

QUANTITATIVE CHANGES IN THE ANTHROPOLOGICAL STATUS OF MIDDLE SCHOOL AGED PUPILS OVER A TWO-YEAR PERIOD

L. Benassi¹, lbenassi@unipu.hr, ORCID: 0000-0002-3235-1791,
 I. Blažević¹, iblazevic@unipu.hr, ORCID: 0000-0002-4437-2792,
 B. Trajkovski², biljana.trajkovski@ufri.uniri.hr, ORCID: 0000-0002-0003-6746

¹Juraj Dobrila University of Pula, Pula, Croatia,

²University of Rijeka, Rijeka, Croatia

Aim. The research was conducted with the primary aim of determining the antropometric characteristics as well as motor and functional abilities of three groups of examinees over a two-year period of organized physical activity engagement. The secondary aims were to examine each group's nutritional status and their connection to the results achieved in the functional ability evaluation. **Material and methods.** In the total sample which consisted of 147 pupils, one group was engaged in martial arts (karate, wrestling, taekwondo and kick-boxing), the second group in team sports played with a ball (football, handball and basketball), while the third group was physically active only on Physical Education classes. Ten variables were used for the needs of the research, while to process the data, the Student's t-test for dependable samples, the discriminant analysis and the correlation analysis were used. **Results.** For all the three measurements, the results show the superiority of examinees – athletes compared to non-athletes. Engaging in team sports played with a ball at the age of 11 to 13 has a more positive influence on the analysed variables of the anthropological status than for peers who are non-athletes, but the same was not shown for athletes engaging in martial arts ($p < 0.05$). The highest values of nutritional status were measured in non-athletic pupils, while lower values of the body mass index condition the better results of the six-minute run test ($p < 0.01$). **Conclusion.** The obtained data lead to the conclusion that only regular Physical Education classes held two school hours a week cannot secure a long-term significant influence on the development of children and adolescents' kinanthropological characteristics, but it is necessary to encourage children to take part in extracurricular sport activities. Some of the reasons due to which the differences in improvements acquired by the two groups of athletes compared to the group of non-athletes were not significantly higher can be explained by inadequate work conditions and the children's lack of interest for a specific sport activity, as well as by the choice of the coaching staff.

Keywords: conditioning, sport, nutritional level, Physical Education, pupils.

Introduction

Childhood and adolescence are very important periods when it comes to health and the preventive effects of regular physical activity [29]. In the last few decades, the continual decrease of children and adolescents' physical activity has been registered [48]. According to the World Health Organisation data [50] in 2010 there were 81 % of 11 to 17 year-old adolescents who were insufficiently physically active. A larger number of studies state that overweight and obese children will probably remain overweight and obese as adults and are in danger of chronic diseases [46, 50], which could lead to a more frequent morbidity and mortality in their adulthood [5]. Diminished everyday physical activity and a sed-

entary way of life represent a significant contribution to the development of excess weight and obesity. It is important to identify factors of risk for excess weight and solve them as early as in childhood and adolescence [41]. It can be certainly said that obesity represents one of the most serious problems in present times and is connected to the development of numerous illnesses during childhood and adulthood [20]. The World Health Organisation [50] defines physical inactivity as the fourth leading cause of mortality in the world and suggests to children and the young aged 5 to 17 to accumulate a mild physical activity at least 60 minutes a day with the aim of preserving health and preventing the occurrence of a number of chronic diseases. Insufficient

physical activity is one of the main public health problems linked to the period of childhood and adolescence [16]. Hence, the main aims in public health present and future guidelines for the period of childhood and adolescence should be both the increase of time spent doing physical activities of a stronger character and high-intensity training and the improvement of not only the level of the cardio-respiratory fitness, but the muscular fitness, speed and agility [36].

Unlike the adult population, the estimate of the nutritional status according to children and adolescents' body mass index is determined regarding sex and chronological age and based on the percentile rank [30]. Due to its reliability and simple use, it is a good indicator of the childhood level of obesity [22] and it can be useful in the evaluation of malnutrition or excess body mass and obesity in children and adolescents [11]. In the last decades, the world's data [8] are also present in our country (The Croatian Health-Statistical Yearbook – with the equal criteria > 90 centiles for the single sex) and they clearly show an increase in the number of overnourished children and adolescents. A recent research [39] conducted on higher primary school grades' boys from Zagreb confirms the negative trend in the pupils' nutrition, according to which only 62 % of pupils were correctly nourished, while 43 % of 13-year-olds had excess body mass. According to Kopelman [20], the increase in the body mass index increases the possibility of health risks brought by some diseases primarily linked to diabetes type 2, hypertension, the coronary artery disease and brain stroke, the respiratory system, cancer, reproductive functions, liver and bladder diseases.

Conditioning represents a group of training procedures for the development and maintenance of the athlete's functional and motor abilities, as well as the athletes' morphological characteristics in line with a certain sport's requirements. It is, thus, an issue of an advancement in the aerobic ability and anaerobic capacity, the development of quantitative and qualitative motor abilities and the optimisation of athletes' morphological characteristics [28]. It is a generally known fact that the level of conditional readiness depends on age, sex, race, anthropometric measures and the intensity of training or exercising. Sports scientists have been trying for decades to find reliable ways of its evaluation on a various selection of populations. Resulting from these researches, today there are numerous methods to

determine the state of the conditional readiness which have shown to be adequate for both the general population and athletes of different ages [17]. Researches have shown that exercising will be more regular and active in places where the conditions for it are fulfilled, primarily the material ones, and where exercising is supported and appreciated [4]. Moreover, the consulted literature shows that there were more authors dealing with the athletes' conditional readiness regarding the school-aged population. All of them found out that better results are accomplished by participators of programmes with more hours of exercising [1, 14], a higher intensity and level of general abilities [41], a normal-desirable nutritional status – value of the body mass index [37] and more adequate working conditions, especially regarding personell and material conditions [6, 10, 33, 49].

Article's aims and hypotheses

This article's primary role is to determine the quantitative changes in boys' kinanthropological characteristics during a period of two years occurring by the application of three different kinesiological operators. Its secondary role is to examine each group's nutritional state and its connection to the results of the aerobic type functional abilities test.

- H1.H₁:** There will be statistically significant changes in the kinanthropological characteristics for children – athletes engaging in team sports played with a ball when compared to children – athletes engaging in martial arts and children – non-athletes.
- H2.H₁:** There will be a statistically significant connection between the body mass index and functional abilities for all three groups of examinees.

Material and Methods

Sample of examinees

There were 147 boys attending two primary schools from Istria – Croatia who took part in the research. Of the total amount of examinees, there were 60 pupils who, during the two-year period, trained team sports played with a ball (21 football, 17 handball and 22 basketball players), 30 pupils trained martial arts (15 karate practitioners, 8 wrestlers, 4 kick-boxers and 3 taekwondoists – ITF version), while 57 pupils were non-athletes, pupils who did not attend any extracurricular sport activity except for Physical Education twice a week for 45 minutes. The examinees

were monitored for two years: initial measurement at the age of 11, transitive measurement at the age of 12 and final measurement at the age of 13 (their age being ± 6 months at each measurement) – i.e. at the beginning of the 5th, 6th and 7th grade, from 2013 to 2015. Examinees who were engaged in team sports played with a ball and martial arts had, along with the regular Physical Education, three trainings a week of the duration of at least 60 minutes. All pupils who were chosen for the research were clinically healthy and with no visible motor, functional or psychic deviations.

Sample of variables

A set of 10 tests for measuring the anthropometric characteristics, motor abilities and functional abilities was used for the needs of this research [12] and the variables of the ITM centiles (CDC BMI).

- To measure the anthropometric characteristics the following variables were used: height (ATV), body mass (ATT), forearm girth (AOP), while the body mass index (ITM) was worked out of the body height and body mass results and used as the indicator of the nutritional status of a person. The body mass index (ITM) was defined as: $\text{body mass (kg)/body height}^2 \text{ (m}^2\text{)}$, while the calculated value for each pupil was corrected into centiles [9] according to the child's sex and chronological age (criterion: < 5 centiles = malnutrition, $5 - 85$ centiles = normal body mass, $85 - 95$ centiles = overweight, ≥ 95 centiles = overnourishment (obesity)).

- To measure the motor abilities the following variables were used: reverse training ground (MPN) – *spatial coordination*, standing long jump (MSD) – *explosive power of lower extremities*, pull up endurance (MIV) – *static power of the arms and shoulders*, hand tapping (MTR) – *speed of simple movements*, touch-toe with legs astride (MPR) – *flexibility of the pelvis*, trunk lifts (MPT) – *repetitive power of the trunk*.

- To measure the functional abilities the variable of the 6 minute run (F6') was used.

The measurements were conducted in the first two weeks at the beginning of the school-year. The body mass was measured with a medical balance and all the examinees were without their footwear and wearing their sports clothes (a T-shirt and shorts). Body height was measured with the Martin anthropometer with the measuring exactness of 0.1 cm. The examinees were without their footwear with the position of the head in the so called Frankfurt horizontal plane.

Data processing methods

Entering and processing data was done by a computer programme for the statistical data processing named IBM SPSS Statistics Version 2.2. The basic descriptive parameters were calculated: arithmetic mean, standard deviation and the minimal and maximal value of results. The distribution normality was determined by the Kolmogorov-Smirnov test (K – S test). To analyse the changes in the two year period, i.e. to determine the statistically significant differences in the arithmetic means for the three groups of examinees the Student's t-test for dependable samples was used. The discriminant analysis determined the differences among the three groups of examinees at the initial, transitive and final measurement. The level of correlation between the nutritional status results and the level of functional ability in the three measurements was determined by the correlation analysis. The set hypotheses are the results obtained by testings at the level of statistical significance $p < 0.05$.

Results

Table 1 shows the common results of the basic descriptive parameters for the three groups of examinees at the initial, transitive and final measurement. The Kolmogorov – Smirnov test determined the normality of distribution which showed that the results of distribution did not significantly depart from the normal. In the area of anthropometric characteristics, looking from the initial to the final measurement, pupils undergo an increase in the results of body height (ATV), body mass (ATT) and forearm girth (AOP), while an insignificant downfall is seen in the body mass index (ITM) at the transitive measurement to slightly grow again to the average result (Mean) of 0.17 centiles at the final measurement. Regarding motor and functional abilities, pupils made an advancement in all variables from the initial to the final measurement.

The Student's t-test results for dependable samples at the transitive measurement after a one-year period show that pupils engaging in martial arts (Table 2) achieve a quantitative advancement for all eleven variables. A statistically significant improvement of arithmetic mean was achieved for eight variables (ATV, ATT, AOP, ITM, MTR, MPN, MPT and F6'), while for three variables (MSD, MPR and MIV) there were no statistically significant differences.

Unlike pupils engaging in martial arts, those playing team sports with a ball achieved a negative move in the variable of body mass index

Table 1

Basic descriptive parameters of the whole sample at the initial, transitive and final measurement

Var./Per.	N	Mean	Std. Dev.	Min.	Max.	Skew.	Kurt.	K-S p
ATV/i	147	149.82	7.86	130.80	167.00	.16	-.42	.094
ATT/i	147	44.97	13.70	26.00	95.00	1.60	2.85	.000
AOP/i	147	22.07	2.50	17.50	30.20	.79	.59	.046
ITM/i	147	61.01	31.49	5.00	95.00	-.45	-1.24	.000
MTR/i	147	23.83	3.95	16.00	36.00	.42	.32	.005
MSD/i	147	148.53	22.22	71.00	190.00	-.54	.50	.164
MPN/i	147	18.09	5.29	10.38	37.80	1.13	1.33	.001
MPT/i	147	31.50	7.30	6.00	57.00	-.14	1.68	.190
MPR/i	147	39.61	10.47	6.00	63.00	-.34	.41	.098
MIV/i	147	21.36	19.78	.00	85.00	1.03	.61	.000
F6'/i	147	1065.61	204.28	611.00	1472.00	.05	-.71	.166
ATV/t	147	156.49	8.63	134.60	177.00	.05	-.38	.197
ATT/t	147	50.10	14.22	28.00	105.00	1.40	2.32	.000
AOP/t	147	23.04	2.46	18.50	31.00	.63	.54	.160
ITM/t	147	60.22	30.04	5.00	95.00	-.34	-1.30	.000
MTR/t	147	26.64	3.74	17.00	39.00	.19	.76	.063
MSD/t	147	152.80	24.06	76.00	213.00	-.22	-.03	.188
MPN/t	147	15.99	4.33	9.59	38.40	1.79	5.82	.000
MPT/t	147	34.84	8.09	13.00	59.00	-.13	.30	.194
MPR/t	147	42.60	10.87	16.00	66.00	-.36	-.42	.033
MIV/t	147	23.13	20.96	.00	100.00	1.08	1.09	.000
F6'/t	147	1116.12	201.18	602.00	1506.00	-.13	-.77	.185
ATV/f	147	163.76	9.46	140.00	185.70	-.07	-.34	.180
ATT/f	147	56.90	16.25	31.00	120.00	1.40	2.84	.000
AOP/f	147	23.97	2.67	18.80	34.00	.75	1.19	.189
ITM/f	147	60.39	29.90	5.00	95.00	-.39	-1.20	.000
MTR/f	147	28.59	4.02	17.00	39.00	-.05	.25	.005
MSD/f	147	164.47	26.38	91.00	211.00	-.25	-.61	.192
MPN/f	147	14.53	4.01	8.66	26.63	1.06	.68	.000
MPT/f	147	38.40	7.64	12.00	67.00	-.45	2.63	.000
MPR/f	147	44.64	12.88	4.00	75.00	-.48	.13	.003
MIV/f	147	29.84	23.92	.00	102.00	.63	-.29	.003
F6'/f	147	1176.61	228.63	626.00	1690.00	.05	-.59	.191

Note: Var. – variable / Per. – measurement period (i – initial, t – transitive, f – final); N – number of entities in the sample; Mean – arithmetic mean; Std. Dev. – standard deviation; Min. – minimal result; Max. – maximal result; Skew. – distribution curve; Kurt. – flattening of the distribution.

(ITM) after one year, but a statistically significant improvement in seven out of eleven variables (ATV, ATT, AOP, MTR, MPN, MPT and F6'). A positive move, yet not statistically significant, was recorded in three motor ability variables (MSD, MPR and MIV) (Table 2).

Table 2. shows the Student's t-test results for dependable samples of pupils who were not engaged in any sport, but were physically active only during Physical Education classes at school. After the one-year period they achieved statistically significant changes in nine variables (ATV, ATT, AOP, MTR, MSD, MPN, MPT, MPR and F6'). Advancement was recorded in the two remaining variables (ITM and MIV), but it was not statistically significant.

After the two-year monitoring period, examinees engaged in martial arts (Table 3) achieved a significant advancement in eight variables (ATV, ATT, AOP, MSD, MPN, MPR, MIV and F6'). In two motor abilities variables (MTR and MPT) the advancement was not significant, while in the variable for the evaluation of a person's nutritional status (ITM), a decline in the results compared to the transitive measurement was recorded.

In the same period (Table 3), examinees engaged in team sports played with a ball achieved a significant move in nine out of eleven variables (ATV, ATT, AOP, MTR, MSD, MPN, MPT, MIV and F6'). The changes were not significant, although a slight positive move was recorded, for the remaining two variables – evaluation

Table 2

T-test results for dependable samples between the initial and transitive measurement of examinees engaged in martial arts, team sports played with a ball and non-athletes

Var./Per.	Martial arts			Sports played with a ball			Non-athletes		
	Mean	N	p < .05	Mean	N	p < .05	Mean	N	p < .05
ATV/i	150.53	21		151.14	52		148.56	47	
ATV/t	157.21	21	.000	157.85	52	.000	155.13	47	.000
ATT/i	43.08	21		41.12	52		50.01	47	
ATT/t	46.57	21	.000	46.73	52	.000	55.22	47	.000
AOP/i	21.44	20		21.43	52		23.06	47	
AOP/t	22.30	20	.001	22.61	52	.000	23.79	47	.000
ITM/i	53.76	21		51.10	52		75.13	47	
ITM/t	46.24	21	.006	52.19	52	.737	74.72	47	.774
MTR/i	23.27	22		24.67	55		22.82	55	
MTR/t	27.55	22	.000	26.73	55	.000	25.91	55	.000
MSD/i	159.50	22		156.60	55		135.44	55	
MSD/t	166.41	22	.102	159.47	55	.168	140.60	55	.015
MPN/i	16.72	21		16.10	55		21.67	55	
MPN/t	14.35	21	.006	14.39	55	.000	19.24	55	.000
MPT/i	34.68	22		34.22	55		28.22	55	
MPT/t	38.00	22	.024	37.00	55	.001	31.29	55	.001
MPR/i	43.18	22		41.24	55		38.20	55	
MPR/t	44.46	22	.534	43.09	55	.113	42.07	55	.001
MIV/i	29.27	22		28.11	55		10.09	55	
MIV/t	36.46	22	.084	30.76	55	.075	10.56	55	.709
F6'/i	1086.96	22		1168.64	55		921.93	55	
F6'/t	1210.46	22	.003	1214.31	55	.039	974.15	55	.007

Note: Var. – variable / Per. – measurement period (i – initial, t – transitive, f – final); Mean – arithmetic mean; N – number of entities in the sample; p – level of significance; the leading zeros have been left out.

of a person's nutritional status (ITM) and flexibility of the pelvis (MPR).

Table 3 shows the examinees non-athletes' results between the second and third measurement. A positive move was recorded in all variables, the results being statistically significant in nine variables (ATV, ATT, AOP, MTR, MSD, MPN, MPT, MIV and F6').

Tables 4, 5 and 6 show the discriminant analysis results for the three assessed groups of examinees at the initial, transitive and final measurement. They show the inferiority of the anthropological status of those examinees who were physically active only during Physical education classes compared to their peers who did sports in extracurricular activities, more precisely team sports played with a ball and martial arts, during both years of the training process. At all three measurements, a significant difference between athletes playing team sports with a ball and athletes doing martial arts was not recorded.

The correlation analysis results of the total sample of examinees (Table 7) show that there is a statistically significant correlation (error level $p = .01$) between the body mass index (ITM) and

the functional abilities measured with the six minute run test (F6'). The correlation coefficient was negative for all three evaluations and it was equal to $r = -.422$ for the initial measurement, $r = -.480$ for the transitive measurement and $r = -.397$ at the final measurement.

The average values of the examinees' nutritional state (Fig. 1) clearly show the difference between the group of non-athletes and athletes. Non-athletes recorded 20 and more centiles higher values at the final measurement than the two groups of athletes. If the final measurement results are seen according to the nutritional state, it can be seen that 55 % of non-athletes are overweight or obese. Of the total number of overweight or obese non-athletes, 90.32 % kept the measured values during the two-year period of assessment. The team sports played with a ball and martial arts examinees are predominantly of a normal body mass.

The obtained results indicate that young athletes engaged in martial arts (wrestling, karate, kick-boxing and taekwondo) achieved significant positive moves of the anthropological status after a two-year period of organised training processes.

ФИЗИОЛОГИЯ

In the first part of the analysed period, during the fifth grade, the anthropometric characteristics results for boys engaged in martial arts indicate a statistically significant positive increase in the body height (ATV), body mass (ATT) and forearm girth (AOP). The examinees achieved an

average growth of 6.7 cm, they were 3.5 kg heavier and their forearm girth was about 1 cm longer. Regarding their age, the obtained results, especially in regard to body height and body mass, are slightly above the average when compared to results found in earlier literature [13].

Table 3

T-test results for dependable samples between the transitive and final measurements of examinees engaging in martial arts, team sports played with a ball and non-athletes

Var./Per.	Martial arts			Sports played with a ball			Non-athletes		
	Mean	N	p < .05	Mean	N	p < .05	Mean	N	p < .05
ATV/t	155.57	27		157.65	57		155.76	52	
ATV/f	163.64	27	.000	165.16	57	.000	162.27	52	.000
ATT/t	46.94	27		46.87	57		56.06	52	
ATT/f	53.47	27	.000	53.32	57	.000	62.90	52	.000
AOP/t	22.56	25		22.63	57		23.96	52	
AOP/f	23.47	25	.001	23.55	57	.000	24.88	52	.000
ITM/t	50.52	27		53.53	57		76.06	52	
ITM/f	51.33	27	.743	53.30	57	.894	76.00	52	.969
MTR/t	27.04	28		26.75	59		25.84	57	
MTR/f	27.96	28	.252	29.03	59	.000	27.42	57	.000
MSD/t	166.54	28		161.00	59		140.14	57	
MSD/f	174.04	28	.001	174.92	59	.000	149.88	57	.000
MPN/t	14.08	27		14.59	59		19.43	57	
MPN/f	11.95	27	.000	12.99	59	.000	17.52	57	.000
MPT/t	37.86	28		37.41	59		31.47	57	
MPT/f	40.60	28	.066	40.88	59	.000	34.75	57	.000
MPR/t	45.39	28		44.05	59		42.54	57	
MPR/f	49.46	28	.025	45.97	59	.142	43.75	57	.265
MIV/t	33.12	28		29.63	59		10.35	57	
MIV/f	38.64	28	.039	37.25	59	.000	14.61	57	.008
F6'/t	1164.82	28		1204.53	59		968.30	57	
F6'/f	1272.71	28	.002	1262.56	59	.008	1012.67	57	.016

Note: Var. – variable / Per. – measurement period (i – initial, t – transitive, f – final); Mean – arithmetic mean; N – number of entities in the sample; p – level of significance; the leading zeros have been left out.

Table 4

The discriminant analysis results at the initial measurement

	Eigenvalues	Canonical correlation	Wilks' Lambda	Chi-square	p < .05	Group 1	Group 2
Differences in results between martial art groups and non-athletes	.75	.66	.57	35.06	.000	1.31	-.56
Differences in results between groups playing team sports with a ball and non-athletes	.91	.69	.52	60.46	.000	.92	-.97
Differences in results between martial art groups and groups playing team sports with a ball	.26	.45	.80	14.95	.185	.79	-.32

Note: here and in Table. 5, 6 Eigenvalues – discriminant functions' characteristic values; Canonical Correlation – canonical correlation coefficients; Wilk's Lambda – Wilk's Lambda values for each discriminant function; Chi-Sqr. – the value of the hi square test for the assessment of the discriminant function significance; p-level – the proportion of the error done by accepting the hypothesis that the difference is statistically significant; Group 1 – the position of the first group centroids on the discriminant function; Group 2 – the position of the second group centroids on the discriminant function; the leading zeros have been left out.

Table 5

The discriminant analysis results at the transitive measurement

	Eigenvalues	Canonical correlation	Wilks' Lambda	Chi-square	p < .05	Group 1	Group 2
Differences in results between martial art groups and non-athletes	.60	.61	.63	34.09	.000	1.04	-.56
Differences in results between groups playing team sports with a ball and non-athletes	.81	.67	.55	60.84	.000	.85	-.94
Differences in results between martial art groups and groups playing team sports with a ball	.20	.41	.84	14.17	.224	.63	-.31

Table 6

The discriminant analysis results at the final measurement

	Eigenvalues	Canonical correlation	Wilks' Lambda	Chi-square	p < .05	Group 1	Group 2
Differences in results between martial art groups and non-athletes	.64	.63	.61	36.51	.000	1.19	-.53
Differences in results between groups playing team sports with a ball and non-athletes	.69	.64	.59	56.31	.000	.80	-.84
Differences in results between martial art groups and groups playing team sports with a ball	.13	.34	.89	9.24	.600	-.54	.23

At the end of the first year of the training process, the martial arts examinees did not show a significant advancement in the variables which measure flexibility (MPR), the explosive power of the legs (MSD) and the static power of the arms and shoulders (MIV). However, these three motor abilities results showed a statistically significant improvement after the second year of training and so confirmed some earlier researches' results [21, 45]. The reason for the improvement of flexibility can probably be found in better trained techniques like high kicks in karate, taekwondo, kick-boxing and a number of specific gripping, lifting, throwing and turning techniques in the stand-up and floor position in wrestling which contribute to a better flexibility of the hips, the whole pelvis area, the lower trunk and the back region of lower limbs. „A high level of these abilities makes possible movements which are more economical, fatigue is easier to endure, the sensitivity to the occurrence of acute and chronic injuries is lower, psycho-physical relaxation etc.“ [47]. Flexibility is the only motor ability which produces the best results and values in childhood, which is significant for all martial arts [45]. At the end of the observed training period for all measured types of action, power re-

sponse (explosive, repetitive and static) and expressed advancement was seen, especially in the explosive and static power where statistically significant improvements are recorded. They are certainly conditioned by a number of different factors, from the chronological to the significantly biological age, and also by factors linked to the sole training – volume, intensity and duration of the training [31]. The results achieved by boys engaged in martial arts are encouraging, since too little attention was paid to the strength and flexibility of the trunk [2]. “Insufficient attention paid to the strength and flexibility of the trunk in the basic preparation stage (from 10 to 14 years of age) will be reflected as a lag in learning the advanced techniques of lifting from the floor at the stage of direct specializing preparation (from 15 to 18 years of age) which will eventually cause sport stagnation and a permanent latent danger of injuries to the trunk“ [3]. The variable which continually records a significant positive move in the two-year period is the variable for the measurement of functional abilities – the six minute run (F6'). Although power, speed of motoric reaction, coordination... [23, 24, 26, 43] are predominant for the success in martial arts, which more precisely represent the

Table 7
The correlation between the body mass index variable and the test for measuring functional abilities (F6')

	F6' Initial	F6' Transitive	F6' Final
ITM Martial arts	-.032	-.462	-.292
ITM Team sports played with a ball	-.340	-.338	-.086
ITM Non-athletes	-.313	-.334	-.409
ITM Total	-.422	-.480	-.397

Note: Level of error $p < .01$; the leading zeros have been left out.

dominance of speed-strength abilities, the permanent advancement and total achievement in the aerobic capacity of martial arts athletes is seen as an envious success. Functional abilities of an aerobic character are essential for an adequate recovery between rounds or matches at competitions, but also for the recovery during and after a training [25, 44]. It is known that a well developed aerobic capacity at this age is the base for working on the sport-specific anaerobic endurance in the ages to come. According to Bompa [6], the children's organs and systems adaptation to the endurance training has many good sides, from improving the lung and heart functions to the increase of red blood cells in charge of the transfer of oxygen to the muscles engaged.

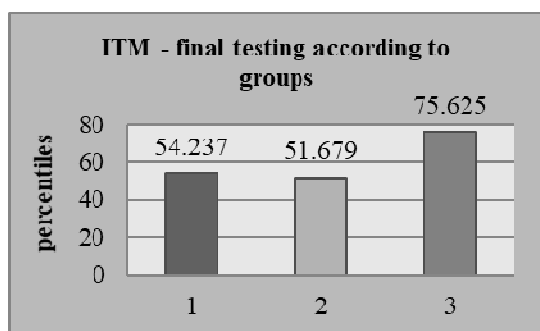


Fig. 1. Average values of the body mass index (ITM) at the final measurement for all three groups of examinees: 1 – sports played with a ball; 2 – martial arts; 3 – non-athletes

The second group, young athletes playing team sports with a ball, in comparison to peer athletes doing martial arts and non-athletes, achieved the highest results in body height (ATV) and the lowest results in body mass (ATT) after the two year period. The first two measurements show differences in the body height on the side of examinees playing sport games with a ball, while at the final measurement the average values were 2 cm compared to non-athletes and 1.5 cm compared to martial arts athletes. Considering the significance body height has for success in handball and especially basket-

ball, athletes in sport games played with a ball have an advantage over their peers from the two other groups already in the initial phase of puberty. In the area of functional-motor abilities, positive moves in all the measured variables were achieved after one year of training. The variables which measure the explosive and static power (MSD and MIV) and the flexibility of the pelvis (MPR) were the only ones which did not show a statistical advancement. The variable touch-toe with legs astride (MPR) did not register significant changes even after the second year of the training process which indicates that exercises which develop flexibility are not sufficiently present in the sport games played with a ball training contents. There are more than one earlier researches which show that flexibility does not significantly change in team sports [35]. Although boys' flexibility diminishes after their eleventh year of age, action should be taken to improve it [25]. The flexibility of the back thigh muscles has a keyrole for the execution of a number of specific tasks in football, like young football players' sprinting, jumping, agility and kicks [15]. Its importance is significant for the execution of certain basketball technique elements [26]. The same authors emphasize that an adequate flexibility is a support to a quality growth and development, as well as to the prevention of injuries. The results obtained in the area of explosive and static power after a one-year training period do not confirm some earlier researches [18, 32]. The reasons can be only assumed. On one hand, the popularity of sports played with a ball attracts a larger number of children (than martial arts) which diminishes the coach's individual approach to each single person, while on the other, there is a larger number of children who, due to a lack of interest, train without the wish and will to succeed which after a time leads to giving up training these sports. It is certain that persistent and motivated boys who find it harder to reach their condition potentials directly suffer from such circumstances. The end of the two-year period brought

significant positive moves for these two measured variables of motor abilities. Like the martial arts examinees, a statistically significant improvement in the functional ability variable (F6') was registered for young team sports athletes after the first and second year of the training process. If the average value results for the two groups at the initial, transitive and final measurements are taken into consideration, it can be concluded that young athletes playing sport games with a ball have better results at the initial (M = +81 m) and transitive (M = +40 m) measurement, while the results are worse at the final measurement (M = -10 m). According to Mikulić [27], "a significant improvement in the aerobic endurance indicators, it has been determined, is achieved from the beginning of the intensive puberty growth in height, which is averagely one year after a boy enters puberty or around their 13th year of age." Since the functional ability (F6') is a precondition for the qualitative and quantitative engagement in team sports played with a ball, a higher improvement was expected in the second year of the training process. In giving the periodization of children's long term trainings, Bompa [6] names the puberty period as the formation of athletes phase (11 to 14 years of age) when the aerobic capacity should be further developed. He adds that a strong endurance base will enable athletes to face the training and competition requirements in a more efficient way during the following phase (15 to 18 years of age) which is called specialization.

Like the two groups of young athletes engaged in martial arts and team sports played with a ball, pupils who are physically active in an organised way only during Physical Education classes achieve a statistically significant improvement during the two-year measurement period in almost all variables linked to anthropometric characteristics and functional-motor abilities. Only the variable for measuring the flexibility of the pelvis (MPR), which registered a significant improvement in the first year, did not show a significant positive move at the last measurement. Flexibility often declines with years, especially for boys, probably due to the muscle growth, growth and muscle strength so it demands training during the young's developmental phases [6]. This research results show that an adequate Physical Education curriculum, primarily based on feedback information of the pupils actual condition and by considering their interests and needs, would reach a certain positive move of

kinanthropological tasks. Unlike in previous researches [37], the obtained results indicate the contrary effects of the Physical Education transformative process. More significant cumulative effects of the children's whole anthropological status are only possible if higher values of the load's extensity and intensity are applied. This is the reason why the non-athletes' results, when considering all the measured variables, are significantly behind the results achieved by peer athletes engaged in martial arts and team sports played with a ball. They are especially manifested on the anthropometrical characteristics' values in the variables body mass and forearm girth (ATT, AOP), similarly to results obtained by certain previous researches [44]. It confirms the further negative trend of increment in the children and adolescents' body mass which was mentioned at the beginning of this article. Unlike the two groups of athletes whose results were permanently similar, pupils non-athletes had a higher body mass (averagely from 7 to 9 kg) and larger forearm girth (averagely 1.5 cm) from the initial to the final measurement. Although the forearm crease was not measured, when the lower values of the pupils non-athletes body height and their sedentary way of life are considered, it can be easily concluded that Physical Education classes held twice a week for 45 minutes only slightly diminishes the growth of the ballast mass, but it does not reduce it to a significant extent.

It should be pointed out that examinees in this research lived in rural and suburban areas and attended school in two shifts. A larger number of pupils was not able to come to trainings in the city on foot, nor could parents drive them due to their job obligations. Since an increase in the number of primary school Physical Education classes from twice to three times a week cannot be anticipated in due time, it is essential for the school and the social environment to encourage the pupils' participation in extracurricular activities, school sport associations and sport clubs. By taking part in some of the aforementioned forms of organised physical exercising, they would accumulate the necessary time to be spent in an organised physical activity and surely give a contribution to the positive improvement of their kinanthropological status.

If the three groups of examinees are compared after the two-year training process (Tables 4, 5 and 6), statistically poor results achieved by pupils non-athletes at all three measurements in comparison to their peers from the two groups

of athletes can be noticed. It was expected that the negative differences between non-athletes and the groups of athletes would increase during time, but it did not happen in this research. Indeed, although the differences were significant, the transitive and final measurements showed their slight diminution. It can be derived that, compared to non-athletes, there is a lack of athletes' improvement in their clubs. The reasons can be only assumed, since this paper did not give the specific working conditions and indicators of the training process. We are of the opinion that the main reason "lies" in insufficiently experienced coaches, with questionable qualifications and in the system of insufficient permanent, life-long learning and practice to work with younger age groups. The Sport Community of the City of Poreč annual report for the year 2015 says that in clubs from which this article's examinees were taken from there were 55 % of coaches who had less than seven years of experience and 82 % of coaches who worked with young people and had qualifications lower than the level of a bachelor coach¹. The groups of athletes engaged in martial arts and team sports played with a ball did not show statistically significant differences at any of the three measurements. Although not significant, the differences existed and they were mostly expressed at the initial measurement in favour of martial arts. During the first, and especially second, training year, the group of team sports played with a ball significantly diminished these differences. Based on the obtained result, the set hypothesis according to which there will exist statistically significant differences in the changes of kinanthropological characteristics of athletes engaged in team sports played with a ball when compared to athletes doing martial arts and non-athletes can be only partly accepted.

The correlation analysis results of the total sample of examinees regarding the body mass index (ITM) and functional abilities leads to the conclusion that an increase in the value of the body mass index is influenced by the poorer result achieved at the six minute run test (F6'). Overweight or obese examinees in all three groups showed a significantly poorer result at the final measurement in comparison to the normally nou-

rished or malnourished. Namely, their six minute running section was averagely 156 m shorter than all the examinees total result and 216 m shorter than the result of examinees in the category of normal body mass or malnourishment. The results obtained in this research give an additional confirmation to the current knowledge which says that a poorer execution of functional ability tests is closely related to the presence of excess weight and obesity. Previous studies conducted in our country and in the world show that children and adolescents with a higher body mass achieve poorer results in the area of functional-motor abilities than their normal body mass peers [7, 19, 34, 38, 40, 42]. By consulting twelve transversal and two longitudinal studies published in relevant electronic academic data bases (PubMed, SportDiscus, Web of knowledge and Ovid) in the period from 2000 to 2011, the authors Rauner et al. [41] analysed the interaction of physical activity, physical fitness (muscle strength, endurance and motor skills) and excess body mass in adolescents and the young aged 11 to 23. The conclusion of a larger number of studies about the relation between excess body mass including obesity and physical activity lies in their reversed correlation. All the twelve transversal studies report about the reverse correlation between physical fitness and body mass. In line with the results, this paper can confirm the set hypothesis according to which there is a statistically significant correlation between the body mass index (ITM) and the functional abilities for the three groups of examinees.

Conclusion

The discriminant analysis results showed the superiority of both groups of athletes over the pupils non-athletes at the initial, final and transitive measurement. During the two-year training period the two groups of athletes did not show significant differences. Based on the obtained results, it can be concluded that engaging in team sports played with a ball at the secondary school age (11 to 13) has a more positive and significant influence on the development of the analysed anthropometrical characteristics, motor and functional abilities' variables than on those peer pupils who did not engage in sports, but not on athletes engaged in martial arts. Thus, the set alternative hypothesis is partially accepted. More precisely, the alternative hypothesis according to which there is a statistically significant difference in the changes of the anthropological status for children athletes engaged in team sports played

¹ A person who completes at least the professional study for the education of coaches of the duration of three years (six semesters) and acquires the title of bachelor of sports coaching.

with a ball in comparison to children who are non-athletes is accepted, while the alternative hypothesis is rejected because a statistically significant difference in the changes of the anthropological status between the groups of team sports played with a ball and martial arts was not determined so the null hypothesis is accepted.

The highest values of the nutritional state at the final measurement were measured for pupils non-athletes and in relation to the examinees athletes, they were higher for an average of 21 percentiles than for pupils training team sports played with a ball and 25 percentiles than for pupils doing martial arts. It can be determined that a better result of the six minute run test (F6') influences the reduction of the body mass index (ITM) value. The correlation analysis confirmed the second alternative hypothesis according to which there would be a statistically significant correlation between the body mass index and the functional abilities for all three groups at the initial, transitive and final measurement.

Pupils who were engaged in organised exercising only during Physical Education classes twice a week for 45 minutes, although they achieved a significant improvement (t-test for dependable samples) in almost all variables of the anthropological status during the two-year activities, could not cope with peers who trained team sports played with a ball or martial arts as part of their extracurricular activities – three times a week for at least 60 minutes. This article's results also indicate that Physical Education classes are not sufficient for a long term significant influence on the children and adolescents' kinanthropological characteristics. It is essential for the local community to ensure the possibility for children to attend school only in the morning shift, while the school and the community as a whole should be more engaged into offering the interested pupils the possibility to take part into organised forms of sports and make them simple and more available.

Since this article did not analyse the content aspects of the two groups of athletes' training and the representation of examinees according to sports varied significantly, the results should be taken with a pinch of salt. Future studies should equalize the number of examinees according to particular sports, increase the total number of examinees per groups and consider a larger number of factors, primarily exogenous, like information about the training process of the chosen sports, attendance of trainings, pupils nutritional

habits, free time activities and others. In any case, it was expected that the differences between the two groups of athletes compared to the group of non-athletes would increase over time, but it did not happen. Some of the reasons can be found in insufficiently experienced coaches and a lower level of professionalism which raises a question about the necessary quality of the training work, training conditions and the children's interest for a certain sport activity. The basic precondition for an adequate progress and development of the children's conditional potential for the chosen sport is a professional and experienced coach who knows the working and developmental regulations and applies contemporary knowledge about planning and programming the training process in his/her work. Such a coaching profile would contribute to keeping children and adolescents engaged in the chosen sport and it would indirectly cause physical exercising to become children's permanent possession.

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КОЛИЧЕСТВЕННЫЕ ИЗМЕНЕНИЯ В АНТРОПОЛОГИЧЕСКОМ СТАТУСЕ УЧЕНИКОВ СРЕДНЕЙ ШКОЛЫ ЗА ДВУХЛЕТНИЙ ПЕРИОД

Л. Бенасси¹, И. Блажевич¹, Б. Трайковски²

¹Университет Пулы им. Юрая Добрилы, г. Пула, Хорватия,

²Университет Риеки, г. Риека, Хорватия

Цель. Основная цель данного исследования заключалась в определении антропометрических характеристик, а также двигательных и функциональных возможностей среди трех групп испытуемых, наблюдаемых в течение двух лет в рамках организованных занятий по физической культуре. Второстепенная цель исследования состояла в изучении пищевого статуса каждой группы и его взаимосвязи с результатами оценки функциональных возможностей. **Материалы и методы.** Из общей выборки, состоявшей из 147 учеников, было выделено три группы: первая группа включала представителей боевых искусств (карате, рестлинг, тхэквондо, кикбоксинг), во вторую группу вошли представители командных видов спорта с мячом (футбол, гандбол, баскетбол), третья группа состояла из учеников, занимающихся спортом только в рамках занятий физической культурой. Исследование проводилось на основе 10 показателей. Для обработки полученных данных были использованы t-критерий Стьюдента, дискриминантный и корреляционный анализ. **Результаты.** На всех трех этапах результаты продемонстрировали превосходство испытуемых, занимающихся спортом на регулярной основе. Занятия командными видами спорта с мячом в возрасте от 11 до 13 лет оказывают более благоприятное влияние на анализируемые показатели антропологического статуса, чем простые занятия физической культурой, при этом результаты, полученные для представителей боевых искусств, выявили статистически значимые отличия ($p < 0,05$). Наибольшие значения оценки пищевого статуса были получены для учеников, не занимающихся спортом на регулярной основе, при этом чем ниже индекс массы тела, тем лучше результаты шестиминутного бега ($p < 0,01$). **Заключение.** Полученные данные позволяют прийти к выводу, что регулярные занятия физической культурой по два академических часа в неделю не обеспечивают долгосрочного значительного воздействия на развитие антропологических характеристик, поэтому необходимо поощрять детей к дополнительным занятиям спортом. Различия в улучшении показателей между двумя группами спортсменов и группой учеников, не занимающихся спортом, могут объясняться неподходящими рабочими условиями, низкой заинтересованностью детей в определенных видах физической активности и выбором тренерского состава.

Ключевые слова: общеразвивающие упражнения, пищевой статус, физическая культура, ученики.

Бенасси Лорис, магистр кинезиологии, ассистент факультета образовательных наук, Университет Пулы им. Юрая Добрилы. Ул. И.М. Роньгова, 1, 52100, Пула, Хорватия. E-mail: lbenassi@unipu.hr, ORCID: 0000-0002-3235-1791.

Блажевич Ива, доктор кинезиологии, доцент факультета образовательных наук, Университет Пулы им. Юрая Добрилы. Ул. И.М. Роньгова, 1, 52100, Пула, Хорватия. E-mail: iblazevic@unipu.hr, ORCID: 0000-0002-4437-2792.

Трайковски Биляна, доктор кинезиологии, старший преподаватель кафедры методик преподавания предметов из области естественных и гуманитарных наук, педагогический факультет, Университет Риеки. Ул. Свеучилишна, 6, 51000, Риека, Хорватия, E-mail: biljana.trajkovski@ufri.uniri.hr, ORCID: 0000-0002-0003-6746.

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