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THE COMPARATIVE ANALYSIS OF CONTRACTILE PROPERTIES IN GYMNASTICS USING TENSIOMYOGRAPHY ON SKELETAL MUSCLES

Original Scientific Paper

Almir Atiković, Adis Bekrić, Ekrem Čolakhodžić

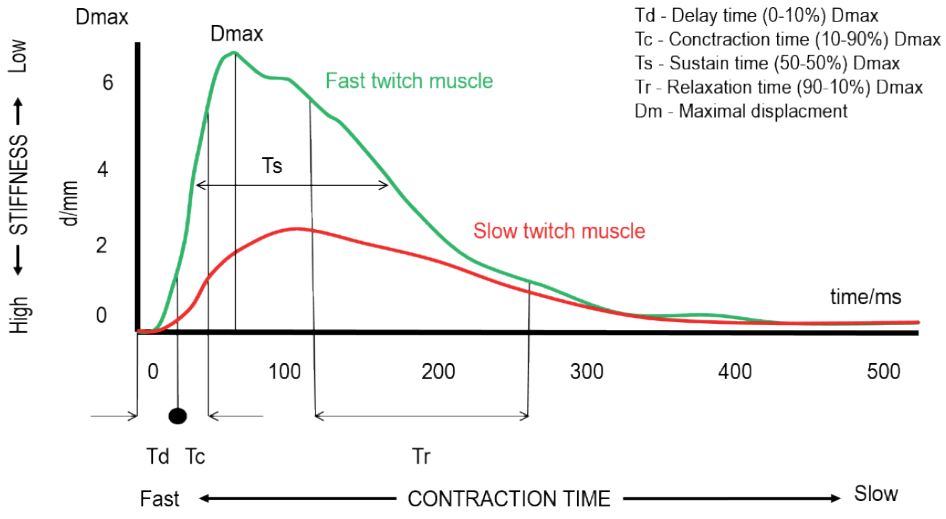
ABSTRACT: The purpose of this study is a comparison of skeletal muscle characteristics in Slovenian gymnasts assessed by TMG and values of contraction properties of muscles, lateral symmetries, and the effect of aging on selected contraction properties of skeletal muscles in men's artistic gymnastics (MAG); women's artistic gymnastics (WAG) and rhythmic gymnastics (RG). A survey of 81 athletes from different disciplines was conducted as follows: MAG (n = 26), WAG (n = 28), and RG (n = 27). The athletes' average age was 15.41±5.03 years. In this study, the contraction times of ten skeletal muscles for Slovenian gymnasts on the right and left sides of the body were compared: m. biceps brachii BB, m. triceps brachii TB, m. biceps femoris BF, m. erector spinae ES, m. gastrocnemius lateralis GL, m. gastrocnemius medialis GM, m. rectus femoris RF, m. tibialis anteriror TA, m vastus lateralis VL, m. vastus medialis VM. Out of all twenty-nine pairs analyzed, there are differences only in six pairs, namely: BB_Tc_MAG_WAG, TB_Tc_MAG_WAG, BF_Tc_MAG_RG, BF_Tc_WAG_RG, ES_Tc_MAG_RG and VM_Tc_MAG_RG.

Keywords: *tensiomyography, gymnastics, contraction time, muscle contractile properties.*

INTRODUCTION

Scientific results in sports have led to changes in both the concept of the athlete's preparation and sports theory. Selection and orientation to systematic training started al-most 20 years ago in almost every sport. This is why experts created diagnostic models for use in selection, and diagnostic models for monitoring changes i.e. the body's response to physical activity among young, middle-aged and elderly athletes. Many studies can be found about young athletes' guidance in different sports, the effect of exercise on body composition, as well as the development of functional and loco-motor skills and qualities. In contrast, not a lot of information is available about the type and composition of skeletal muscle, especially in adolescents (Šimunič et al., 2011). With development of the tensiomyography (TMG), which is scientifically proven, objective and reliable (Šimunič, 2012; Jiménez et al., 2013). Contraction time (Tc) and maximal displacement (Dm) are the most researched parameters of the TMG method in different sports (Figure 1). The TMG monitors radial muscle belly displacement under isometric conditions. A twitch type of electrical stimulus induces the concentric contraction of the muscle. Due to the maintenance of the muscle volume, the muscle thickens, causing the sensor to move and send the signal (Šimunič et al., 2005).

Figure 1. Parameters of tensiomyography (TMG) method.



TMG is both a non-invasive as well as time and financially non-demanding method which can be used to define the structure of skeletal muscle (Šimunič et al., 2011; Šimunič, 2012) and on the basis of time parameters, data about the muscle function. The latter can be used for different analysis such as measurement of adaptation abilities of muscles to specific training or exercise, diagnosis of lateral and functional symmetries, measurement of muscle fatigue and control of a rehabilitation programme (Dahmane et al., 2001; Šimunič et al., 2011; Šimunič, 2012; Rusu et al., 2013; Šimunič et al., 2014).

Studies have shown that muscle asymmetries increase the risk of injuries in different locations (Baumhauer et al., 1995; Richards et al., 2002). Sensitive and accurate measuring devices for discovering muscle asymmetries are an isokinetic device, force plate and TMG (Samardžija & Zupet, 2014), except for the trunk where the TMG method is used to discover muscle asymmetries in modern sports diagnostics. Asymmetries of the back muscles (m. Erector spinae) can lead to different back deformations and injuries. In addition to the basic parameters, it is useful to longitudinally monitor and study the correlation of different parameters over longer periods. In prior studies, the impact of age on contraction time was found (Dahmane, 2006; Šimunič et al., 2014).

Competitive artistic gymnasts experience significant limb loading asymmetries when performing foundation floor skills. This is important knowledge for coaches and sports practitioners, considering the potential association between asymmetrical loading and injury. It also emphasizes that gymnasts have individualized responses, indicating that screening at the individual level is needed to accurately identify gymnasts and limbs that are at a higher risk for injury. Every gymnastics skill showed significant inter-limb asymmetry and every gymnast demonstrated intra-limb variability for at least one gymnastics skill (Campbell et al., 2021).

A compilation of twenty gymnastics injury rate studies shows a large range of rates being 5.3 to 200 injuries per 100 gymnasts and 0.44 to 22.7 injuries per 1000 hours of participation (Dowdell, 2011), which makes elite gymnasts and younger gymnasts a risk population. Within artistic gymnastics, the foor apparatus is associated with the highest injury risk (Kirialanis et al., 2002). It is worth to note also asymmetric landing on hands i.e. exercise on one hand (e.g. round off and pommel horse elements) could have impact on injury rates of arms. From familiar gymnastics practice and from publicly known data, it can be assumed that most injuries are asymmetric (i.e. on one body side only).

Long-term asymmetric landing can probably cause acute injuries (mostly like in ankles or knees) or chronic injuries (most likely in the back trunk). It is especially important that young gymnasts learn to perform every landing as symmetrically as possible (Čuk, 2004; Čuk & Marinšek, 2013). Most sports have a degree of asymmetry. For instance, throwers in sports like baseball, basketball, football, handball and cricket have a dominant arm. This arm will undergo repetition and a higher volume of training. In contrast, a sport like gymnastics or swimming requires a much greater degree of symmetry. Gymnastics requires the use of both sides of body at different times and interval jumps, landing, takeoff, etc. Therefore, asymmetry would impair gymnasts' capacity for optimum performance and this is not ideal.

Review of Code Of Points „COP" (Čuk, 2016) revealed that it mostly contains elements (in 60% of cases) where a single leg at take-off or at landing is loaded. Researchers (Čuk & Marinšek, 2013) conclude that asymmetric lower limb loading is present at balance beam routines in elite gymnasts. They hypothesize that the unilateral distribution of load may be associated with the unilateral predominance of injuries.

Without a definition of symmetry in COP MAG and WAG, there is an impact on the creation of the exercise in the area of symmetry in the ordering element group and within difficulty, where it is crucial to increase the exercise's difficulty value. Hypothetical most difficulty exercises on each apparatus revealed that in general for all around gymnast proportion between asymmetric and symmetric elements is close to 70% to 30%, what suggests that difficulty relates to increased asymmetry. However, coaches' duties are to be mindful of COP influence on gymnasts' health, limit asymmetries in load, and focus on symmetric conditioning. COP in MAG and WAG pushes asymmetric motions for high performance (Čuk, 2016).

Table 1. Initial database search content title: tensiomiography (TMG)

Google Schoolar (1996-2023)	1480 sources 158 TMG Gymnastics
Web of Science Core Collection 257	In WoS, without other restrictions (all fields), the term tensiomyography appears in 257 sources. Of these, 230 are scientific articles, 11 review papers, 6 letters (to the editor), 6 summaries, 5 articles in proceedings.
Scopus 267	Scopus is searched for title, keywords and abstract terms tensiomyography appears 267 times. Of these, 237 are scientific articles, 11 review papers, 6 letters, 7 articles in proceedings.
TMG data base (1996-2023)	288 sources List of scientific publications TMG data base
MPDI 33 (1996-2023)	33 sources Multidisciplinary Digital Publishing Institute
PubMed (2005-2023)	197 sources PubMed comprises more than 36 million citations for biomedical literature from MEDLINE
SPORTDiscus EBSCO host	150 sources SPORTDiscus is the leading bibliographic database for sports and sports medicine research.

The purpose of this study was a comparison of skeletal muscle characteristics in Slovenian gymnasts assessed by tensiomyography and values of muscles' contractile properties, lateral symmetries, and the effect of aging on selected skeletal muscles' contractile properties in men's artistic gymnastics (MAG); women's artistic gymnastics (WAG) and rhythmic gymnastics (RG).

MATERIALS AND METHODS

Samples

Measurements of (n=81) athletes from different disciplines were conducted in this study: men's artistic gymnastics (n=26 athletes), women's artistic gymnastics (n=28 athletes) and rhythmic gymnastics (n=27 athletes). Their average age was 15.41±5.03 years.

Table 2. Descriptive statistical data and differences between variables (according to disciplines).

Variable	Age (years)	BH (cm)	BW (kg)
Disciplines	Mean (SD)	Mean (SD)	Mean (SD)
MAG n = 26 (32.1%)	18.46 (7.18)	160.51 (15.20)	56.85 (16.32)
WAG n = 28 (34.6%)	14.32 (3.33)	155.05 (6.25)	45.78 (7.42)
RG n = 27 (33.3 %)	13.59 (1.89)	156.84 (9.63)	42.87 (8.96)

Abbreviations: BH, Body Height, BW, Body Weight, BSA, Body surface area.

Ethical approval

The study was approved 29.12.2020. year by Ethics Commission of the Gymnastics Federation of Slovenia of the Republic of Slovenia for Medical Ethics, approval study number: 485/2020 in line with the criteria of the Helsinki Declaration for research involving human beings. Commission agrees that the data for can be used for scientific purposes through the research project "Development of an expert model of preparation and performance of athletes".

Measured Muscles

The measurements lasted 30–35 minutes per athlete. We conducted one measurement of the left-side muscles and one measurement of the right-side muscles on a therapeutic desk, which provided comfort and exactly accommodated the athlete in a lying or sitting position. All muscles were relaxed before and after the measurement. The measurements were always taken between 9-12 am in a temperature-controlled room. During the measurements, the temperature was between 21 and 25 °C. Measurement of m. biceps brachii (m. BB) and m. triceps brachii (m. TB) was carried out in a sitting position. The measured upper extremity was 30º abducted in the shoulder, 90º flexed in the elbow (where 0° means a fully extended elbow), the forearm was pronated. To maintain this position, we used foam pads placed under the elbow. Measurement of m. rectus femoris (m. RF), tibialis anteriror (m. TA), m. vastus lateralis (m. VL), m. vastus medialis (m. VM) were done in a lying position, where flexion of the knee was 30° (where 0° means a fully extended knee). To maintain this position, we used foam pads placed under the knee. The measurement of m. biceps femoris (m. BF), m. erector spinae (m. ES), m. gastrocnemius lateralis (m. GL) and m. gastrocnemius medialis (m. GM) were performed lying on the abdomen, with 5º of knee flexion (where 0° means a fully extended knee). To maintain this position, we used foam pads placed under the ankle (Šimunič et al., 2014).

Electrical Stimulation

Two surface electrodes were placed on the muscle belly in an appropriate position. After marking the sensor location, positioned the electrodes at ±7 cm. The electrodes were connected to an electric stimulator, which releases an electric stimulus lasting 1 millisecond with a power supply voltage of 12 V and output intensity from 0 to 110 mA. For all athletes, we gradually increased the output intensity from 5 to 10 mA until the contraction time parameter reached the highest values or until the muscle response no longer increased (Dahmane et al., 2001). A sensor was placed on the muscle belly perpendicularly. The electric stimulus induced the muscle contraction, the muscle belly thickened and pushed the perpendicularly placed sensor away. The sensor measured the maximal displacement, contraction time, sustain time, delay time, relaxation time and sent the measurements for further computer analysis.

Statistical Analysis

Data processing was done with SPSS Statistics 27 and Microsoft Office 2013 – Excel. Data is displayed as (mean, standard deviation) which included descriptive statistics, correlational analyses, t-tests. In order to check for any deviation from normality, a number of methods can be used. One method is to use skewness and kurtosis.

Differences in the activity of each pair of muscles for each gymnast were confirmed by measuring the t-test. Paired t-test was performed to determine whether there were any significant differences left and right side of body. Cohen's d is an effect size r used to indicate the standardised difference between two means. Some general rules of thumb are that |d| = 0.20 indicates a small effect; |d| = 0.50 indicates a medium effect; |d| = 0.80 indicates a large effect. Statistical analysis was performed with descriptive statistics (contraction time, laterality) and Pearson's correlation coefficient (the effect of age on the muscle contractility). Correlation coefficient values <0.10 were considered as trivial, 0.10–0.30 as small, 0.30–0.50 as medium, and >0.50 as large. The significant level was defined as ($p < 0.05$). Symmetrical and synchronized muscle function is essential prerequisite for optimal performance in

gymnastics. The newly developed TMG report is able to provide an immediate reflection of the results obtained during the test. This colour-coordinated report designates optimal, average, and poor muscle responses and muscle symmetries. This report designates: optimal 90-100%, average 80-89% (monitor), and poor <80% (concern) muscle responses and muscle symmetries.

Results

Skeletal muscles have different contraction times. Table 3 shows the lowest value was reached in m. Erector spinae_Tc (14.06-14.81) in all three events and the highest value was reached in m. Biceps brachii_ Tc (21.46-24.02). A peer-to-peer comparison of all three disciplines shows the smallest differences occur in the contraction time of all (3) disciplines MAG, WAG and RG.

Table 3. Results of the descriptive statistics of contraction time parameter according to muscle group.

	Muscle	Disciplines	N	Mean	SD	Range	Min	Max	Skew	Kurt
1	M. Biceps brachii_ Tc	MAG	26	24.02	3.15	12.24	16.64	28.88	-.60	-.17
		WAG	16	21.46	2.49	7.75	17.47	25.22	.07	-1.54
2	M. Triceps brachii_ Tc	MAG	26	17.73	1.85	9.82	14.94	24.76	2.17	7.70
		WAG	16	16.16	2.17	8.27	13.08	21.35	.87	.92
3	M. Biceps femoris_Tc	MAG	52	23.62	4.55	23.66	14.70	38.36	.98	1.68
		WAG	50	24.61	4.57	18.86	16.35	35.21	.35	-.43
		RG	54	26.92	6.33	30.37	16.96	47.33	1.45	2.31
4	M. Erector spinae_Tc	MAG	52	14.81	1.66	8.28	10.78	19.06	-.14	.10
		WAG	56	14.56	1.39	6.24	12.12	18.36	.96	.61
		RG	54	14.06	1.33	6.80	11.31	18.11	.43	.86
5	M. Gastrocnemius lateralis_Tc	MAG	16	20.05	2.07	8.82	16.95	25.77	1.22	2.94
		WAG	22	20.64	3.05	14.20	15.63	29.83	1.07	2.75
		RG	36	19.66	2.68	10.56	14.27	24.83	.01	-.52
6	M. Gastrocnemius medialis_Tc	MAG	16	19.93	1.83	6.48	17.28	23.76	.65	-.35
		WAG	22	21.13	4.03	17.68	15.51	33.19	1.49	3.02
		RG	36	20.33	2.33	9.87	17.23	27.10	1.45	2.23
7	M. Rectus femoris_Tc	MAG	52	21.16	3.25	13.18	15.34	28.52	.11	-.48
		WAG	56	21.33	3.09	12.68	16.33	29.01	.52	-.23
		RG	54	21.93	2.50	11.32	16.88	28.20	.41	-.08
8	M. Tibialis anteriror_Tc	MAG	18	15.55	1.62	6.60	13.59	20.19	1.52	2.72
		WAG	22	15.88	1.10	3.87	14.13	18.00	.46	-.68
		RG	36	16.03	1.79	8.23	13.23	21.46	1.47	2.44
9	M Vastus lateralis_Tc	MAG	52	18.10	2.35	9.95	14.21	24.16	.43	.12
		WAG	54	17.48	1.70	7.88	14.26	22.14	.50	.45
		RG	54	17.84	2.04	8.58	14.11	22.69	.78	.40
10	M. Vastus medialis_Tc	MAG	52	19.86	2.73	12.92	13.74	26.66	.43	.03
		WAG	56	18.96	2.13	8.91	14.79	23.70	.26	-.39
		RG	54	18.59	2.21	11.28	14.33	25.61	.65	.95

Abbreviations: *Tc (ms) – contraction time in milliseconds (ms).

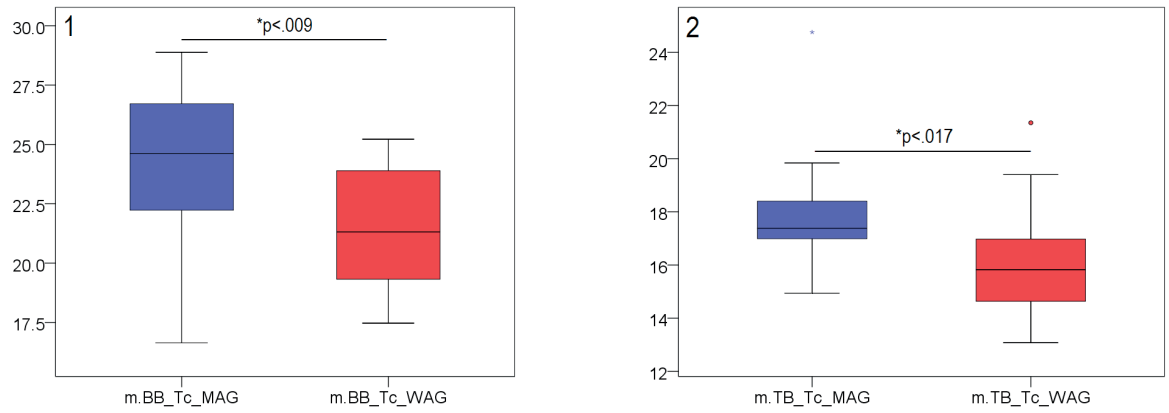
The results in (Table 4) of t test artistic gymnastics between m.BB_Tc_MAG-WAG were significant; t test (40)=2.76, p<.009, Cohen's d=.90. The results of t test artistic gymnastics between m.TB_Tc_MAG-WAG were significant; t test (40)=2.49, p<.017, Cohen's d=.77. There was a difference in m.BF_Tc_MAG_RG; t test (104)=-3.07, p<.003, Cohen's d=.59. There was a difference in m.BF_Tc_WAG_RG; t test (102)=-2.12, p<.036, Cohen's d=.41. Significant differences were found for m.ES_Tc_MAG_RG; ; t test (104)=2.55, p<.012, Cohen's d=.49. There were significant differences in m.VM_Tc_MAG_RG; t test (104)=2.62, p<.010, Cohen's d=.51. There were no differences in Tc combination muscle pairs across groups (Figure 2).

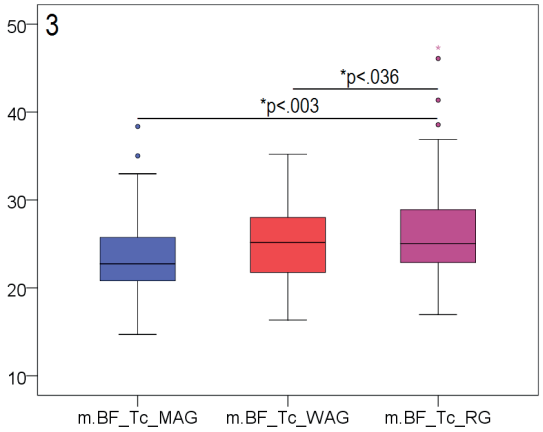
Table 4. Independent Samples Test

Muscle pairs		Levene's Test		t-test for Equality of Means						Cohen's *d*
		F	Sig.	t	df	Sig.	Mean Difference	95% CI		
								Lower	Upper	
1	BB_Tc_MAG_WAG	.448	.507	2.763	40	.009	2.566	.688	4.444	.901
2	TB_Tc_MAG_WAG	.897	.349	2.495	40	.017	1.568	.298	2.838	.778
3	BF_Tc_MAG_WAG	.566	.454	-1.095	100	.276	-.990	-2.784	.803	ns
	BF_Tc_MAG_RG	3.314	.072	-3.071	104	.003	-3.301	-5.434	-1.169	.598
	BF_Tc_WAG_RG	1.670	.199	-2.120	102	.036	-2.311	-4.474	-.148	.418
4	ES_Tc_MAG_WAG	1.437	.233	.851	106	.396	.250	-.333	.835	ns
	ES_Tc_MAG_RG	3.115	.080	2.555	104	.012	.747	.167	1.326	.498
	ES_Tc_WAG_RG	.449	.504	1.903	108	.060	.496	-.020	1.012	ns
5	GL_Tc_MAG_WAG	1.668	.205	-.672	36	.506	-.594	-2.386	1.198	ns
	GL_Tc_MAG_RG	2.108	.153	.514	50	.610	.388	-1.130	1.907	ns
	GL_Tc_WAG_RG	.039	.844	1.284	56	.205	.982	-.551	2.516	ns
6	GM_Tc_MAG_WAG	3.765	.060	-1.107	36	.276	-1.199	-3.397	.998	ns
	GM_Tc_MAG_RG	.218	.643	-.606	50	.547	-.400	-1.727	.926	ns
	GM_Tc_WAG_RG	4.460	.039	.958	56	.342	.799	-.872	2.470	ns
7	RF_Tc_MAG_WAG	.005	.944	-.276	106	.783	-.168	-1.381	1.043	ns
	RF_Tc_MAG_RG	2.890	.092	-1.361	104	.176	-.766	-1.884	.350	ns
	RF_Tc_WAG_RG	3.218	.076	-1.112	108	.269	-.598	-1.664	.468	ns
8	TA_Tc_MAG_WAG	1.565	.219	-.748	38	.459	-.323	-1.201	.553	ns
	TA_Tc_MAG_RG	.001	.979	-.938	52	.352	-.472	-1.483	.538	ns
	TA_Tc_WAG_RG	1.326	.254	-.349	56	.728	-.148	-1.002	.705	ns
9	VL_Tc_MAG_WAG	4.693	.033	1.565	104	.121	.622	-.166	1.411	ns
	VL_Tc_MAG_RG	1.357	.247	.595	104	.553	.254	-.593	1.102	ns
	VL_Tc_WAG_RG	.855	.357	-1.016	106	.312	-.367	-1.086	.350	ns
10	VM_Tc_MAG_WAG	3.425	.067	1.906	106	.059	.896	-.035	1.829	ns
	VM_Tc_MAG_RG	3.111	.081	2.629	104	.010	1.267	.311	2.223	.511
	VM_Tc_WAG_RG	.000	1.000	.893	108	.374	.370	-.451	1.192	ns

Abbreviations: ns - not measured; * Correlation p<0.05 level, ** 0.01 level, t = t test, df = Degrees of Freedom, *p, p<0.05

Figure 2. Differences between skeletal muscles (1-10) contractile parameters from 10% to 90% of maximal displacement.

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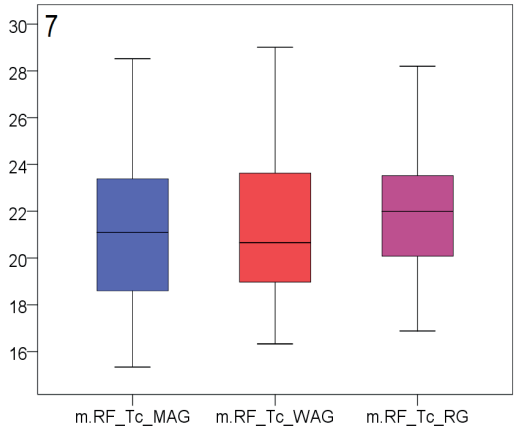
*p<.036
*p<.003
m.BF_Tc_MAG
m.BF_Tc_WAG
m.BF_Tc_RG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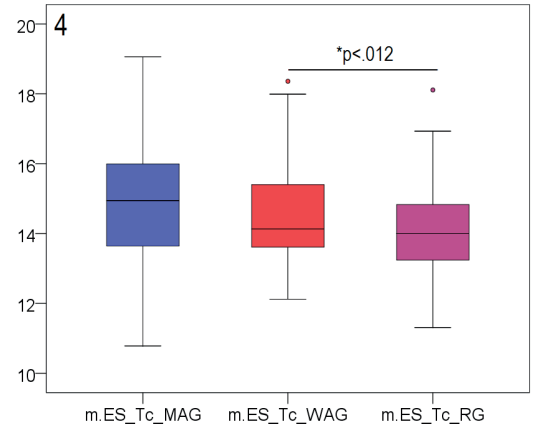
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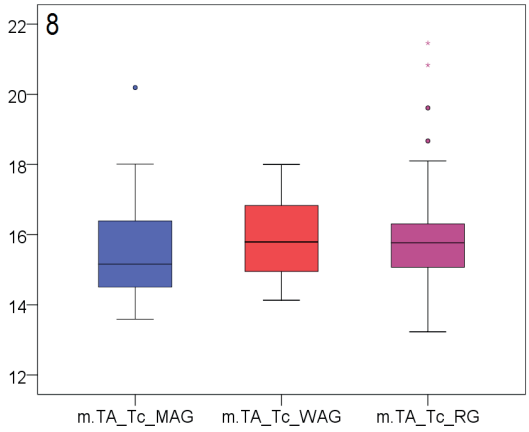
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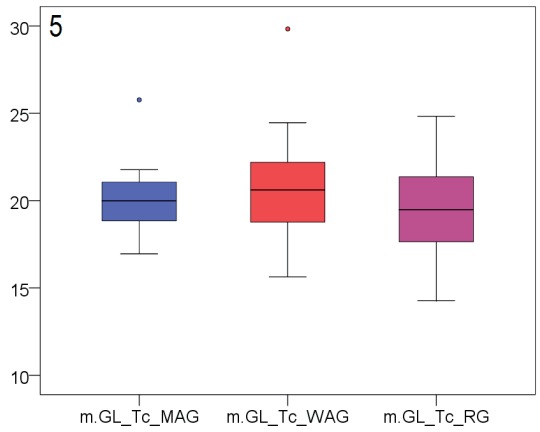
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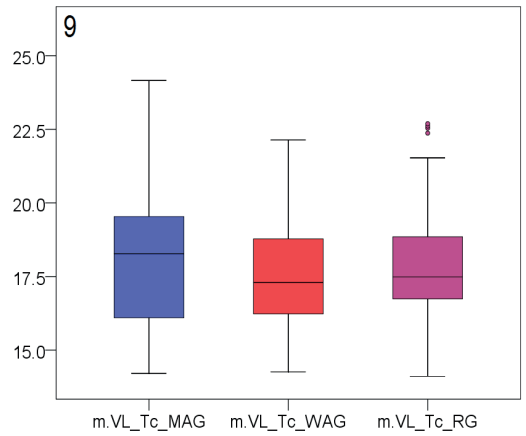
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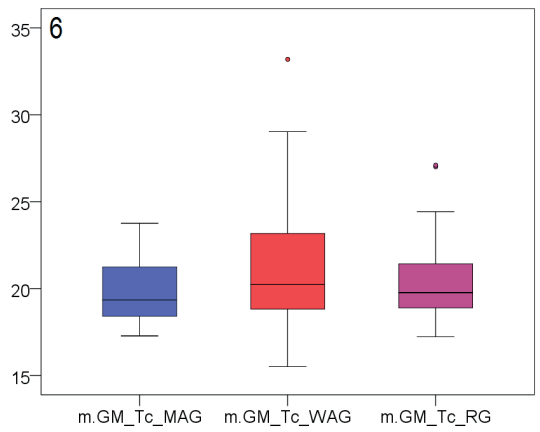
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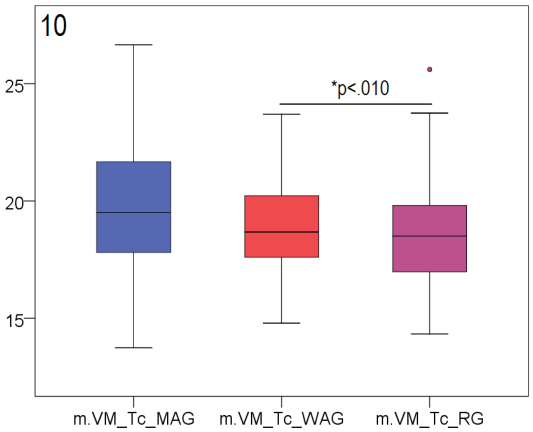
10
*p<.010
m.VM_Tc_MAG
m.VM_Tc_WAG
m.VM_Tc_RG

DISCUSSION

The sample of athletes in the present study is representative for Slovenia and represents almost the whole population of MAG, WAG and RG gymnasts who take part in competitive sports. A characteristic of gymnastics is quick and explosive movements.

In a study of eight top dancers (average age 19.1±3.6 years) it was found that the contraction time (m. BF: 34.2±7.7, m. ES: 18.3±2.2, m. GM 23.5±2) was slower than the contraction times for the same muscles in gymnastics (Zagorc et al., 2010). Šimunič & Samardžija (2015) established that gymnasts have on average quicker m. BB and m. TB muscles compared to footballers and volleyball players, a quicker m. BF muscle compared to footballers and volleyball players, and longer contraction times of m. BF compared to athletes. Longer contraction times (m RF 45.9±16.2 and m BF 28.2±5.2) were also found in professional bikers (Vuelta race) aged 27.5±5.5 years (Garcia-Garcia, 2013).

This study is one of the first large studies to use the TMG measurement system in gymnastics. One case study of a top gymnast from Croatia was found. He was injured and with the use of TMG he obtained additional diagnostics. Based on the results, a corrective programme was designed, which he successfully completed and this allowed him to continue his basic training. He also obtained the best score for a floor event at the European championship in 2015. Values of contraction time after the rehabilitation (when the gymnast was ready for 100% loading) were similar to the values of Slovenian gymnasts, except for m. GM which was slower in the Croatian athlete (43%) in comparison to Slovenian MAG gymnasts (Atiković, Samardžija & Tabaković, 2015).

The results also allow us to define lateral symmetries, which represent a great problem in gymnastics. In addition to studies dealing with risks of injuries and rehabilitation programmes (Campbell et al, 2019). In high-level gymnastics, asymmetries have also been reported. Analyzing beam routines of the 2014 B World Cup. Authors (Bučar et al., 2016) observed that the gymnasts initiated ~43% of their takeoffs and landings with the right lower limb, while the left lower limb was used to initiate ~30% of the actions; the remaining takeoff and landing actions were performed with both legs simultaneously. Only four out of 19 gymnasts loaded the left lower limb more often than the right, denoting a clear group preference for loading the right lower limb and using it to take off or land.

Results of the conducted research in WAG the asymmetry does not exceed 10% (Table 3) and, according to the range of risks, it can be defined as a low-risk injury factor (low: up to 5-10%, middle: 10–20%, high: 20% and more). Higher asymmetry, which also means a bigger risk of injury. The risk of injury is increased primarily because of movement biomechanics, where the loading is greater on one extremity, especially upon landing (Čuk & Marinšek, 2013). Authors (Marshal et al., 2007) found that the majority of injuries in gymnastics happen on landing, and so it is clear why larger asymmetries increase the risk of injury. Age has a negative impact on contraction properties of muscles in all observed disciplines. Dahmane (2006) made similar findings in elderly people as did Šimunič et al. (2014) among 9-year-old to 13-year-old children. The analysis of each gymnastics discipline shows there is a statistically significant correlation of slower contraction time and age among MAG in m. VM and m. VL, among RG in m. TA and m. VL and among WAG in m. GM (Table 3).

We agree with previous study (Marinšek & Samardžija, 2020) examined the association between contraction properties of muscles and jumping skill performance in gymnasts. TMG parameters failed to predict jumping performance in our sample of female and male gymnasts. Additionally, peak power, jump height, vertical take-off velocity, and vertical peak force in squat jump, countermovement jump, and drop jump were recorded. The TMG parameters did not predict jumping performance in our sample of female and male gymnasts. However, results indicate that healthy back muscles are very important for the explosive function of the leg muscle and, therefore, performance of jumping skills. The lower maximal radial displacement of the erector spinae muscle could indicate back problems and be indicative of inferior jumping performance in gymnasts.

This study is the first larger study to use the TMG method and in which top athletes from artistic and rhythmic gymnastics participated. Considering the findings, it would be reasonable to use TMG as a method of analysis for comprehensively evaluating artistic and rhythmic gymnasts. It would add value to the synthetic (force plate) and partly analytic (isokinetic) measurement systems, which are already systematically used in artistic and rhythmic gymnastics. With use of TMG, we could improve the evaluation of gymnasts' condition and gain better insights into their risk of injury. According to this research, further studies define the normative values regarding the speciality of a gymnast because different movement structures and varying loadings on the body could impact on the results. Our study defined the framework of asymmetry considering the existing measurement systems. It would be reasonable to define the extent of the injury risk considering the established asymmetries and to adjust the ranges of risk to the TMG system. Tensiomyography has a high predictive ability to discriminate between injured and non-injured non-invasively and functionally (Santana et al., 2018). This study shows a typical example of injured and non-injured BF signals from the same subject. Comparing the Tc and Td of the injured subjects in the injured and non-injured BF muscles, statistically significant differences were found for Tc (all injured 32.9±8.5 ms vs. all non-injured 24.6±5.1 ms; $p<0.001$) (Đorđević et al., 2023). In this study (Abazović et al., 2022) suggests that the TMG sensor is a sensitive tool to monitor PAP effects, and showed that Tc, estimated from the TMG response, is shorter during the PAP, while it is not when estimated from torque twitch response.

CONCLUSIONS

TMG as an analytic method will hold an important place in sport diagnostics in gymnastics. With TMG, we can assess the discipline's demands and help improve gymnasts' performances along with the safety of training. Tensiomyography has a high predictive ability to discriminate between the left and right sides of the body functionally. Muscle asymmetries in gymnasts are common and can lead to injury.

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Disclosure statement

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Conflict of interest

The authors state no conflict of interest.

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DIFFERENCES IN SOME MORPHOLOGICAL CHARACTERISTICS AND MOTOR ABILITIES OF PRESCHOOL CHILDREN

Original Scientific Paper

Lulzim Ibri

ABSTRACT: Primary goal of educational field of physical education is to acquire habit of regular physical exercise at children. Physical education programs contribute to overall development of child and should be an integral part of every school program. Aim of this research is to determine differences in some variables for assessing morphological characteristics and variables for assessing basic motor abilities of preschool children in physical education programs designed according to needs of children of this age, and children in regular kindergarten programs. On samples from 64 boys, aged 6 years ± 6 months, was applied a battery of 5 morphological characteristics and 5 variables of motor abilities. Using t-test, results were obtained that indicate the existence of differences between boys of group A and boys of group B in motor abilities. Therefore, it is recommended that boys' kinesiological activities in kindergartens and sports clubs be organized from preschool age, where formation of motor behavior can be greatly influenced, which certainly depends, among other things, on their morphological characteristics, which is basis for later formation and development of motor abilities, motor dexterity and active participation in sports or simply to create adequate capacity for various activities in following age. Based on presented results, we can speak about the importance of physical exercise for youngest children where motor abilities are just one of the other segments that can be influenced in preschool age.

Keywords: *Morphological characteristics, motor abilities, differences, preschool boys.*

INTRODUCTION

Physical education is a part, type or side of general education in which means of specifically organized motor activity affect primarily the physical side of man (physical training), and through this his personality in general (Grandić, 2001). Physical education programs contribute to overall development of child and should be an integral part of every school program (Campbell, 1997). Today, children have greater opportunities for involvement in various forms of organized programmed exercise. (Ibri, 2012). Physical education has a significant impact on quality of life of children, which is achieved through professionally ruminated education, process of transformation of anthropological characteristics, motor abilities and achievements. This also presupposes that physical exercises should be appropriate to developmental abilities of children, aimed at optimal development and improvement of those knowledge, abilities and characteristics that are primary in a particular developmental period for preschool children (Dedaj, 2010). Early acquired knowledge about the importance of physical exercise and adoption of regular physical exercise habits significantly contribute to quality of health during childhood. Primary goal of educational field of physical education is to acquire habit of regular physical exercise in children. Development of technology and information has made a person's life easier, but it has also deprived him of many physical activities. Preschool period is one of the most important periods in a child's life because at this time good or bad bases are created that will later affect the formation of a person. Therefore, it is necessary to show children the importance of physical activity, which is of great importance for healthy life of a young person. It contributes to development and maintenance of human abilities throughout life (Neljak, 2009). Thus, it can be said that physical activity plays a major role in achieving optimal health, while also reducing risk of various diseases. Adequate physical exercises are an integral and necessary part of children's daily life, moreover, an inevitable part of the integral system of their training and education. Physical activity, as the basis of physical culture and health, reflects one of the basic conditions for the normal growth and development of children (Findak, Metikoš, Mraković, Neljak, 1996). In order to engage in physical activities regularly, it should be started at an early age and this habit must be strengthened throughout primary school, which means that this role belongs primarily to parents. It is very important to create this lifestyle habit of physical exercise in childhood because it can be difficult to make up in adulthood (Findak, 1999). Habits that children adopt from a young age usually remain throughout their entire lives. Children who are more physically active bear heavier loads more easily, are more resourceful and cope more balance, strength, etc. Play is a basic child need. At a certain age, there is a certain need for certain games (Lazar, 2007). Children from the age of 5 until starting school are stronger and more durable than children of the younger and middle age groups, and their movements are even faster and more precise. In this age group, movements are performed much more precisely and dexterously, and their spatial orientation is even more improved. The physical education activity for children of the older age group of 5-6 years, in a preschool institution, lasts about 35 minutes. The introduction of physical exercise in the preschool institution simultaneously ensures that all those children who are not involved in extracurricular activities also systematically exercise (Findak, 2001). This research provides insight into formation of direct conclusions about morphological characteristics and motor abilities of preschool children, under influence of physical education programs.

AIM OF THE RESEARCH

Main goal of this research is to determine the differences in some variables for assessing morphological characteristics and variables for assessing basic motor abilities of preschool children attending organized physical education programs, designed according to needs of children of this age and children attending regular kindergarten programs who were not affected by programmed physical education treatment.

RESEARCH METHODS

Sample of respondents

Sample of respondents consists of two groups of 64 preschool children from the kindergarten "Yllka (40) and Ylberi (24)" in Prizren. The first group of children consists of 32 boys aged 6 years ± 6 months, who were affected by programmed physical education, and the second group of children consists of 32 boys aged 6 years ± 6 months, participants in regular kindergarten program who were not affected by programmed physical education, the boys at the time of testing were clinically healthy and without visible motor, functional and psychological abnormalities.

Sample of variables

In order to assess the morphological characteristics and basic motor abilities the following variables are analyzed: Morphological characteristics: Body height (ABH); Body weight (ABW); Average chest diameter (ACH); Forearm diameter (AFD); Thigh diameter (ATHD); Motoric abilities: Medical ball hurling with both hands from bottom to front (MHM); Hand tapping (MHT); Jumping in squares (MJS); Forward bent on a ground (MFB) and Long jump (MLJ).

Description of experimental approach

For purposes of this research, testing was conducted on a sample of 32 preschool children who were under the treatment of physical education programs in kindergarten "Yllka and Ylberi" in Prizren. The directors of kindergarten approved research in this kindergarten. Before to conducting research, parents were informed about course of the research, its goals and purpose, and the written consent of parents was collected for each respondent, which is in accordance with the Code of Ethics for Research with Children. All measurements, research and its procedure are appropriate for children of that age and in no way pose a danger to children or endanger their rights. Program attended by participants in programmed physical education treatment as a process was conducted over course of one school year, three times a week in the morning for 35 minutes. Program consists of elementary and relay games, on natural forms of movement (walking and running, jumping, throwing, catching and shooting, rolling and wriggling, climbing, crawling and pulling, lifting and carrying, pushing and pulling and hanging and resisting). Furthermore, children are introduced to basics of various sports such as gymnastics, athletics, basketball, football, handball, as well as various physical exercises appropriate for children of this age applied from the manual "Preschool Games II" (Roller-Halačev-Veger 1986). Methods of work are suitable for the children we work with in order to achieve the greatest possible transformation processes. Children attending regular kindergarten programs, who were not affected by the programmed physical education treatment, physical exercise is conducted once a week for 30 minutes. Organization and implementation of program of this group of children was carried out by a kindergarten teacher based on the methodology of physical education and health in preschool education. Program is aimed at encouraging the optimal development of motor potentials of children at an age when this is extremely important. All motor content intended for development of motor skills were selected in accordance with capabilities of preschool children. Testing was conducted at the June of 2023 year, the implementation of a training program with standard-made instruments that were calibrated before measurement, and was conducted by trained surveyors, professors of physical culture and sports. Room where the measurement was carried out was sufficiently lit and tempered. Equipment used in the implementation of program was appropriate for children age.

Methods of processing data

Basic descriptive parameters of variables: arithmetic mean (Mean) were calculated by standard statistical procedures. T-test determined differences and the significance of differences between groups of respondents. Data were processed by statistical package "Statistics for Windows 21.

RESULTS AND DISCUSSION

Table 1. Descriptive parameters of morphological characteristics entities of the group A.

No.	Variabl	N	Minimum	Maximum	Mean	Std. Deviation
1	ABH	32	115.00	132.00	122.468	6.4607
2	ABW	32	18.50	34.50	24.900	6.5779
3	ACH	32	54.50	63.50	62.600	1.5157
4	AFD	32	15.70	25.70	21.943	2.8768
5	ATH	32	30.20	46.20	37.372	4.7500
6	MHM	32	205.00	385.00	301.875	49.4930
7	MHT	32	10.00	19.00	14.437	2.5136
8	MJS	32	3.65	15.20	10.134	3.5167
9	MFB	32	20.50	41.50	29.109	5.8802
10	MLJ	32	46.00	157.00	106.437	28.4728

Table 1 shows us results obtained in arithmetic means of all variables for assessment of morphological characteristics and basic motor abilities of group A.

In area of morphological features, it can be noticed that the examinees of group A are on average body height 122.4 cm, body weight 24.9 kg, average chest diameter 62.6 cm, forearm diameter 21.9 cm, thigh diameter 37.3 cm. In motor space, it is evident that average result of medical ball hurling is 301.8 cm, hand tapping 14.4, jumping in squares 10.1, forward bent on a ground 29.1 cm, while the average long jump result is 106.4 cm.

Table 2. Descriptive parameters of morphological characteristics entities of the group B.

No.	Variab	N	Minimum	Maximum	Mean	Std. Deviation
1	ABH	32	109.00	129.00	120.968	5.2944
2	ABW	32	18.10	32.50	24.687	4.4253
3	ACH	32	47.80	73.20	58.575	5.2170
4	AFD	32	14.50	24.60	20.728	2.5534
5	ATH	32	30.10	44.20	35.512	3.3441
6	MHM	32	175.00	390.00	295.312	51.0208
7	MHT	32	9.00	18.00	13.562	2.6388
8	MJS	32	3.55	13.25	6.782	3.2136
9	MFB	32	19.50	40.50	29.859	5.1653
10	MLJ	32	44.00	152.00	86.812	31.2930

If we take a look at Table 2, we can see results obtained in arithmetic means of all variables for assessing morphological characteristics and basic motor abilities of group B. In the space of morphological characteristics, it can be seen that group B subjects, on average, 6, kg, average chest diameter 58.5cm, forearm diameter 20.7 cm, and the Thigh diameter is 35.5 cm. In motor space, it is evident that average result of medical ball hurling is 295.3 cm, hand tapping 13.5, humping in squares 6.7, forward bent on a ground 29.8 cm, while average result of the long jump is 86.8 cm.

Table 3. t - test between two groups respondents.

No.	Variables	Arithmetic mean boys		T	Sig. (2-tailed)
		Group (A)	Group (B)		
1	ABH	122.4688	120.9688	1.176	.249
2	ABW	24.9000	24.6875	.155	.878
3	ACH	62.6000	58.5750	4.637	.000
4	AFD	21.9437	20.7281	1.769	.087
5	ATH	37.3719	35.5125	1.884	.069
6	MHM	301.8750	295.3125	1.036	.308
7	MHT	14.4375	13.5625	5.944	.000
8	MJS	10.1344	6.7828	4.249	.000
9	MFB	29.1094	29.8594	-1.007	.322
10	MLJ	106.4375	86.8125	3.029	.005

According to t-test, variables of the group of respondents differ. Looking at Table 3, variable statistically significantly differentiates groups of subjects at level of significance p <0.05, is morphological variable average chest diameter (ACH = 0.00), and in basic motor ability: hand tapping (MHT=0.00), jumping in squares (MJS=0.00) and long jump variables long jump (MLJ=0.05). Anthropometric variable, body height (ABH); body weight (ABW); forearm diameter (AFD); thigh diameter (ATH); and variables to assess basic motoric abilities; medical ball hurling (MHM); and forward bent on a ground (MFB), by arithmetic means of results, they do not differ statistically significantly. Results obtained by this research have identical results with other research conducted with aim of determining differences between boys of this age in the morphological space (Bala, 2004.). Statistically significant differentiation of groups in variable Average chest diameter (ACH) is very likely caused by an increase in height, which shows higher values in group of boys influenced by physical education programs, rather than gains in muscle mass and other component body structures. In same way, statistically significant differences in variables for assessing basic motor abilities, especially movement speed, hand tapping (MHT), coordination abilities, jumping in squares (MJS) and explosive forces long jump (MLJ) are explained. The nerve-muscular changes that take place in children under influence of training program, increased coordination of synergists and antagonists and enlarged level of motor activation of muscles are probably cause for achieving better results with variables of estimating the explosive strength, speed and coordination which are the subject of this research.

CONCLUSION

Based on obtained results, it can be concluded that in morphological and motor space of six-year-old children attending programmed physical exercise and children not attending such a program, a difference was found after one year of completed program. Out of ten anthropometric and motor variables observed, statistically significant difference at level of p <0.05 was found in four variables. Based on these results, it can be concluded that at this age of children participating in this exercise program there are no significant differences in the observed morphological space. However, results of research in motor space at this age of children, given differences in three motor variables, determine that there are some significant differences in motor space. It should be noted that before creating a training program with children, it should be taken into consideration that programs must be designed more in accordance with degree of maturation of child than with chronological age, because individual needs and requirements vary from child to child. Only application of planned and well-constructed and programmed exercise treatment benefits children for proper physical growth and development, on basis of which children can build self-confidence and increase their intellectual abilities.

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GENDER RELATED DIFFERENCES IN THE LEVEL OF FLEXIBILITY IN AGE GROUP SWIMMERS IN BOSNIA AND HERZEGOVINA

Original Scientific Paper

Alena Ćemalović, Damir Đedović, Almir Popo, Adi Palić, Adnan Ademović

Abstract: The main goal of this research are the differences of the flexibility levels in age group swimmers at the national championship of Bosnia and Herzegovina. The number of respondents included in this survey was 137, and included the best male and female age group swimmers ranked from the 1st to the 8th place at the national swimming championship, from 8 swimming teams from Bosnia and Herzegovina. Selected variables in this study will cover the area of flexibility (3 variables). For the success at national championship FINA points from best swimmer's event were conducted. The results showed significant difference between flexibility levels within boy and girls in age group category. In two out of three tests, girls have achieved better results than boys. In one test, the results of the boys were similar to results of the girls. The data showed that younger the girls were, better results were achieved at the tests.

Keywords: *age group, swimming, flexibilty, gender, championship*

INTRODUCTION

Given that the result in swimming largely depends on the amplitude of the movement and the frequency of the movement, it is of great importance to work on the development of flexibility in boys and girls who compete in swimming. Like other motor abilities, one part is under genetic influence and this is more pronounced in female swimmers than in male swimmers. Depending on the motor structure of individual swimming techniques, there are big differences in the mobility of individual joints in swimmers. Unlike other motor skills, flexibility can be developed relatively well under the influence of kinesiology stimuli. Working on flexibility improves swimming technique and thus the result. Propulsion during swimming will be reduced if the swimmer is unable to perform the maximum amplitude of movement in the shoulder joint (Volčanšek, 1996). Due to all of the above, this paper will look for answers to the question of what is the level of flexibility development in the best male and female age group swimmers who achieve best results at the BiH national championships.

Willems, Cornelis, De Deurwaerder, Roelandt, De Mits (2014) conducted research on the influence of ankle joint strength and flexibility on performance in elite sports. During the training process, stretching exercises were used and the results showed a statistically significant correlation between speed, flexibility of the ankle joint and the impact strength of the entire legs. Increasing the flexibility of the ankle joint contributed to the speed of work of the entire legs, so that male and female swimmers who have poor ankle flexibility can benefit greatly in the overall result if they include additional stretching, dorsiflexion and plantar flexion exercises in their training program. Krstić, Kitanović-Krstić, Čavka (2012) presented stretching exercises for the development of flexibility in the training process of swimmers. Exercises are performed with your own weight or with a band that represents minimal resistance. Depending on the swimmer's preferred technique, greater emphasis will be placed on exercises to develop that joint. Butterfly swimmers, backstroke and freestyle techniques will work more on stabilization and flexibility of the shoulder joint, while for breaststroke swimmers the flexibility of the shoulder joint is not primary, but flexibility in the area of the pelvic joint, knee and dorsiflexion of the foot. Flexibility can be active and passive.

Active flexibility is manifested in the process of own muscle strain (eg. performing leg movements with maximum amplitudes forward, sideways, backward, etc.). Passive flexibility appears under the influence of external forces (resistance from the external environment, partners, etc.). In this way, we can improve flexibility quite easily and quickly. It should not be forgotten that the level of this motor ability can quickly decline if swimmers do not regularly maintain the level of its development (Gundling, 1988; Behmetal, 2001).

METHOD

This research is transversal study with the aim of determining difference in flexibility levels between boys (11 -12 and 13-14) and girls (age 9-10 and 11-12). These are youngest categories in competition system at national championship.

A sample of respondents

The sample of respondents consisted of 137 young male (11 -12 and 13-14) and female (age 9-10 and 11-12) swimmers from 8 teams in Bosnia and Herzegovina (Mostar, Sarajevo, Banja Luka, Tuzla). They were ranked from place one to eight at national championship.

Sample variables

This research included 4 variables, 3 variables for testing flexibility level and 1 variable for success. Boys and girls were tested with three flexibility test (shoulder rotation with bat, deep bow over the box, bow forward

sitting). Criteria variable for success are FINA points from single best swimming event for success.

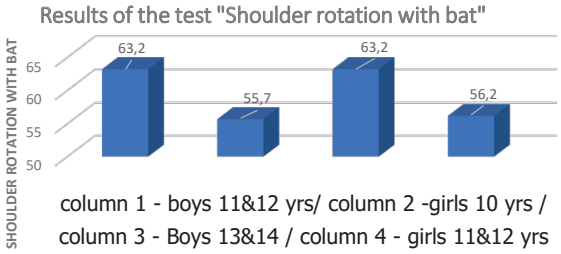
Data processing methods

The obtained results were processed in the statistical package SPSS (version 26.0; SPPS, Inc., Chicago, IL, USA). Central and dispersion parameters were calculated for each applied variable. The normality of the distrubution of the results was examined on the basis of the skewness coefficient and the elongation coefficient (Kurtosis).

RESULTS AND DISCUSSION

Graph 1 shows data values of the test "Shoulder rotation with the bat" performed by boys age 11-12 and 13-14 and girls age 9-10 and 11-12. Values of the test are expressed in centimeters and lower data has greater value that indicates better flexibility of shoulder joint. It can be seen from graph that girls age 9 and 10 have achieved best results. Girls age 11 and 12 have close values to results of the younger girls. Boys have higher values from girls with 63.2 cm for both male age groups (11 and 12, 13 and 14). These results indicates that girls have better shoulder flexibility than boys.

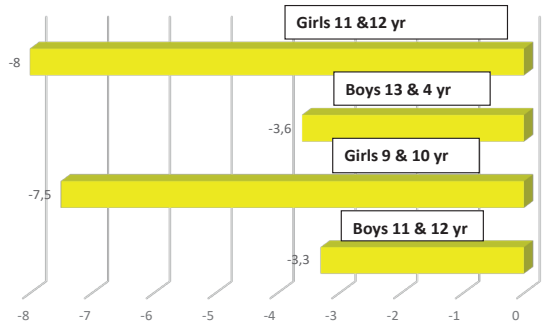
Graph 1. Results of the test "Shoulder rotation with bat"



column 1 - boys 11&12 yrs/ column 2 -girls 10 yrs / column 3 - Boys 13&14 / column 4 - girls 11&12 yrs

Graph 2 shows the results of test in which swimmers have to bow down with their legs outstretched while standing on the box. In this test, negative score is better score than positive one. From the graph can be seen that best results have achieved girls with slighty difference between age groups (girls age 11&12 have 0,5cm higher values than girls 9&10 yr). Significant higher values are from the boys, both age groups.

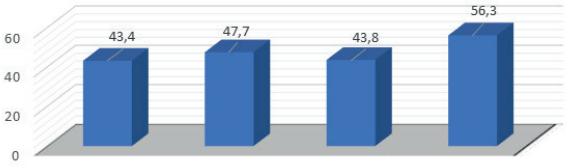
Graph 2. Results of the test „Deep bow over the box"



Graph 3 shows the results of test in which swimmers have to bow down their legs while sitting.

Results of this test are the closest one in all three tests. Comparing both age groups of boys and girls, highest values in this test have girls (combined 104 cm). Combined result of both boys age groups is 87,2 cm which is significant lower than girls' results.

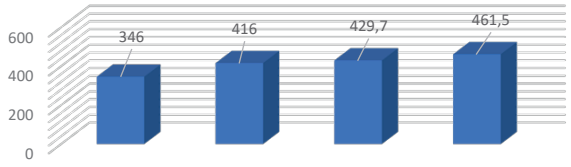
Graph 3. Results of the test „Bow forward sitting"



Column 1 – boys 11&12 / Column 2 – girls 9&10 / Column 3 – boys 13&14 / Column 4 – Girls 11&12

Graph 4 shows FINA points from one single swimming event, best event, from swimmers that are in this research. This points are representing success in swimming. It can be seen from the graph that highest FINA points have girls age 11 and 12. This is common in age group results, that girls have slightly higher points from single event. In junior category, boys have better results and higher FINA points.

Graph 4. Highest FINA points from one single event



Column 1 – boys 11&12 / Column 2 – girls 9&10 / Column 3 – boys 13&14 / Column 4 – Girls 11&12

Table 1. Analysis of differences of arithmetic means of variables for assessing flexibility between genders (boys 13-14yr, girls 11-12yr)

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Shoulder rotation with bat	1.164	.285	1.797	64	.077	6.98077
Deep bent over bench (standing on box)	.026	.872	2.184	64	.033	4.40192
Bending while sitting	.307	.582	-3.833	64	.000	-12.52115

From looking at table 1, which t ells us about the analysis of the differences in arithmetic means for the age of 13-14 for boys and 11-12 for girls with regard to gender (T-test), the results indicate that two of the three variables achieved statistically significant

differences. The greatest statistical significance was achieved by the variable "Bending while sitting" (p = 0.000), with a T-test value (t = -3.83). The second in order is the variable "Deep bent over bench" with significance (p = 0.033) and T-test value (t = 2.18). The third variable did not achieve statistical significance "Shoulder rotation with bat" (p = 0.077), with a T-test value (t = 1.79).

Table 2. Correlation of the variables used to assess flexibility with FINA points (swimming success) in boys (13-14yr) and girls (11-12yr) group

	Shoulder rotation with bat	Deep bent over bench (standing on box)	Bending while sitting	Highest number of FINA points
Shoulder rotation with bat	1	.071	-.115	.131
		.568	.358	.294
	66	66	66	66
Deep bent over bench (standing on box)	.071	1	-.418**	-.500**
	.568		.000	.000
	66	66	66	66
Bending while sitting	-.115	-.418**	1	.297*
	.358	.000		.016
	66	66	66	66
Highest number of FINA points	.131	-.500**	.297*	1
	.294	.000	.016	
	66	66	66	66

From the table 2, which shows the results of the connection between the variables for assessing flexibility and the points won in the national competition, we can see that two of the three variables achieved connections that are significant to mention. The variable "Bending while sitting " had a low correlation with the variable "Highest number of points" r = 0.29, while its significance is p = 0.16. The sign of this obtained result is positive, which means that the variables are proportionately proportional, that is, a drop in one variable causes a drop in the other variable and vice versa. The variable "Deep bent over bench (standing on box)" achieved a significant connection with the variable "Highest number of points" r = -0.50, with significance p = 0.00. The sign of this obtained result is negative, which means that the variables are disproportionately proportional, i.e. a decrease in one variable causes an increase in the other variable and vice versa. We must emphasize here that the specificity of the measurement of the variable "Deep bent over bench (standing on box)" is such that the lower the score on the scale, the better the achievement, and therefore this result was to be expected. The variable "Shoulder rotation with the bat" had no connection with the variable "Highest number of FINA points", the correlation level is 0.13 with a significance of 0.29.

Table 3. Analysis of the differences of the arithmetic means of the variables for the assessment of flexibility between the genders in the age 11-12 for boys and 9-10 for girls.

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Shoulder rotation with bat	.207	.650	2.241	69	.028	7.43077
Deep bent over bench (standing on box)	.418	.520	2.823	69	.006	4.16667
Bending while sitting	.001	.980	-1.621	69	.110	-4.28034

By looking at table 3, which tells us about the analysis of the differences in arithmetic means for the age of younger girls (9-10) and boys (11-12) with regard to gender (T-test), the results indicate that two of the three variables achieved statistically significant differences. The highest statistical significance was achieved by the variable " Deep bent over bench (standing on box)" (p = 0.006), with a T-test value (t = 2.82). The second in order is the variable "Shoulder rotation with bat" with significance (p = 0.028) and T-test value (t = 2.24). The third variable did not achieve statistical significance "Bending while sitting" (p = 0.110), with a T-test value (t = -1.62).

Table 4. Correlation of variables used to assess flexibility with FINA points (swimming performance) in young male (age 11-12) and female (age 9-10) swimmers.

	Shoulder rotation with bat	Deep bent over bench (standing on box)	Bending while sitting	Highest number of FINA points
Shoulder rotation with bat	1	.128	-.104	-.101
		.286	.388	.401
	71	71	71	71
Deep bent over bench (standing on box)	.128	1	-.420**	-.387**
	.286		.000	.001
	71	71	71	71
Bending while sitting	-.104	-.420**	1	.286*
	.388	.000		.016
	71	71	71	71
Highest number of FINA points	-.101	-.387**	.286*	1
	.401	.001	.016	
	71	71	71	71

Table 4 shows the results of the correlation of variables for assessing flexibility with the FINA points won in single event at nationals among younger swimmers. We can see that two of the three variables achieved correlations that are significant to mention. The variable "Bending while sitting " had a low correlation with the variable "Highest number of FINA points" r = 0.28, while its significance is p = 0.16. The sign of this obtained result is positive, which means that the variables are proportionately proportional, that is, a drop in one variable causes a drop in the other variable and vice versa. The variable "Deep bent over bench (standing on box)" achieved a significant connection with the variable "Highest number of points" r = -0.38, with significance p = 0.00. The sign of this obtained result is negative, which means that the variables are disproportionately proportional, i.e. a decrease in one variable causes an increase in the other variable and vice versa. We must emphasize here that the specificity of the measurement of the variable "Deep bent over bench (standing on box)" is such that the lower the score on the scale, the better the achievement, and therefore this result was to be expected. The variable "Shoulder rotation with bat" did not have a connection with the variable "Highest number of FINA points", the correlation level is -0.10 with a significance of 0.40.

CONCLUSION

The results of this research gave us very interesting data about the importance of flexibility in the performance of age group swimmers and among other things, confirm numerous research results, which tell us that the optimally developed flexibility of athletes is one of the prerequisites for maximum expression of coordination, precision and speed of performing a certain motor task. These results have shown us that younger girls (age 9-10) have good level of flexibility compared to slightly older girls (age 11-12) and especially better results compared to the boys' results. Results are following todays' science and hereby confirm that there is significant difference between genders in age group athletes. For further research, flexibility levels and gender difference among older swimmers should be researched.

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THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY OF WOMEN, RATING PERCEIVED EXERTION AND BODY IMAGE SATISFACTION

Original Scientific Paper

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Abstract : Regular physical activity, along with numerous health, psychological, social and economic positive effects impacts the satisfaction with body image. The main goal of the work was to determine the connection between women's physical activity, rating perceived exertion (RPE) and satisfaction with their physical appearance. Data were obtained on sample of 157 women (M=38, SD=11) members of fitness centers in the area of Sarajevo. Scale of perception of physical self-esteem for adolescence and adults, modified BORG scale of subjective assessment of fatigue in the last month of training and Questionnaire of general data were used for the needs of this study. Criterion for participation in the study was that subjects are (female) members of fitness centre for at least two months, in continuity, and that they trained in that period at least two times a week. Obtained results show that there is statistically positive correlation between regular physical activity and overall satisfaction with body image. Descriptive parameters of overall satisfaction with body image also have high average means: satisfaction with body image 83% (28.38), satisfaction with body weight 78.3% (19.35) and satisfaction with personal attributes i.e. attributing of body-self 75% (10.22). Statistically significant correlation between rating perceived exertion (RPE) of physical activity and descriptive parameter of satisfaction with body weight (BW), which is most pronounced in age groups between 21-30, 31-40 and 41-50, where intensity of correlation decreases with age, is determined. Satisfaction with personal attributes (PA) and rating perceived exertion (RPE) are connected only in one age group of women (aged from 21-30). There is no established correlation between overall satisfaction of one's own body and intensity of physical activity. Research shows how the subjective assessment of greater load during exercise has a connection with personal satisfaction with own body weight and physical attributes in women who exercise recreationally engage in fitness, while between overall satisfaction with one's own body and subjective assessment load during exercise has not been determined to be related.

Key words: *psychology, recreation, fitness, body image, satisfaction, intensity*

INTRODUCTION

Benefits of physical activity are commonly classified in five categories: health, psychological, social, ecological and economic (Jurakic, 2015). Prskalo and Sporis (2016) state that term health does not only refer to physical components but psychological as well, which means that physical activity and satisfaction with body image are part of concept of health.

A mechanism that explains the connection between physical activity, self-esteem and satisfaction physical appearance can be explained by the Model of exercise and self-esteem (eng. "The exercise and self-esteem model EXSEM; Sonstroem, Harlow and Josephs, 1994 and Sonstroem i Morgan, 1989). According to this model, positive changes in physical parameters are the result conducting physical activity (eg: better physical condition, weight loss, etc.) hypothetically lead to an increase in the perception of self-efficacy (e.g. beliefs about personal abilities). Increased self-efficacy hypothetically leads to greater self-perception of differences subdomain of physical abilities and characteristics (self-esteem related to the physical grows strength, endurance or physical appearance) which further increases the general valuation of the physical abilities and characteristics.

Changes in physical parameters (for example physical fitness) mediate the influence of physical activity on general self-esteem (Spence, McGannon and Poon, 2005) and moderate the influence of physical activity on the component of self-concept related to physical abilities and characteristics, including physical appearance (eng. physical self-concept) (Schneider, Dunton and Cooper, 2008). The bodily concept of oneself is one of the most visible components of our concept of self, satisfaction with own body depends on shape of the body, height, mass, muscles and overall satisfaction with the body (Kovacevic, 2015).

Results of the meta-analytical study confirm effects of physical exercise on development of self-respect. (Ekeland, Heian, Hagen, 2005) in children, adolescents and vulnerable individuals.

Given the importance of satisfaction with one's own bodily self, the resulting dissatisfaction its own appearance can cause a negative mood. Bartlett, Vowels & Saucier (2008) defined negative image of self as a way of thinking and feeling about one's own body, which reflects, negatively on individual's self-respect, respect of the body and satisfaction with the body. In research Pucci, Rech, Fermino and Reis (2012, according to Jurakic, 2015) state that physically active individuals have higher level of satisfaction in life. Based on the previous ones empirical findings from all of the above, we assume that there is a connection between physical activities, subjective assessments of the load during exercise and physical satisfaction appearance in the female population that engages in recreational fitness

METHODS DESIGN

Sample

Data were obtained on sample of 157 women from Sarajevo Canton. Criterion for participation in the study was that subjects were regular members of fitness centre for at least two months and that they trained at least two times a week in group or individual fitness programs. Average age of female subjects was 38.5 (SD=11). Data were obtained by: Scale of perception of body self-respect in adolescents and adults (BES- Body-Esteem scale by author Mendelson, B.K. Mendelson, B.J. & White, 2001), modified BORG scale of subjective assessment of fatigue in the last month of training (Borg 1998) and Questionnaire of general data. Surveys were distributed to subjects in January 2023. All data of participants of the study were protected and ethical aspects of the study were also applied.

Instrumentation

Questionnaire of general data was constructed for the needs of the research and includes questions which refer to basic socio-demographic features, age and education. Scale for measurement of perception of body esteem for adolescents and adults (BES – Body-Esteem scale of authors Mendelson et al. (2001) was used for the purpose of evaluation of satisfaction with body image. Scale includes 22 particles and subjects' task was to circle means, which best describe their opinion, on the Likert's scale of five degreed (from 0-never to 4-always). Scale includes three subscales 1) perception of self body-image 2) perception of body mass 3) attributing of self body-image. An example of particle for the first subscale: "I like how I look in photographs"; second subscale: "I'm proud of my body" and third: "I think my look would help me get a job". Authors of scale report that coefficient of internal reliability for overall scale was α =.89; for subscale perception of own body appearance (BA) α = .93; for body mass (BM) α = .95 and for attributing of viewing body self (BS) α = .81.

For the purpose of evaluation of loading during exercising, a modified scale of author Borg (1998) (BORG RPE – Rating of perceived exertion) was used. The Borg Rating of Perceived Exertion (RPE) is a way of measuring physical activity intensity level. Scale includes ten ranked categories (from 0-without any signs of fatigue to 10- the biggest fatigue (Table 1). Scale is most commonly used for the purpose of subjective perception of quantification of loading of physical activity (Eston et al 1987. Damayanti et al 2022; Kumar et al 2022).

Table 1. Modified Borg's Scale for Evaluation of Rating Perceived Exertion

Degree	Description of a fatigue degree
0	No signs of fatigue
0,5	Extremely light, barely noticeable fatigue
1	Negligible
2	Mild fatigue
3	Mid fatigue
4	Rather severe fatigue
5	Severe fatigue
6	Quite severe fatigue
7	Very severe fatigue
8	Extremely severe fatigue
9	Almost most severe fatigue
10	The most severe fatigue

METHODS OF DATA PROCESSING

All statistical analysis were conducted by IBM SPPS 26 software package for Windows operative system. Frequencies were presented for all demographic features and particles of survey of BORG's scale. Central and dispersion parameters and means of Cronbnach α were presented for results of BES survey and subscale BES survey. Since the results of previous scales do not follow normal distribution, the correlation between perception of body-esteem and subjective loading is determined by Spearman's coefficient of correlation. The level of statistical significance is set on $p<0.05$.

RESULTS

Tables 2a, 2b and 2c show frequencies of basic demographic information such as: age, level of education and subjective evaluations of average intensity of exercising (BORG scale). Analysis of results of the study shows that biggest of 8%). The physically active women who participated in this study are in the age group between 41-50 (41.4%) followed by women of the age group 31-40 (31.8%). The biggest percentage (56.7%) of participants of this study are highly educated women (master degree), who are in 64.3% completely satisfied with their life. During training, in the last month, most of subjects evaluated subjective intensity of loading as mild fatigue (30.6%) and rather severe fatigue (26.1%).

Table 3 shows the average score of satisfaction with body image BES score was 66.77 which is relatively high (89%).

Obtained coefficients of internal consistency of this study were α= . 92, for the whole scale and for the subscales by order α= .86; α= .90 and α= .61. as we can see low coefficient of internal consistency was obtained for subscale of attributing of body self (BS) and results in this subscale were taken with a grain of salt.

Table 2 a) frequency of age groups b) frequency in groups according to level of education c) frequency recorded by BORG scale (level of intensity)

a)

Age categories	%
15-20	3,2
21-30	10,8
31-40	31,8
41-50	41,4
51-60	10,2
60+	2,5

b)

Level of education	%
Elementary school	2,5
High school	21
Bachelor degree	16,6
Master degree	56,7
Doctoral degree	3,2

c)

BORG scale	
Extremely light, barely noticeable fatigue	1,9
Negligible	2,5
Mild fatigue	6,4
Moderate fatigue	30,6
Rather severe fatigue	26,1
Severe fatigue	8,3
Quite severe fatigue	13,4
Very severe fatigue	7,6
Extremely severe fatigue	2,5

Table 3. descriptive parameters and normality of distribution

Descriptive Statistics Kolmogorov-Smirnov[a]						Tests of Normality					
						Shapiro-Wilk					
	Min	Max	Mean	Std. Dev.	Cronbach α	Stat.	df	Sig.	Stat.	df	Sig.
BESscore	37	91	66.77	10.744	0.92	.079	157	.018	.974	157	.005
Looks	5	40	28.38	6.362	0.86	.107	157	.000	.960	157	.000
Weight	0	32	19.35	6.919	0.9	.102	157	.000	.973	157	.003
Attributes	0	19	10.22	3.274	0.61	.098	157	.001	.982	157	.043

Table 4. Coefficients of correlation between level of intensity and results on BES

Correlations					
		L	Weight	"Attributes"	BESscore
15-20	BORG RPE	-.462	-.462	-.649	-.462
21-30	BORG RPE	.170	.634**	.498*	.460
31-40	BORG RPE	.038	.614**	.019	.235
41-50	BORG RPE	-.133	.426**	-.053	.050
51-60	BORG RPE	-.212	.182	-.161	-.238
60+	BORG RPE	.316	.833	-.316	.632
Overall	BORG RPE	-.050	.496**	.039	.146
**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).					

DISCUSSION

The participants of this research are physically active women, where most of them (64.3%) are fully active satisfied with her life, based on the overall average score of physical satisfaction with an apparent BES score of 66.77, which is relatively high (80%), we can say that they are physically active people generally satisfied with their life and physical appearance. Which is confirmed by others previous research that points to the connection between an insufficient level of physical activity and a lower level of physical activity the level of satisfaction with physical appearance, as well as the overall level of physical activity significantly correlates with satisfaction with physical appearance (Alić, 2015). In research by Pucci, Rech, Fermino, & Reis, (2012, according to Jurakić, 2015) physically active people show a higher degree of satisfaction with life. Descriptive parameters of overall satisfaction with body appearance also have high averages values: (IT) body appearance 83% (28.38), (TT) body weight 78.3% (19.35) (TA) attributes/ attractiveness 75% (10.22). On the basis of these data, we can see that there is expressed satisfaction with the perception of the body's own aesthetic appearance in physically active women. The previous one research shows that among women, aesthetic appearance is considered the leading motive for women's decision to they start exercising (Jankauskiene et.al., 2005). The results of the research show that there is a clear correlation of the descriptive parameters (TT) of the body weight with exercise intensity (Table 4) in the total sample of subjects. The correlation is pronounced in most age categories (21-30, 31-40 and 41-50), except for the youngest group (18-20 years) and the oldest groups (51-60 and 60+ years). It is noticeable that

the strength of the correlation increases with age decreases, it is assumed that the perception of body weight in the oldest and youngest age groups it does not correlate with exercise intensity or satisfaction with one's physical appearance. We can state that in this research, the oldest and youngest age groups in women body weight is not related to exercise intensity. The highest correlation was found in the age categories of 21-50 years, where also with years tends to decrease (highest correlation in the period of 21-30 years) after that gradually decreases. In young women (21-30 years old), exercise intensity is most associated with body weight, where they associate more intense exercise with a greater loss of fat tissue. The modern ideal of thinness has an impact on the desired physical appearance in women, so it is clear why it is more related to exercise intensity. In women, society equates thinness with beauty and attractiveness in men, body weight is not the central criterion for assessing attractiveness (Babarović, 2017). Younger women often choose more intense cardio programs that burn calories because they are constantly looking for more effective and thus faster methods for losing weight and fat. This information speaks in favor of the assumption that it is more pronounced in the respondents correlation of the intensity of physical exercise with body weight, it is possible that there is still little greater dissatisfaction with physical appearance due to the norms set by modern society. Often are changes in physical condition due to physical activity, responsible for the change ideas about one's own body (Alić, 2015). Descriptive parameter "attributes" and level of intensity are related only in one class among women aged 21-30 years. Which also shows us how much exercise intensity there is in younger women greater impact on perception and satisfaction with body weight and body attributes. However, there is no relationship between exercise intensity and overall physical satisfaction appearance in no age group. Satisfaction with body image depends on the way how each individual personally perceives their physical appearance, and what factors people attribute to it your physical appearance: internal or external attributions. Banfield and McCabe (2002; according to Erceg Jugović, 2011) state that body image consists of a perceptual and a subjective component. The perceptual component refers to the accuracy of estimating the size, shape and weight of one's own body in relation to real proportions, and is determined at the level of the body as a whole or its specifics parts. The subjective component refers to experiences of pleasure - displeasure and satisfaction - dissatisfaction with body size or shape and includes attitudes that can refer to physical appearance as a whole or to individual parts of the body and physical characteristics (Gardner, 2002; according to Erceg Jugović, 2011). The assessment of one's own body image does not have to be in accordance with realistic body proportions. It plays a significant role in the perception of the body's concept of oneself normative social influence (Aronson, Willson & Akert, 2005). Furnham & Greaves, (1994; according to Cvenić, 2016, p. 41) state that the basis of dissatisfaction is one's own body image the contradiction is between the perceived and the ideal self, whether it is our inner ideal or o the ideal imposed by society. It is assumed that there are social ideals of beauty thatthey internalize in such a way that satisfaction or dissatisfaction with the appearance is the result of the ratio according to which a certain ideal is achieved or not achieved (Tiggemann, 2011; according to Leško, 2018). Dissatisfaction with one's appearance can result in positive or negative behavior forms. More precisely, dissatisfaction with one's physical appearance can act as a stimulant on the individual and to encourage him to proactive behavior. Proactive behavior implies that the person engages in physical activity and follows a healthy diet. Consequently, it will contribute improving mental and physical health. Physical activity that causes changes in physical appearance and fitness may contribute increasing satisfaction with one's own appearance. Increased satisfaction is most often the result reduction of body mass or shaping of the body (muscles). It is also possible that a person who is started to exercise, she becomes more satisfied, although there are no visible changes in the appearance of her body. As they state Bungić and Barić (2009), in most works dealing with this issue, the authors are consistent in the opinion that physical exercise has positive effects on both physical and psychological well-being individual. It is also to be assumed that a person satisfied with his own appearance considers himself more attractive than the one who is unsatisfied, so the satisfaction with the appearance has a positive effect as well on self-confidence and positive body self-esteem. For the purpose of a more detailed understanding of the issue, qualitative research is also recommended to a male sample of respondents that can help interpret the relationship between the intensity of physical exercise and satisfaction with one's own appearance. Longitudinal research in this regard is also recommended area, wherever possible, it is desirable to determine what kind of physical activity (by type, frequency, duration and intensity) has the greatest connection with satisfaction with one's own body appearance.

CONCLUSION

Intensity of physical activity in this sample explains one small part of overall satisfaction with body image in the femal population and it is related to satisfaction with body weight.

Correlation of subjective evaluation of intensity of physical activity with satisfaction with body weight is mainly pronounced in women aged 20-30, who choose more intense cardio programs that burn calories, because they are in constant search for faster and more efficient method for losing kilograms and fat. All this leads to the conclusion that intensity of physical activity at younger girls and women has bigger influence on perception and satisfaction with body weight and personal attributes. Research shows that physical activity is one of the important factors of healthy lifestyle, which helps in achievement or maintenance of psychological health which relates to satisfaction with body image, as well.

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ANALYSIS OF QUANTITATIVE CHANGES IN SCOPE OF THE RESEARCHED MORPHOLOGICAL CHARACTERISTICS OF YOUNG BASKETBALL PLAYERS

Original Scientific Paper

Mile Galić, Azer Korjenić, Ante Vučić

ABSTRACT: Research of the impact of the training program on the structure and relation of latent anthropological dimensions, as well as of the progress of the overall situational success, the efficiency of basketball, could contribute to an easier understanding of the overall basketball game of young female basketball players. In contrast to that, a well-designed and programmed training can be effective in contributing to the desirable direction of growth and development of young female basketball players. The main aim of this research was to determine the level and magnitude of changes in the morphological characteristics of young female basketball players, who are 13 to 15 years of age, under the influence of the applied basketball training program. In order to determine global quantitative changes within the researched anthropological scopes, a discriminative canonical analysis was applied in manifest scope.

Keywords: *anthropological status, basketball, transformations, training program.*

INTRODUCTION

It can be concluded that it is necessary to research how and to what extent a certain program fulfills the assumptions, and whether it is possible that it influences the abilities and improvement of the basketball game itself. The need for research related to this topic, especially refers to the transformation of the morphological characteristics of 13 to 15-year-old female basketball players, under the influence of the applied training program.

It was necessary to research, discover and obtain significant information that can greatly improve the training process of basketball players, and therefore have a positive effect on their overall anthropological status.

Therefore, basketball, as an integral part of the broad field of physical education and sports, undoubtedly represents, at the same time, a means for energy-motor and intellectual activity. From the point of view of the movement and structure of the situation in the game, basketball is one of the most complex team games dominated by rapid transformations from action to action, which inevitably leads to transformations in the anthropological status of the participants of the basketball game.

RESEARCH METHODOLOGY

In the methodological elaboration of this research, it was given an overview of the definition of the sample of respondents, instruments, a battery of tests that were used to analyze the researched anthropological scopes, as well as the description of their technical performance, then a brief description of the research, methods of statistical data processing, and the time frame of the research.

Sample of respondents

The population from which the entity sample was taken for this research was defined as the sample of 13 to 15-year-old female basketball players, who actively play and train in the Female Basketball Club "Ljubuški" from Ljubuški. 88 female players, who train at the basketball school Female Basketball Club "Ljubuški" from Ljubuški, were included in this research. There were no special restrictions regarding the validity of the sample, except that the girls included in this sample at the time of testing and measurement, as well as the implementation of the training work, had to be healthy and they had to complete the planned training program.

Sample of variables

12 variables were used for the assessment of morphological characteristics. Their measurements were performed according to the method recommended by the International Biological Program (IBM). Longitudinal dimensionality of the skeleton - three measurements: AVISTJ - body height, ADUŽNO - leg length, ADUŽRU - arm length. For the assessment of the transferal dimensionality of the skeleton, we used the following variables: ADRZGL - diameter of the wrist. The following variables were used to estimate body volume and mass: ATJMAS - body mass, AOBGRK - medium chest circumference, AOBTRB - abdominal circumference, AONADL - upper arm circumference, AONADK - upper leg circumference. The following variables were used for the assessment of the subcutaneous fat tissue: ANABLE - skinfold of the back, ANABNA - skinfold of the upper arm, ANABTR - skinfold of the abdomen.

RESULTS AND DISCUSSION

Box's test (table 1), between the obtained results of the researched morphological variables at the initial and final measurement, determined that there were significant changes in covariances of the analyzed matrices.

Table 1 Box's test

Box's M		187.661
F	Approx.	1.766
	df1	87
	df2	12316.129
	Sig.	.000

Table 2 Significance of the isolated discriminative function

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.138a	100.0	100.0	.411

It can be seen that a statistically significant discriminative function was obtained, whose canonical correlation coefficient is Rc = . 411.

Based on the values of Wilks' Lambda, chi-square and degrees of freedom (df) in table 3, it can be seen that for the entire sample, the statistical significance of the differences is at level p < .00.

Table 3 Wilk's Lambda

Test of function(s)	Wilk's Lambda	Chi-square	df.	Sig.
1	.885	33.043	12	.002

Based on the correlation of the applied variables with the first discriminative function (structure of the discriminative function), with the variables that maximally differentiate the first from the second measurement, it can be stated that the variables: body mass (ATJMAS), abdominal skinfold (ANABTR) and abdominal circumference (AOBTRB), are the most responsible for the observed changes (table 4). The largest percentage of changes occurred precisely in the variables that are largely genetically determined, and given the fact that the respondents are adolescents, this outcome was expected.

Table 4 Structure of the discriminative function

	Function
	1
AVISTJ	.017
ATJMAS	.514
ADUŽNO	.143
ADUŽRU	.112
AOBGRK	.120
ANABTR	-.567
ANABNA	-.042
ANABLE	-.347
AONADK	.216
AOBTRB	.467
ADRZGL	.013
AONADL	.079

The centroids of the groups (initial and final measurement) with significant discriminative functions were also calculated (table 5).

Table 5 Centroids of the groups

	Function
Group	1
1.00	-.431
2.00	.393

Looking at the results of the analysis of quantitative changes in the researched area of the morphological characteristics of 13 to 15-year-old female basketball players, we can state that the applied training program produced partial transformations of researched morphological variables.

CONCLUSION

In order to determine global quantitative changes within the researched anthropological scopes, discriminative canonical analysis was applied in the manifest scope. Values of: coefficient discrimination, percentage of explained group variability, Bartlett's chi-square test, degrees of freedom, Wilk's Lambda and the probability of error in rejecting the hypothesis that the real value of the canonical correlation is equal to zero, were calculated. The criterion for the discriminative strength of the applicable system of variables was the so-called Wilk's Lambda. Determination of the statistical significance of each discriminative variable was performed on the basis of Bartlett's chi-square test. Significant discriminative variables were used for the interpretation, and they explain a certain percentage of variability. In order to interpret the differences between the two measurements, after the implemented program, it was necessary to define each significant discriminatory variable – function.

Because od all mentioned, we can conclud that applied training work program produced partial transformator researchwd morphological variables, it means that it had produced partial statistical important quantitative changes inside researchwd space od morphological characteristics od young basketball players, aged between 12 and 15 Years..

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RELATIONSHIP BETWEEN SCHOOL BAG WEIGHT, MORPHOLOGICAL CHARACTERISTICS, AND BODY COMPOSITION OF YOUNG SCHOOL-AGE CHILDREN

Original scientific work

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ABSTRACT: The purpose of this research was to determine the relationship between the weight of school bags and the body weight of younger students, and to highlight potential problems arising from the excessive weight of school bags. The study was conducted on a sample of 93 students from first to fifth grade of primary school. In the first grade, the weight of the school bag was measured in 20 students, in the second grade 17, in the third grade 16, in the fourth grade 21, and in the fifth grade 19 students. The values of the ratio of body weight to school bag weight were measured. The participants were tested on variables such as the ratio of the school bag weight to the student's body weight, and the results were analyzed using descriptive indicators of primary school students (age, height, weight, body mass index, basal metabolism, percentage of body fat, fat in kilograms, lean body mass, body water content, bag weight). From the obtained data, we can see the significance of differences in the average weight of the bag by grades, which are not statically significant. No differences in bag weight were observed between each grade, the only two cases where a difference was achieved were the difference between the fourth grade compared to the first and second grade. Fourth-grade students have statistically significantly heavier bags than first and second-grade students. The difference in bag weight can be attributed to the fact that fourth-grade students have a greater number of subjects compared to lower grades. The variables related to sports participation with the variables of anthropometric characteristics achieved a moderate correlation that was not statistically significant. The results of this research indicate that physical activity affects anthropometric characteristics, motor and functional abilities in children, and children who do not engage in physical activity are more prone to a higher percentage of body fat and a higher percentage of body water.

Keywords: *school bags, physical activity, weight*

INTRODUCTION

Starting school represents the beginning of a new and significantly more responsible way of life for a child. In addition to the new regime of life and work, which involves attending school and fulfilling regular obligations, there is also the school bag as an essential part of the equipment for school children and adolescents. Questions about the impact of the weight of the school bag and its influence on children's posture have been the subject of many studies (Parušić, J. et al. (2013); Bolčević, F. (2018); Ali, S. et al. (2016); Oka, Gauri A. et al. (2019); Mohammadi, S., Mokhtarinia, H., Nejatbakhsh, R., Scuffham, A. (2017); Mwaka, E. et al. (2014); Dianat, I., Allahverdipour, Z., J. (2011); Rai, A. et al. (2013); Kasović, M. et al. (2014); Šimetin Pavić, I. (2012); Košinac, Z. (2004); Kendić, S., Skender, N., et al. 2007).

Upon starting school, children will carry the burden of school bags on their backs throughout the school year. Parents and the media believe that students' bags are too heavy, but many scientists through their research point out the dangers of school bags to children's health. Research is focusing on determining the upper limit of the "safe weight" of school bags and the precise connection between the weight of the school bag and problems with body posture (Skender, 2001). Sometimes a child cannot carry the bag at all and needs a "companion" or "assistant." If a child carries a too heavy load, they will have difficulty walking and get tired more quickly.

Starting school is characteristic of a child's transition from limited activity to a phase of sitting for several hours in school desks, and for this reason, the school period may be marked by postural deviations (Beck, M. 2018). This problem can be resolved or at least mitigated by engaging in physical activities.

Inappropriate use of the school bag during a child's growth phase can lead to muscle imbalance that can turn into chronic pain and problems with the cervical spine later in life (The American Academy of Orthopaedic Surgeons – AAOS, 2008). In addition to rickets, the weight of the school bag and improper sitting in the school desk are closely related to the occurrence of irregular body posture and the development of spinal and foot deformities (Skender, 2001).

Most authors believe that inadequate weight of the school bag, as well as neglected musculature and poor body posture habits, are significant factors leading to the appearance of bodily deviations, muscle pain, and fatigue. It should be added that internal muscle and bone defects in childhood also arise from rapid and asymmetric growth, insufficient movement, and excessive sitting, combined with a heavy school bag, can lead to problems and pain in the shoulders,

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back, and feet that are reflected in later life to a much greater extent and intensity (Jovović, V. 2016).

Considering that in the lower grades of elementary school, physical and health education is subordinated to other subject activities, it is clear that there is an increased possibility of the negative impact of the so-called "school stress" on the locomotor system.

Children in their growth undergo phases of growth and development and often become overloaded due to the influence of various nonspecific external factors. In recent years, there has been increasing talk about the problem of heavy school bags and its connection to various types of irregular posture and the appearance of pain in certain parts of the spine.

Therefore, the school bag should be appropriate in weight and age for the child, i.e., it should be 5 to 10% of the child's body weight.

The aim of the research was to find a solution for overweight school bags for younger school-age students, as well as to highlight preventive measures and procedures to counteract the negative impact of overweight school bags on the health of young people.

METHODS

Participant Sample

The study was conducted on a sample of 93 students from the first to fifth grade of elementary school. In the first grade, the weight of the school bag was measured for 20 students, in the second grade for 17 students, in the third grade for 16 students, in the fourth grade for 21 students, and in the fifth grade for 19 students. The research was conducted in the area of the municipality of Mostar, including both sexes, aged 6-10 years. All students, including their parents and teachers, were fully informed orally and in writing about the testing itself, its purpose, and the method of implementation. (Čolakhodzić, 2021). Only those participants whose parents gave consent were included in the study.

Variable Sample

The values of the body weight-to-school bag weight ratio were measured. The mean values of all five measurements (five school days) were taken. Body weight and body mass structure were measured using a BIA analyzer (Tanita – 300). The variables obtained from these measurements were: Body weight, BMI, Fat %, Fat mass, TBW, FFM.

Research Description

Measurements of body weight and school bag weight were conducted once randomly in a selected school week, and the values were measured for all five days at the beginning of the first class. The mean values of all five measurements (5 school days) were taken.

Data Analysis Methods

The data were processed using the statistical software SPSS 21. Descriptive statistics were used to analyze the results at the univariate level. To examine the differences in bag weight among students in different grades, univariate analysis of variance (ANOVA) was used. The influence of sports on body structure was examined using Pearson's correlation coefficient.

RESULTS AND DISCUSSION

By examining Table 1, specifically the part of the table that describes the descriptive indicators of first-grade students, we observe the normal distribution of the results, indicating that almost all variables have a normal distribution. The variables lean mass and body water content have slightly higher kurtosis values than the reference values (2.44 and 2.32). These results were obtained due to participants who have significantly higher values than average.

Comparing the values of all parameters in Table 1, we can see that there are no major deviations from normal values among the variables, except for the lean mass and body water content variables. This indicates a lack of physical activity among younger students.

In the second part of the table, which describes the second-grade students, we can see that 17 students were tested. Only the age variable shows slightly higher kurtosis values, indicating a deviation from normal distribution, but within acceptable limits for further analysis.

One variable has a higher kurtosis value than the reference, which is the age variable. This case can be attributed to the small sample size of participants.

In the third part of the table, which describes the descriptive indicators of third-grade students, we can conclude that 16 students were tested. Out of the total of 10 variables used to measure morphological characteristics, 6 show increased skewness and kurtosis values. The increased value in the age variable, as in the previous case, can be attributed to the small number of participants. The variables body weight, body mass index, basal metabolism, and lean mass can be attributed to a student with increased body weight. Namely, this student is an extreme case of excessive body weight.

By comparing the parameter values, we can see that 6 variables are outside the reference values. This indicates obesity, which can be attributed to the following factors: genetic, improper diet, and physical inactivity, leading to increased values of body mass index, basal metabolism, and lean mass.

In the fourth part of the table, which describes the fourth-grade students, we see that 21 students were tested. By examining the skewness and kurtosis columns, we can see that all variables meet the criterion of normal distribution of results. The same case is observed for fifth-grade students, of whom 19 were tested.

Comparing the results of Parušić, J. et al. (2014), we can see that the research results significantly differ from the results obtained in the study of fourth-grade students IV O.Š. The authors aimed to examine the

percentage of school bag weight in relation to body weight and the intensity and location of pain during carrying the school bag and its method of carrying. The results indicate that the average values of the bag-to-body weight ratio, compared to the permitted maximum limit of 10%, are on average (16.72%) higher than this limit in all grades, and that the values of skewness and kurtosis are outside the reference values.

Table 1. Descriptive Indicators of Primary School Students

Grade		N	Opseg	Min.	Max.	A.S.	Std. Dev.	Skew.	Kur.
1	Age of students (age)	20	2	6	8	6.50	.607	.785	-.213
	Student height (cm)	20	16	119	135	126.35	5.174	-.195	-1.281
	Student weight (kg)	20	14.8	18.8	33.6	26.565	4.2924	-.086	-.921
	Body Mass Index	20	7.5	13.3	20.8	16.565	2.0064	.376	-.509
	Basal metabolism (kCal)	20	345	883	1228	1067.80	93.178	-.176	-.301
	Fat percentage (%)	20	23.9	4.6	28.5	17.285	6.2592	-.637	.237
	Fat mass (kg)	20	7.7	.9	8.6	4.725	2.0547	-.163	-.436
	Lean body mass (kg)	20	13.3	17.9	31.2	21.840	3.2150	1.343	2.443
	Body water content (kg)	20	9.7	13.1	22.8	16.000	2.3515	1.314	2.321
	Bag weight (kg)	20	1.3	1.7	3.0	2.313	.3254	.043	-.411
2	Age of students (age)	17	1	7	8	7.41	.507	.394	-2.109
	Student height (cm)	17	16	123	139	132.18	4.733	-.265	-.673
	Student weight (kg)	17	21.5	25.0	46.5	31.418	6.4728	1.537	1.556
	Body Mass Index	17	10.0	14.1	24.1	17.829	2.9832	1.042	.076
	Basal metabolism (kCal)	17	496	1011	1507	1174.47	151.914	1.197	.698
	Fat percentage (%)	17	30.6	8.6	39.2	20.176	8.7584	.952	-.084
	Fat mass (kg)	17	15.8	2.4	18.2	6.753	4.4546	1.491	1.458
	Lean body mass (kg)	17	11.0	20.5	31.5	24.547	2.8736	.783	.717
	Body water content (kg)	17	8.1	15.0	23.1	17.965	2.1157	.786	.748
	Bag weight (kg)	17	1.5	1.9	3.4	2.361	.4415	1.635	2.057
3	Age of students (age)	16	1	8	9	8.44	.512	.279	-2.219
	Student height (cm)	16	26	125	151	136.88	7.710	.196	-1.052
	Student weight (kg)	16	30.7	26.6	57.3	33.956	7.9011	1.882	4.322
	Body Mass Index	16	10.6	14.5	25.1	17.950	2.5553	1.621	3.284
	Basal metabolism (kCal)	16	693	1042	1735	1209.81	168.735	2.096	5.941
	Fat percentage (%)	16	25.1	8.8	33.9	19.669	7.4939	.670	-.355
	Fat mass (kg)	16	16.2	2.4	18.6	7.094	4.3843	1.508	1.879
	Lean body mass (kg)	16	16.1	22.6	38.7	26.863	4.2046	1.486	3.103
	Body water content (kg)	16	11.8	16.5	28.3	19.669	3.0759	1.462	3.036
	Bag weight (kg)	16	1.8	1.7	3.5	2.509	.4585	.325	-.021
4	Age of students (age)	21	1	9	10	9.33	.483	.763	-1.579
	Student height (cm)	21	22	129	151	142.24	5.709	-.620	-.155
	Student weight (kg)	21	25.5	27.7	53.2	38.143	7.0352	.555	-.557
	Body Mass Index	21	8.5	14.9	23.4	18.814	3.0062	.285	-1.467
	Basal metabolism (kCal)	21	603	1051	1654	1283.52	132.498	1.010	1.932
	Fat percentage (%)	21	23.0	10.3	33.3	20.610	7.5737	.254	-1.144
	Fat mass (kg)	21	12.8	3.1	15.9	8.295	4.3107	.575	-.859
	Lean body mass (kg)	21	13.8	23.7	37.5	29.838	3.4061	.319	.078
	Body water content (kg)	21	10.1	17.4	27.5	21.862	2.4895	.332	.094
	Bag weight (kg)	21	1.9	1.9	3.8	2.679	.4862	.583	.041

5	Age of students (age)	19	1	10	11	10.37	.496	.593	-1.856
	Student height (cm)	19	39	126	165	148.37	9.731	-.452	.267
	Student weight (kg)	19	36.4	26.6	63.0	43.311	12.0686	.425	-1.157
	Body Mass Index	19	13.3	13.6	26.9	19.432	3.9529	.315	-1.016
	Basal metabolism (kCal)	19	742	1010	1752	1321.32	185.463	.844	.806
	Fat percentage (%)	19	29.6	6.7	36.3	21.658	9.4630	.184	-1.191
	Fat mass (kg)	19	20.4	2.2	22.6	10.321	6.7556	.567	-1.074
	Lean body mass (kg)	19	19.9	24.1	44.0	32.989	6.0620	.426	-1.004
	Body water content (kg)	19	14.6	17.6	32.2	24.147	4.4545	.419	-1.015
	Bag weight (kg)	19	2.5	1.4	3.9	2.498	.6766	.243	-.562

By examining Table 2, which shows the significance of differences in mean bag weight by grade, we can see that they do not significantly differ.

Table 2. Analysis of Differences in Mean Weights of Bags by Grades

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.648	4	.412	1.706	.156

A detailed analysis of Table 3, which displays the differences in bag weight between each grade, shows that the only two cases where a difference is significant are the difference between the fourth grade compared to the first and second grades. In the case of the fourth-grade students, their bags are statistically significantly heavier than those of first and second-grade students.

The difference between the first and second grades compared to the fourth grade can be attributed to fourth-grade students having a larger number of subjects compared to lower grades, resulting in significantly heavier bags for them. Additionally, the increased bag weights in this grade are due to new backpack models that, by their natural size, shape, and mass, are heavier than standard backpacks.

Table 3. Differences in Bag Weight by Grade

(I) Grade	(J) Grade	Mean Diff. (I-J)	Sig.
1	2	-.0482	.767
	3	-.1958	.238
	4	-.3660*	**.019**
	5	-.1849	.243
2	3	-.1476	.391
	4	-.3179	**.051**
	5	-.1367	.407
3	4	-.1703	.299
	5	.0109	.948
4	5	.1812	.247

This table shows the correlation between participation in sports and various variables across different grades. The "Correlation" column indicates the strength of the correlation, while the "Significance" column shows the significance level of the correlation.

By examining Table 4, which shows the correlation between sports participation and variables used to measure anthropometric characteristics and bag weight, we can see that all variables show a moderate correlation. The lowest correlation is observed between height and sports participation in first-grade students, with a positive correlation indicating that students who do not participate in sports have a higher body height.

Comparing the values in Table 4, we can see that there are no significant deviations from the normal values among the variables, except for the correlation between height and sports participation. Sports participation influences children's growth and development, as well as proper nutrition. Active participation in sports will have a positive impact on a child's mental and physical development.

The highest correlation with sports participation is observed in body water content in grades 1, 2, and 5. The correlation is positive, indicating that students who do not participate in sports have a higher percentage of body water. Another variable showing the same correlation is body weight in grades 3, 4, and 5. We know that the longitudinal dimension of the skeleton and body mass are basic indicators of children's growth and development. Similar results were obtained by Skender et al. (2010).

The third variable showing the same level of correlation with sports participation is the body mass index in first-grade students. The fourth variable showing the same correlation is bag weight in third and fifth-grade students. Additionally, in the correlation between body weight, subcutaneous fat tissue, and bag weight, the result is positive, indicating that students who do not participate in sports have a higher body weight, a higher percentage of subcutaneous fat tissue, and carry heavier bags.

Comparing the parameter values, we can see that there are no significant deviations from the reference values among the variables, except for sports participation and child weight, as well as a higher percentage of body water. Childhood obesity in preschools is a problem due to less physical activity, intake of high-calorie foods (sweets, fast food) immediately before or after meals, and time spent at home. This problem can be most effectively addressed by preschools by providing as many activities as possible that involve

fun and educational games requiring physical activity. It is known that children develop both motor skills and intelligence through learning new motor skills, so such activities can be of multiple benefits.

Table 4. Correlation of playing sports with individual variables

Grade	Varijable	Relation-ship	Signifi-cantnost
1	Height (cm)	.504	.743
	Weight (kg)	.707	.333
	Body Mass Index (kg/m^2)	.707	.274
	Subcutaneous Fat (kg)	.686	.469
	Body Water (kg)	.707	.395
	Bag Weight (kg)	.707	.395
2	Height (cm)	.633	.329
	Weight (kg)	.680	.334
	Body Mass Index (kg/m^2)	.633	.579
	Subcutaneous Fat (kg)	.680	.481
	Body Water (kg)	.707	.256
	Bag Weight (kg)	.680	.334
3	Height (cm)	.654	.451
	Weight (kg)	.707	.313
	Body Mass Index (kg/m^2)	.674	.426
	Subcutaneous Fat (kg)	.707	.382
	Body Water (kg)	.674	.426
	Bag Weight (kg)	.707	.382
4	Height (cm)	.609	.576
	Weight (kg)	.707	.397
	Body Mass Index (kg/m^2)	.687	.343
	Subcutaneous Fat (kg)	.707	.337
	Body Water (kg)	.687	.407
	Bag Weight (kg)	.687	.473
5	Height (cm)	.631	.637
	Weight (kg)	.707	.329
	Body Mass Index (kg/m^2)	.686	.395
	Subcutaneous Fat (kg)	.707	.392
	Body Water (kg)	.707	.269
	Bag Weight (kg)	.707	.392

CONCLUSION WITH SUGGESTED

Based on this research, the conclusion arises that the problem of overweight school bags significantly affects body posture and burdens the overall health of young people. During the process of ontogenetic growth and development when the skeletal system needs support, inadequate weight of school bags causes great harm to the children's skeletal system. This is a problem that we must address.

In this regard, it is necessary to involve the entire community and individuals, primarily the measures that the school must take, as well as the that parents and students must take.

Suggested that parents and students can take: Choosing an optimal bag that includes an anatomical shape for the spinal column, bag weight, carrying it on both shoulders, carrying it at a higher level in relation to the spinal column, and carrying only the books and notebooks necessary for class. Additionally, it is important to avoid prolonged sitting (especially in irregular and awkward positions) without movement and exercise, and to limit screen time (up to a maximum of 2 hours per day in front of all screens: TV, computer, console, mobile phone, etc.).

Increasing the level of physical activity (at least one hour daily, including physical activity in the daily routine such as walking to and from school).

Suggested that the school can take:

Scheduling classes in a way that students have fewer different subjects in one day (double classes). Do not include subjects that require carrying a particularly heavy load (physical education and art education) in the same day. Allow students to leave all books and equipment at school and only carry worksheets for homework home. Completely free younger students from learning and doing homework at home, allowing them to do everything at school. This measure has advantages in terms of the quality time parents and children spend at home, greater student satisfaction with school, and less work for parents.

Enable a higher level of physical activity for students in school through additional physical education classes and additional sports activities.

Society should invest in the development of education in a way that children spend a certain period of the school year in nature, engaging in physical activities.

Physical activity and exercise are considered the best prevention, and every child should practice them, primarily swimming and other sports for which children have an affinity.

Regular physical activity for children and adolescents is important for their growth and development, health, and protection against diseases. When starting school, children change their lifestyle and significantly reduce their movement. Physical inactivity can be a significant factor in the development of obesity and chronic diseases in school children (long periods in front of the TV, computer, etc.).If changes have already occurred, choosing the appropriate type of sport can significantly help in correcting certain deformities. It is recommended that school bags be in the form of backpacks carried on both shoulders. The desk should not be too high or too low, and the best chair is one whose height can be adjusted as needed and has lower back support.It is necessary to include activities that improve the health of the skeletal system, muscle strength, and elasticity (with significant pressure on bones, e.g., jumping) at least twice a week. For young children under 10 years old, the focus should not be on specific sports disciplines but on unorganized activities through play.

The most common postural deformities affecting children are spinal deformities (scoliosis, lordosis, and kyphosis), flat feet, and knee deformities (knock-

knees and bowlegs). Incorrect sitting and lying positions, overweight school bags, spending free time in front of the TV and computer, and lack of physical activity favor the development of improper body posture. Initial forms of improper posture appear in preschool children, so postural deformities and systems of preventive and corrective measures should be of interest not only to doctors but also to parents and educators of children.

With corrective exercises, it is possible to completely strengthen insufficient muscles and thus correct improper body posture and prevent or alleviate postural deformities. It is important to tailor each exercise program to the child, their health condition, type, intensity, and location of the disorder. If deformities occur, it is important to seek help and cooperation from educated professionals. The introductory part of this study statically proves the importance of school bag weight in relation to the body weight of younger students. The research was conducted on students from first to fourth grade of primary school, with the aim of addressing the problem of excessive backpack weight in younger students.

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THE COMMERCIAL ASPECT OF FOOTBALL

Expert work

Jasmin Peco

ABSTRACT: Sport is a very specific activity because it awakens a strong personal identification and emotional connection, and it has a universal appeal and penetrates all elements of life (geographic, demographic, socio-cultural). It has always been a reason for the gathering of people, where even in ancient Rome and Greece it was popular to organize large sporting events. People have always been in favor of sports as entertainment and recreation, but over time sports acquired some new characteristics. The emergence of modern sports develops with the emergence of capitalism and the strengthening of civil society, where sports suddenly grows from entertainment to business. The sports industry is growing faster and more than any other industries and is getting bigger every day, so according to the AT Kearney consulting agency, the global sports market reaches a value of up to 600 billion dollars, and in the near future it is assumed to increase to a dizzying 1 billion dollars. In this paper, football is viewed as a global phenomenon that conquered and is still conquering the world outside the Eurocentric framework. An originally popular ball game gradually turns into an organized activity of a rational and, therefore, bureaucratic organization, while at the same time the expropriation of the football game is made from those who directly produce it, i.e. players.

Keywords*: football, commercialization, sports marketing, personal branding, sports industry*

INTRODUCTION

Football is a game that throughout history has attracted numerous spectators and fans, and with the modern lifestyle and great popularization, football has become a lucrative business. The main driving force behind the rise of football is globalization, which led to complete liberalization, deregulation and privatization in this area, which had, as a direct consequence, the increasing commercialization of football. With globalization and liberalization came the transformation of the economy of the football game. Huge amounts of money have been pumped into the game, to buy the best players, build stadiums, build sports infrastructure, sell television rights, aggressive marketing and advertising, which has created a speculative economic bubble of soccer capitalism. Today, football has become the golden cage of the economy, in which hundreds of billions of euros are turned over annually.

This paper shows the connection between globalization, social networks, famous athletes, marketing tools used in personal branding and commercial effects on that basis.

SPORTS AS AN INDUSTRY

People have always been fond of sports as entertainment and recreation, but over time sports acquires new features. The emergence of modern sports develops with the emergence of capitalism and the strengthening of civil society. Sport suddenly grew from entertainment to business, and that's how sport as an industry appeared when football began to go beyond entertainment and health activities in free time. (Novak, 2006:21) As already stated, a greater turnover of money turned recreation into a business, thus creating a sports industry. The sports industry is considered to include professional sports, amateur sports, health and fitness, recreation, management of sports facilities and sports events outside the professional. The sports industry is growing faster and more than other industries and is getting bigger day by day. Promotion of sports events in the very beginnings were the pinnacle of marketing in sports. Newspapers, posters, magazines, etc. were used for promotion. Such promotion led to inevitable commercialization. The commercialization of sports began in 1858, in baseball, when tickets for all-star games between New York and Brooklyn were charged. After that event, other clubs occasionally charged entrance fees under the guise of prize games, "contributions" for players and contributions to charity. Until 1862, clubs charged 0 cents for entrance, and by 1865, that price rose to 50 cents. Some promoters justified the increase in ticket prices with the necessity of supporting the high quality of the game. From this, it is possible to conclude that players were already paid and received compensation depending on the quality of the game they provided.

The sudden expansion of commercialization was favored by the pursuit of sports spectacle, the development of technology, increased competition, the pursuit of records and the professionalization of management. In the stage of institutional development, all kinds of management development, development of sports products and their promotions come to the fore. The first trademarks and product brands appear. There is a greater development of the offer in terms of price and quality, and well-known athletes are starting to appear as protective faces. Big changes are also taking place in the clubs themselves, where regulations on salary levels have appeared, which led to the establishment of the players' union. In a structural sense, this phase of development encourages the emergence of marketing departments in sports organizations.

Sports marketing and marketing in football

With the globalization and development of the sports industry, marketing has become an indispensable part of the business of all sports associations, federations, clubs, products and even the athletes themselves. Today, it is unthinkable to watch television or surf the Internet without noticing promotions of major sports matches, sales of well-known sports brands, etc. Aware of their environment and marketing as a branch of business, it is clear that sports marketing is very important today, both in sports and in the business sense. The emergence of marketing in sports was preceded by the emergence of modern sports. Modern sport can be characterized as a sport that has expanded from the sports game itself to general entertainment and earnings through greater spending of money in and around sports, betting, etc. (Novak, 2006:29) Since there was a greater turnover of money in sports, the basic prerequisite for the development of marketing in sports was created. It cannot be determined exactly when marketing in sports appeared, but it is known that globalization and the development of the sports industry greatly favored the very rapid progress of marketing in sports. Football, as a global game, has historically attracted numerous spectators and fans, but with the modern way of life and great popularization, football has become a business. Stadiums with a capacity of up to 100,000 and even more are being built. Several hundred million euros are spent in player transfers and similar activities. Of course, these are all jobs that bring huge profits to the clubs, and marketing makes a big contribution to that. The great growth of the football industry is also evidenced by the enormous sums allocated for the purchase of players. A little more than ten years ago, the most expensive football transfers amounted to ten million euros, while today they are over 200 million, and the buyout clauses are even higher. Buying players does not directly belong to the domain of marketing, but the overall undertaking of bringing in players certainly surpasses the domain of football. Such promotion of the club, when a big star signs a contract, is of enormous importance. Bringing a player for over 100 million euros sounds abstract and everyone wonders how many goals a player has to score or how many good games he has to play to justify his value. From a marketing point of view, in just a few days, that player exceeds the figure for which he was brought by selling jerseys with his name on them. In the case of football, we can see the product as an event itself, i.e. a match that is sold to spectators and fans. The price of the event is set by the price of the ticket, and for the fans it is not an important aspect because they will pay as much as they need, while for the spectators it is a slightly more important factor. Promotion of the event itself is carried out through various media, in which social networks are leading the way today, inviting all interested parties to come to the event.

Another case is "real" products, i.e. branded products of the club. There is already a more classic marketing approach here than is the case with the event itself.

The product is tangible and can exist in the form of clothing, fan props, food and drinks and many other services. Distribution is expanding, so we can talk about sales at the stadium, in various stores in the country, traveling sales when the club is visiting, and of course the online stores. Product promotion is done through advertisements in various media and, of course, social networks, which are indispensable nowadays. Through the club's official website, advertisements in and around the stadium, are the most common way of advertising products. Jumbo posters and internet ads are a big part of club promotion, their activities and services and can bring excellent results in promoting club products.

Big companies also use football, football clubs and players as their collaborators in advertising their products, i.e. they support them to win the hearts of fans and thus attract them to buy their goods and services. We will mention Turkish Airlines as an example. This company decided to promote its comfort, safety and top quality through advertisements featuring top athletes like Michael Jordan and Lionel Messi. Using world-famous people in its promotion, Turkish Airlines reaches the masses, that is, with the help of globally famous athletes, the advertisement of this airline spreads very quickly all over the world and in this way they improve their business.

Sale of television rights

With the emergence of globalization, the media had and still have an increasing influence on people's lives, including football. Back in the 1920s, a major turning point in sports was the radio broadcast of football matches, while the first television service of the British Broadcasting Corporation (BBC) in 1936 caused great enthusiasm. Since from 1954 onwards sporting events were seen as something that should be available to all residents, the BBC was present in every home. The BBC then held the rights to all the most popular sports in Britain, such as the Football Association Challenge Cup, horse racing, tennis matches and such like - and until 1984, no independent commercial television had the right to broadcast sports events. The turning point was in 1988, when the BBC/ITV cartel lost the rights to broadcast football matches because clubs, first in the Premiership, decided to accept new satellite channels, and later other leagues, which offered them more lucrative contracts than those offered by the BBC or ITV or other public services.

Transformation of communication methods

Nowadays, most news and important content is transmitted through media and social networks. This practice is used by all major football leagues, whose clubs communicate with fans through social networks and expand their fan bases to the most distant parts of the world. Social media has given sports stars the opportunity to build their personal brands. Football players are among the world's most famous stars on social networks such as Facebook, Twitter, Snapchat and Instagram. The influence of football players is directly related to their sponsors and the sponsors of the clubs in which they play. Through advertisements of various products, many fans hear about certain sponsors, and some even decide to buy a certain

product based on the sponsor's early announcement on social networks (Global Web Index, 2020). Apart from social networks, video games are also one of the tools which increase the presence of the most famous football leagues among football fans and supporters. Sponsors like EA Sports give people the opportunity to participate in leagues through video games. The Fantasy Premier League game is also becoming more and more popular, in which an increasing number of players participate every year. Football video games play a major role in connecting millions of fans with the sport every day and in commercializing their brand, thereby increasing the number of younger fans.

The vast majority of football clubs also have their own TV channel, radio or magazine through which fans can find out the latest information about their favorite club.

PERSONAL BRANDING OF FOOTBALL PLAYERS ON SOCIAL NETWORKS

Social networks play an increasingly important role through social networks because they are also a measure of the influence of athletes, which can be quantified by the number of fans on social networks such as Facebook, Twitter, Instagram, etc. Some athletes earn more through their own sponsorship contracts and activities on social networks in which they promote a certain brand, but from professional contracts and salaries in their clubs. In the context of the topic of this paper, social networks can be viewed in two ways, as a means of improving the image of athletes, and as a tool used by athletes to promote brands. In the first case, the main outcome is their greater commercial value, while in the second the commercial effects are reflected in the earnings from promoting brands. If successfully implemented, personal branding with the support of social network tools increases the recognition of the athlete, making him more popular for the general public. The above implies greater commercial results if the athlete's image is better.

Branding no longer applies only to physical products, services or companies, but also includes people, primarily those who are already known by the nature of their work. Among such persons are actors, musicians, writers, athletes, politicians, managers, humanitarian workers and others engaged in so-called "public" affairs. At the same time, the commercial aspects of the personal branding of athletes on social networks, modern trends, such as the integration of information and communication technologies into the business and private segments of the lives of most people on the global market, create another role for an individual for whom image is very important, and in today's informational and commercial sense, we call such people influencers.

Creating your own brand

Much of the profit in sports depends on advertising companies that hire famous athletes as promoters of their brands or sponsors that build relationships with participants in the sports market on a long-term basis. Such cooperation can also be called a partnership for profit, because sports promoters, sports clubs or sports events increase the visibility of the partner's brand because its name is exposed to a wide audience that follows the athlete on social networks, through electronic or print media, or at a sports event. Such exposure certainly affects the increase in sales of the promoted brand. A successful and responsible athlete is strong, influential, especially in the social media environment. By engaging in social, philanthropic and cultural activities, and avoiding inappropriate, immoral and violent behavior, athletes can improve their lifestyle and develop their own brand.

In addition to relations with the public, publicity as its consequence, but also the consequence of other activities of the athlete, represents a significant marketing potential for the personal brand. Given that the so-called live word is transmitted in many places in the online environment, and that it is a free form of advertising, it is necessary to strive to create a positive connotation of the athlete's work and life, which results in a positive perception of the public. To achieve this, it is necessary to share content and images, including selfies, related to the athlete's family life, personal details from private life to some extent, reminding of career successes, participation in humanitarian actions and events, etc.

Many athletes create product lines with their names, trying to transfer the value of their image to a new value. There are many more examples because most famous athletes decide to co-produce products and have a great chance to become global brands with the names of those who created them, who are already known and loved for their product. A particular problem that causes direct damage to the process of personal branding are scandals that athletes directly create or are accidentally involved in. Such behaviors generate negative publicity, so it is important to act proactively and provide an appropriate explanation to fans as soon as possible. The importance of branding on social networks is great, because these networks have experienced a large increase in use in a short time, and they also serve as a marketing tool. In certain crisis situations on a global level, such as the Covid-19 pandemic, the importance of using social networks was even greater, both for business and for society as a whole, and the effects of communication between athletes and their fans, as well as the effects of activities of personal branding, have multiplied since then.

The influence of the athlete's image on the club

The effects that an athlete with a good image has on his sports club are multiple. Popular athletes who successfully use social networks in the process of personal branding share their experiences through the content they publish in the online environment, but at the same time communicate directly with their audience through these channels. Promotion through content sharing, as well as direct communication in the context of direct marketing, and indirect relations

with the public and publicity are the basic directions of using marketing for the purpose of personal branding of athletes. Athletes, as individuals interested in using social networks for the purpose of personal branding, aim to improve their image and popularity, but also to achieve commercial effects. The progressive growth of information and communication technologies, and therefore the use of social networks on a global level, implies their importance due to the commercial aspects of the work of athletes. In this whole story, the clubs for which the athletes perform also profit, both in commercial and marketing terms. The most recent example of this phenomenon is the transfer of Lionel Messi to the French football club PSG in 2021. Before his arrival, the official Instagram profile of the French club had around 17 million followers, and after his arrival, the number of followers rose to 70+ million. In commercial terms, after signing the contract, the stock of jerseys with his name disappeared after a day. This case speaks in favor of how much financial and marketing benefit an athlete can bring to a club.

Athletes have always been one of the most effective ways for companies to reach target markets, while the online environment has definitely changed the way the business world connects with target groups today. Long-term sustainability largely depends on trust, which, including the athlete's sports performance, makes his personal brand imperative in the sports market. As part of the sports industry, professional athletes are always faced with challenges, including injuries, loss of performance and involvement in intentional or accidental scandals, as they are public figures whose lives are of interest to the general public.

CONCLUSION

Soccer, as one of the most popular sports in the world, is an ideal example of how the commercialization and professionalization of sports can influence the creation of a modern sports phenomenon. Globalization is a process that in recent decades has brought great changes to sport and permeates it most intensively in the economic sense. With this, he becomes a factor of influence in the world through advertisements, brands and sponsors, which in this way enable large profits. The sport itself seems to be becoming less and less important in this, and this is especially obvious with football.

Through sponsorship contracts, football clubs reach a large number of football fans, which is why football enjoys great popularity in many parts of not only Europe but the whole world. This is why we can talk about a sports phenomenon for which phenomena such as McDonaldization and Americanization, the growing market economy and internationalization were the main impetus for recognition, first in Europe, and then in other parts of the world.

Some athletes earn more from their sponsorship contracts and activities on social networks in which they promote a certain brand, than from professional contracts and salaries in their clubs. In the context of the topic of this paper, we looked at social networks in two ways, as a means of improving the image of athletes, and as a tool used by athletes to promote brands.

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