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An attempt to determine the difference in the impact of loading with the mass of school supplies carried using the left- and right-hand thrust on body posture of 7-year-old pupils of both genders

[1]Mirosław Mrozkowiak

[1]Physiotherapy Practice AKTON, Warsaw

Abstract

Introduction. Periodically, the issue of overloading children with too heavy school backpacks is raised. **Material and methods**. Body posture tests were conducted in a group of 65 pupils aged 7 using mora projection in the following three positions: 1- habitual posture, 2 – body posture after pulling the container with school supplies for 10 minutes with the left hand, 3 - pull with the right hand. We measured physical fitness by means of the Sekita test. Then, we analysed the significance of differences between measurement 1 and 2, and measurement 3 and 4 to define the influence of load and correlation with physical fitness and to investigate which mode of transport, pulling with the left or right hand, disturbs body posture to a lesser extent.

Conclusions. 1. Transporting a 4-kilo mass of school supplies with the right or left hand disturbs the biomechanical statics of the body of a 7-year-old child with the same significant and negative effect, which may cause postural mistakes in the long term and consequently postural defects. Therefore, this method of transporting school items should not be recommended to first form pupils. 2. General physical fitness is of greater positive importance in biomechanical disorders of body posture among boys than girls. Among boys, the relationships of individual postural characteristics are similar in both modes of transport, and among girls, more relationships are observed in the case of right hand pulling. The most significant motor skills among boys include endurance and strength and among girls - speed and strength. 3. Restitution of the size of any of the analysed body posture features was not complete 1 and 2 minutes after stopping pulling with the right or left hand.

Key words: backpack, mora projection, body posture, physical fitness

Introduction

Periodically, at the turn of August and September, the issue of overloading children with too heavy school backpacks is raised suggesting the influence of this load on the initiation of various dysfunctions not only in the spinal region. According to exaggerated media reports, nearly 90% of children have postural defects. Own research carried out in a group of 10,517 children and adolescents in 13 selected provinces of Poland using the simplified orthopedic examination method has revealed the highest percentage of static disorders in the Małopolskie Voivodeship 93.39% and the lowest percentage in the Świętokrzyskie Voivodeship, i.e. 67.39%. Does this mean that 67% to 93% of children have postural defects, or is it only distorted symmetry in the frontal and transverse plane and incorrect size of the sagittal spinal curvatures? In accordance with the definition of a postural defect, reversible disorders in the biomechanics of posture are not defects. The studies revealed about 10-15% of postural defects. On the contrary, the highest percentage of normal postures was found in the Świętokrzyskie Voivodship, i.e. 32.6% and the lowest in the Małopolskie Voivodeship - 6.79% [1]. Skawiński's research [2] on the level of knowledge in the field of prevention of posture defects among 121 children and teenagers in primary and junior high school showed, among others, that 75.8% of respondents were aware of the negative effects of incorrect body posture on health, 11.7% represented an extremely different viewpoint, 10.8% did not know this influence, 77.5% could notice the impact of long-term sitting position on the body posture, 35% were convinced of the optimal proportions of the school chair and table, and 89.2% of respondents confirmed the negative impact of too much weight of the school backpack on the posture. At the same time, it was shown that 5% of respondents believed that the weight of the backpack had no effect on posture, the same percentage had no knowledge on the subject, 48.3% of respondents wore the backpack alternately on both shoulders, and 36.6% on one shoulder, whereas 21.7 % of students did not attach importance to this. A review of media reports clearly shows that orthopaedists and physiotherapists do not recommend "a container on wheels". Instead they suggest a wheelchair pushed in front of a pupil or a backpack with wheels.

The author's interest in this topic stems from the persistently high percentage of static posture disorders in the oldest group of pre-school children and the primary grades 1-3, from the permanently expressed opinion on the negative effects of the carriage of school supplies on static posture and from the lack of unequivocal recommendations for optimal carriage and contraindications of the negative transporting of school supplies. The general purpose of the research program is an attempt to determine the influence of the weight load of school supplies transported in the school way, that is, on the right shoulder, on the left shoulder, on the back, on the chest, on the back and chest, obliquely on the left shoulder and on the right hip, and obliquely on the right shoulder and on the left hip. The partial goal is to show which method of carrying school supplies is more conducive to a 7-year-old pupil's body posture: pulling a container with the left or right hand.

1. Research material

The research was conducted in accordance with the principles of the Helsinki Declaration, and for research purposes the consent of: a pupil, its legal guardian, tutor, kindergarten management, and bioethics committee (KEBN 2/2018, UKW Bydgoszcz) was obtained. The type of biomechanical body static disorders was not an exclusion criterion for participation in the research program. The division of respondents into rural and urban environment was abandoned due to the fact that this feature would never determine the homogeneity of the group, but only the blurred cultural and economic border of both environments. The age of the children was defined by the number of completed months of life on the day of each test. The study included 65 children from randomly selected kindergartens of the Zachodnio-Pomorskie and Wielkopolskie Voivodships. The research was carried out from 27 May 2019 for nine consecutive days, always between 9 a.m. and 2 p.m. and in the same properly prepared room. On the first day, all children participated in the training during which they were provided by the researcher with the necessary information on the purpose, course and behaviour during the study. Children were also encouraged to maintain the anthropometric points marked on the skin. During the measurements, the preschool teacher's assistant of the examined group was always present, which was to ensure the emotional stability of the children. The accepted rules of the research procedure were observed during the study.

The total of 65 pupils participated in the program with 53.84% (35 individuals) being girls and 46.15% being boys (30 individuals). The average body weight (Mc) among girls was 24.46 kg and body height (Wc) was 123.87, whereas among boys the values were 24.56, kg, 123 cm, respectively. All children had a slender body type according to Rohrer's weight-height ratio (IR).

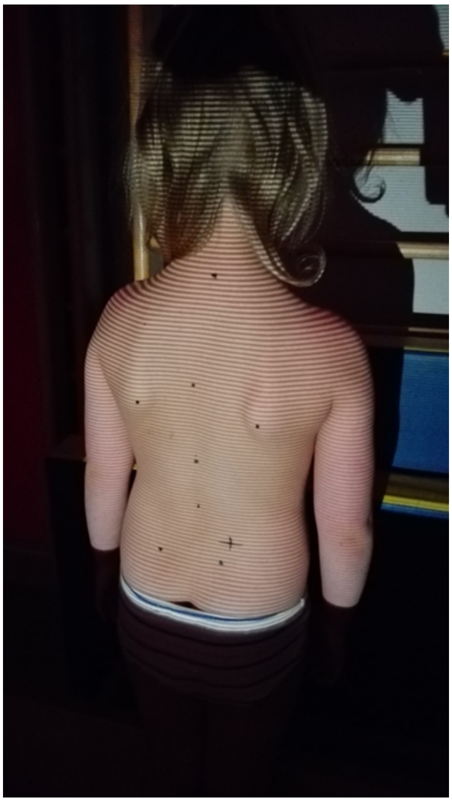
2. Research method

Overall physical fitness

The Wroclaw fitness test for children between the age of 3 to 7 years was used to diagnose children's physical fitness [3]. According to the author, the test has a high degree of reliability and is adequate in terms of discrimination power and difficulty level. The proposed test consists of four trials conducted in the form of the Sport Day, which significantly increased their motivation to exercise in the presence of parents. The author added the fifth test - endurance. P.w. – standing start, Movement – a 300-meter run. The running time from start to finish was assessed. If the child did not finish the race, it received "0" points. The race took place on the recreational path with a hardened surface, observing all safety rules.

Body posture

The measurements were carried out according to the developed procedure, always with the same tools and by the same people. The presence of the teacher’s assistant was dictated by the need to minimize the time elapsing from removing the load until the second recording of the postural feature values. The load time for children was the average time taken to travel from home to school and was 10 minutes as specified in the survey by the pupil's guardian. On the other hand, the load was determined by averaging the mass of school supplies carried by first grade children from a randomly selected primary school. In the second position a spring dynamometer was used. The proximal end with a handle was held by the examined person, and the distal end with the cord was stabilized. The manner of holding and thrust of the dynamometer handle imitating the handle of the pulled container was in no way affected. The angle of the cord line corresponded to the individual inclination angle of the handle of the carried container with school supplies and was from 40^{o} to 45^{o}. The pulling force indicated by the dynamometer ranged from 1 kg to 2 kg.



Source: author’s own research

Fig. 1. Position 1: habitual posture

Source: author’s own research

Fig. 2. Position 3: posture with asymmetrical load pulled with the right hand


Source: author's own research

Fig. 3. Position 2: posture with asymmetrical load pulled with the left hand

The measurement of the selected postural features was conducted in four positions related to the right-hand thrust (Fig. 2) and four positions related to the left-hand thrust (Fig. 3):

Position 1: habitual posture, Fig. 1.

Position 2: posture with asymmetric load pulled with one hand, Fig. 2, 3.

Position 3: posture after one minute from removing the load, Fig. 1.

Position 4. posture after two minutes from removing the load, Fig. 1.

Each research day, children were subjected to four positions of load. On the first day, measurements included all children in positions 1, 2, 3 and 4 with the right-hand thrust and on the following day - in positions 1, 2, 3 and 4 using the left-hand thrust. In this way, the authors tried to exclude overlapping of postural muscle fatigue during examination from one position to another. On each day, the first recording of the values of postural features took place in a habitual posture, and the second one in the last 5 seconds of the assumed time of the current posture with load. The third recording took place in the habitual posture one minute after the load was removed, and the fourth one in the existing posture two minutes after removing the load. This is in line with the author's previous research results which have shown that after this time the traits can have the initial values [6]. When diagnosing the habitual posture in the first edition, it could be assumed that the position was appropriate and relatively constant for each student. However, to maintain research reliability, it was assumed that any inconsistency with the feature values from the first edition of measurements could influence the final test result. Therefore, before applying the body posture load provided for in the procedure, the characteristics of habitual posture were always identified as a reference for subsequent dynamic changes in the diagnosed postural features. The height and weight of children as well as the weight of carried school accessories were measured with a medical scale before the first day of the study.

The measuring stand dedicated for the assessment of selected postural features consisted a computer, a card, software, a display monitor, a printer and a projection-reception device with a camera to measure selected parameters of the pelvis-spine complex and feet. The camera was levelled in the sagittal, frontal and transverse planes also according to a child's toe line. Obtaining the spatial picture was possible thanks to displaying the lines of strictly defined parameters on a child's back. The lines, falling on the skin of the child got distorted depending on the configuration of the surface. The applied lens ensured that the imaging of the subject could be received by a special optical system with a camera, then transmitted to the computer monitor. The distortions of the line imaging recorded in the computer memory were processed through a numerical algorithm on the topographic map of the investigated surface [4]. The obtained image of the back surface enabled multi-faceted interpretation of body posture. In addition to assessing the torso asymmetry in the frontal plane, it is possible to determine the values of angular and linear features describing the pelvis and physiological curvatures in the sagittal and transverse plane. The most important thing in this method is the simultaneous measurement of all real values of the spatial location of individual body sections. Due to the research methodology, the authors resigned from examining a child standing on the strain gauge mat.

To minimize the risk of measurement errors as regards selected postural features, the following test procedure was developed [21]:

1. The habitual posture of the subject with a thin and bright necklace against the background of a white, slightly illuminated sheet: free, unforced posture, with feet

slightly spaced apart, extended knee and hip joints, arms dangling along the torso and eyes directed straight ahead, back to the camera in the appropriate distance from it.

2. Marking the following points on the skin of the child's back: the peak of the spinous process of the last cervical vertebra (C_7), the spinous process at the peak of thoracic kyphosis (KP), the spinous process at the peak of lumbar lordosis (LL), the place where thoracic kyphosis goes into lumbar lordosis (PL), lower shoulder blades (Łl and Łp), upper posterior iliac spines (Ml and Mp), vertebra S_1 and point SP. A white necklace was placed on the neck of the subject for the purpose of unambiguous marking of points B_1 and B_3, and long hair was tied.
3. After entering the necessary data about the respondent (name and surname, year of birth, body weight and height, remarks on: the condition of knees and heels, chest, injuries, surgical procedures, musculoskeletal disorders, gait, etc.), a digital image of the back and feet is recorded in the computer memory in each of the four positions from the middle phase of exhalation.
4. Having saved the mathematical characteristics of photos into the computer memory, the size of the features describing the body posture spatially is printed, Fig. 4.
5. The recorded images are processed without the participation of the examined individual.

MAGMAR Olsztyn
Mirosław Mrozkowiak
tel.602 529 652

KOMPUTEROWE BADANIE POSTAWY CIAŁA

Nazwisko: [redacted] Wzrost: 119 cm, Rok ur. 1993 ,
Dane: 1SP1MK\0CIOLL00, Data badania: 2000-12-02, Wydruk dnia,2001-01-23
Wywiad: Uwagi:

Parametry globalne

Długość kręgosłupa DCK 346.6 [mm] czyli 29.1 % wzrostu
Kąty pochylenia [st] : ALFA 10.1, BETA 15.2, GAMMA 13.9, Łącznie: 39.2 [st]
Kąt pochylenia tułowia: KPT 6.3 [st]. Wskaźnik kompensacji 3.8 [st]

Kifoza piersiowa

D.LL_C7 DKP 309.9 [mm] (89.4%) Kąt KKP 150.9 [st]
D.PL_C7 RKP 195.7 [mm] (56.5%) Głębokość GKP 32.7 [mm] (WKP 0.167)

Lordoza lędźwiowa

D.S1_KP DLL 271.2 [mm] (78.2%) Kąt KLL 154.7 [st]
D.S1_PL RLL 150.9 [mm] (43.5%) Głębokość GLL -30.8 [mm] (WLL -0.204)

Płaszczyzna czołowa

Kat nachylenia tułowia KNT 1.4 [st]
Lewy bark wyżej o 8.2 [mm] Kąt linii barków KLB -1.7 [st]
L.łopatka wyżej o 6.1[mm] (-2.4st)(UL), bliżej o 20.6[mm] (-8.0st)(UB)
R. oddal. łopatek od kręgosłupa OL: 2.4 [mm] (1.7%)
Lewy tr.talii wyższy o -46.2 [mm] (TT) szerszy o -14.7 [mm] (TS)
Miednica: kąt nachylenia KNM 1.5 [st], kąt skręcenia KSM -6.4 [st]
Wsp.asym.barków względem KK WBS=-10.5 (-3.8%), wzg.C7 WBC= 6.3 (2.3%)
Wsp.asym.bark-miednica pion WBK= 10.2 (1.9%) poziom WBX= -10.5 (-5.3%)
Maks. odch. l.wyrost. kol. od C7_S1 UK 11.1 [mm] na wys.Th6

OPIS

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CQ Elektronik System, mgr inż. Artur Swierc, ul.Na Niskich Łąkach 19/2, Wrocław, tel. 0601 794162

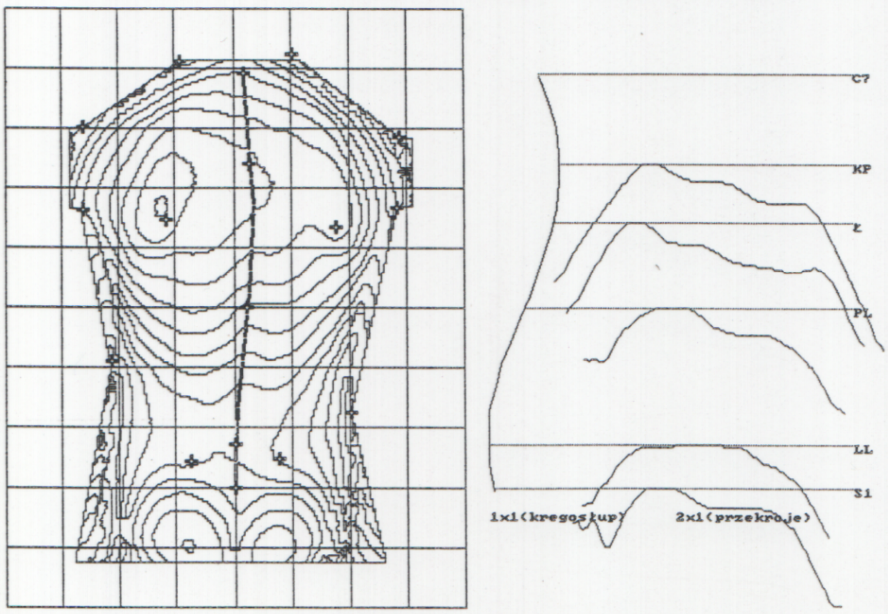

Fig. 4. Worksheet of measurement results for body posture features of the spine-pelvis complex
Source: author's own research

3. Research subject

The Wrocław fitness test allows one to determine the level of strength, power, speed and agility of preschool children. The author enriched the Sekita test with an endurance test. Definitions of examined conditioning and comprehensive motor skills are generally available in reference literature.

The measuring device defines several dozen postural features. 36 angular and linear features of the spine, pelvis and torso in the sagittal, frontal, and transverse planes as well as body mass and height were selected for statistical analysis. The authors appreciated the need for the most reliable and spatially full view of a child's body posture, which allowed full identification of the measured factors, Tab. 1, Fig. 1.

Tab. 1. List of recorded trunk and morphological parameters

No.	Symbol	Parameters		
		Unit	Name	Description
Sagittal plane				
1	Alpha	degrees	Inclination of lumbo-sacral region	
2	Beta	degree	Inclination of thoracolumbar region	
3	Gamma	degree	Inclination of upper thoracic region	
4	Delta	degree	The sum of angles	Delta = Alfa + Beta + Gamma
5	KPT	degree	Angle of extension	Defined as a deviation of the C7-S1 line from vertical position (backwards)
6	KPT -	degree	Angle of body bent	Defined as a deviation of the C7-S1 line from vertical position (forwards)
7	DKP	mm	Thoracic kyphosis length	Distance between LL and C_7
8	KKP	degree	Thoracic kyphosis angle	KKP = 180 – (Beta+Gamma)
9	RKP	mm	Thoracic kyphosis height	Distance between points C7 and PL
10	GKP	mm	Thoracic kyphosis depth	Distance measured horizontally between the vertical lines passing through points PL and KP
11	DLL	mm	Lumbar lordosis length	Distance measured between points S1 and KP
12	KLL	degree	Angle of lumbar lordosis	KLL = 180 – (Alfa + Beta)

13	RLL	mm	Lumbar lordosis height	Distance between points S1 and PL
14	GLL -	mm	Lumbar lordosis depth	Distance measured horizontally between the vertical lines passing through points PL and LL
Frontal plane				
15	KNT -	degree	Angle of body bent to the side	Defined as deviation of the C7-S1 line from the vertical axis to the left
16	KNT	degree		Defined as deviation of the C7-S1 line from the vertical axis to the right
17	KLB	degree	Shoulder line angle, right shoulder up	Angle between the horizontal line and the straight line passing through points B_2 and B_4
18	KLB –	degree	Shoulder line angle, left shoulder up	
19	UL	degree	Angle of scapula line, right scapula up	Angle between the horizontal line and the straight line passing through points Ł1 and Łp
20	UL -	degree	Angle of scapula line, left scapula up	
21	OL	mm	Lower angle of left scapula more distant	Difference of the distance of lower angles of scapulas from the line of spinous processes measured horizontally along the lines passing through points Łl and Łp
22	OL -	mm	Lower angle of right scapula more distant	
23	TT	mm	Left waist triangle up	Difference of the distance measured vertically between points T1 and T2, T3 and T4.
24	TT –	mm	Right waist triangle up	
25	TS	mm	Left waist triangle wider	Difference of the distance measured horizontally between straight lines passing through points T1 and T2, T3 and T4
26	TS -	mm	Right waist triangle wider	
27	KNM	degree	Pelvis tilt, right ilium up	Angle between the horizontal line and the straight line passing through points M1 and Mp
28	KNM -	degree	Pelvis tilt, left ilium up	

29	UK	mm	Maximum inclination of the spinous process to the right	Maximal deviation of the spinous process from the line from S1. The distance is measured in horizontal line.
30	UK -	mm	Maximum inclination of the spinous process to the left.	
31	Vertebrae number	-	Number of vertebrae maximally deviated to the left or right	Number of vertebrae most deviated to the left or right in the asymmetrical line of spinous processes, counting as 1 the first cervical vertebrae (C_1). If the arithmetic mean takes the value of e.g. from 12.0 to 12.5, it is Th_5, if from 12.6 to 12.9 it is Th_6.
Transverse plane				
32	UB –	degree	Angle of projection line of lower scapula angles, the left one more convex	Difference in the angles UB1 – UB2. Angle UB2 between: the line passing through point Łl and at the same time perpendicular to the camera axis and the straight line passing through points Łl and Łp. Angle UB1 between the line passing through point Łp and perpendicular to the camera axis and the straight line passing through points Łp and Łl.
33	UB	degree	Angle of projection line of lower scapula angles, the right one more convex	
34	KSM	degree	Pelvis rotated to the right	Angle between the line passing through point M1 and perpendicular to the camera axis and the straight line passing through points M1 and MP
35	KSM -	degree	Pelvis rotated to the left	Angle between the line passing through point Mp and perpendicular to the camera axis and the straight line passing through points Ml and MP
36	DCK	mm	Total length of the spine	Distance between C_7 and S_1, measured in vertical axis
Morphological features				
37	Mc	kg	Body mass	Measurement of body height and weight conducted by means of a digital medical scale
38	Wc	cm	Body height	

Source: author's own research

4. Research questions and hypotheses

The following research questions arise from the research objective:

1. Which of the methods of carrying school supplies disturbs body posture to a lesser extent?
2. Which method of carrying school supplies is more affected by physical fitness, which postural feature?
3. Which method of carrying school supplies results in complete restitution of the values of postural features?

Own study results and the analysis of available literature suggest that:

1. The method of carriage of school supplies with the left hand disturbs static body posture to a lesser extent.
2. A greater impact of physical fitness is observed in the transport of the mass of school supplies with the left hand. The most influential abilities include endurance, speed, power and agility, whereas the ability with the least impact is strength.
3. Restitution of the values of postural features is faster after transporting the mass of school items with the left hand.

5. Statistical methods

Only the results achieved in accordance with the adopted procedure were qualified for statistical analysis and were implemented in the IBM SPSS Statistics 26 program. At the initial stage, Shapiro-Wilk and Kolmogorov-Smirnov tests were used to check whether the distributions of the analysed variables were consistent with the normal distribution. For most variables, statistically significant deviations from the normal distribution were found at $p < 0.05$. Therefore, it was decided to apply nonparametric tests and coefficients in statistical analysis. The Wilcoxon rank test was used to determine whether there was a statistically significant difference (change) between the two measurements of quotient variable (in the same group) the distribution of which significantly deviated from the normal. The following symbols were used in the tables: M - arithmetic mean, Me - median, SD - standard deviation, Z - Wilcoxon test statistics, "p" - significance of the Wilcoxon test. Significance levels were set at $p < 0.05$. Therefore, if $p < 0.05$, the difference between measurements is statistically significant. Spearman's rho correlation coefficient was applied to establish any statistically significant correlations between variables measured at the quotient level whose distribution significantly deviated from normal. If correlation is statistically significant at the level of $p < 0.05$, then the rho correlation ration should be interpreted. It may range from -1 to +1. The more distant the coefficient is from 0 and the closer it is to -1 or +1, the stronger the correlation. Negative values mean that as the value of one variable increases, the value of the other variable decreases. On the other hand, positive values show that as the value of one variable increases, the value of the other variable increases.

There was also made an analysis of the correlation between the results of five physical fitness tests and the average difference between measurement 1 and 2, measurement 2 and 3, and measurement 3 and 4 relating to the values of features in the posture assumed during the right and left hand thrust, broken down by sex. The difference between the measurements was given in absolute values, so that negative differences would also indicate the size of the change. We took into account only those pupils who had been subjected to both physical fitness tests and body posture measurements, which considerably reduced the size of the group involved in the study. For this reason, it was impossible to calculate correlations for some variables. If this is the case, there are empty cells in the tables. Statistically significant correlations are marked with a grey background.

Individual values of postural traits are expressed in various ranges so it is not possible to calculate the average difference for all these variables between two measurements. An analysis conducted in such a way would distort the results and increase the significance of the variables where values are higher by definition, and reduce the significance of those variables with values lower by definition. Therefore, the assessment of correlations between the average difference in the values of postural features between measurement 2 and 1 using the right-hand and left-hand thrust, and physical fitness was made separately for girls and boys, using absolute quantities, i.e. the ratio of the difference to the initial value was used in the calculations instead of exact quantities. Owing to such an approach no variables are over- or underrepresented in the average result.

6. Results

The total of 65 subjects of both genders were involved in the study, which allowed to record 9,815 values of features describing body posture in habitual position and dynamic positions, body weight and height as well as physical fitness.

Considering the differences between measurement 1 and 3, and measurement 1 and 2 regarding posture feature values in the case of the right-hand thrust among boys, the Wilcoxon rank test showed statistically significant differences in terms of all analysed variables. As to measurement 1 and 4, significant differences were also observed in all investigated values except for feature Alpha: inclination of lumbo-sacral region, Tab. 1, 2.

Table 1. Significance of differences in the values of postural features between measurement 1 and 2, 3 and 4 in the right-hand thrust among boys

Right-hand thrust - boys	Measu-re-ment 1	Measu-re-ment 2	Measurement 3	Measu-re-ment 4	Test U-W		
	Me	Me	Me	Me	2/1 p	3/1 p	4/1 p
DCK	314.05	287.60	296.50	307.05	<0.001	<0.001	<0.001
Alpha	8.45	11.25	9.90	9.25	<0.001	<0.001	0.089
Beta	9.75	20.50	16.35	14.70	<0.001	<0.001	<0.001
Gamma	11.20	18.80	15.40	13.20	<0.001	<0.001	<0.001
Delta	29.65	50.30	41.70	36.15	<0.001	<0.001	<0.001
KPT-	4.25	1.80	2.55	3.50	<0.001	<0.001	<0.001
KPT+	4.75	12.65	9.60	5.95	0.005	0.005	0.005
DKP	279.00	261.30	270.55	273.20	<0.001	<0.001	<0.001
KKP	159.00	140.40	148.30	151.90	<0.001	<0.001	<0.001
RKP	185.30	170.15	178.30	181.35	<0.001	<0.001	<0.001
GKP	19.95	37.10	27.45	23.10	<0.001	<0.001	<0.001
DLL	247.00	236.05	241.15	242.20	<0.001	<0.001	<0.001
KLL	161.95	148.70	154.10	157.60	<0.001	<0.001	<0.001
RLL	135.60	126.05	128.70	131.85	<0.001	<0.001	<0.001
GLL	24.45	26.15	25.25	24.65	<0.001	<0.001	<0.001
KNT-	1.40	0.20	0.70	1.05	<0.001	<0.001	<0.001
KNT+	2.35	12.80	6.50	4.30	0.012	0.012	0.012
KLB-	1.90	10.65	6.50	4.00	0.017	0.012	0.011
KLB+	1.05	0.30	0.45	0.75	<0.001	<0.001	<0.001
UL-	4.15	10.50	6.15	4.10	0.012	0.012	0.049
UL+	1.95	0.50	0.90	1.20	<0.001	<0.001	<0.001

UB-	3.30	10.20	5.45	3.85	0.012	0.012	0.012
UB+	3.65	0.80	1.20	2.05	<0.001	<0.001	<0.001
OL-	8.10	1.20	2.80	4.20	<0.001	<0.001	<0.001
OL+	4.30	10.85	6.50	5.25	0.012	0.012	0.011
TT-	4.80	12.65	6.55	5.40	0.012	0.012	0.011
TT+	8.30	0.70	2.45	4.70	<0.001	<0.001	<0.001
TS-	5.10	17.60	9.65	7.15	0.012	0.012	0.011
TS+	8.35	0.85	2.45	5.95	<0.001	<0.001	<0.001
KNM-	7.50	1.10	2.80	5.80	<0.001	<0.001	<0.001
KNM+	3.40	14.60	10.40	4.30	0.008	0.008	0.008
KSM-	2.45	7.75	6.30	3.95	0.012	0.012	0.012
KSM+	5.50	0.80	2.10	3.50	<0.001	<0.001	<0.001
UK-	1.50	13.00	7.60	3.75	0.012	0.012	0.012
UK+	6.95	0.75	3.70	4.85	<0.001	<0.001	<0.001

Source: author's own research

Looking at the differences between measurement 1 and 2, measurement 1 and 3, and 1 and 4 concerning the values of posture features using the right-hand thrust among girls, the Wilcoxon rank test presented statistically significant differences within all analysed variables, Tab. 3.

Table 3. Significance of differences in the values of postural features between measurement 1 and 2, 3 and 4 in the right-hand thrust among girls

Body posture feature	Measu-re-ment 1	Measu-re-ment 2	Measure-ment 3	Measu-re-ment 4	Test U-W		
	Me	Me	Me	Me	2/1 p	3/1 p	4/1 p
DCK	294.10	271.35	281.45	289.90	<0.001	<0.001	<0.001
Alpha	8.90	11.50	10.30	9.60	<0.001	<0.001	0.002
Beta	11.20	21.10	17.45	14.80	<0.001	<0.001	<0.001
Gamma	11.25	18.90	15.70	13.70	<0.001	<0.001	<0.001
Delta	31.00	51.85	43.10	38.10	<0.001	<0.001	<0.001
KPT-	4.10	1.60	2.40	3.20	<0.001	<0.001	<0.001
KPT+	4.20	12.50	7.90	5.70	<0.001	<0.001	<0.001
DKP	276.25	258.80	264.50	270.80	<0.001	<0.001	<0.001
KKP	157.70	139.60	147.85	151.45	<0.001	<0.001	<0.001
RKP	176.90	160.90	169.30	173.30	<0.001	<0.001	<0.001
GKP	20.45	37.60	26.50	23.10	<0.001	<0.001	<0.001
DLL	248.15	238.90	241.00	244.60	<0.001	<0.001	<0.001
KLL	159.70	147.60	152.25	155.55	<0.001	<0.001	<0.001
RLL	129.15	119.35	122.35	124.55	<0.001	<0.001	<0.001
GLL	23.40	24.35	24.00	23.60	<0.001	<0.001	<0.001
KNT-	0.40	0.10	0.20	0.30	0.001	0.001	0.001
KNT+	0.80	11.50	5.40	2.70	<0.001	<0.001	<0.001
KLB-	1.40	10.50	5.40	3.20	<0.001	<0.001	<0.001
KLB+	1.50	0.20	0.60	1.10	0.001	0.001	0.001
UL-	2.80	10.50	5.40	3.60	<0.001	<0.001	<0.001
UL+	3.20	0.70	1.10	2.10	0.001	0.001	0.001
UB-	2.70	10.50	5.40	3.20	<0.001	<0.001	<0.001
UB+	2.80	0.70	1.30	1.90	0.001	0.001	0.001

OL-	7.60	1.10	2.40	3.20	0.001	0.001	0.001
OL+	4.30	11.50	7.60	6.20	<0.001	<0.001	0.001
TT-	4.70	14.30	7.30	5.80	<0.001	<0.001	<0.001
TT+	4.80	0.80	1.50	2.90	0.001	0.001	0.001
TS-	4.90	16.50	9.90	6.50	<0.001	<0.001	<0.001
TS+	5.10	0.80	1.50	3.10	0.001	0.001	0.001
KNM-	2.70	0.70	1.50	2.40	0.001	0.001	0.001
KNM+	2.90	13.80	8.40	5.10	<0.001	<0.001	<0.001
KSM-	2.90	7.90	6.10	4.10	<0.001	<0.001	<0.001
KSM+	4.10	0.50	1.50	2.70	0.001	0.001	0.001
UK-	2.40	12.80	7.60	4.70	<0.001	<0.001	<0.001
UK+	3.70	0.50	1.70	2.90	0.001	0.001	0.001

Source: author's own research

Taking into account the differences between measurement 1 and 2, measurement 1 and 3, and 1 and 4 concerning the values of posture features using the left-hand thrust among girls and boys, the Wilcoxon rank test revealed statistically significant differences in terms of all analysed variables, Tab. 4, 5.

Table 4. Significance of differences in the values of postural features between measurement 1 and 2, 3 and 4 in the left-hand thrust among boys

Body posture feature	Measu-re-ment 1	Measu-re-ment 2	Measure-ment 3	Measu-re-ment 4	Test U-W		
	Me	Me	Me	Me	2/1 p	3/1 p	4/1 p
DCK	314.05	298.00	302.90	308.30	<0.001	<0.001	<0.001
Alpha	8.45	13.10	11.40	10.20	<0.001	<0.001	<0.001
Beta	9.75	18.20	14.40	11.75	<0.001	<0.001	<0.001
Gamma	11.20	19.80	17.40	15.20	<0.001	<0.001	<0.001
Delta	29.65	50.95	43.20	37.30	<0.001	<0.001	<0.001
KPT-	4.15	12.60	7.60	5.40	<0.001	<0.001	<0.001
KPT+	4.75	0.65	1.35	2.40	0.005	0.005	0.005
DKP	279.00	262.95	270.00	274.00	<0.001	<0.001	<0.001
KKP	159.00	141.90	148.70	152.45	<0.001	<0.001	<0.001
RKP	185.30	170.85	178.65	182.20	<0.001	<0.001	<0.001
GKP	19.95	37.70	29.40	24.85	<0.001	<0.001	<0.001
DLL	247.00	237.40	242.00	243.70	<0.001	<0.001	<0.001
KLL	161.95	149.10	153.40	158.35	<0.001	<0.001	<0.001
RLL	135.60	127.60	129.60	132.55	<0.001	<0.001	<0.001
GLL	24.45	27.25	25.55	24.85	<0.001	<0.001	<0.001
KNT-	1.40	13.55	6.70	3.80	<0.001	<0.001	<0.001
KNT+	2.35	0.25	0.85	1.20	0.012	0.018	0.027
KLB-	1.90	0.40	1.05	1.50	0.012	0.012	0.018
KLB+	1.05	13.15	6.60	3.25	<0.001	<0.001	<0.001
UL-	4.15	0.65	1.40	3.15	0.011	0.011	0.018

UL+	1.95	12.60	7.55	3.70	<0.001	<0.001	<0.001
UB-	3.30	0.75	1.25	2.50	0.012	0.012	0.011
UB+	4.00	12.55	7.70	5.80	<0.001	<0.001	<0.001
OL-	8.10	14.30	12.50	10.10	<0.001	<0.001	<0.001
OL+	4.30	0.70	2.10	2.75	0.012	0.017	0.017
TT-	4.80	0.90	1.70	2.90	0.012	0.012	0.011
TT+	8.30	22.45	14.55	10.35	<0.001	<0.001	<0.001
TS-	5.10	7.60	7.35	5.40	0.012	0.012	0.011
TS+	8.35	17.20	11.25	9.30	<0.001	<0.001	<0.001
KNM-	7.50	16.50	12.40	9.40	<0.001	<0.001	<0.001
KNM+	3.40	0.20	2.10	3.10	0.008	0.008	0.007
KSM-	2.45	0.40	1.50	1.55	0.012	0.012	0.012
KSM+	5.50	16.50	10.55	7.20	<0.001	<0.001	<0.001
UK-	1.50	0.40	0.70	1.10	0.012	0.012	0.011
UK+	6.95	19.10	12.95	10.35	<0.001	<0.001	<0.001

Source: author's own research

Table 5. Significance of differences in the values of postural features between measurement 1 and 2, 3 and 4 in the left-hand thrust among girls

Body posture feature	Measu-re-ment 1	Measu-re-ment 2	Measure-ment 3	Measu-re-ment 4	Test U-W		
	Me	Me	Me	Me	2/1 p	3/1 p	4/1 p
DCK	294.10	278.40	284.45	288.70	<0.001	<0.001	<0.001
Alpha	8.90	13.75	12.20	9.75	<0.001	<0.001	<0.001
Beta	11.20	19.40	15.95	13.40	<0.001	<0.001	<0.001
Gamma	11.25	19.85	17.60	15.45	<0.001	<0.001	<0.001
Delta	31.00	52.65	45.00	38.85	<0.001	<0.001	<0.001
KPT-	4.10	12.60	7.10	5.10	<0.001	<0.001	<0.001
KPT+	4.20	0.60	1.30	2.10	<0.001	0.005	<0.001
DKP	276.25	260.40	267.85	272.35	<0.001	<0.001	<0.001
KKP	157.70	140.55	146.70	151.60	<0.001	<0.001	<0.001
RKP	176.90	162.85	169.05	173.00	<0.001	<0.001	<0.001
GKP	20.45	38.45	29.85	25.40	<0.001	<0.001	<0.001
DLL	248.15	238.10	242.55	244.90	<0.001	<0.001	<0.001
KLL	159.90	146.95	152.30	156.60	<0.001	<0.001	<0.001
RLL	129.15	120.45	124.10	125.95	<0.001	<0.001	<0.001
GLL	23.40	26.50	24.95	23.75	<0.001	<0.001	<0.001
KNT-	0.40	13.60	7.60	3.20	0.001	0.001	0.001
KNT+	0.80	0.20	0.40	0.60	<0.001	<0.001	<0.001
KLB-	1.40	0.30	0.70	1.10	<0.001	<0.001	0.003
KLB+	1.50	13.60	6.50	3.10	0.001	0.001	0.001
UL-	2.80	0.40	1.00	1.90	<0.001	0.002	<0.001
UL+	3.20	12.50	6.90	5.30	0.001	0.001	0.001

UB-	2.70	0.40	1.10	1.90	<0.00 1	<0.00 1	<0.00 1
UB+	2.80	12.70	7.80	4.80	0.001	0.001	0.001
OL-	7.60	15.40	11.80	9.40	0.001	0.001	0.001
OL+	4.30	0.50	1.90	3.20	<0.00 1	<0.00 1	<0.00 1
TT-	4.70	0.90	2.10	2.80	<0.00 1	<0.00 1	<0.00 1
TT+	4.80	20.40	13.50	6.50	0.001	0.001	0.001
TS-	4.90	6.90	6.40	5.10	<0.00 1	<0.00 1	<0.00 1
TS+	5.10	14.80	7.80	6.80	0.001	0.001	0.001
KNM-	2.70	16.50	12.10	5.40	0.001	0.001	0.001
KNM+	2.90	0.20	1.40	2.50	<0.00 1	<0.00 1	<0.00 1
KSM-	2.90	0.30	1.30	2.10	<0.00 1	<0.00 1	<0.00 1
KSM+	4.10	15.40	10.30	5.60	0.001	0.001	0.001
UK-	3.10	0.50	1.30	2.10	<0.00 1	<0.00 1	<0.00 1
UK+	3.70	18.60	12.10	5.70	0.001	0.001	0.001

Source: author’s own research

The analysis of correlations between physical fitness tests and differences in the values of body posture features in measurement 1 and 2 and measurement 3 and 4 using the right-hand thrust among boys suggested that the greater endurance the lower differences within variables of Alpha, KLL, TT+ and TS-, and the bigger the difference in the case of variable KLB+. In turn, the higher the speed, the smaller the difference in variable DLL. The greater the strength, the smaller the difference between variable DLL and KNM-, and the greater the variable Gamma. Power and agility do not correlate with the difference in any of the variables. The greater the overall physical fitness, the smaller the differences in Alpha, DLL and TT +. However, taking into account the left hand thrust mode, it turned out that the greater the endurance, the smaller the differences of variable KLB +. Yet, the higher the speed, the greater the difference of TS +. The greater the strength, the greater the differences in variables: Gamma, Delta, KNM- and UK +. The greater the power, the greater the difference in variable GLL, and the greater the agility, the greater the difference in variable KNM-. General physical fitness positively correlates only with the change in UK +, Tab. 6.

Table 6. Correlations between physical fitness and average differences in measurement 1 and 2, 3 and 4 concerning the values of postural features in the right- and left-hand thrust among boys

Variable	Right-hand thrust						Left-hand thrust					
	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
DCK	0.09	0.23	0.21	0.08	-0.09	0.15	-0.30	-0.08	-0.41	-0.30	-0.40	-0.50
Alpha	-0.57*	-0.23	-0.30	-0.45	-0.34	-0.54*	-0.35	0.06	0.46	0.11	0.17	0.22
Beta	-0.34	-0.31	-0.45	-0.12	-0.19	-0.42	0.29	0.13	-0.19	-0.28	-0.02	0.00
Gamma	0.20	0.19	0.52*	0.22	0.20	0.46	-0.23	-0.02	0.63*	-0.10	0.28	0.29
Delta	-0.46	-0.13	0.07	-0.09	0.12	-0.17	-0.12	0.13	0.71*	-0.08	0.30	0.44
KPT-	0.22	0.37	-0.33	-0.29	-0.15	-0.18	-0.07	0.04	0.64	0.01	0.40	0.55
KPT+	0.55	0.23	0.34	0.09	0.46	0.57	-0.20	-0.37	-0.51	0.27	-0.70	-0.46
DKP	-0.45	-0.49	-0.30	-0.14	-0.22	-0.45	-0.04	-0.38	-0.27	0.21	0.00	-0.12
KKP	-0.01	-0.11	-0.07	-0.04	0.05	0.00	-0.09	0.00	0.58	-0.09	0.22	0.36
RKP	-0.11	-0.22	-0.22	-0.05	0.13	-0.18	-0.11	-0.43	-0.32	-0.09	-0.04	-0.29
GKP	-0.29	-0.33	-0.32	0.46	-0.10	-0.17	-0.10	-0.24	-0.35	-0.01	-0.11	-0.29
DLL	-0.32	-0.55*	-0.61*	-0.04	-0.32	-0.56*	0.13	-0.43	-0.15	-0.15	0.26	0.00
KLL	-0.59*	-0.16	-0.08	-0.09	0.08	-0.27	0.10	0.21	0.50	-0.23	0.35	0.43
RLL	-0.04	0.17	-0.16	-0.03	-0.37	-0.18	-0.23	0.03	-0.10	-0.16	-0.22	-0.13
GLL	0.01	-0.32	-0.09	0.05	0.27	0.02	-0.38	-0.29	0.34	0.58*	0.07	0.25
KNT-	-0.08	0.28	-0.20	-0.41	-0.23	-0.20	-0.15	-0.43	-0.03	0.23	-0.16	-0.09
KNT+	0.80	0.95	-0.74	-0.26	-0.80	-0.60		0.74	-0.95	-0.78	-0.60	-0.80
KLB-	0.80	0.21	-0.63	-0.78	0.00	-0.40	-0.80**	-0.21	0.63	0.78	0.00	0.40
KLB+	0.70*	0.35	0.17	-0.39	0.32	0.43	-0.74	-0.52	-0.22	0.15	-0.31	-0.52
UL-		0.74	-0.95	-0.78	-0.60	-0.80		-0.74	0.95	0.78	0.60	0.80
UL+	0.09	0.19	0.15	0.28	-0.29	0.07	0.01	-0.01	-0.19	-0.38	0.13	-0.13
UB-	0.40	0.21	-0.63	-0.78	-0.40	-0.80	-0.40	-0.63	0.21	-0.26	0.40	0.00
UB+	0.01	-0.48	-0.46	-0.02	-0.26	-0.29	0.01	0.24	0.32	0.28	0.18	0.25
OL-	0.27	-0.35	0.02	0.23	0.02	0.19	0.06	0.12	-0.24	-0.18	-0.03	-0.17
OL+	-0.60	-0.95	0.74	0.26		0.80	0.00	0.63	-0.21	0.26	-0.80	-0.40
TT-	0.40	0.63	-0.21	0.26	-0.40	0.00	-0.40	0.32	0.32	0.78	-0.40	0.20
TT+	-0.68*	-0.20	-0.47	-0.44	-0.27	-0.69*	0.03	-0.36	0.49	0.13	0.31	0.46
TS-	-0.40	0.32	0.32	0.78	-0.40	0.20	0.74	0.89	-0.89	-0.54	-0.95	-0.95
TS+	-0.67*	-0.25	-0.17	-0.10	0.01	-0.37	-0.05	0.62*	0.14	0.37	-0.08	0.14
KNM-	-0.38	-0.20	-0.75**	-0.13	-0.56	-0.68	0.11	0.03	0.64*	-0.03	0.68*	0.53
KNM+	0.40	-0.32	-0.32	-0.78	0.40	-0.20		-0.74	0.95	0.78	0.60	0.80
KSM-	0.40	-0.11	-0.11	-0.26	0.40	0.20	-0.80	-0.21	0.63	0.78	0.00	0.40
KSM+	0.01	-0.28	-0.33	0.07	-0.44	-0.21	0.18	-0.07	0.37	-0.05	0.49	0.32
UK-		0.74	-0.95	-0.78	-0.60	-0.80	-0.80	-0.21	0.63	0.78	0.00	0.40
UK+	-0.51	0.12	-0.50	-0.49	-0.26	-0.57	0.15	0.13	0.78*	0.41	0.58	0.73*

The analysis of correlations between physical fitness tests results and significant differences in the value of posture features in measurement 1 and 2, and measurement 3 and

4, using the right-hand thrust among girls has shown that the higher the speed, the greater the differences in variables Delta and KLL and the smaller the difference in variable OL-. The greater the power, the smaller the difference in RKP. The bigger the power, the smaller the difference in variable DKP. The greater the agility, the smaller the difference in RKP and the greater the difference in KLL. Overall physical fitness does not significantly correlate with any of the studied variables. In turn, considering the left-hand thrust, it turned out that the greater the endurance, the smaller the difference in variable Gamma, and the greater the agility, the greater the difference in variable KLL. Speed, strength, power as well as overall fitness do not significantly correlate with the difference in any of the variables, Table 7.

Table 7. Correlations between physical fitness and average differences in measurement 1 and 2, 3 and 4 concerning the values of postural features in the right- and left-hand thrust among girls

Variable	Right-hand thrust						Left-hand thrust					
	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
DCK	0.06	-0.26	-0.27	0.49	-0.44	-0.22	0.19	-0.38	-0.15	0.21	0.05	-0.12
Alpha	-0.22	0.42	-0.11	-0.36	0.05	-0.14	0.20	0.56	0.14	-0.22	0.46	0.25
Beta	0.07	0.40	0.29	-0.45	0.40	0.32	-0.08	0.01	0.36	0.09	-0.03	0.21
Gamma	-0.23	0.30	0.10	-0.52	0.23	0.05	-0.66*	-0.41	-0.51	-0.26	-0.55	-0.53
Delta	0.09	0.72**	0.30	-0.49	0.53	0.38	-0.21	0.31	0.19	-0.42	0.32	0.11
KPT-	0.05	-0.22	0.53	0.48	0.41	0.43	0.00	0.61	0.00	-0.30	-0.03	-0.02
KPT+	-0.80	-0.20	0.00	-0.95	0.20	-0.40	0.20	0.80	0.45	0.11	0.00	0.40
DKP	-0.02	0.20	0.00	-0.73*	0.28	0.06	-0.14	-0.15	-0.06	-0.50	0.26	-0.08
KKP	0.08	0.50	0.29	-0.48	0.45	0.36	-0.38	-0.11	0.04	-0.14	-0.31	-0.09
RKP	-0.28	-0.26	-0.76**	0.01	-0.68*	-0.59	-0.07	-0.01	-0.26	0.02	-0.28	-0.18
GKP	-0.07	-0.32	-0.08	0.37	-0.06	0.06	-0.51	-0.40	-0.40	-0.23	-0.31	-0.38
DLL	-0.16	0.25	-0.11	-0.44	0.12	0.00	0.29	0.24	0.15	-0.02	0.38	0.29
KLL	0.20	0.68*	0.42	-0.30	0.59*	0.47	0.20	0.57	0.48	-0.29	0.61*	0.47
RLL	0.11	0.08	-0.14	-0.21	-0.11	-0.13	-0.40	0.17	-0.50	-0.45	-0.47	-0.40
GLL	0.34	0.12	0.32	0.12	0.34	0.29	0.04	0.59	-0.12	-0.19	0.00	0.06
KNT-	0.01	-0.31	0.37	0.19	0.05	0.18	-0.60	-0.46	-0.46	0.27	-0.50	-0.60
KNT+	0.63	0.80	0.63	0.20	0.80	0.80	0.74	-0.40	-0.32	0.40	-0.40	-0.40
KLB-	-0.11	0.80	-0.32	-0.80	0.00	0.00	0.63	-0.40	0.63		0.40	0.40
KLB+	0.55	0.46	0.17	-0.43	0.40	0.41	-0.31	-0.42	-0.11	0.46	-0.28	-0.19
UL-	0.50	0.32	-0.50	-0.32	-0.32	-0.32	0.11	-0.80	0.32	0.80	0.00	0.00
UL+	0.43	0.02	0.41	-0.06	0.78*	0.48	-0.62	-0.36	-0.47	-0.08	-0.90	-0.67
UB-	-0.95	-0.40	-0.32	-0.40	-0.40	-0.40	0.95	0.40	0.32	0.40	0.40	0.40
UB+	0.26	0.34	0.16	-0.32	0.14	0.17	-0.31	-0.28	0.01	0.28	-0.05	-0.10
OL-	-0.34	-0.81*	-0.30	0.01	-0.37	-0.31	0.13	0.12	0.37	0.11	0.30	0.36
OL+	0.95	-0.20	0.32	0.80	0.20	0.20	0.74	-0.40	-0.32	0.40	-0.40	-0.40
TT-	-0.32	0.00	-0.95	-0.80	-0.80	-0.80	0.63	-0.40	0.63		0.40	0.40
TT+	0.36	-0.07	0.54	0.33	0.08	0.36	-0.24	-0.19	0.09	0.70	-0.19	-0.05
TS-	-0.63	0.40	-0.63		-0.40	-0.40	-0.74	-0.20	0.32	0.00	0.20	0.20
TS+	0.21	-0.41	0.10	0.55	-0.20	0.10	-0.05	-0.10	0.22	0.38	0.16	0.00
KNM-	0.05	-0.30	-0.10	0.17	-0.19	0.02	-0.47	0.00	-0.14	-0.03	-0.19	-0.37
KNM+	0.74	0.20	-0.32	0.00	-0.20	-0.20	0.95	-0.20	0.32	0.80	0.20	0.20
KSM-	0.11		0.32	-0.40	0.60	0.60	-0.11		-0.32	0.40	-0.60	-0.60
KSM+	-0.21	-0.50	0.24	0.09	0.12	-0.02	0.24	0.31	-0.25	-0.27	-0.19	-0.02
UK-	0.95	-0.20	0.32	0.80	0.20	0.20	0.11	-0.80	0.32	0.80	0.00	0.00
UK+	0.26	-0.12	0.57	0.43	0.07	0.41	-0.55	-0.20	0.21	-0.38	-0.08	-0.24

7. Discourse

The literature concerning this subject is scarce. In fact, only Mrozkowiak [6] and Romanowska [7] have attempted to describe changes due to the loading of a pupil's body posture with an external mass. Both authors came to very similar conclusions in their investigations. The influence of symmetrical six-kilogram load on the upper limb girdle of 12-year-old girls revealed insignificant changes in the values of selected body posture features. This effect also showed a full restitution of the values of the diagnosed features two minutes after the load was removed. The return to initial values after the first minute was more intense. The author also came to the conclusion that the symmetrically distributed load has little effect on the spinal-pelvic complex in the frontal plane, including right-sided scoliosis at Th_3.

Changes in body posture statics during the carriage of school supplies using the left- or right-hand thrust to pull a container among students of both sexes showed significant changes in the values of the diagnosed postural features. This is evidenced by significant differences in all features between measurement 1 and 2. However, these changes are not dependent on gender. The analysis also showed the importance of restitution concerning the values of body posture features. The return of changed values of postural features after the first and the second minute was not complete. This can be demonstrated by significant differences between measurement 1 and 2, and measurement 3 and 4. The author showed the impact of general physical fitness and individual motor skills on average significant differences in the values of features between measurement 1 and 2, and measurement 3 and 4. Among boys, when pulling the container with the right hand, strength and endurance have the greatest influence whereas speed is less influential. However, power and agility do not affect any of the differences. Overall physical fitness has little effect on differences in the values of features. When pulling a container with the left hand, strength is most important, power and agility are less important, while speed is insignificant. Overall physical fitness influences variable UK +. However, among girls, in the case of right-hand carriage, speed and power have the greatest impact, and force is less important. Endurance, agility and overall physical fitness are not meaningful at all. When pulling a container with the left hand, endurance and agility are most important. Speed, strength, power and general physical fitness are insignificant.

Considerations on which method of transporting the weight of school supplies has a less destructive effect on body posture, the right- or left-hand thrust, are pointless. Statistical analysis of the values of measurements concerning selected postural features clearly indicates that none of the methods should be practiced by 7-year-old children. Both methods modulate body posture in the same negative way and both significantly disturb the habitual stability of posture. It should be assumed that the longer and the more intense the analyzed carriage method and the larger the weight of school supplies, the greater negative adaptation changes will be. The age of surveyed students is also important. Epigenetic factors of a pupil's environment will affect ongoing posturogenesis, in accordance with Arndt-Schultz law, and any weight load of school supplies is part of this environment. The presented overall fitness as well as the influence of its individual features have a different meaning which is greater among boys in the case of left- and right-hand thrust. As far as girls are concerned, general physical fitness does not matter, and the impact of individual abilities is lower than among boys. In addition, the effect is greater with the right hand.

8. **Conclusions**

1. Transporting a 4-kilo mass of school supplies with the right or left hand disturbs the biomechanical statics of the body of a 7-year-old child with the same significant and negative effect, which may cause postural mistakes in the long term and consequently postural defects. Therefore, this method of transporting school items should not be recommended to first form pupils.
2. General physical fitness is of greater positive importance in biomechanical disorders of body posture among boys than girls. Among boys, the relationships of individual postural characteristics are similar in both modes of transport, and among girls, more relationships are observed in the case of right hand pulling. The most significant motor skills among boys include endurance and strength and among girls - speed and strength.
3. Restitution of the size of any of the analysed body posture features was not complete 1 and 2 minutes after stopping pulling with the right or left hand.

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