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Trend of Body Mass Index Movement of Primary School Students Over a 15 – Year Period

Martin ERDELJAC
University of Zagreb, Faculty of Kinesiology
martin.erdeljac@kif.hr

Marija RAKOVAC
University of Zagreb, Faculty of Kinesiology
marija.rakovac@kif.hr

Vilko PETRIĆ (contact author)
University of Rijeka, Faculty of Teacher Education
vilko.petric@uniri.hr

The aim of this study was to describe the trend of median body mass index (BMI) in students from the fifth to the eighth grade in a primary school in Zagreb in the period from 1999 to 2014. The sample consisted of students (N=3.567; 1.652 female and 1.915 male students) from the fifth to the eighth grade of primary school in the city of Zagreb, chronological age of 12 to 15 years. BMI was defined at the beginning of the school year on the basis of the collected data on body mass and body height of the students. This method was used as an indicator of their nutritional status. Regression analysis was used in order to review the trend of BMI. The results have shown that among the majority of the classes an increase in BMI was visible, but it was statistically significant only in the male students of the sixth and seventh grade. The regression analysis of the sixth graders showed a statistically significant (p=0.019) increase of the median of BMI (0.08 kg/m² per year) during the period of research. As for the seventh graders, there was a statistically significant (p=0.004) increase in the median of BMI (0.14 kg/m²) per year.

Key words: *physical activity, children, overweight, obesity*

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1. Introduction

The prevalence of excess weight is reaching alarming proportions in many countries and represents a serious menace to young persons' present and future health (Inchley et al., 2016). According to the data provided by the World Health Organisation (WHO, 2016a), in 2010 there were 81% of adolescents aged 11 to 17 who were insufficiently physically active. One of the consequences of physical inactivity is the growing trend of excess weight and obesity (Inchley et al., 2016). It can certainly be said that obesity is a major problem of contemporary times and it is linked to the development of many illnesses in the childhood and adult age (Kopelman, 2007).

These are alarming data which could be attributed to the growth of the sedentary way of life, insufficient physical activity and irregular dieting resulting in energetic imbalance.What is also worrying is the growing prevalence of children and adolescents' obesity. In 2010, 43 million children were evaluated as being overweight or obese, while 92 million were in danger of being overweight (De Onis et al., 2010). According to the same authors, the world's prevalence of childhood excess weight and obesity has grown from 4.2% in 1990 to 6.7% in 2010.

These days, children grow in an environment which stimulates the body weight increase and obesity. The possibilities for physical activities are diminished and more time is spent on sedentary activities. The World Health Organisation states that obese children will probably remain obese in their adulthood, which puts them in danger of chronic diseases (WHO, 2016a).

Numerous researches have shown (Magarey et al., 2001; Petrić, 2016; Schonbeck et al., 2011; Tambalis et al., 2010) that the prevalence of childhood and adolescent obesity is growing in many countries. School-age children are faced with exceptional challenges and are very sensitive to their environment's pressure, the perception of an ideal body image, the availability of unhealthy food and a sedentary way of life (WHO, 2016a). Hence, it is very important to act immediately to improve this and future generations' health.

De Onis et al. (2010) have analysed 450 nationally representative surveys from 144 countries of the world. The results have shown

that in 2010, 43 million children (35 million of them coming from developing countries) were estimated as being overweight or obese. There are 92 million children in danger of excess weight. The World Health Organisation (2016b) states the alarming information about 10.3 million African children with excess weight or obesity, which is almost the double than in 1990, when 5.4 million children had excess weight or were obese.

Albon et al. (2010) studied the changes in the health and physical components on a sample of 3.306 children aged 10 to 14 attending New Zealand primary schools between 1991 and 2003. In this 12-year-period the average BMI increased by 0.12 kg/m² (0.6%) and 0.11 kg/m² (0.5%) a year for boys and girls.

Tambalis et al. (2010) have analysed the height and weight of 651.582 Greek boys and girls aged between 8 and 9. They were testing 11-year trends (1997 – 2007) in malnutrition, excess weight and obesity on a sample encompassing more than 80% of all Greek schools. Between 1997 and 2007, the prevalence of excess weight and obesity rose from 20.2% to 26.7% for girls and from 19.6% to 26.5% for boys.

The study conducted in Croatia on a sample of 960 primary school first graders (467 girls) has shown that 12.6% of girls were overweight, while 6.9% of them were obese. Regarding boys, this percentage was 13.8% and 8.3% (Jureša et al., 2012).

Taking into consideration the significant connection between excess body mass and obesity with the development of chronic diseases, it can be stated that monitoring the movement of the body mass index in children and adolescents is an extremely important public health task. The aim of the paper is to describe the movement trend of the median body mass index in children from the fifth to the eighth grade of a primary school in Zagreb in the period from 1999 to 2014.

2. Methods

2.1. Sample of participants

The sample of participants consisted of students (N=3.567), of whom 46% (1.652) were female and 54% (1.915) male students

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from the fifth to the eighth grade of primary school "Ivan Cankar" in the city of Zagreb, the chronological age being 12 to 15 years. The research included students belonging to generations 1999 to 2014. Table 1 shows the number of female and male students tested per year within the observed period.

Table 1. The number of participants per year and gender

Year*	Primary school grade								Total (n)
	Fifth		Sixth		Seventh		Eighth		
	M n (%)	F n (%)	M n (%)	F n (%)	M n (%)	F n (%)	M n (%)	F n (%)	
1999	40 (51.9)	37 (48.1)	31 (54.4)	26 (45.6)	36 (48.6)	38 (51.4)	23 (52.3)	21 (47.7)	252
2000	39 (57.4)	29 (42.6)	39 (52.0)	36 (48.0)	31 (56.4)	24 (43.6)	29 (45.3)	35 (54.7)	262
2002	26 (42.6)	35 (57.4)	38 (53.5)	33 (46.5)	36 (58.1)	26 (41.9)	10 (50.0)	10 (50.0)	214
2003	29 (49.2)	30 (50.8)	29 (37.7)	48 (62.3)	38 (52.1)	35 (47.9)	36 (62.1)	22 (37.9)	267
2004	33 (46.5)	38 (53.5)	28 (46.7)	32 (53.3)	29 (37.2)	49 (62.8)	33 (51.6)	31 (48.4)	273
2005	41 (57.7)	30 (42.3)	34 (47.9)	37 (52.1)	28 (46.7)	32 (53.3)	26 (34.7)	49 (65.3)	277
2006	27 (54.0)	23 (46.0)	39 (56.5)	30 (43.5)	31 (47.0)	35 (53.0)	28 (47.5)	31 (52.5)	244
2007	42 (67.7)	20 (32.3)	27 (57.4)	20 (42.6)	36 (56.3)	28 (43.7)	32 (45.7)	38 (54.3)	243
2008	36 (52.9)	32 (47.1)	40 (67.8)	19 (32.2)	25 (54.3)	21 (45.7)	33 (58.9)	23 (41.1)	229
2009	42 (59.2)	29 (40.8)	30 (55.6)	24 (44.4)	38 (67.9)	18 (32.1)	28 (58.3)	20 (41.7)	229
2010	35 (54.7)	29 (45.3)	40 (61.5)	25 (38.5)	31 (52.5)	28 (47.5)	19 (76.0)	6 (24.0)	213
2011	28 (60.9)	18 (39.1)	34 (52.3)	31 (47.7)	39 (60.9)	25 (39.1)	29 (50.9)	28 (49.1)	232
2012	38 (65.5)	20 (34.5)	28 (59.6)	19 (40.4)	34 (53.1)	30 (46.9)	43 (62.3)	26 (37.7)	238
2013	25 (50.0)	25 (50.0)	24 (55.8)	19 (44.2)	30 (65.2)	16 (34.8)	33 (55.9)	26 (44.1)	198
2014	20 (42.6)	27 (57.4)	28 (53.8)	24 (46.2)	33 (61.1)	21 (38.9)	28 (65.1)	15 (34.9)	196
Total	501	422	489	423	495	426	430	381	3567

***there were no available data for the year 2001; M=male, F=female**

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2.2. Measured variables

The examinees were measured as part of the initial monitoring of morphological characteristics during regular physical education classes in the period between 1999 and 2014. The measurement was done by the Physical Education teacher at the beginning of each school year.

The participants' body height and body mass were measured and the body mass index (BMI) was calculated based on the measured variables. The body height was measured using an altimeter, with the exactness of 0.1 cm. Body weight was measured with a decimal balance, with the exactness of 0.1 kg.

2.3. Data analysis

The basic descriptive parameters for the body mass index (BMI) were calculated (the arithmetic mean (AS), median, standard deviation (SD), minimal and maximal value) for the sample of male and female students for each year. Initial statistical procedures were conducted. The normality of variable distribution was tested by the Kolmogorov – Smirnov test. The simple regression analysis, where the median BMI was the dependent and the years the independent variable, was used to determine the movement trend of the body mass index. The statistical significance was tested with a possibility of errors of 0.05. The programme STATISTICA, version 12 (StatSoft., Inc., Tulsa, OK, USA) was used in the analysis.

3. Results

Figure 1 shows the movement of the median and the minimal and maximal values of the body mass index for a) female students and b) male students of the fifth grade in the period from 1999 to 2014, where a mild growth trend of the body mass index value for girls and a minor growth of the results' value for boys can be seen. The results of the regression analysis show that the trend of the median body mass index growth for female students of the fifth grade during the observed period is 0.05 kg/m² a year which is statistically insignificant

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(p=0.193). When it comes to boys, a statistically insignificant (p=0.462) trend of the median body mass index growth was also recorded, and it was 0.03 kg/m² a year.

Figure 1. Body mass index (median, minimum and maximum value) for a) female and b) male students of fifth grades in the period from 1999 to 2014

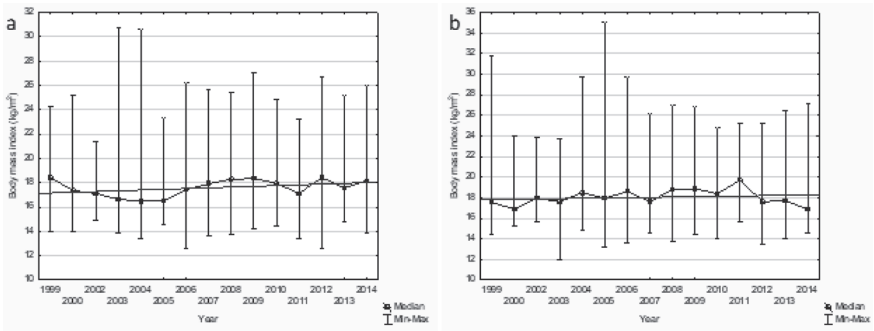

Figure 2 shows the median movements and the minimal and maximal values of the body mass index for a) female students and b) male students of the sixth grade in the period from 1999 to 2014, where a mild growth trend of the body mass index value for girls and a significant growth of the results' value for boys can be seen. The regression analysis has shown a growth trend of the girls' median body mass index in the observed period. It was 0.3 kg/m² a year, which is not statistically significant (p=0.365). A statistically significant growth trend of the median body mass index was determined for boys (p=0.019), and it was 0.08 kg/m² a year

Figure 2. Body mass index (median, minimum and maximum value) for a) female and b) male students of sixth grades in the period from 1999 to 2014

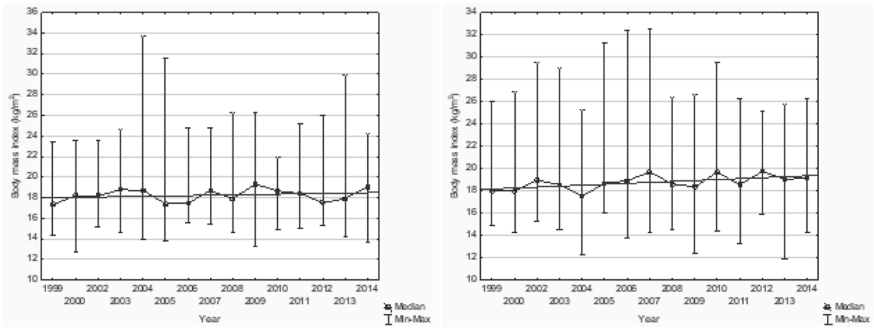

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Figure 3 shows the median movement and the minimal and maximal values of the body mass index for a) female students and b) male students of the seventh grade in the period from 1999 to 2014, where a mild growth trend of the body mass index value for girls and a significant growth of the results' value for boys can be seen. The regression analysis results show a statistically insignificant (p=0.134) growth trend of the median body mass index for girls, which was 0.06 kg/m² a year during the observed period, while a statistically significant (p=0.004) growth trend of the median body mass index was determined for boys, and it was 0.14 kg/m² a year.

Figure 3. Body mass index (median, minimum and maximum value) for a) female and b) male students of seventh grades in the period from 1999 to 2014

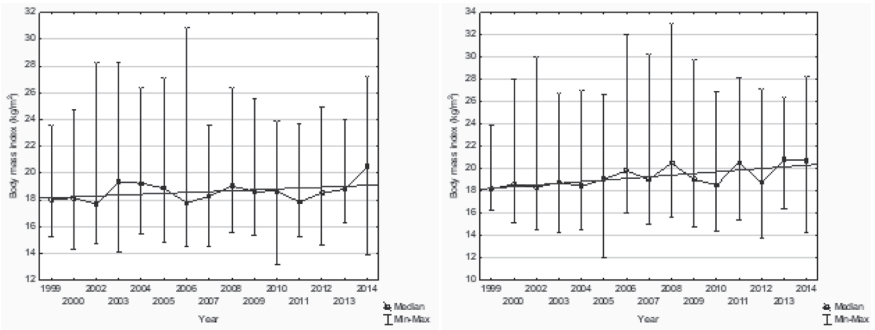

Figure 4 shows the median movement and the minimal and maximal values of the body mass index for a) female students and b) male students of the eighth grade in the period from 1999 to 2014, where a growth trend of the body mass index value for girls wasn't noticed, however, a significant growth of the results' value for boys can be seen. There was a statistically insignificant (p=0.895) growth trend of the median body mass index for girls, which was 0.004 kg/m² a year during the observed period. For boys, the growth trend of the median body mass index was also statistically insignificant (p=0.060) and it was 0.07 kg/m² a year.

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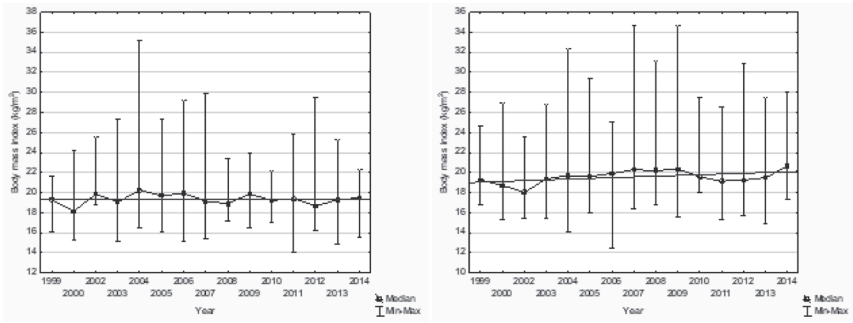
Figure 4. Body mass index (median, minimum and maximum value) for a) female and b) male students of eighth grades in the period from 1999 to 2014



4. Discussion

When comparing the results of the body mass index for female students from the fifth to the eighth grade, a mild growth trend of the median body mass index can be noticed in all grades through the studied period. However, neither one was statistically significant. The highest median growth of 0.06 kg/m² a year in the observed period was seen in the seventh- grade female students, which represents a total growth of 0.9 units of body mass index. The lowest median was in 2002 and it amounted to 17.70 kg/m², while the highest was 20.51 kg/m² in 2014.

The lowest growth of the median body mass index of 0.004 kg/m² was observed in the eighth grade female students which represents a total growth of 0.06 body mass index units. The lowest median was in 2000 and it amounted to 18.13 kg/m², while the highest was 20.24 kg/m² in 2004.

When comparing the results of the body mass index for students from the fifth to the eighth grade, a statistically significant growth of the median body mass index can be seen in the sixth and seventh grades. A statistically significant ($p=0.019$) growth trend of the median body mass index was determined for sixth grade students and in the observed period it amounted to 0.08 kg/m² a year, which is a total growth of 1.2 body mass index units. The lowest median was in 2004 and it amounted to 17.52 kg/m², while the highest was in 2012 and it was 19.73 kg/m².

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A statistically significant (p=0.004) growth of the median body mass index was also determined for seventh- grade students and in the observed period it amounted to 0.14 kg/m², which is a total growth of 2.1 body mass index units. The lowest median was in 1999 and it amounted to 18.19 kg/m², while the highest was in 2013 and it was 20.83 kg/m². A growth trend of the median BMI was also seen in fifth and eighth grade students, but it is not statistically significant. The obtained results are similar to former researches, which had shown a growing trend of the body mass index and of the number of overweight and obese persons.

Similar results were obtained in the research conducted by Ogdena et al. (2012), in which the prevalence of obesity and the trends in body mass index for children and adolescents of the United States of America in the period from 1999 to 2010 were observed. The 12-year analysis showed a significant growth of obesity prevalence in boys aged 2 to 19, but not in girls. A significant growth of BMI was observed in adolescent males aged 12 to 19.

Schonbeck et al. (2011) have compared the researches undertaken in 1980, 1997 and 2009 among Dutch children and adolescents and determined that in 2009 there were 12.8% overweight boys and 14.8% overweighed girls aged 2 to 21 , while 1.8% of boys and 2.2% of girls were obese. This represents a two to three times higher prevalence of excessive weight and a four to six times higher prevalence of obesity than in 1980.

The prevalence and obesity trends among Chinese children and adolescents in the period from 1985 to 2010 was analysed by Sun et al. (2014). The prevalence of excess weight and obesity was 8.1% and 19.2% in children and adolescents aged 7 to 18. Obesity was more frequent in male children and adolescents aged 10 to 12. The trend analysis of the period between 1995 and 2010 showed a significant and continuous increase in the prevalence of obesity among children and adolescents.

Similar results, although on a population of secondary school students, were obtained by Petrić (2016). He analysed the secondary school students' anthropological characteristics on the sample of 647 female and 632 male students in the period between 2010 and 2015. It was determined that for both genders the average body mass index

was higher for every next generation. The average was increased by 2.14 for male students and 1.53 for female students in a five-year period.

One of the flaws of our research is the fact that the conclusions are limited by the impossibility of calculating the studentswe did not have their exact date of birth. If we assume that at the time of undertaking the measurement all the children of the fifth grade were 11 years old, those of the sixth grade 12, in the seventh 13, while in the eighth grade 14 years old, and if the year 1999 was compared to 2014, the following results would be obtained according to the IOTF criteria (Cole&Lobstein, 2012; World Obesity, 2015). In comparison with 1999, a larger number of overweight and obese children would be present among boys and girls of the seventh grade and boys of the eighth grade. In 1999, 5.3% of girls and 5.6% of boys would be overweight. In 2014 this percentage would raise to 28.6% of girls and 27.3% of boys being overweight and 9.1% of boys being obese.

Regarding eight-grade boys, in 1999 there would be 4.3% of boys with excess body mass, while in 2014 there would be 17.9% with excess body mass and 3.6% of them would be obese.

It should be pointed out that the number of girls with a low body mass would be diminished if these two years are to be compared. In 1999, 16.2% of fifth-grade girls, 15.4% of sixth-grade, 23.7% of seventh-grade and 19% of eight-grade female students would have a low body mass. In 2014 this percentage would diminish to 11.1% in the fifth grade, 4.2% in the sixth, 4.8% in the seventh and 13.3% of eighth-grade female students with a low body mass.

This projection of results is similar to the HBSC findings (Health-Behaviour in School-Aged Children) for Croatia. This is a periodical research conducted every four years in about 40 European countries and North American states. The survey considers boys and girls who are 11, 13 and 15 years old and examines their different behaviour connected to health. The research has been conducted in Croatia, too. The reports about our country's data have been published under the title "Behaviour Linked to Health in School-Aged Children" for the years 2001/2002, 2005/2006 and 2009/2010 (Kuzman et al., 2004, 2008, 2012). Due to the relative unreliability of the 11-year-olds' anamnestic declarations, these data have been left out. The 2001/2002

research showed that among the 13-year-old Croatians, 11% of boys and 5% of girls were overweight, while 2% of boys and 1% of girls were obese. Among the 15-year-olds, 15% of boys and 6% of girls were overweight, while 2% of boys and girls were obese (Kuzman et al., 2004).

In 2005/2006 among the 13-year-old children, 14% of boys and 9% of girls were overweight, while 3% of boys and 2% of girls were obese. Among the 15-year-olds, 17% of boys and 9% of girls were overweight, while 2% of boys and 1% of girls were obese (Kuzman et al., 2008). The 2009/2010 data indicate that 20% of boys and 12% of girls aged 13 were overweight or obese, while among the 15-year-olds, 23% of boys and 10% of girls were overweight or obese (Kuzman et al., 2012).

Inchley et al. (2016) have analysed data from the year 2013/2014 as part of the Health Behaviour in School-Aged Children (HBSC) research. According to these years' data, there were 27% of boys and 14% of girls aged 13 who were overweight or obese, while there were 24% of boys or 9% of girls aged 15 with the same problem.

After analysing all the results, a continual growth in the percentage of overweight or obese Croatian children can be noticed. In 2002, among the 13-year-olds there were 13% of overweight/obese boys, in 2006 there were 17% of them, in 2010 there were 20% and in 2014 there were 27% with the problem. Among the 15-year-old boys, the percentages were, in the same order, 16%, 28%, 23% and 24%. In regard to girls, in the research periods there were 6%, 10%, 12% and 14% of overweight/obese 13-year-old girls, and 6%, 10%, 10% and 9% of 15-year-old girls with the same problem respectively.

The share of overweight and obese children is growing, especially in the younger age groups. In comparison to other European countries, in 2002 Croatian children were in the 25th place, in 2006 in the 11th and in 2010 in the 7th place. Our country was 23rd in 2002, it was 8th in 2006 and 10th in 2010 regarding the number of 15-year-old children with excessive weight and obesity. The same researches have confirmed the hypothesis that with the growth of overweight and obese children, the number of insufficiently physically active children grows as well (Kuzman et al., 2004, Inchley et al., 2016). These authors have determined that in our country there were 54% of boys

and 68% of girls aged 11 who were insufficiently physically active in 2002, while in 2014 this percentage grew to 61% of boys and 74% of girls. Among the 13-year-olds the percentage of those insufficiently physically active grew from 56% of boys and 75% of girls in 2002 to 67% of boys and 81% of girls in 2014. Worse results are also seen in 15-year-old children, where the percentage of insufficiently active ones grew from 66% and 83% in 2002 to 75% of boys and 88% of girls in 2014.

The average results indicate a visible growth trend of the median body mass index from one generation to the other, and consequently a growing number of overweight and obese children. Obesity can influence the current child's health, the level of education and quality of life (WHO, 2016a). Overweight and obese children and adolescents have a bad body image which also includes a lowered level of physical activity, unhealthy eating habits and mental health problems like depression (Grogan, 2006). Children with a high body mass index have also a high level of excess weight or obesity in their 35th year of age, which can be linked to various chronical diseases (Guo et al., 2002).

5. Conclusion

It can be concluded that the results of this research indicate a noticeable growth trend of the body mass index in most grades, but it is statistically significant only for students of the sixth and seventh grade. These results were expected in regard to the current trends in Croatia and the world. Excessive weight and obesity amongst children is a global epidemic which represents a serious menace for the young persons' present and future health. Children with a high body mass index often become obese adults.

That is why at this sensitive age awareness should be risen about the importance of physical activity and a correct diet, which contribute to health and quality of life. More extensive research should be conducted on the children and adolescents' body mass index, with the aim of determining further trends and prevalence of excessive weight and obesity. Meanwhile, we should act in accordance with to the Global strategy of the World Health Organisation related to

dieting, physical activity and health if the further growth of the body mass index is to be prevented.

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Trend kretanja indeksa tjelesne mase kod učenika osnovne škole tijekom 15 – godišnjeg razdoblja

Martin ERDELJAC
Sveučilište u Zagrebu, Kineziološki fakultet
martin.erdeljac@kif.hr

Marija RAKOVAC
Sveučilište u Zagrebu, Kineziološki fakultet
marija.rakovac@kif.hr

Vilko PETRIĆ (*kontakt autor*)
Sveučilište u Rijeci, Učiteljski fakultet
vilko.petric@uniri.hr

Cilj je ovoga rada bio opisati trend kretanja medijana indeksa tjelesne mase učenika od petih do osmih razreda jedne osnovne škole u Zagrebu u razdoblju od 1999. do 2014. godine. Uzorak ispitanika čine učenici (N=3.567; 1.652 učenice i 1.915 učenika) od petih do osmih razreda osnovnih škola u gradu Zagrebu, kronološke dobi od 12 do 15 godina. Na temelju prikupljenih podataka mase i visine tijela na početku školske godine izračunat je indeks tjelesne mase. Ova metoda koristi se kao pokazatelj stupnja uhranjenosti osobe. Za prikaz kretanja indeksa tjelesne mase korištena je regresijska analiza. Podaci pokazuju da je u većine razreda uočljiv rastući trend indeksa tjelesne mase, ali je statistički značajan samo kod učenika šestih i sedmih razreda. Kod učenika šestih razreda regresijska analiza pokazuje statistički značajan (p=0.019) trend porasta medijana indeksa tjelesne mase tijekom promatranoga razdoblja u iznosu od 0.08 kg/m^2 godišnje. Kod učenika sedmih razreda utvrđen je statistički značajan (p=0.004) trend porasta medijana indeksa tjelesne mase u iznosu od 0.14 kg/m^2 godišnje.

Ključne riječi: *tjelesna aktivnost, djeca, prekomjerna tjelesna masa, pretilost*