Public Health

CHANGES IN WEIGHT STATUS OF 7-YEAR-OLD CHILDREN IN NORTH MACEDONIA BETWEEN 2010 AND 2019

Igor Spiroski[1,2], Vladimir Mikik[3], Natalija Miloradovska[4], Marjan Veljanovski[5], Jeton Shaqiri[6], Aleksandra Petrova[1,2], Biljana Dzikovska[6], Blerta Shahini[7], Julijana Kitanovska-Spasev[8]

[1] Institute of Public Health of the Republic of North Macedonia, Skopje, Republic of North Macedonia
[2] Faculty of Medicine, Ss. Cyril and Methodius University – Skopje, Republic of North Macedonia
[3] The Global Fund to Fight AIDS, Tuberculosis and Malaria – Geneva, Switzerland
[4] Center of Public Health – Kochani, Republic of North Macedonia
[5] Center of Public Health – Bitola, Republic of North Macedonia
[6] Center of Public Health – Skopje, Republic of North Macedonia
[7] Center of Public Health – Kumanovo, Republic of North Macedonia
[8] Center of Public Health – Veles, Republic of North Macedonia

Abstract

Childhood obesity is growing as one of the most important public health issues that affects individual and population health but also puts heavy burden on the health systems. It is frequently associated with immediate adverse consequences, such as psychological problems, and a higher risk of many harmful comorbidities later in life, such as type 2 diabetes, dyslipidemia, non-alcoholic fatty liver disease, hypertension, and coronary heart disease. Comparability of anthropometric data is crucial to track the changes over time. The aim of this paper was to present prevalence of thinness, overweight, and obesity in 7-year-old schoolchildren in North Macedonia in 2010 and 2019, and the changes in their nutritional status during that period. Material and methods: Anthropometric measurements of body height and body weight were performed to the nationally representative sample of 7-year-old children in school years 2010/2011 and 2018/2019. Measurements followed the Childhood Obesity Surveillance Initiative (COSI) protocol and data collecting procedures. In total, 2737 children (1317 girls and 1420 boys) in 2010 and 2059 children (1045 girls and 1014 boys) in 2019 were measured. WHO Growth references were used to determine the growth and nutritional status of children. Results: The average height of children in the observed period has increased by 1.7 cm, weight for 1.2 kg and the BMI for 0.3 kg/m2. As for the weight classification, thinness prevalence is significantly increased for 0.3%. Overweight (including obesity) significantly increased (p=0.0377) from 34.4% (95% CI 32.6%-36.2%) in 2010 to 37.3% (95% CI 35.2%-39.5%) in 2019. Obesity significantly increased (p=0.040) from 16.3% (95% CI 14.9%-17.7%) in 2010 to 18.4% (95% CI 16.7%-20.1%) in 2019. The main driver of that increase was the highly significant (p=0.0004) increase of almost 7% of overweight (including obesity) in girls. Conclusion: There is unfavorable rising trend which indicates deterioration of the situation with childhood obesity in the country. Focused and more comprehensive public health nutrition actions are needed to plateau or reverse the trends. The childhood obesity national monitoring system is well established and should continue to be one of the key public health monitoring systems that provide evidence for actions.

Јавно здравје

ПРОМЕНИ ВО ТЕЖИНАТА КАЈ 7-ГОДИШНИ ДЕЦА ВО СЕВЕРНА МАКЕДОНИЈА ВО ПЕРИОДОТ МЕЃУ 2010 И 2019 ГОДИНА

Игор Спироски[1,2], Владимир Микиќ[3], Наталија Милорадовска[4], Марјан Велјановски[5], Јетон Шаќири[6], Александра Петрова[1,2], Билјана Циковска[6], Блерта Шаини[7], Јулијана Китановска-Спасев[8]

[1] Институт за јавно здравје на Република Северна Македонија, Скопје, Република Северна Македонија
[2] Медицински факултет, Универзитет „Св. Кирил и Методиј“ - Скопје, Република Северна Македонија
[3] Глобален фонд за борба против СИДА, туберкулоза и маларија – Женева, Швајцарија
[4] Центар за јавно здравје – Кочани, Република Северна Македонија
[5] Центар за јавно здравје– Битола, Република Северна Македонија
[6] Центар за јавно здравје– Скопје, Република Северна Македонија
[7] Центар за јавно здравје– Куманово, Република Северна Македонија
[8] Центар за јавно здравје– Велес, Република Северна Македонија

Извадок

Детската дебелина прераснува во едно од најважните јавноздравствени прашања кои влијаат на индивидуалното и популациското здравје, но и силно ги оптоваруваат здравствените системи. Често е поврзана со негативни последици како психолошки проблеми и со зголемен ризик од многу други коморбидитети подоцна во животот како што се дијабетес мелитус тип 2, дислипидемија, замастување на црниот дроб кое не е предизвикано од алкохол, хипертензија и коронарна болест на срцето. Споредливоста на антропометриските податоци е клучна за да се прикажат промените низ времето. Цел на овој труд беше да ја прикаже преваленцијата на слаби, како и на деца со зголемена телесна тежина и дебелина во Северна Македонија, на возраст од 7 години, во 2010 и 2019 година, како и промените во нивниот нутритивен статус за тој временски период. Материјал и методи: Беа направени антропометриски мерења на телесната висина и тежина кај национално репрезентативен примерок на 7-годишни деца во училишните години 2010/2011 и 2018/2019. Мерењата ги следеа процедурите и пропишаниот протокол на Иницијативата за следење на дебелината кај децата (COSI). Вкупно беа измерени 2737 деца (1317 женски 1420 машки) во 2010 и 2059 деца (1045 женски 1014 машки) во 2019. Референците за раст на СЗО беа користени за утврдување на растот и нутритивниот статус на децата. Резултати: Висината за време на испитуваниот период се зголемила за 1,7 cm, тежината за 1,2 kg, а ИТМ за 0,3 kg/m2. Во однос на класификацијата на тежината, преваленцијата на слабост кај децата незначајно пораснала за 0,3%. Зголемената телесна тежина (вклучувајќи дебелина) значајно пораснала (p=0,0377) од 34,4% (95% CI 32,6%-36,2%) во 2010 на 37,3% (95% CI 35,2%-39,5%) во 2019. Дебелината значајно пораснала (p=0,040) од 16,3% (95% CI 14,9%-17,7%) во 2010 на 18,4% (95% CI 16,7%-20,1%) во 2019. Главен двигател на тоа зголемување била значајно зголемената телесна тежина (вклучувајќи дебелина) од скоро 7% кај девојчињата. Заклучок: Постои неповолен растечки тренд кој индицира влошување на ситуацијата со детската дебелина во земјата. Потребни се насочени и посеопфатни јавноздравствени акции на исхраната ре или смени насоката на трендот. Системот на следење на детската дебелина во државата е добро воспоставен и треба да продолжи како еден од клучните јавноздравствени системи на следење кој обезбедува докази за идни акции.

Introduction

Changes in the anthropometric characteristics of children over time are affected by variety of factors including hereditary, nutritional, environmental, and societal factors. There is an increasing evidence that in Europe, overweight and obesity has become more of a concern comparing to hunger and undernutrition.[1] Childhood obesity is growing as one of the most important public health issues that affects individual andpopulation health but also puts heavy burden on the health systems.[2,3] It is frequently associated with immediate adverse consequences, such as psychological problems and lower educational attainment, and a higher risk of many harmful comorbidities later in life, such as type 2 diabetes, dyslipidemia, non-alcoholic fatty liver disease, hypertension, and coronary heart disease.[4-7] Data from the 2416 population-based measurement studies, for the period 1975 – 2016, showed that there was a rising trend in children's and adolescents' BMI. In 2016, 124 million children and adolescents aged 5–19 years were estimated to suffer from obesity worldwide, and 213 million were overweight.8 Rising BMI trends follow the rising height trajectories among children and adolescents in countries with developed or developing economies.[9]

Comparability of anthropometric data is crucial to show the changes over time both inside one country and between the countries. However, in practice, comparability of available data is often not possible, mainly due to the difference in sample, methodology, and quality of the obtained data.[10]Lack of comparable data between the countries of the European Region was the reason behind the establishment of the World Health Organization (WHO)Childhood Obesity Surveillance Initiative (COSI). COSI is a survey based on nationally representative samples that takes standardized weight and height measurements and collects information about school environments and dietary and physical activity habits of the school-aged children. The first data collection took place during the 2007–2008 school year, generally repeating data gathering rounds every three school years. The fifth round took place during the 2018-2019 school year.[11] COSI is now established in over 40 Member States of the WHO European Region, with the number of countries growing with each data collection round.

Macedonia joined COSI in the second round in2010/2011 school year and since then it has participated in all data collection rounds. COSI in North Macedonia has built up onto the already existing system of measuring height and weight among the school-aged children. Every school year, representative samples of children attending kindergartens, second and fifth graders and children attending 1st year of the secondary school are subject to height and weight measurements, in a coordinated action of the Institute of Public Health and the Centers of Public Health in the country. The measurements are provisioned in the National Annual Program of Public Health and are funded by the Government of the country.[12]Experienced personnel, which annually perform the measurements and country-wide standardized measuring instru-

ments, were crucial for the inclusion of North Macedonia into the COSI monitoring system. Adjustment to COSI system additionally required fine tuning of the process of sample preparation and more frequent communication with the Ministry of Education and Science (MoES)due to the national and regional changes of the number of children enrolled in schools between two rounds of data collection.

The aim of this paper was to present prevalence of thinness, overweight, and obesity in 7-year-oldschoolchildren in Macedonia in 2010 and 2019, and changes of their nutritional status during that period, by comparing the data of those two rounds of data collection.

Material and methods

The measurements of children took place in the school premises in the period April-May 2019. The study protocol was approved by the Ethics Committee of the Faculty of Medicine, Ss. Cyril and Methodius University in Skopje (approval no. 03-242/10 from 24.01.2019).

The target population for measurements were second graders from primary schools in the country. For that reason, the list of primary schools with number of second grade classes and enrolled children in the second grade for the 2010/2011 and 2018/2019 school years were obtained from the MoES. Since for the COSI measurements we implement the sentinel approach, which means that the same schools are sampled in every round data collection, here we explain the sampling procedure for the 2018/2019 round. The provided list from MoESincluded 347 schools with 1159 classes and a total number of 21292 children. We excluded 9 schools that harbored children with either special needs or those having problems with their behavior. Also, we did not include children from private primary schools in the country (n=3). Stratified two stage cluster sampling was performed: primary sampling units (PSU)were schools and secondary sampling units (SSU) were the second-grade classes. The stratification was done according to the territory covered by the ten Centers of Public Health (CPH) in North Macedonia with each center representing one stratum. Those 10 centers are distributed over the total territory of the country covering all statistical regions. The size of the schools was determined according to the number of second grade classes. Using the probability proportional to size sampling for each stratum and considering the distribution of urban and rural schools (according to the urban and rural distribution of population in the region covered by CPH), we performed the circular systematic sampling for PSUs which resulted in 112 sampled schools in North Macedonia. To select SSUs, we implemented simple random sampling of a total of 437 second grade classes in 112 sampled schools, resulting in 185 classes with 3214 children selected for anthropometric measurements. The same procedure took place in the school year 2010/2011 when 3171 children were sampled. Selected samples of second graders that included children aged 6-8 were further filtered to include only 7- year-old children (7.00-7.99), according to the COSI age differentiation.[13] With this, the

final sample included 2737 children (1317 girls and 1420 boys) in 2010 and 2059 children aged 7 (1045 girls and 1014 boys) in 2019. Twelve children were excluded from the analysis due to the calculated values of BMI-for-age z-score that were higher than +5 standard deviations (SD).

Anthropometric measurements of body height and body weight were performed according to the COSI protocol and data collection procedures.[14] Passive consent (measurement done if no objection from the parents/guardians was filed) was in place for the measurements in 2010 and active consent (informed written consent from parents/guardians had to be obtained before the measurement) for 2019 data collection. Parents/guardians were contacted by the teachers who sent them the consent forms together with the *family form*, one of the three forms used in COSI. After receiving the signed *consent form* and filled in family form, the children were measured and data was registered into the *child form*. The third form about the school nutrition environment or the *school form*, was filled in by the responsible person in school (teacher, principal etc.). Anthropometric measurements were done by trained teams from CPHs which consisted of a medical doctor and a nurse or technician. Methodology of measurements has been described elsewhere.[14] Children were asked to take off their shoes as well as all heavy clothing (coats, sweaters, jackets, etc.) and to remove items such as wallets, mobile phones or key chains. Body weight was measured to the nearest 0.1 kg with portable digital scales (SECA 881U), and body height was measured with stadiometers (SECA 217) to the nearest 0.1 cm. Team from the Institute of Public Health verified the completeness of forms and quality of data before data processing.

Data anonymization was done at the point of data entry. Excel forms were used for data entry in 2010 and in 2019 the OpenClinica online form was used, according to the COSI manual for that process.[15] The exact age of each child was calculated by subtracting the birth date from the measurement date, then variables with age in months and years were created. Body mass index (BMI) was calculated using height and weight of children (kg/m^2). Thinness, overweight, and obesity were classified according to the WHO growth references[16,17] (Table 1).

Table 1: Definitions for thinness, overweight and obesity according to WHO growth references (BMI-for-age index)

Thinness	Overweight	Obesity	Severe obesity
<-2 SD	>1 SD and ≤2 SD	>2 SD and ≤ 3 SD	>3 SD

Continuous variables are presented with mean and standard errors and weight classifications with percentages and 95% confidence intervals (95% CI). The t-test was used for continuous variables, and Pearson's chi square test for categorical variables, to test gender and time differences between 2010 and 2019. All differences were considered significant

at p<0.05. SPSS statistical software (v.23, IBM) was used for statistical analyses and determination of significance.

Results

Anthropometric variables of 7-year-old children in North Macedonia have significantly changed over the 2010-2019 period. As presented in Table 2, the average height of children increased by 1.7 cm, weight for 1.2 kg and the BMI for 0.3 kg/m². Larger margins of change were observed in girls whose height increased by 1.9 cm, weight by 1.6 kg and BMI by 0.6 kg/m². In boys, height increased by 1.5 cm and weight by 0.7 kg. The only insignificant change over the observed period was the boy's BMI which changed by only 0.1 kg/m².

Table 2: Anthropometric variables in 7-year-old schoolchildren

	All children		Girls		Boys	
	2010 mean (SE)	2019 mean (SE)	2010 mean (SE)	2019 mean (SE)	2010 mean (SE)	2019 mean (SE)
Height (cm)	126.7 (0.12)	128.4 † (0.14)	126.2 (0.18)	128.1 † (0.19)	127.2 (0.17)	128.7 † (0.20)
Weight (kg)	27.6 (0.13)	28.8† (0.15)	27.1 (0.18)	28.7† (0.22)	28.1 (0.17)	28.8 † (0.21)
BMI	17.0 (0.06)	17.3† (0.07)	16.8 (0.08)	17.4† (0.10)	17.2 (0.08)	17.3* (0.09)

SE = Standard Error
†significant change compared to 2010 (p<0.05)
*not significant change compared to 2010(p=0.663)

The classification of the weight status of the children was done by using the BMI-for-age index according to the WHO child growth references. As presented in Table 1, the defined difference of the observed values from the mean, presented as standard deviation, is main determination measure for classification of the child as overweight or obese. Prevalence of thinness, overweight, obesity and severe obesity in 7-year-old school children for 2010 and 2019 is presented in Table 3.

Table 3: Weight classification in 7-year-old schoolchildren

	All children			Girls			Boys		
	% 2010 (95% CI)	%2019 (95% CI)	Total trend (p value)	%2010 (95% CI)	%2019 (95% CI)	Girls trend (p value)	%2010 (95% CI)	%2019 (95% CI)	Boys trend (p value)
Thinness	1.5 (1-1.9)	1.8 (1.2-2.4)	0.346	1.4 (0.8-2.1)	1.8 (1-2.7)	0.470	1.5 (0.8-2.1)	1.8 (0.9-2.7)	0.547
Overweight*	34.4 (32.6-36.2)	37.3 (35.2-39.5)	0.038	30.9 (28.3-33.4)	37.8 (34.8-40.8)	0.0004	37.7 (35.1-40.3)	36.9 (33.8-39.9)	0.670
Obesity**	16.3 (14.9-17.7)	18.4 (16.7-20.1)	0.040	12.9 (11-14.7)	16.1 (13.8-18.3)	0.138	19.5 (17.4-21.5)	20.8 (18.3-23.4)	0.138
Severe obesity	5.7 (4.8-6.6)	5.9 (4.9-7)	0.754	3.1 (2.1-4.1)	4.4 (3.1-5.7)	0.098	8.1 (6.6-9.6)	7.5 (5.8-9.1)	0.567

*% of overweight includes % of obesity and % of severe obesity
**% of obesity includes % of severe obesity

As presented there, thinness increased by 0.3%in all children over the observed period, with slightly higher growth in girls, but that change was low and statistically not significant. On the other hand, overweight and obesity among all children significantly increased (overweight by almost 3% and obesity by 2.1%). The main driver of that increase, both for overweight and obesity, was the highly significant (p=0.0004) increase of almost 7% of overweight among girls. Overweight among boys had insignificantly decreased by less than 1%. That is also the case for severe obesity among boys. There was increase in obesity among boys and both obesity and severe obesity among girls, with the largest change by 3.1% of obesity in girls.

Discussion

Beside the regular measurement of the nutritional status of school children in the frames of COSI, there is not much data based on measured values for the weight status of children in North Macedonia. Our paper focuses on the change of prevalence of overweight and obesity comparing two time points, showing that both overweight and obesity are more prevalent among Macedonian 7-year-old school children in 2019 compared to 2010. Thus, it has shown the worsening of the situation. Our previous paper that compared the changes between 2010 and 2013 COSI rounds showed that prevalence of overweight and obesity decreased in the observed period.[18]

Considering available COSI data in Europe, there is a general conclusion that the prevalence of overweight and obesity is higher in Southern and lower in Northern Europe. Our data showed that in 2019 survey round, prevalence of overweight (including obesity) in North Macedonia was over 35%. The latest available comparable data for all COSI participating countries (from 2016 round)showed that the prevalence among 7-year-old children in North Macedonia was similar to the prevalence observed in Montenegro, Croatia, Serbia, Portugal and Poland (between 30% and 35%).[19]

Trends of overweight and obesity have been analyzed in several countries in Europe and there are countries where trends are either decreasing or plateauing in the observed periods. Italy, Hungary, Sweden, Portugal and Ireland are some of the countries which showed stabilization or reduction in the prevalence of overweight and obesity.[20-24] Gender differences indicate that in North Macedonia overweight and obesity are more prevalent among boys than among girls, which is similar to most of the countries in the region.[25-27] However, it is obvious from our data that the girl's overweight and obesity were more significantly growing over the observed period. Although not examined in our paper, this puts different light on the issue as research suggests that gender differences influence the socio-economic gradient, particularly among girls.[28] Prevalence of severe obesity among 7-year-olds is also worsening in girls and improving in boys. However, this remains to be a significant concern since previous research showed that severe obesity among children in North Macedonia was one of the highest in Europe.[29] Our research has shown that overall situation about the childhood obesity in the country is not favorable and bold steps are needed for the situation

to be improved. Several initiatives and actions have been undertaken in the observed period focusing both on nutrition of general population and children. The first population-based nutrition guidelines in the country that provide recommendations for nutrition of adults and children above 2 years of age has been adopted by the Government.[30] Additionally, standards for meals in kindergartens and primary schools, along with the guidance for its implementation, have been adopted in the form of by-law, meaning that they are obligatory for implementation by the schools and kindergartens.[31-32] As our data suggests, those actions are not enough, and further population-based measures are needed. Some of the measures may include implementing comprehensive programmes that promote the intake of healthy foods and reduce the intake of foods high in salt, sugar and fats and sugar sweetened beverages by children. Programs that promote physical activity and reduce sedentary behaviours in children should also be considered. Children's exposure to advertising practices that promote foods high in calories and low in nutritional value is the latest challenge and appropriate attention should be given to this issue when shaping measures targeting childhood obesity. Investments in public health nutrition are one of the most cost-effective and the decision makers should consider that when prioritizing public health actions.[33]

Conclusions

Childhood obesity becomes one of the most important health concerns in North Macedonia. Over the observed period there has been an unfavorable rising trend which indicates deterioration of the situation. Some steps have been undertaken to tackle the situation in a form of guidelines and rulebooks, but bolder and more comprehensive public health nutrition actions are needed to plateau or reverse the trends. The childhood obesity monitoring system in the country, which is part of COSI Europe, is well established and should continue to be strengthen and supported as one of the key public health monitoring systems that provide evidence for actions.

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