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Secular Trends of Motor Abilities and BMI among Adolescents from 1998 to 2018

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Abstract

Continuous observation of the state and trend in adolescents' physical fitness and BMI (body mass index) is a major indicator of health and well-being sustainability in youth. Because of that, the main goal of this study is to determine secular changes in anthropometric characteristics and some motor abilities of adolescents over a period of 20 years. The research included a total of 177 high school students, 15-16 years old. The first measurement was conducted in 1998 and involved 89 students (63 girls and 26 boys), and the second measurement was conducted in 2018 and involved 88 students (53 girls and 35 boys). Body height and body weight of all participants were measured. Additional tests were performed to asses motor skills: standing long jump (explosive strength), sit and reach (flexibility), sit ups (repetitive strength) and polygon backward (coordination). T-test with descriptive statistics was used to determine the differences between two generations and between genders. The present study indicates no statistically significant difference in anthropometric characteristics among adolescents during the last 20 years. The boys and girls aged 15 and 16 measured in 2018 are slightly taller, heavier, and the BMI is almost the same as in the generation measured in 1998. In terms of motor abilities between the generations of adolescents measured in 1998 and 2018, no negative trend was found except in flexibility, where subjects measured 20 years ago showed statistically better results.The results of this research indicate that the promotion of free play and exercise, the opportunities to participate in organized sports and the quality implementation of physical education classes are very important for contributing to the improvement of motor abilities and maintaining positive anthropometric characteristics in adolescents population.

Key words*: anthropometric characteristics; boys and girls; transversal research.*

Introduction

Adequate growth and development are a good indicator of an individual's health, but also the entire observed population. They are determined by an individual's genetic predisposition, but also by numerous environmental factors (Bralić, 2008). Given the nation-wide health perspective, data on the population's physical fitness, anthropometry and physical activity behaviour are important because long-term observation of such records may be used as an indicator of the health status of specific population (Wyss, Roos et al., 2019). For that reason, scientists in the field of kinesiology systematically monitor the development of children, detecting the progress of motor performance and morphological characteristics so the preventive action can be taken at an early age. It has been proven by many studies over the years that children and youth who have poorly developed motor abilities and unsatisfactory BMI index, which classifies them as overweight or obese, have high risk of various cardiovascular diseases and other chronic diseases such as hyperlipidemia, hyperinsulinemia, hypertension, early atherosclerosis, diabetes, etc. in a later age (Kautiainen et al., 2002; Katzmarzyk et al., 2003; Field et al., 2005; Bailey, 2006).

Therefore, early diagnosis and constant focus on trends in growth, maturity status and physical performance in children is extremely important to identify negative changes in time (Malina, 1978). Numerous studies conducted over the past twenty years have established that physical fitness has declined and body mass index increased among children in developed and industrialized countries around the world (Magarey et al., 2001; Tomkinson , Le´ger et al., 2003; Albon et al., 2010). The researchers concluded in their investigations that negative trends that occurred are highly associated with the presence of sedentary lifestyle, specifically changes in school programs, reduced physical activity and increased television and video games. The large changes and negative secular trends of BMI and physical fitness in children and youth are also especially expressed due to drastic changes in living environment, behavioural choices, eating habits and socio-economic conditions in early years of the twenty-first century (Ignasiak et al., 2016; Drenowatz et al., 2020). This statement refers especially to adolescents with poor physical fitness and obesity so, as a result, they are faced with stigmatization and discrimination in many areas of their lives and therefore more prone to depression, poor physical, mental and social health, and their academic achievements are also impeded (Janssen & Leblanc, 2010; Singh et al., 2012; Bélair et al., 2018; Frömel et al., 2020).

According to a study on health behaviour of school-aged children (2013) in the period between 2002 and 2010, only a minority of adolescent people met the current worldwide recommendation of 60 minutes moderate-to-vigorous physical activity per day (Kalman et al., 2015). On the other hand, screen-time activities such as watching television and using various social media (smartphones, tablets, play stations and computers) have an increasingly prominent role in adolescents' lives. Considering the

devastating results of the previous research, many countries have increased their efforts during the past decades to promote the importance of physical activity patterns on the healthy physical fitness and regulation of body mass (Leech et al., 2014; Kalman et al., 2015; WHO, 2015). International strategies and interventions are focusing on increasing elective physical education classes, increasing physical activity during leisure time, participation in sports clubs and reducing screen-time behaviours in children and adolescents (American Academy of Pediatrics, 2013; Bucksch et al., 2014).

According to the results of studies conducted over the past ten years, it can be established that there are indications of a healthy lifestyle's sustainability positive changes of physical activity at all levels of education, in all forms of leisure-time organizations and in family surroundings (Mitáš et al., 2020). Also, the evidence of the start of a positive secular trend in BMI and in some muscular fitness components over the last decades among youth are recorded in a study carried out by Costa et al. (2017). Apart form that, Wyss et al. (2019) concluded that secular trends of decreasing physical fitness and increasing BMI have stopped, and self-reported sport participation and leisure-time physical activities have been increased in youth over the last ten years.

Guided by the conclusions of previous research, the main goal of this study was to determine secular changes in anthropometric characteristics and some motor abilities of adolescents over 20 years.

Methods

The research included a total of 177 high school students, 15-16 years old, from a high school in Garešnica in Croatia. The first measurement was conducted in autumn 1998 and involved 89 students (63 girls and 26 boys). The second measurement was conducted in autumn 2018 and involved 88 students (53 girls and 35 boys). Body height and body weight of all participants were measured. Based on the ratio of body mass and the square of body height, the body mass index was calculated (BW / BH^2) (kg / m^2) (Garow & Webster, 1985), according to which the degree of nutritional status was determined for the participants with the help of centile curves. The participants up to the 5th percentile were classified in the group of malnourished students, from the 5th to the 85th percentile in the group of normally fed students, from the 85th to the 95th percentile in the group of overweight students, while participants above the 95th percentile were classified in the obese group (CDC, 2000). Additional tests were performed to assess motor skills: standing long jump (explosive strength), sit and reach (flexibility), sit ups in 60 seconds (repetitive strength) and backward obstacle course (coordination).

Descriptive statistics (arithmetic mean, minimum, maximum, standard deviation, skewness, and kurtosis) were calculated, and T-test was used to determine differences between the two generations and genders.

Results

Table 1
Descriptive statistics of students from 1998 and 2018

	Year	Valid N	Mean	Minimum	Maximum	Std.Dev.	Skewness	Kurtosis
Body height	1998	89	167.52	150.90	192.30	7.84	0.43	0.57
	2018	88	167.70	151.10	188.00	7.70	0.74	0.52
Body weight	1998	89	59.80	42.50	95.70	10.59	1.03	0.90
	2018	88	62.27	43.00	96.50	12.57	0.95	0.38
BMI	1998	89	57.31	4.00	96.00	26.18	-0.30	-0.94
	2018	88	58.04	5.00	96.00	28.14	-0.36	-1.03
Standing long jump	1998	89	175.01	118.00	248.00	30.64	0.41	-0.42
	2018	88	179.77	105.00	265.00	36.45	0.41	-0.41
Backward obstacle course	1998	89	15.10	8.09	38.75	5.11	1.74	4.90
	2018	88	10.97	8.69	13.47	1.18	0.29	-0.75
Sit and reach	1998	89	70.05	43.00	90.00	9.39	-0.09	0.21
	2018	88	52.03	34.00	77.00	7.28	0.18	1.26
Sit ups	1998	89	40.01	25.00	64.00	6.79	0.51	1.17
	2018	88	44.72	22.00	60.00	7.97	-0.21	-0.19

Table 2
Descriptive statistics of male students from 1998 and 2018

Variables	Year	Valid N	Mean	Minimum	Maximum	Std.Dev.	Skewness	Kurtosis
Body height	1998	26	175.10	162.60	192.30	6.56	0.82	1.41
	2018	35	172.41	157.90	188.00	8.42	0.31	-0.72
Body weight	1998	26	64.39	48.50	86.10	10.77	0.41	-0.67
	2018	35	67.76	44.00	96.50	15.11	0.31	-0.89
BMI	1998	26	53.80	4.00	96.00	31.32	-0.19	-1.39
	2018	35	59.61	6.00	96.00	33.68	-0.46	-1.51
Standing long jump	1998	26	207.15	160.00	248.00	24.85	-0.26	-0.45
	2018	35	203.00	105.00	265.00	40.22	-0.48	-0.47
Backward obstacle course	1998	26	11.52	8.09	16.40	2.13	0.56	0.20
	2018	35	10.45	8.69	13.22	1.18	0.72	-0.49
Sit and reach	1998	26	69.84	43.00	84.00	9.61	-1.05	1.78
	2018	35	50.97	34.00	77.00	8.64	0.71	1.86
Sit ups	1998	26	43.73	30.00	58.00	6.46	-0.04	0.18
	2018	35	47.17	30.00	60.00	8.64	-0.41	-0.82

Table 1 shows descriptive indicators of two generations of students. Although students were measured with a 20-year gap, the values of body height, body weight and BMI are very similar. The nutritional status of both generations of students belongs to the average group. Descriptive indicators of motor skills tests show that 2018 students are better in all tests (standing long jump, backward obstacle course, sit ups) except flexibility (sit and reach).

Table 2 shows that the male students from 1998 were slightly higher and lighter than male students from 2018. However, both groups of male students have a normal BMI and belong to the group of normally nourished children. As for motor abilities, generation of 1998 is slightly better in tests of standing long jump and sit and reach, while the generation of 2018 improved in the backward obstacle course and sit ups.

Table 3
Descriptive statistics of female students from 1998 and 2018

Variables	Year	Valid N	Mean	Minimum	Maximum	Std.Dev.	Skewness	Kurtosis
Body height	1998	63	164.40	150.90	176.90	5.99	-0.02	-0.27
	2018	53	164.59	151.10	180.30	5.31	0.09	0.63
Body weight	1998	63	57.91	42.50	95.70	10.00	1.45	2.80
	2018	53	58.64	43.00	88.50	9.04	1.13	2.06
BMI	1998	63	58.76	6.00	96.00	23.88	-0.28	-0.82
	2018	53	57.02	5.00	96.00	24.11	-0.30	-0.47
Standing long jump	1998	63	161.75	118.00	210.00	21.71	0.11	-0.63
	2018	53	164.43	115.00	209.00	23.73	-0.05	-0.89
Backward obstacle course	1998	63	16.58	9.19	38.75	5.26	1.67	4.48
	2018	53	11.33	9.44	13.47	1.05	0.35	-0.66
Sit and reach	1998	63	70.14	49.00	90.00	9.38	0.30	-0.33
	2018	53	52.74	37.00	65.00	6.21	-0.39	0.16
Sit ups	1998	63	38.48	25.00	64.00	6.36	0.84	3.18
	2018	53	43.11	22.00	58.00	7.13	-0.38	0.72

Table 3 shows that female students of both generations are equally tall and heavy, with similar BMI. The results of descriptive statistics show that the 1998 female students are better only in the sit and reach test, while the 2018 female students are better in backward obstacle course, standing long jump and sit ups.

Table 4
T-test of all variables between two generations of students

Variables	Mean 1998	Mean 2018	t-value	df	p	Valid N	Valid N	Std. Dev.	Std. Dev.	F-ratio	P
Body height	167.52	167.70	0.14	175	0.88	89	88	7.84	7.70	1.03	0.87
Body weight	59.80	62.27	1.41	175	0.15	89	88	10.59	12.57	1.40	0.11
BMI	57.31	58.04	0.17	175	0.85	89	88	26.18	28.14	1.15	0.50
Standing long jump	175.01	179.77	0.94	175	0.34	89	88	30.64	36.45	1.41	0.10
Backward obstacle course	15.10	10.97	-7.37	175	0.00	89	88	5.11	1.18	18.76	0.00*
Sit and reach	70.05	52.03	-14.25	175	0.00	89	88	9.39	7.28	1.66	0.01*
Sit ups	40.01	44.72	4.23	175	0.00	89	88	6.79	7.97	1.37	0.13*

The analysis of the T-test results revealed no statistically significant difference in the standing long jump between the two student generations. However, differences were observed in the backward obstacle course and sit ups in favor of the 2018 generation. It was also confirmed that the 1998 generation was better in the sit and reach test.

Table 5
T-test by gender (1998 and 2018)

	Gender	Mean 1998	Mean 2018	t-value	df	p	Valid N	Valid N	Std. Dev.	Std. Dev.	F-ratio	p
Body height	M	175.10	172.41	1.35	59	0.18	26	35	6.56	8.42	1.65	0.20
	F	164.40	164.59	-0.17	114	0.86	63	53	5.99	5.31	1.28	0.37
Body weight	M	64.40	67.76	-0.97	59	0.34	26	35	10.78	15.11	1.96	0.08
	F	57.91	58.64	-0.41	114	0.68	63	53	10.00	9.04	1.23	0.45
BMI	M	53.81	59.61	-0.68	59	0.50	26	35	31.33	33.68	1.16	0.71
	F	58.76	57.02	0.39	114	0.70	63	53	23.88	24.11	1.02	0.94
Standing long jump	M	207.15	203.00	0.46	59	0.64	26	35	24.86	40.22	2.62	0.01
	F	159.09	164.43	-1.10	114	0.28	63	53	28.02	23.73	1.39	0.22
Backward obstacle course	M	11.52	10.45	2.51	59	0.01*	26	35	2.14	1.18	3.30	0.00
	F	16.58	11.33	7.14	114	0.00*	63	53	5.26	1.05	24.90	0.00
Sit and reach	M	69.85	50.97	8.04	59	0.00*	26	35	9.62	8.64	1.24	0.56
	F	70.14	52.74	11.54	114	0.00*	63	53	9.38	6.21	2.28	0.00
Sit ups	M	43.73	47.17	-1.71	59	0.09	26	35	6.47	8.64	1.79	0.14
	F	38.48	43.11	-3.70	114	0.00*	63	53	6.36	7.13	1.26	0.39

Looking at the results of the T-test in Table 5, it can be concluded that there are no statistically significant differences in anthropometry both between the boys from 1998 and 2018 as well as between the girls from the mentioned years. With respect to motor abilities, male students from 1998 are better in the sit and reach test, while male students from 2018 are better in the backward obstacle course test. Female students from 2018 are better in the backward obstacle course and sit ups, while female students from 1998 are better in the sit and reach test.

Table 6
Nutritional status of students from 1998 and 2018

Year	Underweight	Normal weight	Overweight	Obese
1998	2.22%	80 %	12.11 %	5.56 %
2018	0 %	76.74 %	13.95 %	9.30 %

According to the data in Table 6, it can be concluded that the nutritional status of students over the last 20 years has not changed significantly. A very high percentage of students from both 1998 and 2018 have normal body weight, which is a good indicator considering that today we are witnessing an epidemic of overweight children.

Discussion

Secular trends refer to changes in body size, motor fitness and other anthropometric characteristics over one or more decades (Claessens & Lefevre, 1992). Continuous observation of the state and trend in adolescents' physical fitness and BMI is a major indicator of health and well-being sustainability in youths. So, the main goal of this study was to determine secular changes in anthropometric characteristics and some motor abilities of adolescents over a 20-year period.

Due to sedentary lifestyle, poorer nutrition and inadequate levels of physical activity, today's generations of children are heavier, with higher BMI than the previous generations (Ogden et al., 2012). In the last 20 years of the 20th century, many studies have shown that body weight has increased, and physical fitness has decreased (Tomkinson, Olds et al., 2007; Matton et al., 2007; Wyss, Beuchat et al., 2009). However, the results of this research prove that this is not the rule. No significant difference was found between the students in anthropometric characteristics according to gender and the year of measurement (1998 and 2018). This is in line with a research of a group of authors who proved that there has been no change in the trend of weight gain after year 2000 (NCD Risk Factor Collaboration, 2014). Troiano and Flegal (1998) measured the height and weight of US children in 1963 and 1994 and concluded that the heaviest children became even heavier over time, while the rest of the BMI distribution showed small changes over time.

However, male students from 2018 are statistically significantly better in coordination, while male students from 1998 in flexibility. No significant difference was found in the other tests. Female students from 2018 are statistically significantly better in coordination and repetitive strength, while female students from 1998 are better

in flexibility. Bös proved in his research that flexibility decreases with time (acc. to Eberhardt et al., 2020), as well as Dos Santos et al. (2015).

There was no statistically significant difference in explosive strength either. This partly coincides with a study by Hardy et al. (2013) which showed that children and adolescents progressed in most motor tests between 1997 and 2010. The results of this study have shown that students from 2018 are better at coordination than students from 1998, which does not coincide with the research of Huotari et al. (2018). They recorded a decline in coordination in both genders between the two measurements (2003 and 2010).

Although no statistically significant difference was shown in boys, girls from 2018 performed better in the repetitive strength test than girls from 1998. However, Malina's claim (Malina & Katzmanyk, 2006) that secular changes in strength are proportional to changes in height and weight cannot be applied to the results of this study. Both generations of girls have almost identical average values of height and weight, but girls from 2018 achieved significantly better results in repetitive strength. On the other hand, Westerstahl et al. (2003) proved in their study on Swedish adolescents that both genders achieved worse results in sit ups in 1995 than the 1974. Albon et al. (2010) noted in their study that there were no significant changes in the standing long jump test in the period between 1991 and 2003, while there was an improvement in the results of the sit-up test. The same was proven in this research regarding the result of female students from 1998 and 2018.

Conclusion

The presented study indicates no statistically significant difference in anthropometric characteristics among adolescents during the last 20 years. Boys and girls aged 15 and 16 measured in 2018 are slightly taller and heavier, and the BMI is almost the same as in the generation measured in 1998. It can be concluded from the measurement results that no negative trend in anthropometric characteristics exists in the observed group of subjects, and that they are normally nourished.

Furthermore, in terms of motor abilities between the generations of adolescents measured in 1998 and 2018, no negative trend was found except in flexibility, wherein the subjects measured 20 years ago showed statistically better results. From the obtained results of this study, it can be concluded that adolescents are at the same level in explosive strength after 20 years, while they perform statistically significantly better in repetitive strength, especially girls. Similar results were recorded in the backward obstacle course test for both genders, and it can also be concluded that today's generations of adolescents are better in coordination than those of 20 years ago.

The results of this research indicate that the promotion of free play and exercise, the opportunities to participate in organized sports, and the quality implementation of physical education classes are very important in contributing to the improvement of motor abilities and maintaining positive anthropometric characteristics in adolescent population.

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Sekularni trendovi motoričkih sposobnosti i ITM-a među adolescentima od 1998. do 2018. godine

Sažetak

Kontinuirano praćenje stanja i trendova u tjelesnoj spremnosti i ITM-u (indeksu tjelesne mase) adolescenata glavni je pokazatelj održivosti zdravlja i dobrobiti kod mladih. Zbog toga je glavni cilj ovoga istraživanja utvrditi sekularne promjene antropometrijskih karakteristika i nekih motoričkih sposobnosti adolescenata tijekom 20 godina.

Istraživanjem je obuhvaćeno ukupno 177 srednjoškolaca, starih 15-16 godina. Prvo mjerenje provedeno je 1998. godine i u njemu je sudjelovalo 89 učenika (63 djevojke i 26 mladića), a drugo mjerenje provedeno je 2018. godine i uključeno je 88 učenika (53 djevojke i 35 mladića). Svim sudionicima izmjerena je tjelesna visina i tjelesna masa. Izvršeni su dodatni testovi motoričkih sposobnosti: skok u dalj s mjesta (eksplozivna snaga), pretklon raznožno (fleksibilnost), podizanje trupa (repetitivna snaga) i poligon unatraške (koordinacija). T test i deskriptivna statistika korišteni su za utvrđivanje razlika između dvije generacije i razlika između spolova.

Ovo istraživanje ne pokazuje statistički značajnu razliku u antropometrijskim karakteristikama među adolescentima tijekom posljednjih 20 godina. Mladići i djevojke u dobi od 15 i 16 godina izmjereni u 2018. godini nešto su viši, teži i ITM im je gotovo jednak kao i generaciji izmjerenoj 1998. Što se tiče motoričkih sposobnosti između generacija adolescenata izmjerenih u 1998. i 2018., nema negativnoga trenda osim u fleksibilnosti gdje su ispitanici mjereni prije 20 godina pokazali statistički bolje rezultate.

Rezultati ovoga istraživanja pokazuju da su promicanje slobodne igre i vježbanja, mogućnosti bavljenja organiziranim sportom i kvalitetna provedba nastave Tjelesnoga odgoja vrlo važni za doprinos poboljšanju motoričkih sposobnosti i održavanju pozitivnih antropometrijskih karakteristika kod adolescenata.

Ključne riječi: *antropometrijske karakteristike; mladići i djevojke; transverzalno istraživanje.*

Uvod

Adekvatan rast i razvoj dobar su pokazatelj zdravlja pojedinca, ali i cjelokupne promatrane populacije. Određuju se genetskom predispozicijom pojedinca, ali i

brojnim okolišnim čimbenicima (Bralić, 2008). S obzirom na zdravstvenu perspektivu u cijeloj zemlji, podatci o fizičkoj spremnosti stanovništva, antropometriji i ponašanju u tjelesnoj aktivnosti važni su jer se dugoročno promatranje takvih zapisa može koristiti kao pokazatelj zdravstvenoga stanja određene populacije (Wyss, Roos, Studer, Mäder, Beuchat, Staub, 2019). Iz toga razloga stručnjaci u kineziološkoj znanosti sustavno prate razvoj djece, otkrivajući napredak motoričkih performansi i morfoloških karakteristika, pa se preventivne mjere mogu poduzeti u ranoj dobi. Mnoga su istraživanja tijekom godina dokazala da djeca i mladi koji imaju slabo razvijene motoričke sposobnosti i nezadovoljavajući indeks tjelesne mase, što ih svrstava u grupu prekomjerno teške i pretile populacije, imaju visok rizik od raznih kardiovaskularnih bolesti i drugih kroničnih bolesti poput hiperlipidemije, hiperinsulinemije, hipertenzije, rane ateroskleroze, dijabetesa itd. u kasnijoj dobi (Kautiainen, Rimpelä, Vikat i Virtanen, 2002; Katzmarzyk, Janssen i Ardern, 2003; Field, Cook i Gillman, 2005; Bailey, 2006).

Stoga je rano dijagnosticiranje i stalna usredotočenost na trendove u rastu, statusu zrelosti i tjelesnim performansama djece izuzetno važno kako bi se promjene identificirale (Malina, 1978). Brojne studije provedene tijekom posljednjih dvadeset godina utvrdile su da se tjelesna spremnost smanjila i da se indeks tjelesne mase povećao kod djece u razvijenim i industrijaliziranim zemljama širom svijeta (Magarey, Daniels i Boulton, 2001; Tomkinson, Le´ger, Olds i sur., 2003; Albon, Hamlin i Ross, 2010). Istraživači su zaključili da su negativni trendovi u velikoj mjeri povezani s pojavom sjedilačkoga načina života, posebno s promjenama u školskim programima, smanjenom tjelesnom aktivnošću i povećanim televizijskim i videoigrama. Velike promjene i negativni sekularni trendovi ITM-a i tjelesne spremnosti kod djece i mladih također su posebno izraženi zbog drastičnih promjena u životnom okruženju, izboru ponašanja, prehrambenim navikama i socijalno-ekonomskim uvjetima u ranim godinama dvadeset i prvog stoljeća (Ignasiak i sur., 2016; Drenowatz i sur., 2020). Ova se izjava posebno odnosi na adolescente koji se zbog loše tjelesne spremnosti i pretilosti suočavaju sa stigmatizacijom i diskriminacijom u mnogim područjima svojega života, pa su stoga skloniji depresiji, lošijem fizičkom, mentalnom i socijalnom zdravlju te akademskim postignućima (Janssen i Leblanc, 2010; Singh i sur., 2012; Bélair i sur., 2018; Frömel i sur., 2020).

Prema studiji o Zdravstvenom ponašanju školske djece (2013.) od 2002. do 2010. godine, samo je manjina adolescenata ispunila trenutačnu svjetsku preporuku od 60 minuta umjerene do visoke tjelesne aktivnosti dnevno (Kalman i sur., 2015), dok aktivnosti poput gledanja televizije i korištenja raznih društvenih medija (pametnih telefona, tableta, PS-a i računala) imaju sve značajniju ulogu u životu adolescenata. Uzimajući u obzir poražavajuće rezultate prethodnih istraživanja, mnoge su zemlje tijekom posljednjih desetljeća povećale napore na promicanju važnosti tjelesne aktivnosti na zdravu tjelesnu kondiciju i regulaciju tjelesne mase (Leech, McNaughton i Timperio, 2014; Kalman i sur., 2015; SZO, 2015). Međunarodne strategije i intervencije usredotočene su na povećanje izborne nastave Tjelesnoga odgoja, povećanje tjelesne aktivnosti tijekom slobodnoga vremena, sudjelovanje u sportskim klubovima i

smanjenje vremena pred ekranima kod djece i adolescenata (Američka akademija za pedijatriju, 2013; Bucksch, Inchley, Hamrik, Finne i Kolip, 2014).

Prema rezultatima istraživanja provedenih u proteklih deset godina može se utvrditi da postoje naznake održivosti zdravoga načina života, pozitivne promjene tjelesne aktivnosti na svim razinama obrazovanja, u svim oblicima organizacije slobodnoga vremena i u obiteljskom okruženju (Mitáš i sur., 2020). Također, dokazi o početku pozitivnoga sekularnoga trenda u ITM-u i nekim komponentama mišićne kondicije tijekom posljednjih desetljeća među mladima, zabilježeni su u istraživanju koje su proveli Costa i sur., (2017). Također, Wyss i sur. (2019) zaključili su da su zaustavljeni sekularni trendovi smanjenja tjelesne spremnosti i povećanja ITM-a, a sudjelovanje u sportu i slobodno provođenje tjelesnih aktivnosti koje su sami prijavili povećani su kod mladih tijekom posljednjih deset godina.

Vođeni zaključcima prethodnih istraživanja, glavni je cilj ove studije utvrditi sekularne promjene u antropometrijskim karakteristikama i nekim motoričkim sposobnostima adolescenata tijekom 20 godina.

Metode

U istraživanju je sudjelovalo ukupno 177 učenika srednje škole Garešnica, starosti 15 - 16 godina. Prvo mjerenje provedeno je ujesen 1998. godine i uključivalo je 89 učenika (63 djevojke i 26 mladića). Drugo mjerenje provedeno je ujesen 2018. godine i sudjelovalo je 88 učenika (53 djevojke i 35 mladića). Svima je sudionicima mjerena tjelesna visina i tjelesna masa. Na temelju omjera tjelesne mase i kvadrata tjelesne visine izračunat je indeks tjelesne mase (TM/TV^2) (kg/m^2) (Garow i Webster, 1985.) prema kojem je određen stupanj stanja uhranjenosti za sudionike pomoću percentilnih krivulja. Sudionici do 5. percentila svrstani su u skupinu pothranjenih učenika, od 5. do 85. percentila u skupinu normalno uhranjenih učenika, od 85. do 95. percentila u skupinu učenika s prekomjernom tjelesnom masom, dok su ispitanici iznad 95. percentila svrstani u skupinu pretilih (CDC, 2000). Provedeni su dodatni testovi za procjenu motoričkih sposobnosti: skok u dalj iz mjesta (eksplozivna snaga), sjedenje i dohvat (pretklon raznožno), podizanje trupa (repetitivna snaga) u 60 sekundi i poligon unatraške (koordinacija).

Izračunati su deskriptivni pokazatelji (aritmetička sredina, minimum, maksimum, standardna devijacija, zakrivljenost i spljoštenost), a T test je korišten za utvrđivanje razlika između dvije generacije i razlika među spolovima.

Rezultati

Tablica 1.

U Tablici 1 prikazani su deskriptivni pokazatelji dviju generacija učenika. Iako su učenici mjereni s 20-godišnjim razmakom, vrijednosti tjelesne visine, tjelesne mase i ITM-a vrlo su slične. Stanje uhranjenosti obiju generacija učenika spada u skupinu normalnih. Deskriptivni pokazatelji testova motoričkih sposobnosti pokazuju da su

učenici 2018. bolji u svim testovima (skok u dalj iz mjesta, poligon unatraške, podizanje trupa) osim fleksibilnosti (pretklon raznožno).

Tablica 2.

Tablica 2 pokazuje da su mladići iz 1998. bili nešto viši i lakši od mladića iz 2018. Međutim, obje skupine mladića imaju normalan ITM i pripadaju skupini normalno uhranjene djece. Što se motoričkih sposobnosti tiče, generacija 1998. nešto je bolja u testovima skok u dalj iz mjesta i pretklona raznožno, dok je generacija 2018. bolja u poligonu unatraške i podizanju trupa.

Tablica 3.

Tablica 3 pokazuje da su djevojke obiju generacija podjednako visoke i teške sa sličnim ITM-om. Rezultati deskriptivne statistike pokazuju da su djevojke iz 1998. bolje samo u pretklonu raznožno, dok su djevojke iz 2018. bolje u poligonu unatraške, skoku u dalj iz mjesta i podizanju trupa.

Tablica 4.

Analizom T testa (Tablica 4) utvrđeno je da u testu skok u dalj iz mjesta nema statistički značajne razlike između dviju generacija učenika. Međutim, potvrđene su razlike u testovima poligon unatraške i podizanje trupa u korist generacije iz 2018. Također je potvrđeno da je generacija učenika iz 1998. godine bila bolja na testu pretklon raznožno.

Tablica 5.

Gledajući rezultate T testa iz Tablice 5, može se zaključiti da nema statistički značajnih razlika u antropometriji između mladića iz 1998. i 2018. kao i djevojaka iz 1998. i 2018. U motoričkim sposobnostima mladići iz 1998. godine bolji su u pretklonu raznožno, dok su mladići iz 2018. bolji u poligonu unatraške. Djevojke iz 2018. bolje su u poligonu unatraške i podizanju trupa, dok su djevojke iz 1998. bolje u pretklonu raznožno.

Tablica 6.

Prema podatcima u Tablici 6 može se zaključiti da se stanje uhranjenosti učenika tijekom 20 godina nije bitno promijenilo. Vrlo visok postotak učenika i 1998. i 2018. godine ima normalnu tjelesnu masu, što je dobar pokazatelj s obzirom na to da se djeca danas suočavaju s epidemijom prekomjerne tjelesne mase.

Rasprava

Sekularni trendovi odnose se na promjene u veličini tijela, motoričkoj kondiciji i drugim antropometrijskim karakteristikama tijekom jednoga ili više desetljeća (Claessens, i Lefevre, 1992). Kontinuirano promatranje stanja i trenda tjelesne kondicije

i ITM-a adolescenata glavni je pokazatelj održivosti zdravlja i dobrobiti mladih. Dakle, glavni je cilj ovoga istraživanja bio utvrditi sekularne promjene antropometrijskih karakteristika i nekih motoričkih sposobnosti adolescenata tijekom 20 godina.

Zbog sjedilačkoga načina života, lošije prehrane i neadekvatne razine tjelesne aktivnosti, današnja je generacija djece teža s višim ITM-om od prethodne generacije (Ogden, Carroll, Kit i Flegal, 2012). U posljednjih 20 godina 20. stoljeća, mnoga su istraživanja pokazala da se tjelesna masa povećala, a tjelesna aktivnost smanjila (Tomkinson, Olds, Kang i Kim, 2007; Matton, Duvigneaud, Wijndaele, Philippaerts, Duquet, Beunen i sur., 2007; Wyss, Beuchat, Zehr i Mäder, 2009). No, rezultati ovoga istraživanja dokazuju da to nije pravilo. U antropometrijskim karakteristikama nema značajne razlike između učenika, s obzirom na spol i godinu mjerenja (1998. i 2018.). To se slaže s istraživanjem skupine autora koji su dokazali da nakon 2000. godine nema promjene u trendu debljanja (NCD Risk Factor Collaboration, 2014). Troiano i Flegal (1998) izmjerili su visinu i masu djece u SAD-u 1963. i 1994. te zaključili da su najteža djeca s vremenom postajala još teža, dok je ostatak distribucije ITM-a pokazao male promjene tijekom vremena.

Međutim, mladići iz 2018. statistički su bolji u koordinaciji, dok su mladići iz 1998. godine u fleksibilnosti. U ostalim testovima nije bilo značajne razlike. Djevojke iz 2018. statistički su značajno bolje u koordinaciji i repetitivnoj snazi, dok su djevojke iz 1998. bolje u fleksibilnosti. Da se fleksibilnost s vremenom smanjuje, dokazali su Bös u svojem istraživanju (preuzetom od Eberhardt, Niessner, Oriwol, Buchal, Worth i Bös, 2020) kao i Dos Santos i sur. (2015).

U eksplozivnoj snazi nije bilo statistički značajne razlike. To se dijelom poklapa sa studijom Hardyja, Barnetta, Espinela i Okelyja (2013) koja je pokazala da su u većini motoričkih testova djeca i adolescenti napredovali između 1997. i 2010. U je ovoj studiji dokazano da su učenici iz 2018. bolji u koordinaciji od učenika iz 1998. što se ne poklapa s istraživanjima Huotari, Heikinaro-Johansson, Watt i Jaakkola (2018). Zabilježili su pad koordinacije u oba spola između dva mjerenja (2003. i 2010.).

Iako nije dokazana statistički značajna razlika kod mladića, djevojke iz 2018. godine imale su bolje rezultate u repetitivnoj snazi od djevojaka iz 1998. godine. Međutim, Malinina tvrdnja (preuzeta od Malina i Katzmanyk, 2006) u kojoj navodi da su sekularne promjene snage proporcionalne promjeni visine i mase, ne može se primijeniti na rezultate ove studije. Obje generacije djevojaka imaju gotovo identične prosječne vrijednosti visine i mase, no djevojke iz 2018. godine postigle su znatno bolje rezultate u repetitivnoj snazi. S druge strane, Westerstahl, Barnekow-Bergkvist, Hedberg i Jansson (2003) u svojoj su studiji o adolescentima iz Švedske dokazali da su oba spola 1995. godine postigla lošije rezultate u podizanju trupa od generacije iz 1974. godine. Albon i sur. (2010) u svojem su istraživanju istaknuli da u razdoblju od 1991. do 2003. godine nije bilo značajnijih promjena u rezultatima testa skoka u dalj s mjesta, dok je došlo do poboljšanja rezultata testa podizanje trupa. Isto je dokazano i ovim istraživanjem s obzirom na rezultate djevojaka iz 1998. i 2018. godine.

Zaključak

Prikazana studija ne ukazuje na statistički značajnu razliku u antropometrijskim karakteristikama među adolescentima tijekom posljednjih 20 godina. Mladići i djevojke od 15 i 16 godina izmjereni 2018. nešto su viši, teži, ali ITM je gotovo isti kao u generaciji izmjerenoj 1998. godine. Iz rezultata može se zaključiti da nije utvrđen negativan trend u antropometrijskim karakteristikama u promatranoj skupini ispitanika koji pripadaju skupini normalno uhranjenih adolescenata.

Nadalje, u pogledu motoričkih sposobnosti između generacija adolescenata mjerenih 1998. i 2018. godine, nije utvrđen negativan trend osim u fleksibilnosti gdje su ispitanici mjereni prije 20 godina pokazali statistički bolje rezultate. Iz dobivenih rezultata ovoga istraživanja može se zaključiti da su adolescenti nakon 20 godina na istoj razini u eksplozivnoj snazi, dok su u repetitivnoj snazi poboljšani, posebno djevojke kod kojih je dobivena statistički značajna razlika. Slični rezultati zabilježeni su i na poligonu unatraške za oba spola, a također se može zaključiti da su današnje generacije adolescenata bolje koordinirane nego prije 20 godina.

Rezultat ovoga istraživanja ukazuje da su promicanje slobodne igre i tjelovježbe, mogućnosti sudjelovanja u organiziranom sportu i kvalitetna provedba nastave Tjelesne i zdravstvene kulture vrlo važni u doprinosu poboljšanja motoričkih sposobnosti i održavanju pozitivnih antropometrijskih karakteristika u adolescentskoj populaciji.