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DIFFERENCES IN THE TESTS FOR ASSESSMENT OF STRENGTH AND SPEED MOTOR ABILITIES BETWEEN 3 GENERATIONS (15, 16 AND 17 YEARS OF AGE) BOYS AND GIRLS

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(Original scientific paper)

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Abstract

The objective of this research was to compare the strength and speed capacities at a sample of N=78 subjects, boys (N=42) and separately for girls (N=36) at the age of 15, 16 and 17 years, secondary school students. Three (3) tests were applied for assessment of the strength capacities and one (1) test for the speed assessment. (Push Ups-1 min, Curl Ups -1 min, Trunk Extension, Run 20meter). The results have shown that there is no significant difference between the 3 generations of boys in terms of the system of motor abilities (Wilks' L=0.74; p=0.187; η_p^2=0.14). Among the girls, there is significant difference between the three generations at level (Wilks' L = 0.497; p=0.01; η_p^2=0.295). Post-hoc tests of the girls have shown difference in the Curl Ups-1 min tests (p=0.003) between the generations first and second year generations, and Run 20 meter between the girls of first and second year (p=0.004), as well as between the girls of second and third year (p=0.002). It can be concluded that there are differences between the three generations of girls; however, we are unable to confirm with certainty the cause for such differences. It can be established with certainty that the sample of subjects presents lower values at the applied tests compared to a similar population. The recommendations of the authors refer to the following: need for correction in the curricula and the number of weekly classes in physical education in the secondary schools; increased motivation for physical activity among this population of young boys and girls, both on and outside of class activities; monitoring of the motor abilities among the youth in the Republic of North Macedonia; application of similar tests in other schools, comparison of results, development of a national strategy with instructions for development and maintenance of motor abilities among the youth.

Keywords: *motor performances, youth, strength development, physical assessment, comparison*

Introduction

The term physical activities mean forms of activities being implemented during the daily activities (executing household-related and professional obligations) as well as recreational-sport activities (Caspersen C, J, (1989) Bouchard, C., & Shephard, R. J. (1994), Kalache, A., & Kickbusch, I. (1997). Physical education, as organized form and through the system action on individuals, aims to create a healthy and physically well-developed youth able to fully, freely and efficiently control their motor skills. In the 21st century, physical activity represents an important factor for the health of children, youth and adults (Mitrović, N., & Stević, D. (2019**).** In addition, the physical activity also has a role in the prevention of potential health problems, such as: diabetes, obesity, cardiovascular diseases and similar. For example, 14 million children are overweight, of which 3 million children are obese (WHO, 2016).

However, regular physical activity can have an impact on the prevention and reduction of obesity and preservation of the healthy body weight (Epstein, L. H., Coleman, K. J., & Myers, M. D. (1996). Physical education classes in secondary schools are mainly of non-active (sedentary) nature, lacking the sufficient inclusion of physical exercises for development of abilities and traits which are the main requirement for healthy development and proper changes of both quantitative and qualitative dimensions of the anthropological status of the student (Vishnjikj, Jovanovikj and Miletikj, 2004; Kragujevikj, 2005). The education system in Macedonia provides only 2 classes of PE per week, which represents a major problem in terms of achievement of the objectives and tasks of the physical education classes. Physical activity

guidelines for adolescents were summarized in a consensus statement by Sallis and Patrick and prescribe that "adolescents should engage in three or more sessions per week of activities that last 20 min or more and that require moderate to vigorous levels of exertion" (Rowe, P., van Der Mars, H., Schuldheisz, J., & Fox, S., 2004).

Exercises and physical activity are important components for the healthy lifestyle of children and adolescents. Strength training is important for the muscle-skeletal health and is supported by many international organizations, including the World Health Organisation. Strength exercises are particularly important for the healthy development of the skeletal system. Healthy bones are formed in childhood, up to the age of 20 years, whereas 90 percent of the skeletal growth occurs between the ages of 10 and 20, and therefore childhood and youth are a critical period of bone development. Adolescence is an exceptionally important period for promoting lifelong health of bones.

Muscle strength and fitness of young people are related to a series of positive health benefits, including the improved body composition and increased self-confidence.

The question always posed is: What is the risk from such exercises? As with any sport or activity, participation is related to a specific risk from injury; however, if exercises are properly set, the risk shall not be any higher than any other recreational or sport activity. In the meantime, many injuries can be prevented with proper programing, supervision and load management. In fact, there are increasing explanations that inclusion of strength training is an important component of the programs for prevention of injuries (Blagrove, R. C., Bruinvels, G., & Read, P., 2017).

In addition, the thesis "At what age should strength exercises start?" is often posed. As long as the children are able to understand and follow the instructions and properly execute the desired exercises, there is no reason why they should not participate in the relevant strength training program. The best period for humans to improve their strength is the age upon turning 18 (Kukolj,1996), which does not mean that strength could not be transformed in younger ages.

Duration of system exercises (Faigenbaum, 2015), even if the exercises only last 15 minutes, within a period of 8 weeks, in children at the age of seven years, consisting of strength and balance exercises, has resulted into improved and increased strength, power, speed and aerobic performances in these young children.

Strength exercises could contribute to the healthy lifestyle, and therefore, the population practicing such type of exercises could be categorized as population working on their health and making an effort to leave the state of hypokinesia.

In addition, physical activity has a positive transfer on the learning success (Ronald W Bass, Dale D Brown, Kelly R Laurson, Margaret M Coleman, 2013).

This paper aims to assess the effect of the programs in the field of physical education in secondary schools, through assessment of the students' strength abilities.

Material & methods

The subject of this research shall be the motor abilities for strength and speed assessment among first, second and third-year students (secondary education) from the secondary school SUGS "Shaip Jusuf" – Skopje. The objective of the research is comparison of the results for assessment of the motor abilities among first, second and third-year students from the secondary school "Shaip Jusuf" – Skopje in 4 tests. The sample of subjects consists of a total of 78 students from the three years (boys=42, girls=36, students from the secondary school SUGS "Shaip Jusuf" – Skopje, at an average age of 15 years (+/- 0.5 y) for the first year students, 16 years (+/- 0.5 y) for the second year students and 17 years (+/- 0.5 y) for the third year students. The subjects have been divided into 3 groups: first year (14 boys and 11 girls), second year (13 boys and 13 girls), third year (15 boys and 12 girls). The differences in terms of the motor abilities have been studied in the population of boys between the first, second and third year, and in particular in the population of girls between the first, second and third year.

Sample of motor tests

1. Push-ups for 1 minute (Vivian, H.,Heyward.,2006)
2. Curl-ups for 1 minute (Robert J. W., 2008)
3. Trunk extension for 1 minute (Moreland J,1997)
4. RUN20M (Metikosh, D., et all., 1989)

Results

The basic descriptive statistic for the boys of the first, second and third year is given in Table No 1, and for the girls (first, second and third year) in Table No 2.

Table 1. The basic descriptive statistic for boys of first, second and third year.

Descriptive Statistics -BOYS								Tests of Normality					
								Kolmogorov-Smirnov(a)			Shapiro-Wilk		
Age	test	N	Min	Max	Sum	Mean	Std. Deviation	Statistic	df	Sig.	Statistic	df	Sig.
1	MPUSHUPS	14	1.00	32.00	222.00	15.857	9.591	0.157	14	.200(*)	0.951	14	0.572
	MCURLUPS		20.00	47.00	467.00	33.357	8.741	0.178	14	.200(*)	0.913	14	0.175
	MTRUNKEXT		12.00	72.00	529.00	37.786	14.094	0.152	14	.200(*)	0.942	14	0.443
	MRUN20M		2.69	3.63	44.99	3.214	0.287	0.159	14	.200(*)	0.954	14	0.622
2	MPUSHUPS	13	2.00	37.00	264.00	20.308	12.750	0.238	13	0.043	0.881	13	0.074
	MCURLUPS		15.00	45.00	446.00	34.308	8.567	0.148	13	.200(*)	0.943	13	0.495
	MTRUNKEXT		29.00	75.00	605.00	46.539	14.426	0.136	13	.200(*)	0.941	13	0.468
	MRUN20M		2.80	3.91	44.34	3.411	0.349	0.156	13	.200(*)	0.952	13	0.630
3	MPUSHUPS	15	4.00	35.00	189.00	12.600	7.679	0.244	15	0.017	0.795	15	0.003
	MCURLUPS		10.00	47.00	446.00	29.733	10.754	0.120	15	.200(*)	0.967	15	0.813
	MTRUNKEXT		16.00	73.00	595.00	39.667	17.899	0.172	15	.200(*)	0.932	15	0.296
	MRUN20M		2.79	4.25	53.14	3.543	0.439	0.157	15	.200(*)	0.950	15	0.521

MPUSHUPS-standard, on floor; MCURLUPS-on barbel;
MTRUNKEXT-trunk extension; MRUN20M-sprint 20 meters;
Age 1= 15y (+/- 0.5) Age 2= 16y (+/- 0.5) Age 3= 17y (+/- 0.5)

* This is a lower bound of the true significance.
(a) Lilliefors Significance Correction

Table 2. The basic descriptive statistic for girls of first, second and third year

Descriptive Statistics - GIRLS								Tests of Normality					
								Kolmogorov-Smirnov(a)			Shapiro-Wilk		
Age	test	N	Min	Max	Sum	Mean	Std. Deviation	Statistic	df	Sig.	Statistic	df	Sig.
1	FPUSHUPS	11	0.00	8.00	34.00	3.091	2.468	0.165	11	.200(*)	0.934	11	0.450
	FCURLUPS		15.00	31.00	231.00	21.000	5.865	0.179	11	.200(*)	0.888	11	0.130
	FTRUNKEXT		5.00	55.00	254.00	23.091	13.103	0.170	11	.200(*)	0.894	11	0.158
	FRUN20M		3.50	5.97	47.12	4.284	0.733	0.209	11	0.196	0.880	11	0.105
2	FPUSHUPS	13	0.00	8.00	32.00	2.462	2.696	0.245	13	0.032	0.839	13	0.021
	FCURLUPS		4.00	22.00	159.00	12.231	5.540	0.214	13	0.106	0.923	13	0.275
	FTRUNKEXT		3.00	29.00	188.00	14.462	7.763	0.147	13	.200(*)	0.958	13	0.727
	FRUN20M		4.20	5.40	64.38	4.952	0.360	0.218	13	0.093	0.890	13	0.098
3	FPUSHUPS	12	0.00	15.00	62.00	5.167	4.726	0.165	12	.200(*)	0.906	12	0.190
	FCURLUPS		7.00	35.00	197.00	16.417	8.339	0.159	12	.200(*)	0.919	12	0.277
	FTRUNKEXT		10.00	55.00	284.00	23.667	12.787	0.227	12	0.089	0.861	12	0.050
	FRUN20M		3.58	5.13	50.98	4.248	0.464	0.107	12	.200(*)	0.972	12	0.935

FPUSHUPS-standard, on floor; FCURLUPS-on barbel;
FTRUNKEXT-trunk extension; FRUN20M-sprint 20 meters;
Age 1= 15y (+/- 0.5) Age 2= 16y (+/- 0.5) Age 3= 17y (+/- 0.5)

* This is a lower bound of the true significance.
(a) Lilliefors Significance Correction

Table 3. Multivariate significance of differences in the test results between the boys of first, second and third year

Effect	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Observed Power(a)
Pillai's Trace	0.279	1.498	8	74	0.173	0.139	0.63
Wilks' Lambda	0.74	1.461(b)	8	72	0.187	0.14	0.615
Hotelling's Trace	0.325	1.423	8	70	0.202	0.14	0.6
Roy's Largest Root	0.191	1.769(c)	4	37	0.156	0.161	0.487

The multivariate analysis of variance (MANOVA), between the girls from the first, second and third year (Table 4), shows a statistically significant difference with result for Wilks' Lambda of 0.497, at the level of p=0.01, (η_p^2=0.295, Cohen, 1988).

Table 4. Multivariate significance of differences in the test results between the girls of first, second and third year

Effect	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Observed Power(a)
Pillai's Trace	0.586	3.209	8	62	0.004	0.293	0.95
Wilks' Lambda	0.497	3.139(b)	8	60	***0.01***	0.295	0.944
Hotelling's Trace	0.846	3.066	8	58	0.006	0.297	0.937
Roy's Largest Root	0.535	4.145(c)	4	31	0.008	0.348	0.873

Table 5. Univariate significance of differences in the test results between the girls of first, second and third year

Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power(a)
FPUSHUPS	49.082	2	24.541	2.056	0.144	0.111	0.393
FCURLUPS	458.415	2	229.207	5.12	***0.01***	0.237	0.787
FTRUNKEXT	664.193	2	332.097	2.585	0.091	0.135	0.48
FRUN20M	3.928	2	1.964	6.972	***0.003***	0.297	0.901

Table 6. LSD post-hoc tests on the significance of the differences of the girls' test results

Dependent Variable	Age	Age	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Upper Bound	95% Confidence Interval Lower Bound
FPUSHUPS	1	2	0.629	1.415	0.659	-2.250	3.509
		3	-2.076	1.442	0.159	-5.010	0.858
	2	1	-0.629	1.415	0.659	-3.509	2.250
		3	-2.705	1.383	0.059	-5.519	0.108
	3	1	2.076	1.442	0.159	-0.858	5.010
		2	2.705	1.383	0.059	-0.108	5.519
FCURLUPS	1	2	8.7692(*)	2.741	***0.003***	3.193	14.346
		3	4.583	2.793	0.110	-1.099	10.265
	2	1	-8.7692(*)	2.741	***0.003***	-14.346	-3.193
		3	-4.186	2.678	0.128	-9.635	1.263
	3	1	-4.583	2.793	0.110	-10.265	1.099
		2	4.186	2.678	0.128	-1.263	9.635
FTRUNKEXT	1	2	8.629	4.643	0.072	-0.817	18.076
		3	-0.576	4.731	0.904	-10.201	9.049
	2	1	-8.629	4.643	0.072	-18.076	0.817
		3	-9.205	4.537	0.051	-18.436	0.026
	3	1	0.576	4.731	0.904	-9.049	10.201
		2	9.205	4.537	0.051	-0.026	18.436
FRUN20M	1	2	-.6687(*)	0.217	***0.004***	-1.111	-0.226
		3	0.035	0.222	0.874	-0.415	0.486
	2	1	.6687(*)	0.217	***0.004***	0.226	1.111
		3	.7040(*)	0.212	***0.002***	0.272	1.136
	3	1	-0.035	0.222	0.874	-0.486	0.415
		2	-.7040(*)	0.212	***0.002***	-1.136	-0.272

Age 1= 15y (+/- 0.5) Age 2= 16y (+/- 0.5) Age 3= 17y (+/- 0.5)

Based on observed means. * The mean difference is significant at the .05 level.

Discussion

The mean value of the Push-ups test results for both groups (boys and girls), compared with the results presented by the Canadian Society for Exercise Physiology (2004), indicates that first and third-year boys fail to meet the recommendations for solid strength capacity of arms and shoulder area (grade 1 out of 5). Second year girls, according to the results of this association, are given the grade 2 (out of 5).

The mean value of the results of the trunk strength capacity assessment (CURLUPS) according to Golding, et al. (1989), in boys (of the three groups), as well as in girls (of the three groups) also fails to meet the recommended values for this test, achieving lower results, with grade 1 (out of 5) in both groups (boys + girls).

The test for assessment of the strength abilities of muscles from the rear body area (back) is a modified test. No data have been found for this test for the purposes of comparing the results in similar studies.

The results of the speed capacity assessment test RUN20M, in boys and girls, have also shown relatively lower values against the recommended values (Tennis Australia, 2011).

Following the application of the multivariate analysis of variance (MANOVA) (Table 3), no statistically significant difference has been established regarding the boys, since Wilks' Lambda=0.74 is at the level p=0.187 (η_p^2=0.14, Cohen, 1988).

The multivariate analysis of variance (MANOVA), between the girls from the first, second and third year (Table 4), shows a statistically significant difference with result for Wilks' Lambda of 0.497, at the level of p=0.01, (η_p^2=0.295, Cohen, 1988). In terms of the univariate analysis of variance (ANOVA) (Table 5), regarding the girls, it can be concluded that there are statistically significant differences in two of the analyzed variables: FCURLUPS (F= 5,12; p= 0,01), and FRUN20M (F= 6,972; p=0,003). The highest effect size is present with the variable FRUN20M (η_p^2 = 0,297). Following the application of the LSD post-hoc test (Table 6), it can be concluded that the statistically significant difference in the variable FCURLUPS is present only between the first and second-year girls (p=0.003). For the variable FRUN20M, the statistically significant difference is present between the first and second-year girls (p=0.04), as well as between the girls from the second and third year (p=0.002).

Regarding the group of girls (N=36), the test for assessment of the strength capacity of the arms and the shoulder area, through the Push-ups test, indicates that all 36 girls have not displayed a statistically significant difference in these capacities. However, there is a significant difference in the strength test for the muscles of the anterior body side (FCURLUPS) among the first and second-year girls. It is interesting to indicate that the first year girls (age of ~15 years) have better results (mean=21) compared to those from the second year (mean=12.23), as well as to those from the third year (mean=16.41), although there is no statistical significance in the relation first-third. This might refer to one of the identified problems – curriculum and number of physical education classes.

There is significant difference in the test for assessment of the speed abilities between the first and second year girls, as well as between the second and third year. The results have indicated that the second year girls have better results compared to the other two groups (second group: mean=4.95sec. other two groups; first: mean=4.28 sec.; third: mean=4.25sec.). Speed is a highly hereditary motor ability, so perhaps this is a homogenized group; however, poor test results could be the result from the poor motivation or the insufficient physical activity. In any case with the three groups of classes, regarding the population of girls, the presented mean value for the speed test is at a low level.

The results explain that the subjects (boys and girls) at the age of 15, 16 and 17 years, selected as random sample of subjects, non-athletes, have displayed non-satisfactory level of strength abilities of the arms and shoulder area muscles (test: Push-ups), the muscles on the anterior body side (test: Sit/Curl up), muscles of the posterior body side (TrunkExt), as well as non-satisfactory level of speed abilities (test: 20 meter sprint), compared to the similar population of same-age subjects.

As previously mentioned, such indicators on the tested motor abilities most probably result from the insufficient physical activity, in particular in the domain of strength capacities. However, the reason for such inactivity is potentially even more interesting, and is perhaps the result of:

- insufficient number of PE classes during the weekly lessons;
- insufficient stimulus at the exercises, during the classes, for the purposes of strength abilities transformation;
- obsolete plan and curriculum for the physical education lessons;

- lack of stimulation, which could potentially result from the general image of the social environment in the Republic of Macedonia;
- the subjects are in a specific group, which is most probably undergoing puberty;

Regarding the analysis of differences between generations (first, second and third year), in both groups of subjects included in the research (boys and girls), it is interesting to indicate that there is no statistically significant difference in the three generations of boys. This indicates that all boys (N=42) included in the research display similar strength capacities, as assessed with the applied tests. Having in mind that their results are non-satisfactory, the authors recommend that there is a need to intervene in the identified problems which have resulted into a non-satisfactory muscle strength capacity among the boys.

Conclusion

According to our findings, and the research, we were unable to find a study that touches upon comparison of strength and speed among high schoolers, in those specific test chosen for this research.

Having in mind the results from the research, the authors recommend improvement of the strength abilities for the purposes of maintaining health and creating healthy and productive youth. In that context, the recommendations are aimed at increasing the volume of physical activities in this sample of subjects. The next steps would consist of the following:

1. need to correct the curriculum and the number of weekly classes in physical education in the secondary schools;
2. increased motivation for physical activity in this population of young boys and girls, both on the classes and in the extracurricular activities;
3. Monitoring the motor abilities among the youth in the Republic of Macedonia.
4. Application of similar tests in other schools, comparison of results, development of a national strategy with guidelines for development and maintenance of the motor abilities among young people.

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