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Spine motion versus fatness in children and youth in the Vicinity of Cracow

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Summary

Introduction. Excessive fatness becomes a social problem. Often and often we can observe it in children and youth. Excess of fatty tissue can cause a lot of diseases and dysfunctions in whole body. This work is aimed at attempting to determine the effect of fatness and overweight on the lumbar spine motion.

Objective. The aim of the research was an attempt of evaluation of fatness and overweight on spine motion especially on lumbar spine and first of all to give an answer to following research question: 1. Is there any correlation between maximal forward flextion and fatness depending on sex?

Material and method. The research was carried out from January to February 2009 among 394 schoolchildren from primary school near Cracow. The subjects were group of 195 girls and 199 boys aged 7 to 12. The examination included measurement of BMI and sum of three skinfolds (subscapula skinfold, abdominal skinfold, triceps skinfold) in each child. Whole spine motion was examinated by fingers – floor test. The lumbar spine motion was examinated by Schober test.

Results. The statistically significant correlation (p?0,001) between maximal spine flexion and fatness in whole examination group was observed. Correlation was statistically significant at p≥0,01 between fingers – floor test and fatness characterized by BMI and sum of three skinfolds. There were no differences between influence of fatness on maximal spine flexion in Schober test in connection with children sex. There were observed some differences between groups of sex in fingers – floor test. The coefficient of correlation were not statistically significant in girls, the level of significant up to the mark of 10% for sum of three skinfolds and 10% for BMI.

Conclusions. Body fatness affects spine motion in primary school children.

Key words: spine, Schober test, fatness

INTRODUCTION

Nutrition disorders, particularly among children and teenagers, are one of the most crucial social and health problems and the most serious civilisation threat in the developed countries. Nutritional status of an organism is influenced by many factors, such as - among other things - food quality, absorption and influence of noxious agents. A proper development of organisms is conditioned by the intensity of those factors. Among contemporary teenagers, there is an increase in the number of people belonging to two contrasting groups. On the one hand, the number of overweight and obese children is growing quite fast, on the other, there are more and more girls who lack proper nutrition. It is caused by conscious food refusal and is reinforced by a desire to maintain a slim figure. Excessive supply of energy is a consequence of an increasingly consumptive way of life combined with availability of high-calorie food and a sedentary lifestyle. Those circumstances affect children so easily because firstly, they are exceptionally prone to environmental, media and commercial pressure and secondly, they cannot balance their diet or consciously and willingly give up pleasure. [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]

Excessive energy supply combined with reluctance to physical effort have a detrimental effect on mobility and flexibility of a child, particularly in the spine section. It also accounts for the development of faulty body posture which is caused by a long time spent in a sitting position at school, chairs and tables which are often improperly adapted for children's use, overburdened school bags or insufficient number of physical education lessons in a weekly lesson timetable. [12] From a mechanical point of view, spinal mobility disorders most frequently affect a lumbar section. It is the shortest section of the spine with large movement capacity but at the same time it is the most overloaded region of the spine. Limitation in lumbar flexibility may result from various factors, but the most frequent cause is undue tightness or muscle and ligament contracture as well as deformities within the spine. [13, 14]

OBJECTIVE

The research aimed at attempting to evaluate an influence of fatness and overweight on spinal mobility with particular consideration of lumbar section, and, first of all, to answer the following research question:

1. Is there a correlation between maximum forward bend and body fatness with regard to the gender?

MATERIAL

In January and February 2009, obesity and spinal mobility was examined among 393 children aged 7 to 12 years, attending primary school in one of the villages in the Kraków area. The examined group comprised 194 girls that amounts to 49.4% and 199 boys – 50.6%. (see Tab. 1.)

The height of the boys examined ranged from 116 cm to 177 cm – average height 139.8 cm. The body mass in the group of boys ranged from 20.8 kg to 79.6 kg – average body mass 36.7 kg. The height of the girls examined ranged from 115 cm to 169 cm – average height 139.8 cm. Body weight in the group of girls ranged from 17.7 kg to 65.3 kg – average body weight 35.2 kg.

METHOD

In order to determine basic parameters of the examined group of children, height measurement was taken by means of a Martin-type anthropometer.

A degree of fatness among children was estimated with a Harpenden skinfold calliper exerting the pressure of 10g/mm^2 to the contact surface.

The measurements of fat folds were taken in three sites:

1. Subscapular – a diagonal fold taken under the inferior angle of the scapula.
2. Abdominal – a diagonal fold approximately 5 cm to the side and 1cm below the navel.
3. Triceps – a vertical fold on the posterior line of the upper arm over the triceps muscle, halfway down the arm's length. [15]

Spinal mobility in the lumbar section was assessed on the basis the Schober's test. Two marks were made on a child's naked back: one at the level of the fifth lumbar vertebra L_5 and the other one 10 cm above the first mark. Then, the distance between them was measured during the maximum forward bend and during extension, with knees straight. On the basis of those measurements a degree of flexibility of the lumbar spine in the sagittal plane was determined. [16]

The parameters gathered during the examination were subjected to a statistical analysis.

Tab. 1. Number of children in particular age groups

Age (years)	Girls		Boys	
	N	%	N	%
7	30	15,5	31	15,6
8	30	15,5	36	18
9	30	15,5	31	15,6
10	33	17	39	19,6
11	38	19,5	30	15,1
12	33	17	32	16,1

RESULTS

Body fatness in the examined group of children was evaluated on the basis of BMI and the sum of three fat folds. An average value of BMI in the whole group equalled 18.1. The average BMI value amounted to 18.4 in the case of all the boys and 17.7 in the case of the girls. The average value of the sum of three fat folds in the whole group was 25.4. In the gender groups, the average value was similar: 25.5 in the boys and 25.3 in the girls. (see Tab. 2.)

The number of children with BMI above the 75th percentile and BMI below the 25th percentile was estimated. The data was compared against the percentile charts of the population of children from Kraków. [17] The results were shown in Graph 1 and 2.

The highest percentage of children with BMI values below the 25th percentile was observed in the group of 8-year-old boys (52.8%). A high percentage of overweight children was registered in the group of boys aged 11 and 12 years. Almost half of those boys had BMI values above the 75th percentile. BMI below the 25th percentile was noted among children in every age category. The highest percentage was observed in the group of 11-year-olds and equalled 6.7%. The percentage of underweight children was also high in the group of boys aged 9 years and was 12.9%. In the remaining age groups, only a small percentage of children had BMI values lower than the 25th percentile. In the group of boys in all age groups, the number of overweight children was higher than the percentage of children with BMI below the 25th percentile.

In the group of girls, excess weight was most frequently observed among 9 and 10-year-olds and 40% of them were diagnosed as overweight. The lowest percentage of girls with BMI above the 75th percentile was among 8-year-olds and reached 20%. BMI values below the 25th percentile were the most common among the girls aged 7 years and equalled 25%. The least frequent was among 10-year-olds and equalled 6.1%. Underweight was registered in almost all age groups and was more common among the girls.

The group of 11-year-old boys was an exception. Here the BMI value below the 25th percentile was slightly higher than among the girls in the same age group.

Graph 3 and 4 illustrates the percentage share of children in both gender groups in specific age categories and the sum value of three fat folds above the 75th percentile and below the 25th percentile.

The percentage of children with the sum value of three fat folds below the 25th percentile was predominant in the group of boys. The highest percentage was observed in the age group of 12 years which was registered in 45.2% of cases and the lowest in the group of 8 and 11-year-olds – 33.3% in each group. The sum value of three fat folds above the 75th percentile was registered in the highest percentage boys aged 10 years. The lowest number of such boys was noted in the group of 7-year-olds which amounted to 12.9%.

In the group of girls, the percentage of children with the sum value of three fat folds below the 25th percentile was higher in comparison with the girls with the values above the 75th percentile. This difference was less significant in the group of 9-year-old girls. The highest percentage share of girls with the sum of three fat folds above the 75th percentile was observed in the group of 10-year-olds which equalled 27.3% and the lowest in the group of 12-year-olds and it was 12.1%.

As regards the values below the 25th percentile, the highest percentage of girls in this category was registered among 8-year-olds and amounted to 60%, while the lowest was in the group aged 9 years and equalled 26.7%.

Flexibility of the lumbar spine was estimated on the basis of the Schober's test. The results in the gender categories are shown in Table 3.

In the sagittal plane, the test results of the forward bend above the norm were noted among 47.4% of all the examined children. Taking into consideration the gender, more than half of the boys and 40.7% of the girls had the values of the forward bend above the norm. Excessive spine extension was observed in almost three-quarters of the examined groups. In the gender groups, a higher percentage of girls displayed spine flexibility above the norm and equalled 75.3%, whereas in the case of boys the value was 70.4%.

In order to determine a correlation between the Schober's test results and a degree of body fatness, Spearman's rank correlation coefficient was applied. The rank corre-

Tab. 2. Average BMI values and sums of three skin folds

BMI	Whole group	Boys	Girls
x	18,1	18,4	11,7
sd	2,9	3,1	2,6
Me	17,6	17,7	17,2
min	11,9	13,9	11,9
max	33,7	33,7	27
Sum of three skinfolds	**Whole group**	**Boys**	**Girls**
x	25,4	25,5	25,3
sd	14,7	16,5	12,7
Me	21	19,6	21,6
min	8,1	8,1	9,3
max	120	120	91,3

lation was used in a statistical analysis because the distribution of the examined elements (BMI and the sum of three fat folds) differs from the normal distribution. Correlation coefficients are presented in Table 4.

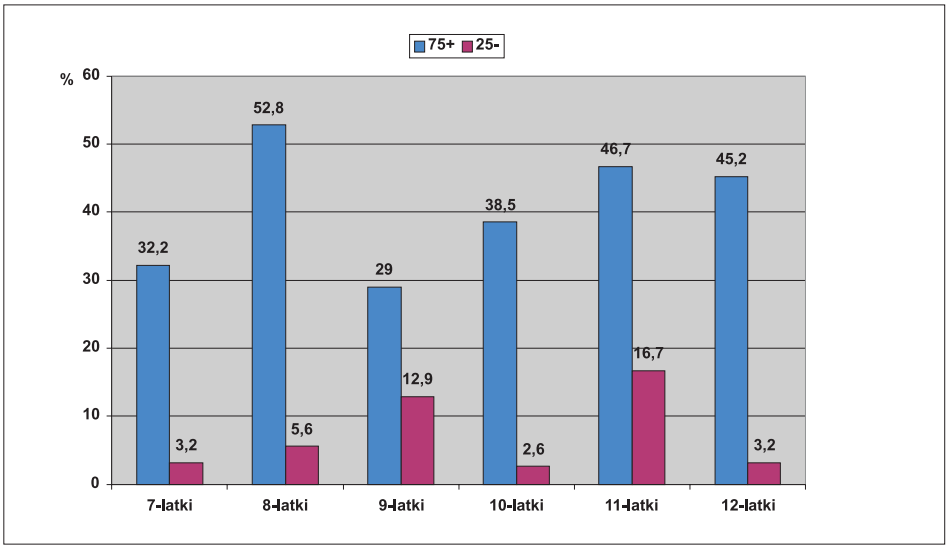
The correlation coefficient was significant on the level of $\alpha = 0.01$ in the case of the correlation of the maximum forward bend both with BMI and the sum of three fat folds in the whole examined group. The correlation of the examined factors with the maximum spine extension was not statistically significant. The differences were observed in the gender groups. Among the boys, the correlation coefficients were statistically significant in the case of the maximum spine extension both for BMI and the sum of three fat folds. Statistical significance reached the level of $\alpha = 0.05$ for BMI and $\alpha = 0.01$ for the sum of three fat folds. In the group of girls, statistical significance on the level of $\alpha = 0.01$ was noted for the correlation coefficients of the forward bend in relation to both of these factors. In this gender group, the correlation coefficients between the spine extension and. BMI and the sum of three fat folds had negative values. The coefficient value on the level of significance equalling $\alpha = 0.1$ was registered only for BMI.

A rank correlation was also carried out in two age groups for both of the genders. The first age group comprised children in grades 1-3 and the other one - in grades 4-6. The values of Spearman's rank correlation coefficient in those age categories are shown in Table 5.

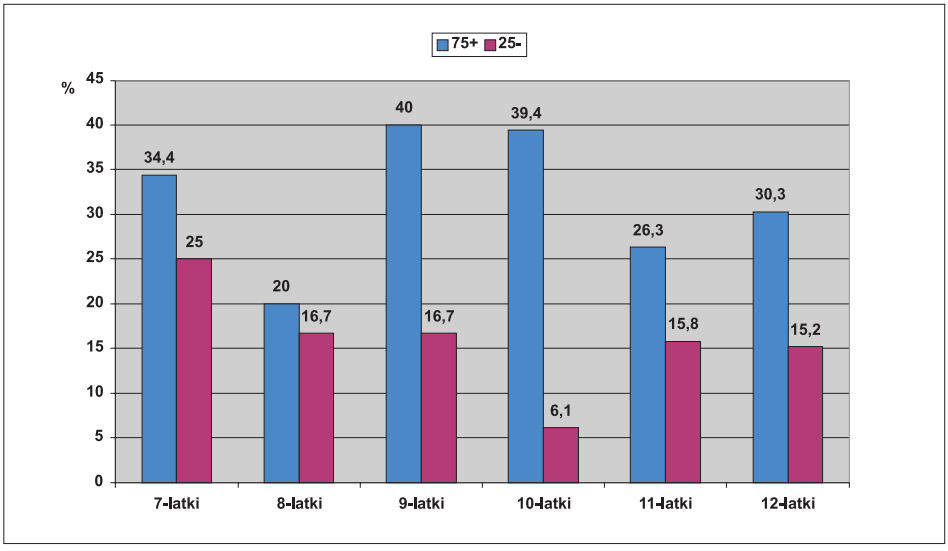
In the group of younger boys, the correlation of BMI and the sum of three fat folds with the maximum forward bend of the lumbar section was significant on the level of $\alpha = 0.01$. In the case of the spinal extension, the statistically significant correlation on the level of $\alpha = 0.01$ was observed only for the sum of three fat folds. In the group of boys in grades 4-6, all rank correlation coefficients were significant on the level of $\alpha = 0.01$.

In the group of girls in grades 1-3, the correlation of the symptoms of fatness with the forward bend proved to be statistically insignificant. The correlation of the

Graph 1. Percentage of boys with BMI above the 75th percentile and below the 25th percentile



Graph 2. Percentage of girls with BMI above the 75th percentile and below the 25th percentile



spinal extension with BMI was significant on the level of $\alpha = 0.05$. In the group of older girls, the situation was opposite. The forward bend was statistically significant on the level of $\alpha = 0.01$ for BMI and the sum of three fat folds, whereas the correlation coefficients of those features with the spinal extension were not statistically significant.

DISCUSSION

As it was already mentioned in the present study, overweight and obesity are nowadays one of the main health, social and psychological problems of children and adolescents. Both of them are common conditions which appear in the population of almost all contemporary societies. These disorders tend to be more and more frequent in highly developed countries. [7, 1] On the other hand, particularly in the case of girls, there is a growing occurrence of undernutrition which results from a conscious reduction of calorie intake caused by the influence of the media and fashion. [1]

In order to assess health status and development of children and teenagers, it is necessary to monitor nutrition. The evaluation can be carried out by means of a nutrition interview, general medical examination as well as biochemical and anthropometric examination. The last one is particularly important in the case of an imbalance in caloric intake and output. [11]

Determining obesity incidence during adolescence in different populations or making comparisons between countries or regions is very difficult. The existing discrepancies, regardless of the choice of research methods, result primarily from a diversity of the criteria applied to estimate excess body weight and from an application of various degrees of overweight. [7, 11]

Abramowicz et al. [8] state that taking into consideration IOTF (International Obesity Task Force) criteria, overweight and obesity are more frequent in comparison with Polish reference values. They maintain that in practice the BMI norms used in Poland and the interpretation of nutrition level based on BMI values may lead to overlooking a certain group of overweight children.

Ostrowska – Nawarycz et al. [5] rejected this assumption. They also pointed out the differences between the interpretation of the results by means of international standards and the interpretation by means of the local ones. They pointed out, however, that an estimation of overweight incidence during adolescence and an observation of trends should be carried out on the basis of the local standards binding in a particular country.

According to the standards used in Poland and referring to BMI measurements and percentile charts, the values in the range of the 90th and 97th percentile indicate overweight, whereas BMI equal to or above the 97th percentile indicates obesity. [6]

Tab. 3. Percentage share of children with Schober's test results above and below the norm

max. flexion	**Whole group**	**Boys**	**Girls**
above 15 cm	47,4%	53,8%	40,7%
below 15 cm	52,6%	46,2%	59,3%
max. extension	**Whole group**	**Boys**	**Girls**
above 8,5 cm	27,2%	29,6%	24,7%
below 8,5 cm	72,8%	70,4%	75,3%

Tab. 4. Correlation coefficients of BMI and the sum of three fat folds with spine flexibility in the whole group and in gender groups

Spine mobility	**Whole group**		**Boys**		**Girls**	
	BMI	**suma 3 fałdów**	**BMI**	**suma 3 fałdów**	**BMI**	**suma 3 fałdów**
max. flexion	0,351***	0,284***	0,431	0,353	0,262***	0,227***
max. extension	0,023	0,040	0,146**	0,200***	-0,115*	-0,049

* $\alpha = 0,1$; ** $\alpha = 0,05$; *** $\alpha = 0,01$

Tab. 5. Correlation coefficients of BMI and the sum of three fat folds with spine flexibility among younger and older children

Spine mobility	**Boys I - III**		**Girls I - III**	
	BMI	**Sum of three skinfolds**	**BMI**	**Sum of three skinfolds**
max. flexion	0,440***	0,376***	0,082	0,032
max. extension	0,131	0,174*	-0,272***	-0,208**
	Boys IV - VI		**Girls IV - VI**	
	BMI	**Sum of three skinfolds**	**BMI**	**Sum of three skinfolds**
max. flexion	0,447***	0,337***	0,346***	0,356***
max. extension	0,304***	0,284***	0,093	0,103

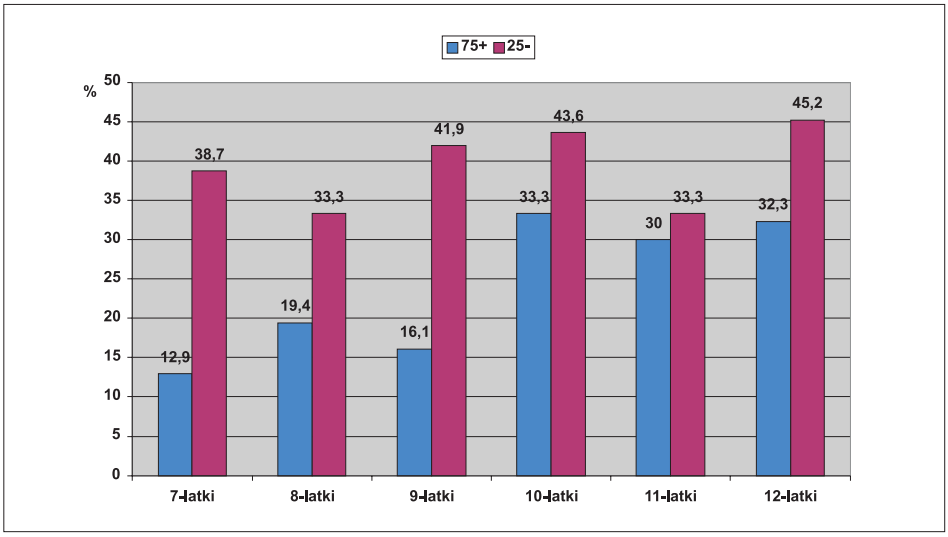
* $\alpha = 0,1$; ** $\alpha = 0,05$; *** $\alpha = 0,01$

In an all-Poland examination, Oblacińska, Wrocławska and Wojnarowska [7] made an evaluation of overweight and obesity incidence among school children. In the group of 2 098 170 children aged 7 to 16 years, excess weight was observed in 8.7% of the examined subjects, including 3.4% of obese children. Considering overweight and obesity with reference to the gender, the authors pointed out that the problem of excess body weight in Poland concerned mostly girls and was registered in 8.4% of cases, whereas among boys it was 8.0%.

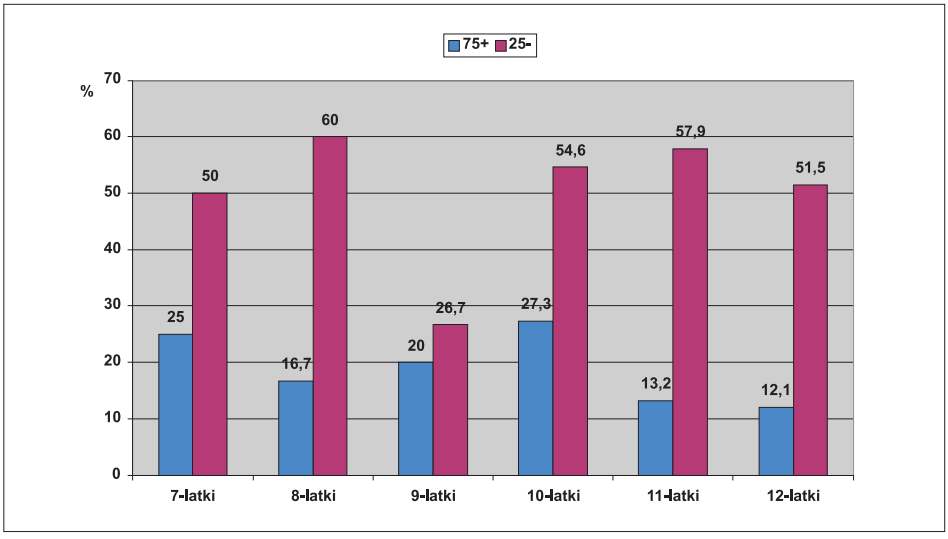
On the basis of her research, Chrzanowska [9] stated that the frequency of excess body weight among children examined in Kraków was diagnosed in 13.32% of cases. She also stressed the existence of overweight and obesity problem with regard to the gender. The fraction of overweight boys equalled 12.19% of the sample group and is relatively higher than the fraction of girls in which case it was 10.67%. The group of obese boys was also more numerous and amounted to 2.55%, whereas obese girls equalled 1.03%.

The same author [9] stated that a more frequent and dynamic increase in overweight can be observed among boys. In the present study, such a situation occurs only partly because excessive body weight indeed happens more frequently among the boys, but as far as the level of existing obesity is concerned, the problem is more common among the girls. The author also stresses the fact that overweight and obesity among children and teenagers increase in a dynamic way.

A long-term research carried out by Chrzanowska, Gołąb et al. [1] which concerned relative body weight and selected fat folds measured in children and adolescents from Kraków, proved that in the last thirty years, the level of average fatness in the population of children and teenagers in Kraków had increased. However, the results obtained by school-age boys and girls differed slightly in comparison with the results of children in the 80s. Such a situation most probably results from a profound social, economic and cultural transformation as well as the change in living conditions that took place in many families in Poland.



Graph 3. Percentage of boys with sum value of three fat folds above the 75th percentile and below the 25th percentile



Graph 4. Percentage of girls with sum value of three fat folds above the 75th percentile and below the 25th percentile

The examination carried out during the present research confirmed the existence of the problem of overweight and obesity among school-age children. Contrary to weight deficiency, excessive body weight evaluated on the basis of BMI was observed in a significantly higher percentage of cases in all age groups. BMI above the 75th percentile was different in both genders and depended on an age group. The highest percentage of excessive body weight was in the group of 8-year-old children.

Another method of anthropologic measurement of body fat is based on the sum of three fat folds. In the study, Chrzanowska et al. [1] stated that obesity assessed on the basis of the measurement of three skin folds and the calculation of the sum concerned 15.29% of the boys and 9.68% of the girls. The observation based on the gender group shows that that obesity is more common among the boys and is diagnosed in 11.1% of subjects, whereas in the case of girls the value amounts to 8.2%. The values of an insufficient level of fatness are different. This problem is more frequently associated with the girls and concerns 39.2% of them as opposed to 22.1% of the boys.

In the present study, the sum of three fat folds proved that there was a significantly higher percentage of children below the 25th percentile and a remarkably lower percentage of children above the 75th percentile in comparison with the results obtained by means of BMI. There was a higher percentage of girls below the 25th percentile than boys in all age categories with the exception of children aged 9 years.

Apart from overweight and obesity, low back pain is becoming an increasing threat too the contemporary people. Among other reasons, it is caused by limited lumbar flexibility. However, the most alarming is the fact that this condition seems to affect children and teenagers as well.

Low back pain syndrome is connected with lumbar flexibility, or more precisely, with its limitation. From a mechanical point of view, lumbar section is the weakest link in a locomotive organ. Mechanical overload and forces acting in this area are huge. In this way, tissue becomes worn out quickly which, in consequence, leads to back pains and mobility disorders. [13]

Dobosiewicz [17] clearly indicated that there was a dependence between pain conditions in the lumbar spine among school-age children and limited flexibility of the lumbar section.

Kutzner – Kozińska [13] stated that when applying the Schober's test in children, a forward bend in the lumbar section should be at least 5 cm.

In the present study, lumbar flexibility labelled as "above standard" was observed in a significant number of children. In the case of the forward bend in the sagittal plane, it referred to almost a half of the examined children, whereas in the case of the spinal extension, it was nearly three-quarters of the group. In the gender groups, a higher percentage of girls presented spine flexibility above standard in comparison with the boys. In the whole examined group, an important correlation between the maximum forward bend, both with BMI and the sum of three fat folds, was also observed although the correlation between the examined elements with maximum spinal extension was not statistically significant.

In the group of girls, BMI and the sum of three fat folds was statistically significant with the forward bend. In the group of boys, those features were significantly correlated only with the lumbar extension. In the group of younger girls, the ones with higher BMI and the sum of three fat folds had better results in the Schober's test. This tendency tended to disappear with age.

CONCLUSIONS

1. Body fatness has a negative effect on the spinal flexibility among school children.
2. Body fatness has a negative influence on the Schober's test values. The only exception are the girls aged 7-9 whose higher BMI values and the sums of three fat folds correlate with better results of the spinal extension.

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