of body weight and the regulation of blood pressure, as well.

Keywords: obesity, hypertension, screening, primary school.

Introduction

According to the International Classification of Diseases, Eleventh Revision (ICD-11), obesity is classified into endocrine, nutritional and metabolic diseases (ICD-XI; E66) (1). It is a chronic disease accompanied by the excessive fat accumulation and the increase in body weight, and it appears due to numerous factors (excess calories, physical inactivity etc.) (1-4). The World Health Organization (WHO) describes an epidemic of childhood obesity as a serious public health challenge of the 21st century (5-7). According to the WHO data, the prevalence of obesity nearly tripled between 1975 and 2016, and therefore, today 41 million children under the age of 5 and 340 million children and adolescents aged 5-19 are overweight or obese (5). Around 31 million children live in developing

countries (6). Obesity may have a significant influence on the health condition, well-being (social and psychological), self-respect, academic success and the quality of life of each child (8).

Obese children are three times more likely to develop hypertension in comparison to normal weight children (9). Factors that lead to obesity are numerous, however, the significance of genetic, endocrine, behavioral and environmental factors is most common (10). In obese children with hypertension, subclinical atherosclerosis with arterial wall thickening and impaired arterial elasticity may arise (11). Besides, changes in the cardiac geometry and function in these persons (left and right ventricular hypertrophy, thickening of the wall of the left ventricle, increase in

na rani početak potencijalno nepovoljnih promena u mišićnom tkivu srca (12).

Gojaznoj deci sa navršene tri godine se preporučuje merenje krvnog pritiska (3,13). Međutim, kod dece mlađe od tri godine merenje krvnog pritiska se preporučuje u slučaju postojanja pozitivne anamneze za neonatalne komplikacije, srčane malformacije, genetsku bolest, stečenu ili urođenu bolest bubrega, neoplazmu, upotrebu lekova (kortikosteroida, teofilina, nazalnih dekongestiva) i bolesti koje uzrokuju povećani intrakranijalni pritisak (3,13). Dijagnoza hipertenzije zahteva neke laboratorijske analize (npr. analizu vrednosti uree, kreatinina, glukoze, lipida i elektrolita u krvi, pregled urina, dokazivanje malih količina proteina u urinu, merenje glomerularne filtracije) i ehokardiografski pregled (3,13).

Cilj ove studije preseka je bio da se ispita učestalost javljanja prekomerne telesne težine i gojaznosti kod osnovnoškolske dece i da se ispita da li postoji veza između hipertenzije i prekomerne telesne težine i gojaznosti.

Metode

Urađena je epidemiološka studija preseka u periodu od 30 dana, od 15.07.2021. do 15.08.2021. Studijski uzorak (ispitanici) bili su učenici Osnovne škole u Krupi na Uni, 85 od ukupno 86 učenika koliko ima škola.

Telesna težina je merena antropometrijskom vagom u kilogramima (dete bez obuće, sa laganom odećom, u ortostatskom položaju na sredini vage). Telesna visina je merena stadiometrom u centimetrima, na najbližih 0,1 cm (dete bez obuće, okrenuto leđima prema zidu, paralelnih, spojenih stopala, u uspravnom položaju i pogledom prema napred u liniji horizonta).

Indeks telesne mase (engl. *Body Mass Index*, BMI) je dobijen deljenjem telesne težine u kilo-

gramima i telesne visine u kvadratnim metrima. Stratifikacija statusa uhranjenosti utvrđena je iz percentila u odnosu na indeks telesne mase, uzrast i pol. Status uhranjenost ispod 5. percentila označen je kao pothranjenost, od 5. do 85. percentila kao normalna uhranjenost, od 85. do 95. percentila kao prekomerna uhranjenost, a iznad 95. percentila kao gojaznost (14,15).

Merenje krvnog pritiska je izvršeno aparatom za merenje krvnog pritiska, živinim sfigomanometrom. Dete je sedelo leđima naslonjeno na naslon stolice i bilo sa mirno položenim nogama. Ruke su bile oslobođene odeće, ekstenzirane, oslonjene na podlogu u visini srca, laktovi ispruženi, dlanovi okrenuti prema gore. Distalni rub manžete je postavljen 2 do 3 cm iznad kubitalne jame, sa balonom narukvice na volarnoj strani. Merenje je izvršeno na obe ruke. Ukoliko je postojala razlika u izmerenim vrednostima na levoj i desnoj ruci, viša vrednost je uzeta za relevantnu. Arterijska hipertenzija kod dece definisana je kao sistolni i/ili dijastolni krvni pritisak jednak ili veći 95. percentila za uzrast i pol. Sistolni i/ili dijastolni krvni pritisak od 90. do 95. percentila za odgovarajuću dob i uzrast predstavljalo je predhipertenziju (16-18).

Za obradu i analizu prikupljenih podataka korišćena odgovarajuća softverska podrška u vidu programa *Microsoft Excel*, te 21 verzije statističkog programa za društvene nauke *IBMSPSS Statistics* (engl. *Statistical Package for the Social Science*, SPSS). U statističkoj analizi korišćeni su hi kvadrat test i Fisherov test.

Rezultati

Istraživanje je obuhvatilo 85 osnovnoškolske dece. Među njima je bilo 40 (47,1%) devojčica i 45 (52,9%) dečaka. Prosečna starost ispitivane populacije iznosila je $10,87 \pm 2,70$ godina (najmlađe dete imalo je 7, a najstarije 16 godina) (Tabela 1).

Table 1. Distribucija dece osnovne škole prema uzrastu i polu

| Uzrast (godine) | Dečaci Broj (%) | Devojčice Broj (%) | Ukupno Broj (%) |
|------------------|--------------------|-----------------------|--------------------|
| 6-9 | 22 (25,9) | 16 (18,8) | 38 (44,7) |
| 10-15 | 23 (27,0) | 24 (28,2) | 47 (55,2) |
| Ukupno | 45 (52,9) | 40 (47,1) | 85 (100,0) |
| $\bar{x} \pm SD$ | $10,44 \pm 2,64$ | $10,35 \pm 2,80$ | $10,87 \pm 2,70$ |

\bar{x} -srednja vrednost; SD-standardna devijacija.

muscle mass of left ventricle) indicate the early development of potentially serious changes in the cardiac muscle tissue (12).

Blood pressure measurements are recommended in obese children aged 3 and above (3,13). However, in children younger than three, blood pressure measurements are recommended in case of positive anamnesis for neonatal complications, heart malformations, genetic diseases, congenital or acquired diseases of kidneys, neoplasma, usage of medications (corticosteroids, theophylline, nasal decongestants) and diseases that cause intracranial pressure (3,13). The diagnosis of hypertension demands certain laboratory analyses (e.g. analysis of urea levels, creatinine, glucose, lipids and electrolytes in blood, urine analysis, proving a small amount of proteins in urine, measuring glomerular filtration) and echocardiographic assessment (3,13).

The aim of this cross-sectional study was to examine the incidence of overweight and obesity in primary school children, as well as to determine the connection between hypertension and overweight, that is, obesity.

Methods

An epidemiological cross-sectional study was conducted from 15th July 2021 to 15th August 2021. The sample (respondents) included students from the Primary School in Krupa on the river Una, that is, 85 students of 86 students of this school.

Body weight was measured with the help of anthropometric scale in kilograms (a child was without shoes, with light clothes, in the orthostatic position in the middle of the board). Body height was measured with the help of a stadiometer in centimeters, to the nearest 0.1 cm (a child was without shoes, standing against the wall, with heels together, in the upright position, eyes looking straight ahead).

Body mass index was obtained by dividing the body weight in kilograms by the body height in meters squared. The stratification of nutritional status was determined in percentiles according to body mass index, age and sex. The nutritional status below the fifth percentile was marked as underweight, from the 5th to the 85th percentile as normal, from the 85th to the 95th as overweight, and above the 95th percentile as obesity (14,15).

The measurement of blood pressure was done with the help of the apparatus for measuring blood pressure, mercury sphygmomanometer. Children were in the seated position with their back leaning against the chair's back and with their legs sitting still. Upper arms were bare, extended, supported at the same vertical height as the heart; elbows were stretched out, palms upward. Distal edge of the cuff was placed 2 to 3 cm above the cubital fossa with the inflated cuff on the volar side. The measurement was done on both arms. If there was a difference between the values on the left and the right hand, higher value was deemed to be relevant. Arterial hypertension in children was defined as systolic and/or diastolic blood pressure equal to or higher than the 95th percentile for certain age and sex. Systolic and/or diastolic blood pressure from the 90th to the 95th percentile for certain sex and age was prehypertension (16-18).

The appropriate software support, such as Microsoft Excel program, and IBM SPSS Statistics 21.0 (Statistical Package for the Social Science, SPSS) were used for the analysis of collected data. The chi-square test and Fisher's test were used for the statistical analysis.

Results

The study included 85 primary school children. There were 40 (47.1%) girls and 45 (52.9%) boys among them. The average age of the examined population was 10.87±2.70 years (the youngest

Table 1. Distribution of primary school children by sex and age

| Age (years) | Boys Number (%) | Girls Number (%) | Total Number (%) |
|------------------|--------------------|---------------------|---------------------|
| 6-9 | 22 (25.9) | 16 (18.8) | 38 (44.7) |
| 10-15 | 23 (27.0) | 24 (28.2) | 47 (55.2) |
| Total | 45 (52.9) | 40 (47.1) | 85 (100.0) |
| $\bar{x} \pm SD$ | 10.44 ± 2.64 | 10.35 ± 2.80 | 10.87 ± 2.70 |

\bar{x} -mean; SD-standard deviation.

Tabela 2. Distribucija dece osnovne škole prema uzrastu i stepenu uhranjenosti

| Uzrast (godine) | Pothranjenost (< 5,00) Broj (%) | Normalna uhranjenost (5,00 – 84,99) Broj (%) | Prekomerna uhranjenost (85,00 – 94,99) Broj (%) | Gojaznost (≥ 95,00) Broj (%) | Ukupno Broj (%) | p vrednost* |
|-----------------|---------------------------------|--|---|------------------------------|-----------------|-------------|
| 6-9 | 8 (9,4) | 20 (23,5) | 4 (4,7) | 6 (7,1) | 38 (44,7) | 0,477 |
| 10-15 | 4 (4,7) | 34 (40,0) | 1 (1,2) | 8 (9,4) | 47 (55,3) | |
| Ukupno | 12 (14,1) | 54 (63,5) | 5 (5,9) | 14 (16,5) | 85 (100,0) | |

*p prema χ^2 testu

Normalna uhranjenost utvrđena je kod 54 (63,5%) dece, pothranjenost kod 12 (14,1%), prekomerna uhranjenost kod 5 (5,9%) i gojaznost kod 14 (16,5%). Između mlađe i starije dece nije bilo značajne razlike u odnosu na stepen uhranjenosti ($p=0,477$) (Tabela 2).

Normalne vrednosti krvnog pritiska imalo je 76 (89,4%) ispitanika, predhipertenziju 5 (5,9%) i arterijsku hipertenziju 4 (4,7%). Između mlađe i starije dece nije bilo značajne razlike u odnosu na vrednosti krvnog pritiska ($p=0,453$) (Tabela 3).

Deca sa prekomernom telesnom težinom i gojaznošću su značajno ($p<0,001$) češće imala predhipertenziju i hipertenziju (Tabela 4).

Diskusija

Gojaznost dece predstavlja globalni javnozdravstveni problem (14). Širom sveta broj gojazne dece raste alarmantnom brzinom (14). Globalna telesna uhranjenost raste 0,32 kg/m²/10 godina kod devojčica, odnosno 0,40 kg/m²/10 godina kod dečaka (20). Udeo dece u najvišim percentilima telesne uhranjenosti je u periodu rasta (7). Najvišu prevalenciju gojaznosti imaju zemlje Severne Amerike (u prvom redu Sjedinjene Američke Države i Meksiko) i Bliskog Istoka (6). Nešto nižu prevalenciju imaju zemlje jugoistočne Azije i zapadnog Pacifika, uključujući Indiju, Maleziju, Vijetnam, Kinu, Australiju, Južnu Koreju i Japan (21). Najniža stopa prevalencije utvrđena je u zemljama Afrike

Tabela 3. Distribucija dece osnovne škole prema uzrastu i vrednostima krvnog pritiska

| Uzrast (godine) | Normotenzija Broj (%) | Predhipertenzija Broj (%) | Arterijska hipertenzija Broj (%) | Ukupno Broj (%) | p vrednost* |
|-----------------|-----------------------|---------------------------|----------------------------------|-----------------|-------------|
| 6-9 | 33 (38,8) | 2 (2,4) | 3 (3,5) | 38 (44,7) | 0,453 |
| 10-15 | 43 (50,6) | 3 (3,5) | 1 (1,2) | 47 (55,3) | |
| Ukupno | 76 (89,4) | 5 (5,9) | 4 (4,7) | 85 (100,0) | |

*p prema χ^2 testu**Tabela 4.** Distribucija dece osnovne škole prema stepenu uhranjenosti i vrednostima krvnog pritiska

| | | Pothranjenost ili normalna uhranjenost Broj (%) | Prekomerna uhranjenost ili gojaznost Broj (%) | Ukupno Broj (%) | p vrednost* |
|------------------------------|-----------------------------------|---|---|-----------------|-------------|
| Krvni pritisak (mmHg) | Normotenzija | 63 (74,1) | 13 (15,3) | 76 (89,4) | <0,001 |
| | Predhipertenzija ili hipertenzija | 3 (3,5) | 6 (7,1) | 9 (10,6) | |
| Ukupno | | 66 (77,6) | 19 (22,4) | 85 (100) | |

*p prema Fisher-ovom testu

Table 2. Distribution of primary school children by age and nutritional status

| Age (years) | Underweight (< 5.00) Number (%) | Normal weight ($5.00 - 84.99$) Number (%) | Overweight ($85.00 - 94.99$) Number (%) | Obesity (≥ 95.00) Number (%) | Total Number (%) | p value* |
|--------------|---|---|---|---|---------------------|----------|
| 6-9 | 8 (9.4) | 20 (23.5) | 4 (4.7) | 6 (7.1) | 38 (44.7) | 0.477 |
| 10-15 | 4 (4.7) | 34 (40.0) | 1 (1.2) | 8 (9.4) | 47 (55.3) | |
| Total | 12 (14.1) | 54 (63.5) | 5 (5.9) | 14 (16.5) | 85 (100.0) | |

*p value according to χ^2 test

child was 7, while the oldest was 16) (Table 1).

Normal weight was found in 54 children (63.5%), 12 children (14.1%) were underweight, 5 children (5.9%) were overweight and 14 (16.5%) were obese. There was no significant difference between younger and older children regarding their nutritional status ($p=0.477$) (Table 2). Normal values of blood pressure were found in 76 (89.4%) respondents, prehypertension in 5 (5.9%) and arterial hypertension in 4 (4.7%). There was no significant difference between younger and older children regarding the blood pressure values ($p=0.453$) (Table 3).

Prehypertension and hypertension were found significantly more often ($p<0.001$) in children who were overweight and obese (Table 4).

Discussion

Childhood obesity is a global public health problem (14). The number of obese children worldwide rises at alarming speed (14). Global body weight grows $0.32 \text{ kg/m}^2/10$ years in girls, that is, $0.40 \text{ kg/m}^2/10$ years in boys (20). The share of children in the highest percentiles of body weight is in the period of growth (7).

The countries of the North America (first of all the United States of America and Mexico) and the Middle East have the highest prevalence of obesity (6). Somewhat lower prevalence is in the countries of Southeast Asia and West Pacific, including India, Malaysia, Vietnam, China, Australia, South Korea and Japan (21). The lowest prevalence is in Africa (16). In the European countries, almost every

Table 3. Distribution of children by age and blood pressure levels

| Age (years) | Normotension Number (%) | Prehypertension Number (%) | Arterial hypertension Number (%) | Total Number (%) | p value* |
|--------------|----------------------------|-------------------------------|--|---------------------|----------|
| 6-9 | 33 (38.8) | 2 (2.4) | 3 (3.5) | 38 (44.7) | 0.453 |
| 10-15 | 43 (50.6) | 3 (3.5) | 1 (1.2) | 47 (55.3) | |
| Total | 76 (89.4) | 5 (5.9) | 4 (4.7) | 85 (100.0) | |

*p value according to χ^2 test

Table 4. Distribution of primary school children by nutritional status and blood pressure levels

| | | Underweight or normal weight Number (%) | Overweight or obesity Number (%) | Total Number (%) | p value* |
|----------------------------------|------------------------------------|---|--|------------------------|----------|
| Blood pressure (mmHg) | Normotension | 63 (74.1) | 13 (15.3) | 76 (89.4) | <0.001 |
| | Prehypertension or hypertension | 3 (3.5) | 6 (7.1) | 9 (10.6) | |
| Total | | 66 (77.6) | 19 (22.4) | 85 (100) | |

*p value according to Fisher test

(16). U zemljama Evrope gotovo svako četvrto dete ima prekomernu uhranjenost ili gojaznost (22).

Naše istraživanje je pokazalo postojanje prekomerne uhranjenosti kod 5,9% (n=5) ispitanika, a gojaznosti kod 16,5% (n=14) ispitanika. Između mlađih i starijih uzrasta nije bilo značajne razlike u odnosu na stepen uhranjenosti.

Patofiziologija uključuje genetske, endokrine, bihevioralne i sredinske faktore (15,23). Disfunkcija adipocita predisponira rezistenciju na insulin (vaskularnu i sistemsku), disfunkciju simpatičkog nervnog sistema i sistema renin angiotenzinaldosteron (23).

Gojazna deca imaju viši nivo aktivnosti renina, angiotenzinogena, angiotenzin konvertujućeg enzima i aldosterona (23,24). Kompresija bubrega prekomernom masnoćom (visceralnom i retroperitonealnom) i prekomerna aktivnost simpatičkog nervnog sistema povećavaju oslobađanje renina iz jukstaklomerularnih ćelija bubrega (24). Adipociti luče angiotenzinogen, angiotenzin II, stimulišu proizvodnju aldosterona iz nadbubrežne žlezde (nezavisno od angiotenzina II) (24). Angiotenzin II povećava proizvodnju aldosterona, uzrokuje sistemsku vazokonstrikciju, direktno zadržavanje natrija i vode i povećanu proizvodnju aldosterona (25). Aldosteron modulira ekspresiju natrijumovog kanala endotelnih ćelija (povećava endotelnu krutost), aktivira nikotinamid adenin dinukleotid fosfat-oksidadu (pospešuje oksidativni stres) i smanjuje bioraspoloživost azotnog oksida (23-25).

Abnormalno lučenje adipokina iz masnog tkiva, disfunkcija renin angiotenzin aldosteron sistema, insulinska rezistencija i disfunkcija baroreceptora u gojazne dece povećavaju aktivnost simpatičnog nervnog sistema (19,24). Stimulacije α -adrenergičnih i β -adrenergičnih receptora povećava minutni volumen, brzinu otkucaja srca i bubrežnu tubularnu reapsorpciju natrijuma (19,24).

Pojavi hipertenzije u gojazne dece mogu doprinjeti genetski i epigenetski faktori (promene u metilaciji deoksiribonukleinske kiseline, modifikaciji histona i regulaciji mikronukleinske kiseline) (25). U našem istraživanju, deca sa prekomernom telesnom težinom i gojaznošću su značajno češće imala predhipertenziju i hipertenziju ($p < 0,001$).

Skrining hipertenzije među 5.000 učenika Osnovne škole u Sjedinjenim Američkim Državama utvrdio je gojaznost kao najvažniji prediktor povišenog krvnog pritiska kod dece (26,27). Hipertenzije je ustanovljena kod 11,1% gojazne dece

(26). Druga studija koja je obuhvatila 9.167 dece uzrasta od 5 do 17 godina ustanovila je da gojazna deca imaju 2,4 puta veću verovatnoću za povišen dijastolni pritisak i 3,0 puta veću verovatnoću za povišen sistolni pritisak (28). Studija preseka, sprovedena u Kini, koja je obuhvatila 78.114 ispitanika starosti od 7 do 20 godina identifikovala je 2,2% veću verovatnoću razvoja hipertenzije u gojaznih ispitanika (29). Istraživanje 1.626 dece uzrasta od 7 do 16 godina u četiri velika kineska grada (Peking, Šangaj, Nanjing, Xi'an) utvrdilo je 5,94 puta veću verovatnoću hipertenzije kod dece s opštom gojaznošću i 3,45 puta veću verovatnoću hipertenzije kod dece s centralnom gojaznošću (30). Istraživanje koje je obuhvatilo 2.650 učenika u osnovnoj školi (uzrast od 5 do 15 godina) u Indiji otkrilo je značajno češće prisustvo hipertenzije kod gojazne dece (13,7% naspram 0,4% u normalno uhranjene dece) (31). Studija preseka u Severnoj Karnataki među 19.263 dece uzrasta od 5 do 16 godina utvrdila je prisustvo hipertenzije u 18,2% gojazne dece (32). Kod normalno uhranjene dece hipertenzija je bila značajno ređa (10,10% ukupno, 5,18% sistolna hipertenzija, 6,15% dijastolna hipertenzija) (32). Istraživanje u Italiji među 1.310 dece uzrasta od 5 do 14 godina identifikovalo je gojaznost kao najznačajniji prediktor hipertenzije (unakrsni odnos = 2,63; 95% interval poverenja = 2,12-3,28) (33). Prospektivna kohortna studija u Sjedinjenim Američkim Državama u kojoj je učestvovalo 242 ekstremno gojazne dece uzrasta od 13 do 19 godina i koji su bili podvrgnuti barijatrijskoj hirurgiji hipertenzija je postojala kod čak 49,5% ispitanika (34). Identifikacija gojazne dece s trajno povišenim krvnim pritiskom zahteva kontinuirano merenje krvnog pritiska u dužem vremenskom periodu (35). Kod gojazne dece s hipertenzijom utvrđeno je prisustvo oštećenja ciljnih organa (povećanje mase leve i desne srčane komore, zadebljanje zida leve komore, zadebljanje arterijskog zida i smanjena arterijska elastičnost) koje ukazuju na rani početak potencijalno nepovoljnih promena miokarda i endotela krvnih sudova (36,37). U cilju ranog otkrivanja ovih patoloških promena koristi se ehokardiografija (36,37).

Glavni nedostatak ove studije ogleda se u malom broju ispitanika, kao i u korišćenju studije preseka u kojoj ne možemo da definišemo uzročnu posledičnu vezu. Neophodna su dalja istraživanja u ovoj oblasti.

fourth child is overweight or obese (22).

Our study showed that 5.9% of participants (n=5) were overweight, while 16.5% (n=14) were obese. There was no significant difference between younger and older children regarding the nutritional status.

Pathophysiology includes genetic, endocrine, behavioral and environmental factors (15,23). Dysfunction of adipose tissues may result in insulin resistance (vascular and systemic), dysfunction of sympathetic nervous system and system of renine angiotensine aldosterone (23).

Obese children have higher levels of the activity of renine, angiotensinogen, angiotensin converting enzyme and aldosterone (23,24). Kidney compression because of excess fat (visceral and retroperitoneal) and excessive activity of the sympathetic nervous system increase the release of renine from juxtaglomerular renal cells (24). Adipocytes secrete angiotensinogen, angiotensin II, stimulate the production of aldosterone from the adrenal gland (independently from angiotensin II) (24). Angiotensin II increases the production of aldosterone, causes systemic vasoconstriction, increases body water and sodium content and production of aldosterone (25). Aldosterone modulates the expression of sodium channel of endothelial cells (increases the endothelial stiffness), activates nicotinamide adenine dinucleotide phosphate-oxidase (activates oxidative stress) and decreases bioavailability of nitric oxide (23-25).

The abnormal secretion of adipokines from adipose tissues, dysfunction of renine angiotensin aldosterone system, insulin resistance and dysfunction of baroreceptors in obese children increase the activity of sympathetic nervous system (19,24). The stimulation of α -adrenergic and β -adrenergic receptors increases the minute volume, the heart rate and renal tubular reabsorption of sodium (19,24).

Genetic and epigenetic factors (changes in the methylation of deoxyribonucleic acid, modification of histones and regulation of micronucleic acid) may contribute to hypertension in obese children (25). In our study, children who were overweight and obese had prehypertension and hypertension significantly more often ($p < 0.001$).

Screening for hypertension among 5000 students of one primary school in the United States of America found that obesity was the most

significant predictor of hypertension in children (26,27). Hypertension was found in 11.1% of obese children (26). Another study, which included 9.167 children aged 5 to 17, found that obese children were 2.4 times more likely to develop elevated diastolic pressure and 3.0 times more likely to develop elevated systolic pressure (28). A cross-sectional study, which was conducted in China and which included 78.114 respondents aged 7 to 20 years, identified that obese respondents were 2.2% more likely to develop hypertension (29). A study, which included 1.626 children aged 7 to 16 years in four big cities in China (Beijing, Shanghai, Nanjing, Xi'an) identified that children with general obesity were 5.94 times more likely to develop hypertension and that children with central obesity were 3.45 times more likely to develop hypertension (30). A study, which included 2.650 students in one primary school (aged 5 to 15) in India, found that hypertension was present significantly more often in obese children (13.7% in comparison to 0.4% in children with normal weight) (31). A cross-sectional study conducted in North Karnataka, which included 19.263 children aged 5 to 16, found hypertension in 18.2% of obese children (32). In children with normal nutritional status, hypertension was significantly rarer (10.10% total, 5.18% systolic hypertension, 6.15% diastolic hypertension) (32). A study, which was conducted in Italy among 1.310 children aged 5 to 14, identified obesity as the most significant predictor of hypertension (odds ratio = 2.63; 95% confidence interval = 2.12-3.28) (33). A prospective cohort study, which was conducted in the United States of America and which included 242 extremely obese children aged 13 to 19 who underwent bariatric surgery, showed that hypertension was present in 49.5% of respondents (34).

The identification of obese children with permanently elevated blood pressure demands the continuous monitoring of blood pressure during a long period of time (35). In obese children with hypertension, damage of target organs was found (left and right ventricular hypertrophy, thickening of the left ventricular wall, thickening of the arterial wall, decreased arterial elasticity), which pointed to the early development of potentially unfavorable myocardial changes and changes in the endothelium of blood vessels (36,37). Echocardiography is used in order to detect these pathological changes early (36,37).

Zaključak

Kod osnovnoškolske dece sa prekomernom telesnom težinom i gojaznošću značajno češće dolazi do pojave predhipertenzije i hipertenzije. Predhipertenziju i hipertenziju imalo je 10,6% učenika, a 7,1% i prekomernu telesnu težinu i gojaznost. Pravovremena promena ishrane, fizičke aktivnosti i drugih životnih navika doprineće kako redukciji prekomerne telesne težine i gojaznosti, tako i regulaciji vrednosti krvnog pritiska. Pozitivni ishodi iziskuju multidisciplinarni pristup, a to znači uključivanje kako porodice, tako i svih nivoa obrazovnog i zdravstvenog sistema, nadležnih ministarstava, šire društvene zajednice, medija, prehrambene i farmaceutske industrije.

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The main shortcoming of this study is the small number of participants, as well as the fact that it is the cross-sectional study, in which we cannot define a causal relationship. Further research is needed in this field.

Conclusion

In primary school children, who are overweight and obese, prehypertension and hypertension develop significantly more often. 10.6% of students had prehypertension and hypertension, while 7.1% were overweight and obese, as well. Timely change of diet, physical activity and other life habits would contribute to the reduction of overweight and obesity, as well as the regulation of blood pressure levels. Positive outcomes demand a multidisciplinary approach, including the participation of family, and all levels of educational and health care system, competent government departments, wider social community, media, food and pharmaceutical industry.

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Autor za korespondenciju: Marijana Jandrić-Kočić, Dom zdravlja Krupa na Uni, Stevana Jakovljevića 23, 78 000 Banja Luka, Republika Srpska, Bosna i Hercegovina; e-mail: marijanajandrickocic@gmail.com

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Corresponding author: Marijana Jandric-Kocic, Health Center „Krupa na Uni“, Stevana Jakovljevic 23, 78 000 Banja Luka, Republic of Srpska, Bosnia and Herzegovina; e-mail: marijanajandrickocic@gmail.com
