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DEFINING A MUTUAL RELATIONSHIP AMONG THE BODY POSTURE, PHYSICAL CONDITION (FITNESS) AND REGULAR PHYSICAL ACTIVITY IN CHILDREN OF YOUNG SCHOOL-AGE

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ABSTRACT. Introduction. The main focus of our study was to evaluate the body posture in a group of 147 children aged 6.4 – 9.8 y. In the study, we tried to find a statistically significant relationship among a body posture, particular components of physical fitness and the amount of physical activity. **Methods.** To evaluate the body posture, a modified Matthias test was used. To test the physical fitness, the UNIFITTEST 6-60 was used, including defining the somatotypes and it´s specific features. To find out the amount of physical activity, a questionnaire was used, which was completed by parents due to the age of the respondents. **Results.** The results have shown disbalances in body posture in the observed group of young school-age children. In total 53.1 % of children of the monitored group had poor body posture. Based on the t-test, statistically significant difference in the evaluation of the quality of body posture was found between the groups of boys and girls ($t=3.21$; $p<0.01$), boys scored worse in the body posture test. Only a feeble correlation between the quality of the body posture and the amount of organized physical activity was measured in the group of girls ($r_s = -0.24$; $p<0.05$) – girls with a higher volume of extracurricular physical activities had better results in the evaluation of posture; however, this effect was small. The study has not shown any relations between the body posture and the individual components of physical fitness. The quality of the body posture is neither related to the amount of subcutaneous fat nor the BMI. Those children who practice some organized physical activity less frequently did worse in most tests concerning physical endurance. Their amount of subcutaneous fat was higher than in children who often participate in various after school activities more. The results of tests of fitness in both groups of girls and boys are even, the only statistically significant difference between these groups was found in the test result of the maximum reach while sitting, boys scored worse in this test ($Z=-2{,}686$; $p < 0.01$). **Conclusion.** More than half of the children of young school-age in the observed group children had poor body posture or at leas some posture deviation, the boys had a worse posture than the girls. The results of our research did not show a relationship between

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posture and performance in physical fitness tests. There was no evidence of a relation between body posture and body composition (measured by amount of subcutaneous fat and BMI). Sufficient physical activity probably has a positive effect on increasing fitness, but the relationship to posture is inconclusive.

Keywords: *body posture, physical activity, body fitness, young school-age children.*

Introduction

A typical feature of today´s lifestyle is a lack of diverse physical activity on one hand and the asymmetrical, typically static activities and overstraining on the other hand which may lead to permanent changes in the body´s motive system. These negative changes cause a lower level of physical fitness, lower muscular activity and may result in disbalances in body posture already in preschool-aged children. The situation gets even worse once children enter school (Kratěnová, Žejglicová, Malý & Filipová, 2007; Murphy, Buckle & Stubbs, 2004). Sixty percent of free time spent by active movement is considered a sufficient amount of physical activity in young school-aged children. The level of physical activity in today´s Czech children covers only about 60-70% of the desired amount (Bunc, 2005; Miklánková, Elfmark & Sigmund, 2013; Sigmund, Sigmundová & Ansari, 2009; Hálková & Ryklová, 2009). However, there are many children who suffer from an excessive amount of physical activity which is often one-sided, performed badly and in a non-compensatory way (Perič, 2010; Grabara, 2012). Fast biological growth, which appears in the period of young school-age children, alongside the lack of physical activity and bad movement habits make the situation in body postures even worse and may result in various orthopaedic issues (Hnízdil, Šavlík & Beránková, 2005; Novotná & Kohlíková, 2000; Mužík, Forejt, Matějová, Mužíková, Gottvaldová, Hlavatá & Škaloudová, 2007; Molina-Garcia, Plaza-Florido, Mora-Gonzalez, Torres-Lopez, Vanrenterghem, J. & Ortega, 2020; Noll, Candotti, Rosa & Loss, 2016).

Not treating ~~a~~ poor body posture in childhood may result in degenerative changes in the skeletal system especially in the spinal area in adulthood, which may be very painful. There are many studies that indicate that about 80% of children and teenagers suffer from ~~a~~ poor body posture. If we take into consideration even minor disbalances in the body posture, we will barely find a child whose body movement system and body posture would be ideal (Bunc, 2005; Kolisko, 2003; Kopecký, 2010; Brackley, Stevenson & Selinger, 2009; Wyszyńska, Podgórska-Bednarz, J., Drzał-Grabiec, J., Rachwał, M., Baran, J., Czenczek-Lewandowska, E., ... & Mazur, 2016).

A sufficient amount of physical activity together with an improvement of physical fitness should then have a positive effect on the quality of the body posture and should prevent children from changes in their posture. However, the results from various studies on this matter differ significantly. All the studies have shown a very important number of children with ~~a~~ poor body posture, which gets even worse with age, but do not agree on the correlation between the amount of physical activity and the occurrence of poor body posture. For example, the studies conducted by Riegerová & Ulbrichová, 1993 or Kratěnová et. al. (2007) indicate that physically active children don´t suffer from poor body posture as frequently. However, studies conducted by Vrbas (2010) or Bunc (2005) showed that the amount of physical activity or one´s fitness have only little effect on the occurrence of a poor body posture.

Studies in younger children concerned mostly subjects with some health problems and deterioration, but few researches were focused on growth changes and body posture in normal population. This study focuses on the quality of body posture, tries to state the level of physical fitness and the amount of physical activity or inactivity in children, and tries to find any possible relation between these quantities. The results should help us define whether a sufficient amount of physical activity and a certain level of physical fitness can be used as preventive measures to avoid poor body posture.

The aim of the study

The study tries to find any significant correlation between a body posture and anthropometric factors, areas of physical fitness and the amount of organized physical activity as well as among all the variables.

Methodology

The specifics of the researched sample

The sample consisted of children in 1st -3rd grade from Na Výsluní Elementary School in Brandýs nad Labem, Czech Republic. The pupils involved in the study were selected based on the informed consent of parents. The selection made was intentional. 178 parents gave consent to include their child in the study, however, complete results were collected from 147 children, 77 boys and 70 girls aged 6.4-9.8. The remaining children did not complet the whole testing (due to illnesses, injuries, incapability of completing given tasks, etc.)

Table 1. Basic characteristics of the sample

		Frequency	Percent
Valid	Boys	77	52.4
	Girls	70	47.6
	Total	147	100.0

Research methods

Body posture evaluation

To evaluate the quality of body posture, the Matthias´s test was used (upright standing position for 30 seconds). The assessment scale was modified to be able to evaluate the quantitative results effectively. On a 3-point scale, 3 specific segments were assessed: position of the head and cervical spine; position of the upper limbs; the form of thorax and shoulder blades; the dorsal curvature; the back symmetry in the frontal plane (to specify the segments, other particular tests were used – Klein, Thomas and Mayer and Jaroš and Lomíček´s test). A picture was taken at the beginning and at the end of the test. Thus, it was possible to depict even the smallest deviations in body posture, which would be difficult to observe with the naked eye. At the beginning and at the end of the test, the body posture was assessed by points. Both sets of points were added to get the final results. For further analysis of potential mutual correlations, the results were left intact. To make the data easier to evaluate, the results of the body posture in the sample group were divided into subgroups as follows: excellent, satisfactory, poor, very poor (unsatisfactory) body posture.

Table 2. Statistical data for basic parameters

	N			Std.				Percentiles	
	Valid	Mean	Median	Deviation	Range	Minimum	Maximum	25	75
Age	147	8.0329	8.0794	0.68470	3.45	6.31	9.76	7.5975	8.5092
Height [cm]	147	131.426	131.800	6.6614	43.0	112.3	155.3	126.900	136.100
Weight [kg]	147	28.723	27.300	6.3294	40.4	19.7	60.1	24.700	31.100
BMI percentil	147	53.37	51.00	27.916	100	0	100	31.00	80.00
Fat	147	25.88	22.00	15.042	74	6	80	16.00	33.00
Body posture	147	18.78	19.00	3.476	17	10	27	16.00	21.00

	N			Std.				Percentiles	
	Valid	Mean	Median	Deviation	Range	Minimum	Maximum	25	75
Physical activity	147	144.18	135.00	101.126	420	0	420	60.00	225.00
Passive entertainment	147	303.23	300.00	217.577	1200	0	1200	150.00	450.00
Shuttle run [s]	147	15.3262	15.0800	1.76280	8.71	11.97	20.68	13.9300	16.4500
Standing broad jump [cm]	147	123.33	121.00	17.971	91	82	173	111.00	137.00
1000 m run [s]	147	381.733	378.100	96.3777	1006.6	253.4	1260.0	330.400	413.100
Sit-ups	147	26.38	26.00	9.635	51	0	51	21.00	33.00
Reach while sitting [cm]	147	2.35	3.00	7.687	40	-20	20	-1.00	8.00

Physical fitness evaluation (assessment)

The assessment of physical fitness was based on a standardized UNIFITTEST 6-60. Values of somatic features (such as height, weight, subcutaneous fat, BMI index) were measured. Standing jump test, shuttle run and sit-ups were used as such, the endurance test was modified to a 1000m run due to the limited possibilities of the facilities used. A test of maximum reach while sitting bended was used to measure flexibility, or to test how much the back thigh muscles and lumbar muscles shortened, which in the standard Unifittest is used for a group of 25 + year-olds.

Evaluation of the amount of physical activity

A simple questionnaire was set up to serve the needs of the research. It assessed the volume and type of organized physical activity and the amount of passive entertainment (tablet, PC, smartphone) during a regular working week. Due to the age of the respondents, the questionnaire was completed by their parents. To serve the needs of correlation analysis, the data in gross score were used.

Statistical methods

The standard statistical characteristics corresponding to the types of variables were used. The importance of the differences between a group of girls and boys and between the groups of younger and older school-aged

children was verified by using a t-test with parametrical data and the Mann-Whitney test with non-parametrical data. To analyze the dependency of variables a Spearman´s rank correlation coefficient was used. The correlations between specific components of physical fitness were tested first, then the correlations between body posture and components of physical fitness compared to the amount of physical activity and passive entertainment (p-value is at the 0.01 level or at 0.05 level).

Results of the research

Basic description

The assumption of a regular distribution was tested by the Shapiro-Wilk test, the conditions given applies to the body height, body posture, sit-ups and standing broad jump. All the remaining variables show other than regular data distribution.

Statistically important differences appeared in body posture ($t=3.21$; $p<0.01$) and reach while sitting test ($Z=-2,686$; $p < 0.01$) between the groups of girls and boys. Boys score worse in both tests. In further analysis of correlations with the given parametres, these two groups were assessed separately. The remaining variables were assessed as a whole set of data.

The number of children with a poor body posture is significant. Excellent or satisfactory body posture was observed in less than half of the sample.

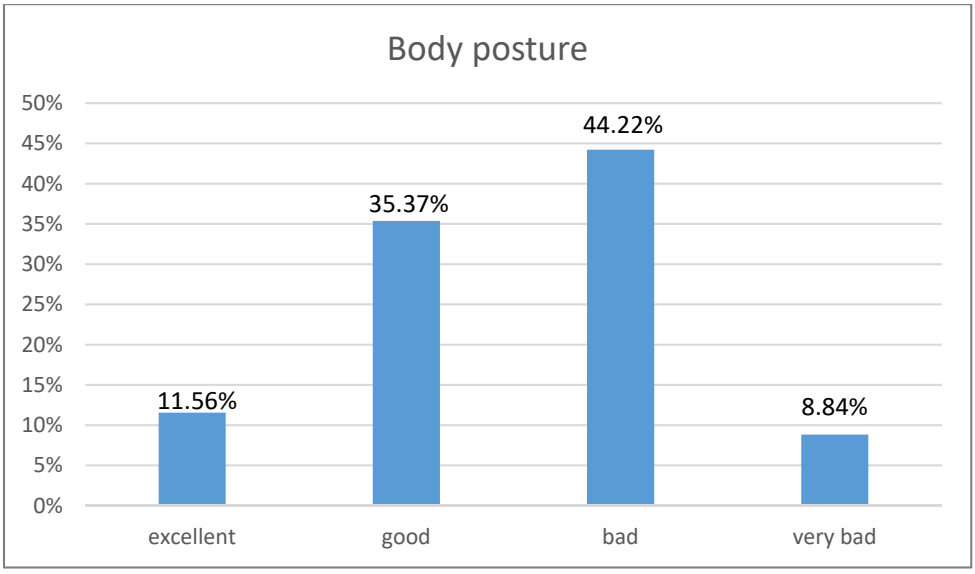

Figure 1. Body posture of the sample

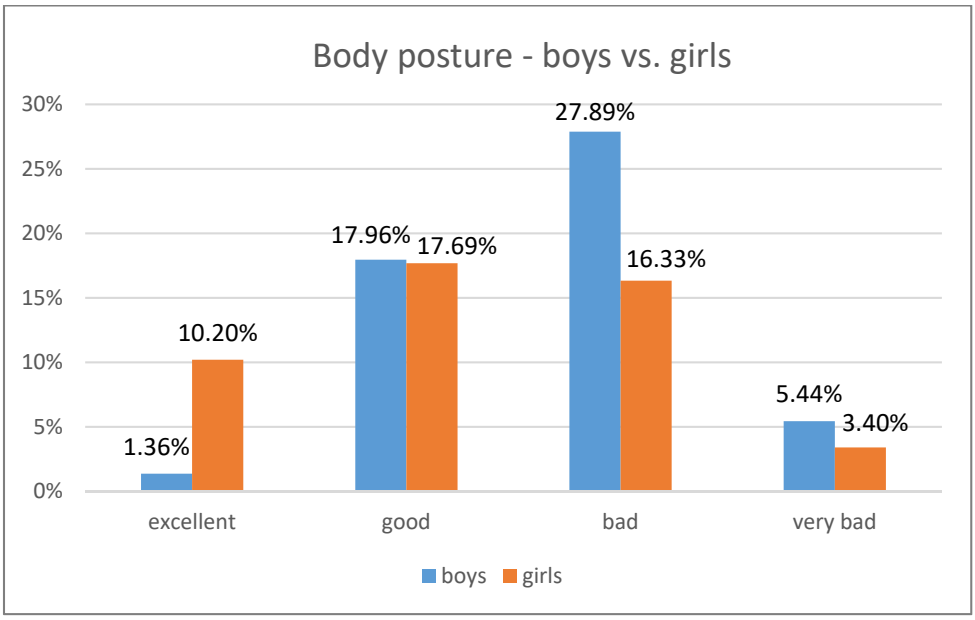

Figure 2. Gender differences in body posture

Results of correlation analysis

The figures of correlations between BMI index, height, age and body weight show a logical and expected relationship between the BMI index, body weight and the amount of subcutaneous fat. There is also a slight correlation between the body height and subcutaneous fat, thus in older and taller children a higher amount of the subcutaneous fat was measured.

Table 3. Correlation of data

Correlation			BMI percentil	Fat
Spearman's rho	Age	Correlation Coefficient	0.137	**0.176***
		p-value	0.097	0.033
	Height [cm]	Correlation Coefficient	**0.324****	**0.236****
		p-value	0.000	0.004
	Weight [kg]	Correlation Coefficient	**0.804****	**0.528****
		p-value	0.000	0.000
	BMI percentil	Correlation Coefficient		**0.625****
		p-value		0.000
**. Correlation is significant at the 0.01 level (2-tailed).				
*. Correlation is significant at the 0.05 level (2-tailed).				

Overall performance of children in physical fitness tests showed mutual dependence in most components of the physical fitness. There is a clear connection in performance in the shuttle run, standing jump, endurance run and sit-ups (good results in one test mostly showed also good results in another). However, the correlations measured were rather weak. The scores in reach test while sitting showed a certain connection with the standing broad jump test in both girls and boys, while weak dependence in the sit-ups test and shuttle run was measured in boys only (Table 4).

Table 4. Correlation between between components of the physical fitness

Correlation		Standing jump	1000 m run	Sit-ups	Reach while sitting - boys	Reach while sitting - girls
Shuttle run	Correlation Coefficient	**-0.355****	**-0.242***	-0.097	**-0.242***	-0.097
	p-value	0.000	0.034	0.426	0.034	0.426
	N	147	147	147	77	70
Standing broad jump	Correlation Coefficient		**0.233***	**0.351****	**0.233***	**0.351****
	p-value		0.042	0.003	0.042	0.003
	N		147	147	77	70
1000 m run	Correlation Coefficient			**0.225***	-0.170	-0.059
	p-value			0.049	0.139	0.627
	N			147	77	70
Sit-ups	Correlation Coefficient				**0.225***	0.071
	p-value				0.049	0.560
	N				77	70
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						

The amount of subcutaneous fat influences negatively almost all components of physical fitness. The extent of dependence, however, is rather small, the strongest relation measured was between the amount of subcutaneous fat and the endurance. No dependence was shown between the body fat and flexibility (reach while sitting).

The extent of correlation between BMI index and individual components of the physical fitness test showed only a small negative relation between BMI index and the performance in a 1000-m run – the higher the BMI index, the poorer performance in the run test.

In a group of boys, a small negative correlation was measured between the reach while sitting test and the body height – taller boys did worse in the test.

Table 5. Correlation between individual components of the physical fitness test and the body posture

Correlation			Shuttle run	Standing jump	1000 m run	Sit-ups	Reach while sitting – boys	Reach while sitting - girls
Spearman's rho	Age	Correlation Coefficient	0.216	-0.010	-0.041	0.134	-0.155	-0.205
		p-value	0.077	0.909	0.619	0.106	0.179	0.088
		N	147	147	147	147	77	70
	Height	Correlation Coefficient	-0.150	0.100	0.014	0.164	**-0.225***	-0.196
		p-value	0.069	0.229	0.868	0.088	0.049	0.103
		N	147	147	147	147	77	70
	Weight	Correlation Coefficient	-0.075	-0.022	.117	0.095	-0.111	-0.108
		p-value	0.367	0.787	0.159	0.252	0.338	0.375
		N	147	147	147	147	77	70
	BMI percentil	Correlation Coefficient	0.005	-0.159	**0.211***	-0.036	-0.047	0.023
		p-value	0.955	0.054	0.010	0.662	0.688	0.848
		N	147	147	147	147	77	70
	Fat	Correlation Coefficient	**0.281****	**-0.346****	**0.388****	**-0.280****	-0.185	-0.225
		p-value	0.001	0.000	0.000	0.001	0.107	0.062
		N	147	147	147	147	77	70
**. Correlation is significant at the 0.01 level (2-tailed).								
*. Correlation is significant at the 0.05 level (2-tailed).								

No significant relation appeared between individual components of the physical fitness test and the body posture.

However, certain relations between the amount of physical activity and particular components of the physical fitness were found. A slight positive dependence proved in shuttle run test and standing broad jump (more physical activity meant better results), the strongest relation appeared between the amount of physical activity and the results in a 1000-m run.

A small positive relation between the body posture and the amount of organized physical activity appeared in a group of girls.

The amount of physical activity negatively correlates with the amount of body fat – the more afterschool activities children have, the smaller amount of the body fat they have.

The amount of passive entertainment did not show any significant relationship with any other parameter measured.

Table 6. Correlation between the amount of physical activity and particular components of the physical fitness

Correlation			Physical activity	Passive entertainment	Body posture BOYS	Body posture - GIRLS
Spearman's rho	Age	Correlation Coefficient	-0.082	-0.019	0.092	0.141
		p-value	0.324	0.824	0.428	0.245
		N	147	147	77	70
	Height	Correlation Coefficient	0.009	-0.107	0.005	-0.117
		p-value	0.916	0.196	0.967	0.197
		N	147	147	77	70
	Weight	Correlation Coefficient	-0.019	-0.040	-0.093	-0.228
		P-value	0.819	0.629	0.422	0.057
		N	147	147	77	70
	BMI percentil	Correlation Coefficient	-0.091	0.033	-0.073	-0.035
		p-value	0.274	0.668	0.527	0.775
		N	147	147	77	70
	Fat	Correlation Coefficient	**-0.231****	-0.022	0.019	0.116
		p-value	0.005	0.793	0.871	0.340
		N	147	147	77	70
	Shuttle run	Correlation Coefficient	**-0.164***	0.035	-0.067	.173
		p-value	0.048	0.677	0.564	0.122
		N	147	147	77	70
	Standing broad jump	Correlation Coefficient	**0.207***	-0.040	-0.056	0.104
		p-value	0.012	0.634	0.627	0.393
		N	147	147	77	70
	1000 m run	Correlation Coefficient	**-0.344****	0.119	-0.026	0.235
		p-value	0.000	0.150	0.821	0.050
		N	147	147	77	70
	Sit-ups	Correlation Coefficient	0.090	-0.029	-0.045	-0.184
		p-value	0.276	0.725	0.695	0.126
		N	147	147	77	70
	Reach while sitting - boys	Correlation Coefficient	0.136	0.002	-0.106	
		p-value	0.239	0.989	0.357	
		N	77	77	77	
	Reach while sitting - girls	Correlation Coefficient	-0.001	0.075	0,123	-0.184
		p-value	0.995	0.537	0.311	0.126
		N	70	70	77	70
	Physical activity	Correlation Coefficient		-0.009	-0.097	**-0.240***
		p-value		0.913	0.401	0.045
		N		147	77	70
	Passive entertainment	Correlation Coefficient			0.043	-0.161
		p-value			0.707	0.183
		N			77	70

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Conclusions

An appropriate body posture is an important factor for the body to function effectively. Deviations from the correct body posture may result in serious health issues. The foundations and appropriate habits for a proper body posture are laid in childhood. It is also the moment when any possible deviations may be diagnosed and fixed. That is why it is so important to observe closely this age group.

The study has not shown any relations between the body posture and the individual components of physical fitness.

Based on the results of our study, the quality of the body posture is neither related to the performance in physical fitness tests nor to the amount of the passive entertainment, nor the amount of the organized physical activity. Only a feeble correlation between the quality of the body posture and the amount of the organized physical activity was measured in the group of girls, while boys have not showed such features. This may be explained by the types of activities girls are usually involved in – dance, ballet, gymnastics, etc., where the quality of the body posture plays an important role, however it is just a speculation.

The results in both groups of girls and boys are even. Boys scored worse in the reach while sitting test where a slight hindering factor was the body height (taller boys suffer more from shortened back thigh muscles). This may also be explained by a gender difference in the choice of activities practiced on regular basis, which may have an influence on this specific feature.

Children who practice an organized activity more often have a smaller amount of the subcutaneous body fat and score better in physical fitness tests. Most notably in the endurance test. Our findings correspond with previously conducted scientific studies in this matter.

Children with a higher amount of body fat showed poorer performance in all tests of the physical fitness. This creates the infamous vicious circle in which it is hard to tell the cause from the result, whether the body structure limits the performance or the lack of physical activity results in a higher amount of the body fat.

Although the amount of the body fat seems to be the limiting factor in all components of physical fitness, the BMI index correlated only with the endurance test. As expected, children with a higher BMI index scored worse in the 1000-m run.

As the children grow older and taller, the amount of body fat grows. Although the relations were rather weak, other studies conducted in this field show that the situation may get worse.

In young school-aged children the level of maturity and genetical factors may play a more important role than the amount of physical activity. This needs to be taken into consideration while making conclusions. From our findings, we may only predict a certain negative trend, which might get worse once puberty is reached, which again corresponds with the results of other studies.

As much as it is important to observe the body posture, the assessment methods are rather limiting in conducting further longitudinal or more extensive studies. The tests based on visual assessment will always be a question of a subjective evaluation. However, if the assessment of the whole study group is carried out by one experienced evaluator, preferably a physiotherapist, we may compare the result within such a group quite objectively and these results may serve their purpose. The assessment based on visual evaluation is not suitable for further longitudinal research and the results cannot really be compared with other studies. To make such a study more objective, 2-3 evaluators should be assessing the sample and the final results would be obtained in accordance with all 3 evaluators, based on the similarities in their assessment.

What is alarming, however, is the number of children with a poor body posture regardless of the amount of physical activity or the level of general fitness. This fact should be a strong impetus for adequate care and attention paid by teachers, sport educators and parents. Thus, corresponding compensatory activities, specific exercises dealing with body posture and observations of deviations in body posture should be their priority.

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