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ORIGINAL ARTICLE

A Comparison of the Explosive Strength, Coordination and Speed of seven-year-old boys

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Abstract
The aim of the present study was to investigate the differences in the explosive strength, coordination and speed among the groups formed in 7-year old children according to their body mass index (BMI). A total of 91 children took part in the study and were divided into the following groups, according to their BMI: participants with normal body mass (n=55, height 127.40±5.13, weight 25.71±2.70, BMI ≤17.91), participants with increased body mass (n=17, height 131.88±5.17, weight 33.81±4.44, BMI ranging from 17.93 to 20.62) and obese participants (n=19, height 131.19±4.44, weight 40.25±8.30, BMI ≥20.63). Excessive weight or obesity was defined according to the recommendations of Cole et al. (2000). All of the participants were aged 7.1±4 months and attended elementary schools in the city of Nish in Serbia. In order to evaluate explosive strength, coordination and speed, three tests were utilized for each of the aforesaid abilities. The obtained data were processed using a one-way ANOVA. In the case of significant between-group differences, the Bonferroni post hoc test was utilized. The results revealed statistically significant differences among the scores of the three BMI groups in explosive strength, coordination and speed tests. The greatest one was between the group of children with normal body mass and that of obese children, a finding that was expected. .

Key words: motor skills, obesity, seven-year-old children

Introduction

In today's world, both in developed and undeveloped countries, more attention is being paid to preventive health measures, especially when it concerns children. Studies on the body status of children indicate that the number of both children with increased body weight and obese ones has currently the tendency to increase.

Increased body weight and obesity are risk factors for the occurrence and development of many non-contagious illnesses during one's lifetime. In addition to health problems, these risk factors lead to problems related to the development of motor skills or movement in general. For this reason, experts from the field of medicine and sport are investing great effort into promoting the need to help children become more physically active. Physical activity is considered a key factor for the healthy physical and mental development of children (Denker & Andersen, 2008; Ortega et al., 2008). Currently, the increasing prevalence of excessive weight/obesity in children is putting them at risk of developing several chronic diseases later in life. Moreover, children who are not physically active during childhood are unlikely to become so in adulthood.

The relations between various motor skills, or physical activities, and the body mass index (BMI), or obesity in children of various ages have been examined in numerous studies and a connection has been proven to exist between problems related to obesity and physical fitness, or the motor skills of children (Ara et al, 2007; Armstrong, Welsman & Kirby, 2000; Bar-Or & Baranowski, 1994; Deforche et al., 2003; Malina et al., 1995; Minck et al., 2000; Mota et al., 2002; Thompson et al., 2003; Ward & Evans, 1995).

The evaluation of physical fitness is mainly based on tests involving motor skills that represent endurance, strength, speed, coordination, agility and the like, while the BMI is calculated using a standard formula. In addition to other findings, the abovementioned authors have, in their respective research projects, drawn a connection between the BMI of children and the level of their physical skills. For example, Malina et al. (1995) compared the level of physical fitness of young girls, who had previously been divided into an overweight and a normal weight group. The results indicated that most of the overweight girls showed signs of low levels of physical fitness, a fact that had an impact on health and mobility. Biskanaki et al. (2004) proved that obesity has a negative effect on the motor skills of children, while the

results of the research carried out by Graf et al. (2004) led to the conclusion that being overweight or obese, is related to poor physical-motor development, and that an active lifestyle has a positive effect on the motor development of first-graders.

According to the relevant research findings, the various forms of organized physical activity have a positive effect on the proper physical, psychological and motor development of children. Research carried out by Zimmer et al. (2008) pointed to the significant effect of a psycho-motor program on the motor skills of preschool children. Moreover, in the research of Vajda et al. (2007) obese and overweight participants were found to need long-term exercise programs of sufficient intensity, duration, and frequency, in addition to dietary measures in order to lose excess body fat. Finally, Babin, Katic and Vlahovic (1999) showed that specially designed physical education classes have a positive effect on aerobic endurance, static strength, explosive strength, flexibility, repetitive strength, and movement frequency speed.

In order to confirm the results of studies which state that increased body mass leads to poor physical and motor development, new research involving different groups of participants living at different locations is needed, so as the negative aspects of obesity to be further examined. The aim of the present study was to investigate the influence of the BMI on the explosive strength, coordination and speed of seven-year-old boys.

Method

Participants

Ninety one children, aged 7.1±0.4, first graders of elementary schools in Nish participated in the study. The schools that had been randomly selected for the research, were the following: „Sveti Sava", „Car Konstantin" and „Ratko Vukicevic". The sample included those children whose parents had given a signed consent for their participation in the study. All of the children were healthy on the testing days. The measurements took place in the school facilities which satisfied the requirements for anthropological research.

After measuring body height and body weight and calculating the BMI, three sub-samples were formed, according to children's BMI in consistency with the work of Cole et al. (2000). The first sub-sample consisted of 55 participants (BMI up to 17.91) which represented the 60,44%, of the children with normal body mass. The second sub-sample consisted of 17 participants (BMI ranging from 17.93 to 20.62), which made up 18,68% of the participants with increased body mass. The third sub-sample consisted of 19 participants (BMI from 20.63), which made up 20,88% of the participants, who were obese.

Measurements

The following tests were used in order children's motor abilities to be assessed:

(a) For explosive strength:

1. Plyometric jump (Nazarenko, 2000): The examinee stands on a crate 30cm in height, dismounts off it on both feet and then immediately jumps up, touching with his right hand the measuring tape on the wall. The results for the jump height represent the difference between the greatest height after the jump and the reached height prior to mounting the crate. The test was carried out only once.
2. Hyperextensions, Twists, Throws (Kostic et al., 2009): In a position where he is facing away from the direction of the throw, the examinee uses both hands to throw a 1kg medicine ball over his right shoulder, backwards and as far as he can. After that, from the same position, the participant throws the medicine ball over his left shoulder and backwards. The performances of both trials are recorded in decimeters and are added. The test was carried out only once.

3. Standing depth jump (Kurelic et al., 1975): The examinee, being barefoot, uses both his feet to jump from a spring board positioned the wrong way around and to jump as far as he can onto a mat. The longest jump of three, measured in cm, was selected.

(b) For coordination:

1. Jumping a horizontal jump rope(Kurelic et al., 1975): The examinee holds a jump rope bent in half, moves it around himself above the floor and jumps over the rope with both feet, for a period of 20 seconds. The best result out of three is recorded.
2. Twenty sidesteps with a baton (Kurelic et al., 1975): The examinee has to carry out the following task ten times, in its entirety. He has to step to the side with his right leg, drag the baton below his leg with his left hand, and catch the baton in his right hand. Then he has to step with his left leg, drag his baton with his right hand below his leg and catch it with this left hand. The time needed for the completion of the above task is recorded. The test was carried out only once.
3. Running and rolling (Kostic et al., 2009): This is a complex movement in space which includes running around a medicine ball and rolling on a mat, alternately executed, with changes in the direction of the running and the circling round the medicine ball. The test was conducted three times and the best performance is recorded.

(c) For speed:

1. Hand tapping (Kurelic et al., 1975): The examinee, over a period of 20 seconds, taps alternately with the palm of one of his hands two round surfaces which are placed at a distance of 61 cm on the table at which he is seated. Two taps are considered a single point. The test was carried out only once.
2. Foot tapping against a wall *(*Kurelic et al., 1975): The examinee tries to touch a square drawn on a wall (36 centimeters from the ground) over a period of 15 seconds, twice with one foot, then twice with the other, alternately. Two taps with one foot count as one point. The test was carried out only once.
3. 5x10 meter sprint (Kurelic et al., 1975): The examinee is running a distance of 10 meters five times in a row. The time needed in order the task to be completed is recorded in tenths of a second. The test was carried out only once.

Prior to the testing, all of the children were familiarized with each of the tests, and each one was given the opportunity to try each of the tests once. The testing was carried out by the same researchers.

The basic metric characteristics of the applied tests were calculated on the basis of three repeated measures for each test, on a sample of 39 participants. Each following measurement was carried out following a 30-minute break. The participants were part of the sample, and the obtained results were used only for the calculation of the metric characteristics, which are shown in Table 1. On the basis of the obtained coefficients, it was concluded that the basic metric characteristics were good, and that the cited tests could be used for the purpose of the research.

Table 1. The basic metric characteristics tests for explosive strength, coordination, and speed

Tests (n=39)	Inter-correlation between the particles	Percentage of the common variance	Cronbach's alfa coefficient of reliability	Homogeneity (Kurtosis)
plyometric jump	.96	97.71%	.98	0.92
hyperextension, twist, and throw	.97	98.01%	.99	1.20
standing depth jump	.98	98.67%	.99	-0.59
horizontal jump rope	.94	96.42%	.97	1.23
20 sidesteps with a baton	.98	99.00%	.99	0.17
Running and rolling	.94	95.98%	.97	0.49
Hand tapping	.94	96.16%	.97	0.16
Foot tapping against a wall	.89	92.88%	.95	0.48
5x10 meter run	.95	96.57%	.97	-0.28

Statistical analyses

The arithmetic means as well as the standard deviations for all of the variables were calculated. Moreover, in order the metric characteristics to be determined, the following were calculated: partial inter-correlation, percentage of the overall common variance, α- Cronbach coefficient of reliability, and particle homogeneity. In order any significant differences between the groups to be investigated, an analysis of variance was used (one-way ANOVA). In the case of significance between groups, the Bonferroni post hoc test was utilized. The level of significance was defined as $p \leq 0.05$.The results were analyzed with the Statistical Package for the Social Science (SPSS) version 12.0.

Results

Table 2 shows the arithmetic means and standard deviations of the participants from all three sub-samples (normal, increase body mass and obese).

Table 2. Descriptive statistics of explosive strength, coordination and speed

Means and standard deviations of explosive strength, coordination and speed tests						
	The subsample with normal body mass		The subsample with increased body mass		The subsample obese children	
	N	M±SD	N	M±SD	N	M±SD
Body height in cm	55	127.40±5.13	17	131,88±5.17	19	131,19±4.44
BMI	55	15.82±1.22	17	19,39±0.90	19	23,31±4.22
Body mass in kg	55	25.71±2.70	17	33,81±3.44	19	40,25±8.30
Plyometric jump in cm	55	15.30±4.30	17	11,76±5.57	19	10,53±4.78
Hyperextension, twist and throw in dm	55	53.39±17.74	17	62,58±19.03	19	49,48±22.04
Standing depth jump in cm	55	114.93±22.71	17	113,88±16.71	19	103,95±20.00
Horizontal jump rope	55	3.29±3.59	17	4,12±5.34	19	2,11±2.62
20 sidesteps with a baton (number)	55	31.24±10.43	17	33,00±11.88	19	38,62±13.08
Running and rolling in sec	55	19.88±2.74	17	20,31±3.59	19	21,69±3.90
Hand tapping (number)	55	26.85±4.81	17	28,18±4.50	19	27,63±5.87
Foot tapping against a wall (number)	55	13.69±2.60	17	11,47±3.02	19	12,26±2.83
5 x 10 meter run (tenths of a second)	55	17.75±1.40	17	17,69±1.66	19	19,67±3.10

Legend: M- average value; SD - standard deviation

The one-way analysis of variance showed that there was a statistical significant difference between all of the groups in the Plyometric jump (F=9.126, p<.001), used to determine explosive strength, Foot tapping (F=5.135, p<.005), used to determine leg frequency speed, and the 5X10 meter sprint (F=7.925, p<.001), used to determine speed.

A follow-up comparison of the studied groups was carried out using the Bonferroni post hoc test that revealed that between the group of participants exhibiting normal weight and participants with increased body weight a statistically significant difference was found in the Plyometric jump (p=0.008) and Foot tapping against a wall, (p=0.004) (Table 3).

Table 3. A follow-up comparison of the groups (post hoc) **-** Bonferroni

	A comparison of the participants with normal weight and those with increased body mass		A comparison of the participants with normal weight and obese participants		A comparison of the participants with increased body mass and obese participants	
Variables	F	P	F	p	F	P
plyometric jump	3.54	.008**	4.77	.000**	1.24	.428
hyperextension, twist, and throw	-9.20	.084	3.91	.440	13.10	.041*
standing depth jump	1.04	.859	10.98	.055	9.93	.164
horizontal jump rope	-0.83	.436	1.19	.245	2.01	.117
20 sidesteps with a baton	-1.76	.576	-7.40	.016*	-5.64	.138
Running and rolling	-0.43	.627	-1.84	.032*	-1.41	.187
Hand tapping	-1.32	.343	-0.78	.560	0.54	.745
Foot tapping against a wall	2.22	.004**	1.43	.050*	-0.79	.386
5x10 meter run	0.05	.926	-1.96	.000*	-2.01	.002*

*Legend: F-test; p – level of significance; * significant at the 0.05 level; ** significant at the 0.01*

Statistically significant differences were found too between the groups of participants with normal body weight and the obese ones (Table 3) in the Plyometric jump, used to determine explosive strength, (p<.001), 20 sidesteps with a baton, used to determine coordination (p<.05), Run and roll (p<.05) used to determine coordination, Foot tapping (p<.05) used to determine leg frequency speed and 5x10 meter sprint (p<.001) used to determine speed. Finally, statistically significant were the differences between the participants with increased body weight and obese ones, in the Hyperextension test, the Twist, and Throw (p<.05), used to determine explosive strength, and the 5x10 meter sprint (p<0.005) used to determine speed.

Discussion

In order to perform the motor tasks which are an integral part of the applied tests, one needs, among other things, the following abilities: proper space perception, orientation in space, orientation speed, body comportment and the swift and harmonized manipulation of props, leg frequency speed, the swift movement of the body or body parts through space and the like.

Between the participants of the current study with normal and increased body weight, weight caused a statistically significant difference (Table 3) in the case of explosive strength and speed. Moreover, between the participants with normal body weight and obese ones there was a statistically significant difference in the tests of explosive strength, coordination and speed (Table 3), while between the children with increased body weight and the obese ones a statistically significant difference was found in the tests of explosive strength and speed (Table 3).

The average values of explosive strength, coordination and speed (Table 2), indicated that obese children and those with increased body weight achieved numerically different results compared to the children with normal body weight. Obese children achieved "weaker" scores on all the tests. The current findings confirm the results of studies carried out so far, which mainly indicate that obese children achieve weaker scores on tests of motor skills. In the research carried out by Casajús, et al. (2007) it was established that overweight and obese children had weaker performance compared to children with normal body mass on tests for which the movement or lifting of body mass was relevant.

In addition, the results of the present study indicated that obese children had weaker results on tests requiring the movement of the body through space, as well as frequency speed. These findings are either indirectly or directly compatible with those of previous studies (Ara et al., 2007; Casajús et al., 2007; Graf et al., 2004; Korsten-Reck et al., 2007; Laparidis et al., 2008; Malina et al., 1995; Zimmer et al., 2008).

The study carried out by Brunet, Chaput and Tremblay (2006) showed that the BMI and waist volume were inversely proportional to physical fitness, which includes explosive strength. These relations were more pronounced in the case of older children. In the research carried out by Blažević, Katić and Zagorac (2002), it was shown that during the ages of 7 to 9, it is possible to use anthropometric characteristics for the prediction of explosive leg strength.

The determined differences confirmed the assumption that children with increased body mass and obese children in particular, have more problems in performing physical activities which require coordination, speed, and explosive strength. Suchomel (2005) stated that as part of the somatic parameters of children with low and high levels of motor skills, significantly greater values were determined for body mass, the BMI as well as subcutaneous fatty tissue among the participants with low values of motor skills.

The percentage of children with increased body mass (approximately around 18%) and obese children (approximately 20%) in the studied sample of seven-year-old children, warns us that it is necessary to monitor the growth and development of children and enable the timely and synchronized reaction of the school, parents, and medical workers. This joint action should lead to the decrease in the number of overweight or obese children. Considering the fact that obesity has a negative influence on one's ability to perform various motor tasks, we could help our children to be more able and healthier by decreasing the number of obese individuals. This would lead to improved health and good motor skills, which are a major part of playing games that is in turn a major part of childhood. During the implementation of the physical education lesson, physical education teachers could follow a special program for obese children. These programs could have the appropriate positive effects.

Conclusion

Statistically significant differences were revealed in tests of explosive strength, coordination and speed among three BMI - groups of seven-year-old boys: those with normal body mass, those with increased body mass and those who are obese. The greatest statistically significant difference was found between participants with normal body mass and obese ones, while the difference between the participants with increased body mass and obese ones not statistically significant. It is assumed that these two groups can be viewed as a unified whole. In this case, the overall percentage of these children in Nish, and in the schools that participated in the research, should act as a warning to all those in charge to act in a timely fashion. On the basis of these research results, it can be concluded that if the motor skills of children are to be improved their body weight is necessary to be permanently regulated.

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