Elezi, A., Elezi, G., Gontarev, S., & Georgiev, G. (2020). Secular Trends in Anthropometric Characteristics and Health-Related Physical Fitness in Macedonian Children: the Makfit Studies. *Teorìâ ta Metodika Fizičnogo Vihovannâ, 21*(1), 12-18.
https://doi.org/10.17309/tmfv.2021.1.02
ISSN 1993-7989 (print). ISSN 1993-7997 (online)

ORIGINAL SCIENTIFIC ARTICLE

SECULAR TRENDS IN ANTHROPOMETRIC CHARACTERISTICS AND HEALTH-RELATED PHYSICAL FITNESS IN MACEDONIAN CHILDREN: THE MAKFIT STUDIES

Abdulla Elezi[1ABCDE], Gresa Elezi[2ABCDE], Seryozha Gontarev[3ABCDE], Georgi Georgiev[3ABCDE]

[1]University of Pristina
[2]American Hospital, Pristina
[3]Ss. Cyril and Methodius University of Skopje

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Gresa Elezi, E-mail: gresaelezi@hotmail.com
Accepted for Publication: March 20, 2021
Published: March 25, 2021

DOI: 10.17309/tmfv.2021.1.02

Abstract

The purpose of the present study was to analyze the secular trends in anthropometric characteristics and health-related physical fitness (i.e., flexibility, muscular strength and speed/agility) in Macedonian children between 2012 and 2019.

Materials and methods. We analyzed the secular trends in anthropometric characteristics and health-related physical fitness in Macedonian children between 2012 and 2019. Two representative population studies were conducted 7 years apart in children (6-10 years) from Skopje (Macedonia). Both studies used the same anthropometric measures and tests to assess physical fitness: height, weight, body mass index, body fat percentage, muscle mass percentage, sit and reach, handgrip strength, standing long jump, 30 sec sit ups, and 4 × 10 m shuttle run.

Result. The boys and girls measured in 2019 had significantly better performance in the sit and reach (Cohen's d ~0.4 and ~0.5, respectively), 30 sec sit ups (Cohen's d ~0.3 and ~0.2, respectively), and 4 × 10 m shuttle run (Cohen's d ~0.7 and ~0.8, respectively) tests compared to those measured in 2012-2013. Levels of the standing long jump were significantly lower in 2019 in boys and girls (Cohen's d ~0.6 for both).

Conclusions. Based on the results of the study, it can be concluded that Macedonian children measured in 2019 have higher levels of flexibility, abdominal muscle strength and coordination, speed and agility, but lower levels of explosive force of the lower limbs than their counterparts measured. 7 years ago, no statistically significant differences were found in anthropometric measures and measures of body weight.

Keywords: fitness, muscular strength, youth, physical activity.

Introduction

Physical fitness is a powerful marker of childhood health and adolescence (Myers et al., 2002; Andersen et al., 2006). Even in children and adolescents, physical fitness is inversely related to critical physiological factors for occurrence of chronic diseases, including high blood pressure (Sallis et al., 1998; Ruiz et al., 2006), obesity (Ruiz et al., 2006), hyperinsulinemia (Gutin et al., 2004), increased abdominal adiposity (Brunet et al., 2006), atherogenic lipid profile (Mesa et al., 2006) insulin resistance, inflammatory markers (Gulati et al., 2003), and other metabolic risk factors (Brage et al., 2004; Ruiz et al., 2007).

Several meta-analyzes have shown a decrease in cardiorespiratory fitness in recent years and a stabilization of muscle strength (Macfarlane & Tomkinson, 2007; Tomkinson & Olds, 2007a; Tomkinson, 2007; Olds et al., 2006; Tomkinson & Olds, 2007b; Tomkinson et al., 2007). Available original reports around the world show different trends depending on the geographic region. To our knowledge, there is no information available regarding the secular trends in physical fitness in Macedonian children. Developing appropriate public health strategies requires regular analysis of the evolution of fitness, especially among young people.

The purpose of the present study was to analyze the secular trends in anthropometric characteristics and health-related physical fitness (i.e., flexibility, muscular strength and speed/agility) in Macedonian children between 2012 and 2019.

Materials and methods

Sample of respondents

In this study we considered data from two separate cross-sectional studies, both representative from the city of Skopje (Macedonia). The research was conducted in seventeen primary schools in the City of Skopje situated in different municipalities. Five classes were randomly selected from each school. Both the first and second measurements were conducted in the same schools. In 2012 the survey was conducted on a sample of 2269 respondents out of which 1110 boys and 1159 girls with an average age of 8.58 ± 1.34 years. In 2019 the survey was conducted on a sample of 2028 respondents of which 1018 boys and 1010 girls with an average age of 8,58 ± 1,33 years.

The study included students for whom their parents had given consent to take part in the research, who were psychically and physically healthy and who regularly attended the classes of physical and health education. Both studies were performed following the ethical guidelines of the Declaration of Helsinki 1961 (revision of Edinburgh 2000). Measurements were realized in March, April and May 2012 and 2019, in standard school conditions at regular classes of physical and health education. The measurement was realized by experts from the area of kinesiology and medicine, previously trained to perform functional tests and to take anthropometric measures.

Anthropometric measures and body composition

Measuring of the anthropometric measurements was realized at the recommendations given by IBP-International Biology Program (Lohman et al., 1988). For estimation of the morphologic characteristics the following anthropometric measures have been applied: body height in standing position (cm), body weight (kg), as well as the body mass index (BMI).

Components of the body composition have been determined by the method of bioelectrical impedance (measuring of the electric conductivity – Bioelectrical Impedance Analysis – BIA). The measuring was realized by a Body Composition Monitor, model "OMRON – BF511", by means of which we have measured the body weight, fat tissue percent and muscular mass percent. Prior to commencing the measurement, we entered the parameters of gender, years and body height of the respondent in the Body Composition Monitor. In order to provide better precision of the results obtained from the estimation of the body composition, prior to each measuring, we ensured that the preconditions recommended by ACSM (2005) and Heyward (2006) had been fulfilled.

Evaluation of Physical Fitness

Prior to starting the study, the researchers involved in the project undertook training sessions in order to guarantee the standardization, validation, and reliability of the measurements. Five tests, forming part of the EUROFIT battery, validated and standardized by the European Council, were applied in the following order:

Sit and Reach test. With the subject seated on the floor and using a standardized support, the maximum distance reached with the tip of the fingers by forward flexion of the trunk is measured. Test indicative of amplitude of movement or flexibility.

Hand Grip test. With the use of a digital Takei TKK 5101 dynamometer (range, 1-100 kg), the maximum grip strength was measured for both hands.

Standing broad jump test. The maximum horizontal distance attained, with feet together, was measured. This test evaluates lower limb explosive-strength.

Sit-ups 30 sec. Maximum number of sit ups achieved in 30 seconds. This test measures the endurance of the abdominal muscles

Shuttle run: 4 × 10 meters. This test provides an integral evaluation of the speed of movement, agility and coordination. The subject does four shuttle runs as fast as possible between 2 lines, 10 meters apart. At each end the subject places or picks up an object (a sponge) beside the line on the floor.

Definition of weight status

Three weight status groups were established in this study: underweight/normal weight, overweight and obesity. Participants were categorized according to the international gender and age-specific BMI (kg/m^2) cut-off points (Cole et al., 2000, 2007). These points have been particularly established for children and adolescents aged from 2-18 years, separately for males and females and for 0.5 year age groups. These cutoff values are based on percentiles passing at age 18 through BMI 18.5 kg/m^2 for underweight, 25 kg/m^2 for overweight and 30 kg/m^2 for obesity (Cole et al., 2000, 2007).

Statistical analysis

The data are presented as frequencies (percentage) for categorical variables and mean (SD) for continuous variables. Gender differences for each measurement point were assessed by one-way analysis of variance (ANOVA). Categorical data (weight status) were analyzed using the χ^2 – test. Mean differences of the secular trends in health-related physical fitness performances (i.e., height, weight body mass index, body fat percentage, muscle mass percentage, sit and reach, handgrip strength, standing long jump, 30 sec sit ups and 4 × 10 m shuttle run) between measurement points were analyzed by one-way analysis of covariance (ANCOVA) for boys and girls separately. The measurement point was entered as fixed factor, each fitness test was entered as dependent variable in separate models, and age were entered as covariates. We calculated the effect size statistics as Cohen's d (standardized mean differences) and 95% confidence interval. Values of Cohen's d ~0.2, ~0.5 and ~0.8 are considered small, medium and large effects, respectively. All the analyses were performed using the Statistical Package for Social Sciences software (SPSS, v. 22.0 for Windows; SPSS Inc., Chicago, IL, USA), and values of $p < 0.05$ were considered statistically significant.

Results

The characteristics of the study population by measurement point (2012 and 2019) and gender are shown in Table 1. The table shows that boys in 2012 and 2019 are heavier, have higher body mass index, higher percentage of fat tissue and higher muscle mass, and show better results in all physical assessment tests related to health, except in the deep-seated bend test in which girls show better results.

Table 2 shows the mean of physical fitness tests by gender in both measurement points after controlling for age. The

Table 1. The characteristics of the study population by measurement point (2012 and 2019) and gender

Indicator	Years 2012				p	Years 2019				p
	Boys		Girls			Boys		Girls		
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Height (cm)	134.04	9.92	132.72	9.94	0.002	133.09	9.83	132.39	10.22	0.118
Weight (kg)	34.65	10.44	32.72	9.80	0.000	33.98	10.63	32.41	9.54	0.001
Body mass index (kg/m^2)	19.00	3.62	18.29	3.49	0.000	19.04	4.16	18.35	3.33	0.000
Body fat (%)	24.09	7.56	22.54	8.41	0.000	23.99	8.16	22.80	8.23	0.002
Muscle mass (%)	30.44	3.51	29.82	2.64	0.000	30.32	3.27	29.83	2.72	0.000
Sit and reach (cm)	12.58	5.63	14.49	5.84	0.000	14.74	6.06	17.68	6.46	0.000
Handgrip strength (kg)	14.15	3.91	12.32	3.52	0.000	13.77	4.82	12.51	4.57	0.000
Standing long jump (cm)	122.93	22.98	110.35	19.91	0.000	101.98	42.41	89.65	39.69	0.000
30 sec sit ups (n)	11.95	5.65	10.24	5.79	0.000	13.49	5.60	11.20	5.76	0.000
4 × 10 m shuttle run (s)[a]	16.17	1.80	17.28	1.71	0.000	14.97	2.13	15.79	2.01	0.000

Table 2. Performance in physical fitness tests by measurement point and gender

	Fitness tests	Years 2012			Years 2019			p	Cohen's d	95% CI
		n	Mean	SD	n	Mean	SD			
Boys	Height (cm)	1110	133.59	9.92	1018	133.61	9.84	0.944	0.00	-0.585 to 0.604
	Weight (kg)	1110	34.31	10.44	1018	34.38	10.63	0.850	-0.01	-0.621 to 0.647
	Body mass index (kg/m^2)	1108	18.96	3.62	1009	19.11	4.16	0.363	-0.04	-0.255 to 0.226
	Body fat (%)	1108	24.08	7.56	1009	24.06	8.14	0.954	0.00	-0.449 to 0.521
	Muscle mass (%)	1108	30.35	3.51	1009	30.43	3.27	0.482	-0.02	-0.234 to 0.183
	Sit and reach (cm)	1084	12.64	5.63	1013	14.67	6.05	0.000	-0.35	-0.682 to 0.030
	Handgrip strength (kg)	1105	14.03	3.91	1017	14.23	11.72	0.581	-0.02	-0.254 to 0.697
	Standing long jump (cm)	1095	122.23	22.98	1013	102.71	42.48	0.000	0.58	-0.783 to 3.194
	30 sec sit ups (n)	1112	11.81	5.66	1021	13.58	5.65	0.000	-0.31	-0.646 to 0.033
	4 × 10 m shuttle run (s)[a]	1095	16.23	1.80	1012	14.88	2.23	0.000	0.67	-0.564 to 0.808
Girls	Height (cm)	1159	132.53	9.94	1010	132.67	10.20	0.626	-0.01	-0.587 to 0.618
	Weight (kg)	1159	32.58	9.80	1010	32.62	9.53	0.921	0.00	-0.568 to 0.586
	Body mass index (kg/m^2)	1154	18.28	3.49	1000	18.37	3.33	0.560	-0.03	-0.228 to 0.188
	Body fat (%)	1154	22.53	8.41	1000	22.85	8.22	0.389	-0.04	-0.527 to 0.489
	Muscle mass (%)	1154	29.80	2.64	1000	29.85	2.72	0.618	-0.02	-0.172 to 0.156
	Sit and reach (cm)	1152	14.51	5.84	1001	17.64	6.46	0.000	-0.51	-0.847 to 0.109
	Handgrip strength (kg)	1155	12.26	3.52	1004	12.60	4.57	0.018	-0.08	-0.288 to 0.198
	Standing long jump (cm)	1153	110.08	19.91	1004	89.79	39.82	0.000	0.66	-0.490 to 3.122
	30 sec sit ups (n)	1158	10.19	5.79	1003	11.23	5.78	0.000	-0.18	-0.513 to 0.178
	4 × 10 m shuttle run (s)[a]	1140	17.30	1.71	1001	15.77	2.07	0.000	0.81	-0.712 to 0.940

Values are adjusted means ± standard deviation. *p* values from one-way analysis of covariance after controlling for age.
[a] In this test, lower scores (time in s) indicate better performance.

boys and girls measured in 2019 had significantly better performance in the sit and reach (Cohen's d ~0.4 and ~0.5, respectively), 30 sec sit ups (Cohen's d ~0.3 and ~0.2, respectively), and 4 × 10 m shuttle run (Cohen's d ~0.7 and ~0.8, respectively) tests compared to those measured in 2012-2013. Levels of the standing long jump were significantly lower in 2019 in boys and girls (Cohen's d ~0.6 for both). Statistical differences between the two sexes were not found in the anthropometric measures of height, weight and body mass index and in the measurements for assesment of body composition, body fat percentage and muscle mass percentage. We repeated all the analyses after further controlling for fat mass, fat free mass and the results did not materially change (data not shown).

Table 3, 4 shows the change in the percentage of boys and girls in this study who were classified as normal, overweight and obese between 2012 and 2019. The analisys of table 3 and the overview of χ^2 test indicate that there are no statistically significant differences in boys and girls in nutrition levels between 2012 and 2019.

Discussion

The results of this study showed that Macedonian children in 2019 have higher levels of flexibility, abdominal muscles strength, coordination, speed and agility, and lower levels of explosive force on the lower limb than their counterparts

Table 3. The proportion of boys classified as normal, overweight or obese using the Cole et al cut-offs

BMI classification	Years 2012		Years 2019		
	n	%	n	%	
Normal weight*	627	56.60%	597	59.20%	
Overweight	281	25.40%	226	22.40%	
Obese	200	18.10%	186	18.40%	ns

*Difference between measurement point (Chi-Square Tests); ns, non-significant.

Table 4. The proportion of girls classified as normal, overweight or obese using the Cole et al cut-offs

BMI classification	Years 2012		Years 2019		
	n	%	n	%	
Normal weight*	701	60.70%	604	60.40%	
Overweight	272	23.60%	256	25.60%	
Obese	181	15.70%	140	14.00%	ns

*Difference between measurement point (Chi-Square Tests); ns, non-significant.

7 years ago. The percentage of overweight and obese children classified on the basis of the BMI criterion in 2012 was 41%, while in 2019 it was 40%. Similar results for overweight and obesity have been obtained in several international studies (Jehn et al., 2006; Ortega et al., 2007; Al-Nakeeb et al., 2007; Ostojic et al., 2011). Over 20% of the respondents in both 2012 and 2019 have a body fat percentage greater than 30%. Such a high percentage of body fat is associated with an increased risk of acute and chronic diseases especially osteoarthritis, hypertension, diabetes mellitus and cardiovascular disease, which can lead to poorer quality of life and increased financial burden of the individual, the family and the society, as well as shorten life expectancy (Williams et al., 1992; Dugan, 2008).

Several meta-analyzes describe global changes in components of physical fitness related to health (Tomkinson & Olds, 2007; Tomkinson, 2007). Studies covering 27 countries and five geographic regions have shown a decrease in cardio-respiratory fitness from late 1970 to 2003, (Tomkinson & Olds, 2007) whereas performance at power and speed tests remained fairly stable from 1980s. (Tomkinson, 2007). Other meta-analyzes performed on large samples yielded similar results (Macfarlane & Tomkinson, 2007), but they were mainly focused on exploring cardio-respiratory fitness (Olds et al., 2006; Tomkinson & Olds, 2007; Tomkinson et al., 2007). Macfarlane and Tomkinson (2007) analyzed the secular changes in strength, speed and cardiovascular fitness tests in 23.5 million Asian children aged 6 to 19 years between 1917 and 2003 and found a steady decline in cardio-respiratory fitness over the last 10-15 years, and a global stabilization in power and speed. Tomkinson and Olds (2007) analyzed 46 studies and identified changes in cardio-respiratory fitness in 161,419 Australian children aged 6 to 17 years from 1961 to 2002 and found a marked decline in the youngest children and boys until about 1990 that appears to be slowing. Tomkinson et al. (2007) analyzed aerobic performance data of over 22 million Koreans (6-18 years) between 1968 and 2000 and found a significant decrease in the years after 1984.

The rich history of pediatric fitness testing all around the world shows many original reports about secular trends in adolescent health-related physical fitness in peer-reviewed scientific journals, especially focused on cardiorespiratory fitness. Analyzes of other health-related components such as muscle strength, speed, or agility show uneven trends across geographic regions (Matton et al., 2007; Albon et al., 2010; Jurimae, et al., 2007; Tomkinson et al., 2003). Matton et al. (2007) conducted a representative sample of Flemish adolescents aged 12 to 18 between 1969 and 2005 and found a decrease in bent arm hang and 10 × 5 m shuttle run results in girls, and an improvement in the results of the boys in 10 × 5 m shuttle run. Albon et al. (2010) analysed changes in New Zealand children between 1991 and 2003 and did not find significant differences in the 4 × 9 m shuttle run and the standing long jump tests. Jürimäe et al. (2007) analysed secular trends of Estonian and Lithuanian children and adolescents in 1992 and 2002. Lithuania's respondents reported a decrease in test scores bent arm hang, standing long jump and 20 m shuttle run, whereas in the Estonian respondents only a decrease in the results of the bent arm hang tests was found. Test results in 10 × 5m shuttle run in Lithuanians and standing long jump, 10 × 5 m and 20 m shuttle run tests in Estonians remained unchanged. Tomkinson et al. (2003) investigated the fitness trends of 18,631 South Australian students (12-15 years) between 1995 and 2000 and found a statistically significant decrease in the 20 m shuttle run and 40 m sprint test results, but found no statistically significant changes in the vertical jump tests. Moliner-Urdiales et al. (2010) researched the secular trends in health-related physical fitness in Spanish adolescents between 2001-2002 and 2006-2007. Both studies used the same tests to assess physical fitness: the handgrip strength, bent arm hang, standing broad jump, 4 × 10 m shuttle run and 20 m shuttle run tests. The results indicate that levels of both speed/agility and cardiorespiratory fitness were higher in 2006-2007 than in 2001-2002, whereas muscular strength components were lower in 2006-2007.

Although there is consistency in the secular trends identified in other studies conducted on the population of children and adolescents, our results do not fully coincide with the above studies. The increase in flexibility, strength of abdominal muscles, coordination, speed and agility while the decrease in lower body muscularity, discard theories related to the increases of fat mass over the reported changes in physical fitness components. And the results of this study disprove this theory, namely that anthropometric measures and body composition measures (fat percentage and muscle mass) did not detect statistically significant differences between the two sexes in 2012 and 2019. According to the model established by Tomkinson (Tomkinson & Olds, 2007; Tomkinson, 2007) we agree in that the reported secular trends in physical fitness are caused by a network of social, behavioral, physical, psychosocial and physiological factors.

Despite the lack of information on secular trends in other populations in recent years, which confirms our findings, the results obtained in this study can be attributed to various factors. The popularity of the more holistic approach to physical activity and exercise over the last decade has seen an increase in activities that have an emphasis on core strength, stability and flexibility (Chang, 2000). These exercises find their way into the physical education curriculum (Kloubec & Banks, 2004) and may affect children in this study. Other factors such as a change in the ergonomics of the schools' seats cannot be discounted, and further research is required to uncover the causes of this positive trend.

The major strength of the present study is the use of identical protocols, sampling methods and sampling frames in two representative cohorts of children from Skopje (Macedonia), as well as the application of valid, reliable and objective fitness tests to assess health-related fitness, and the recent measurement data (2019). It is important to consider when interpreting the findings from the present study that only two dataset including children from Skopje (Macedonia), were used over a 7 years period.

Conclusions

Based on the results of the study it can be concluded that the Macedonian children measured in 2012-2019 have higher levels of flexibility, abdominal muscle strength and coordination, speed and agility, and lower levels of explosive force on the lower limb than their counterparts measured 7 years ago. In order to guarantee healthy levels of physical fitness, Macedonian public health programs should promote physical activity among chidren, especially focussed on muscular strength which was seen to decrease and measures for decrease in obeasety among this group of the population. Schools may play a key role, and parents also have a great responsibility to encourage and support active living of their off spring.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article

References

Myers, J., Prakash, M., Froelicher, V., Do, D., Partington, S., & Atwood, J. E. (2002). Exercise capacity and mortality among men referred for exercise testing. *New England journal of medicine, 346*(11), 793-801. https://doi.org/10.1056/NEJMoa011858

Andersen, L. B., Harro, M., Sardinha, L. B., Froberg, K., Ekelund, U., Brage, S., & Anderssen, S. A. (2006). Physical activity and clustered cardiovascular risk in children: a cross-sectional study (The European Youth Heart Study). *The Lancet, 368*(9532), 299-304. https://doi.org/10.1016/S0140-6736(06)69075-2

Sallis, J. F., Patterson, T. L., Buono, M. J., & Nader, P. R. (1998). Relation of cardiovascular fitness and physical activity to cardiovascular disease risk factors in children and adults. *American Journal of Epidemiology, 127*(5), 933-941. https://doi.org/10.1093/oxfordjournals.aje.a114896

Ruiz, J. R., Ortega, F. B., Meusel, D., Harro, M., Oja, P., & Sjöström, M. (2006). Cardiorespiratory fitness is associated with features of metabolic risk factors in children. Should cardiorespiratory fitness be assessed in a European health monitoring system? The European Youth Heart Study. *Journal of Public Health, 14*(2), 94-102. https://doi.org/10.1007/s10389-006-0026-8

Gutin, B., Yin, Z., Humphries, M. C., Hoffman, W. H., Gower, B., & Barbeau, P. (2004). Relations of fatness and fitness to fasting insulin in black and white adolescents. *The Journal of pediatrics, 145*(6), 737-743. https://doi.org/10.1016/j.jpeds.2004.07.016

Brunet, M., Chaput, J. P., & Tremblay, A. (2007). The association between low physical fitness and high body mass index or waist circumference is increasing with age in children: the "Quebec en Forme" Project. *International journal of obesity, 31*(4), 637-643. https://doi.org/10.1038/sj.ijo.0803448

Mesa, J. L., Ruiz, J. R., Ortega, F. B., Wärnberg, J., González-Lamuño, D., Moreno, L. A., ... & Castillo, M. J. (2006). Aerobic physical fitness in relation to blood lipids and fasting glycaemia in adolescents: influence of weight status. *Nutrition, metabolism and cardiovascular diseases, 16*(4), 285-293. https://doi.org/10.1016/j.numecd.2006.02.003

Gulati, M., Pandey, D. K., Arnsdorf, M. F., Lauderdale, D. S., Thisted, R. A., Wicklund, R. H., ... & Black, H. R. (2003). Exercise capacity and the risk of death in women: the St James Women Take Heart Project. *Circulation, 108*(13), 1554-1559. https://doi.org/10.1161/01.CIR.0000091080.57509.E9

Brage, S., Wedderkopp, N., Ekelund, U., Franks, P. W., Wareham, N. J., Andersen, L. B., & Froberg, K. (2004). Features of the metabolic syndrome are associated with objectively measured physical activity and fitness in Danish children: the European Youth Heart Study (EYHS). *Diabetes care, 27*(9), 2141-2148. https://doi.org/10.2337/diacare.27.9.2141

Ruiz, J. R., Ortega, F. B., Rizzo, N. S., Villa, I., Hurtig-Wennlöf, A., Oja, L., & Sjöström, M. (2007). High cardiovascular fitness is associated with low metabolic risk score in children: the European Youth Heart Study. *Pediatric research, 61*(3), 350-355. https://doi.org/10.1203/pdr.0b013e318030d1bd

Macfarlane, D. J., & Tomkinson, G. R. (2007). Evolution and variability in fitness test performance of Asian children and adolescents. *In Pediatric Fitness* (Vol. 50, pp. 143-167). Karger Publishers. https://doi.org/10.1159/000101358

Tomkinson, G. R., & Olds, T. S. (2007a). Secular changes in aerobic fitness test performance of Australasian children and adolescents. *In Pediatric Fitness* (Vol. 50, pp. 168-182). Karger Publishers. https://doi.org/10.1159/000101361

Tomkinson, G. R. (2007). Global changes in anaerobic fitness test performance of children and adolescents (1958–2003). *Scandinavian journal of medicine & science in sports, 17*(5), 497-507. https://doi.org/10.1111/j.1600-0838.2006.00569.x

Olds, T., Tomkinson, G., Léger, L., & Cazorla, G. (2006). Worldwide variation in the performance of children and adolescents: an analysis of 109 studies of the 20-m shuttle run test in 37 countries. *Journal of sports sciences, 24*(10), 1025-1038. https://doi.org/10.1080/02640410500432193

Tomkinson, G. R., & Olds, T. S. (2007b). Secular changes in pediatric aerobic fitness test performance: the global picture. *In Pediatric Fitness* (Vol. 50, pp. 46-66). Karger Publishers. https://doi.org/10.1159/000101075

Tomkinson, G. R., Olds, T. S., Kang, S. J., & Kim, D. Y. (2007). Secular trends in the aerobic fitness test performance and body mass index of Korean children and adolescents

(1968-2000). *International journal of sports medicine, 28*(04), 314-320. https://doi.org/10.1055/s-2006-924357

Lohman, T.G., Roche, A.F. and Martorell, R. (1988) *Anthropometric standardization reference manual.* Chicago: Human Kinetics Books.

ACSM (American College of Sports Medicine) (2005) *Health-Related physical Fitness As sessment Manual.* Balti more: Lippincott Williams and Wilkins.

Heyward, V.H. (2006) *Advanced fitness assessment and exercise prescription 5-th edition.* Champaign: Human Kinetics Publishers.

Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *Bmj, 320*(7244), 1240. https://doi.org/10.1136/bmj.320.7244.1240

Cole, T. J., Flegal, K. M., Nicholls, D., & Jackson, A. A. (2007). Body mass index cut offs to define thinness in children and adolescents: international survey. *Bmj, 335*(7612), 194. https://doi.org/10.1136/bmj.39238.399444.55

Jehn, M.L, Gittelsohn, J., Treuth, M.S. and Caballero, B. (2006). Prevalence of overweight among Baltimore city schoolchildren and its associations with nutrition and physical activity. *Obesity, 14*(6), 989-993. https://doi.org/10.1038/oby.2006.113

Ortega, F. B., Tresaco, B., Ruiz, J. R., Moreno, L. A., Martin-Matillas, M., Mesa, J. L., Warnberg, J., Bueno, M., Tercedor, P., Gutiérrez, Á., Castillo, M. J., & AVENA Study Group. (2007). Cardiorespiratory Fitness and Sedentary Activities Are Associated with Adiposity in Adolescents. *Obesity, 15*(6), 1589-1599. https://doi.org/10.1038/oby.2007.188

Al-Nakeeb, Y., Duncan, M. J., Lyons, M., & Woodfield, L. (2007). Body fatness and physical activity levels of young children. *Annals of Human Biology, 34*(1), 1-12. https://doi.org/10.1080/03014460601079886

Ostojic, S., Stojanovic, M., Stojanovic, V., Maric, J., & Njaradi, N. (2011). Correlation between Fitness and Fatness in 6-14-year Old Serbian School Children. *Journal of Health, Population and Nutrition, 29*(1), 53-60. https://doi.org/10.3329/jhpn.v29i1.7566

Williams, D. P., Going, S. B., Lohman, T. G., Harsha, D. W., Srinivasin, S. R., Webber, L. S., & Berenson, G. S. (1992). Body fatness and risk for elevated blood pressure, total cholesterol and serum lipoprotein ratios in children and adolescents. *American Journal of Public Health, 82*(3), 358-363. https://doi.org/10.2105/AJPH.82.3.358

Dugan, S.A. (2008). Exercise for preventing childhood obesity. *Physical Medicine and Rehabilitation Clinics of North America, 19*(2), 205-16. https://doi.org/10.1016/j.pmr.2007.11.001

Matton, L., Duvigneaud, N., Wijndaele, K., Philippaerts, R., Duquet, W., Beunen, G., Claessens, A. L., Thomis, M., & Lefevre, J. (2007). Secular trends in anthropometric characteristics, physical fitness, physical activity, and biological maturation in Flemish adolescents between 1969 and 2005. *American Journal of Human Biology, 19*(3), 345–357. https://doi.org/10.1002/ajhb.20592

Albon, H. M., Hamlin, M. J., & Ross, J. J. (2010). Secular trends and distributional changes in health and fitness performance variables of 10–14-year-old children in New Zealand between 1991 and 2003. *British Journal of Sports Medicine, 44*(4), 263. https://doi.org/10.1136/bjsm.2008.047142

Jürimäe, T., Volbekiene, V., Jürimäe, J., & Tomkinson, G. R. (2007). Changes in Eurofit test performance of Estonian and Lithuanian children and adolescents (1992–2002). *In Pediatric Fitness* (Vol. 50, pp. 129-142). Karger Publishers. https://doi.org/10.1159/000101356

Tomkinson, G. R., Olds, T. S., & Gulbin, J. (2003). Secular trends in physical performance of Australian children: evidence from the Talent Search program. *Journal of sports medicine and physical fitness, 43*(1), 90.

Moliner-Urdiales, D., Ruiz, J. R., Ortega, F. B., Jiménez-Pavón, D., Vicente-Rodriguez, G., Rey-López, J. P., ... & Noriega-Borge, M. J. (2010). Secular trends in health-related physical fitness in Spanish adolescents: the AVENA and HELENA studies. *Journal of Science and Medicine in Sport, 13*(6), 584-588. https://doi.org/10.1016/j.jsams.2010.03.004

Chang, Y. (2000). *Grace Under Pressure.* Newsweek, 135(9), 72-73.

Kloubec, J., & Banks, A. L. (2004). Pilates and physical education: a natural fit. *Journal of Physical Education, Recreation & Dance, 75*(4), 34-37. https://doi.org/10.1080/07303084.2004.10609265

ВІКОВІ ТЕНДЕНЦІЇ В АНТРОПОМЕТРИЧНИХ ХАРАКТЕРИСТИКАХ ТА ФІЗИЧНІЙ ПІДГОТОВЛЕНОСТІ У МАКЕДОНСЬКИХ ДІТЕЙ: ДОСЛІДЖЕННЯ МАКФІТА

Абдулла Елезі[1ABCDE], Греса Елезі[2ABCDE], Серьожа Гонтарев[3ABCDE], Георгій Георгієв[3ABCDE]

[1]Університет в Приштині
[2]Американська лікарня, Приштина
[3]Кирило-Мефодіївський університет в Скоп'є

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 4 табл., 34 джерела.

Мета дослідження – проаналізувати вікові тенденції в антропометричних характеристиках та фізичній підготовленості у македонських дітей між 2012 та 2019 роками.

Матеріали та методи. Проаналізовані вікові тенденції в антропометричних характеристиках та фізичній підготовленості, пов'язаній зі здоров'ям, у македонських дітей між 2012 та 2019 рр. Проведено два репрезентативні дослідження популяції з різницею у 7 років у дітей (6-10 років) із Скоп'є (Македонія). В обох дослідженнях використовували однакові антропометричні вимірювання та тести для оцінки фізичної підготовленості: зріст, маса тіла, індекс маси тіла, відсоток жиру в тілі, відсоток м'язової маси, нахил тулуба з положення сидячи, сила кисті, стрибки у довжину з місця, 30-секундні присідання та човниковий біг 4 × 10 м.

Результати. Хлопчики та дівчатка, дані 2019 року, мали значно кращі показники в тестах нахил тулуба з положення сидячи (d ~0.4 і ~0.5 Коена відповідно), 30-секундні присідання (d ~0.3 і ~0.2 Коена відповідно) і човниковий біг 4 × 10 м (тести Коена d ~0,7 та ~0,8 відповідно) порівняно з результатами тестування 2012-2013 рр. У стрибках у довжину з місця результати були значно нижчими у 2019 році у хлопчиків та дівчаток (d Коена ~0,6 для обох груп).

Висновки. Македонські діти у 2019 році, мають вищий рівень гнучкості, сили та координації, швидкості та спритності, але нижчий рівень вибухової сили нижніх кінцівок, ніж їхні однолітки 7 років потому. Статистично значущих відмінностей в антропометричних вимірах та показниках маси тіла не виявлено.

Ключові слова: фітнес, м'язова сила, діти, фізична активність.

Information about the authors:

Elezi A.: abdulla.elezi@uni-pr.edu; https://orcid.org/0000-0003-0225-7494; Faculty of Physical Education and Sport, University of Pristina, Kosovo; Industrial Zone, Pristina, 10000, Kosovo.

Elezi G.: gresaelezi@hotmail.com; https://orcid.org/0000-0002-1937-4294; American Hospital, Industrial Zone, Pristina, 10000, Kosovo.

Gontarev S.: gontarevserjozal@gmail.com; https://orcid.org/0000-0001-5873-2974; Faculty of Physical Education, Sport, and Health, Ss. Cyril and Methodius University of Skopje, Dimce Mircev, 3, Skopje, 1000, Republic of North Macedonia.

Georgiev G.: georgigeorgiev63@yahoo.com; https://orcid.org/0000-0002-1748-9477; Faculty of Physical Education, Sport and Health, Ss. Cyril and Methodius University of Skopje, Dimce Mircev, 3, Skopje, 1000, Republic of North Macedonia.

Cite this article as: Elezi, A., Elezi, G., Gontarev, S., & Georgiev, G. (2020). Secular Trends in Anthropometric Characteristics and Health-Related Physical Fitness in Macedonian Children: the Makfit Studies. *Teorìâ ta Metodika Fìzičnogo Vihovannâ, 21*(1), 12-18. https://doi.org/10.17309/tmfv.2021.1.02

Received: 03.10.2020. Accepted: 20.03.2021. Published: 25.03.2021