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Restitution of the size of postural features in the sagittal and transverse plane after loading with the weight of school items carried with the right or left hand in 7-year-old pupils of both sexes

Restytucja wielkości cech postawy w płaszczyźnie strzałkowej i poprzecznej po obciążeniu masą transportowanych przyborów szkolnych w trybie ciągu lewą i prawą ręką uczniów obojga płci w wieku 7 lat

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Abstract
Material, methods. The study covered 65 pupils aged 7, using the mora projection method in four positions: 1 – habitual posture 2 – posture after pulling a container with supplies with right hand for 10 minutes, then with left hand, 3 – one minute after removing the load, 4 – two minutes after removing the load. Physical fitness was measured using the Sekita test. Significance of differences between measurement 2 and 3, and 3 and 4 was analysed to determine restitution of the size of traits after loading and correlation with physical fitness to examine the relationship with differences. Conclusions. (1) Having excluded the load of transported mass, statistically significant restitution occurred after one and two minutes. Restitution was incomplete and independent of gender. (2) In right-hand transport by boys, after one minute, speed and strength significantly correlated with restitution, and after two minutes, endurance, speed, strength and agility correlated with it. Among girls, after one minute, restitution correlated with strength, and after two minutes with endurance and strength. (3) In left-hand transport by boys, after one minute, restitution correlated with strength, power agility and overall fitness, and after two minutes, with endurance, speed, agility and overall physical fitness. Among girls, after one minute, restitution correlated with endurance, speed, strength and agility, after two minutes, with endurance, speed, agility and overall fitness. (4) Due to incomplete restitution of the size of posture, asymmetrical transport is not recommended to 7-year-old children. Physical fitness in children does not cause complete restitution of examined postural.

Key words:
schoolbags, body posture, mora projection, physical fitness, restitution

Streszczenie
Wstęp. Analiza środowiska ucznia to zbiór stresorów pola ekologii człowieka.
Materiał, metoda. Badania postawy ciała przeprowadzono w grupie 65 uczniów w wieku 7 lat metodą mory projekcyjnej w 8 pozycjach (4 dla ciągu ręką prawą i 4 dla ciągu lewą): 1 – postawie habitualnej, 2 – postawie po 10-minutowym ciągnięciu pojemnika z przyborami szkolnymi jednorącz, 3 – po jednej minucie od zdjęcia obciążenia, 4 – po dwóch minutach od zdjęcia obciążenia. Dokonano pomiaru sprawności fizycznej testem Sekity. Analizowano istotność różnic między 1 a 2, 3 i 4 pomiarem dla określenia restytucji wielkości cech po obciążeniu oraz ich korelacji ze sprawnością fizyczną, dla zbadania związku z badanymi różnicami.
Wnioski. 1. Istotna statystycznie, niepełna i niezależna od płci restytucja wystąpiła po pierwszej i drugiej minucie. 2. W transporcie prawą ręką przez chłopców z restytucją po pierwszej minucie istotnie związana jest szybkość i siła, po drugiej wytrzymałość, szybkość, moc i zwinność. Wśród dziewcząt po pierwszej minucie restytucji z siłą, a po drugiej z wytrzymałością i siłą. 3. W transporcie lewą ręką przez chłopców z restytucją po pierwszej minucie związana jest siła, moc, zwinność i ogólna sprawność fizyczną, a po drugiej wytrzymałość, szybkość, zwinność i ogólna sprawność fizyczna. Wśród dziewcząt z restytucją po pierwszej minucie związana jest wytrzymałość, szybkość, siła i zwinność, a po drugiej z wytrzymałością, szybkością, zwinnością i ogólną sprawnością fizyczną. 4. Ze względu na niepełną restytucję wielkości cech postawy asymetryczny transport nie jest wskazany dla dzieci w wieku 7 lat. Posiadana przez dzieci niska sprawność fizyczna nie doprowadza do pełnej restytucji badanych cech postawy.

Słowa kluczowe:
plecak, postawa ciała, mora projekcyjna, sprawność fizyczna, restytucja

Introduction

In April 2014, the Poviat Sanitary and Epidemiological Station in Ostrów Mazowiecka, in accordance with the guidelines of the Chief Sanitary Inspectorate, assessed the students' load of schoolbags and backpacks at the Primary School and Public Junior High School. The assessment covered a total of 371 students (224 primary school pupils and 147 junior high school students). Analysis of the research results showed that 63 primary school pupils and 117 junior high school students had a backpack whose ratio of backpack weight and the user's body weight was below 10%, which is 48.5% of all weighted backpacks. The ratio of backpack weight and body weight within the range of 10–15% was found in 110 primary school pupils and 29 junior high school students, which constitutes 37.5% of weighted backpacks. Whereas the ratio below normal values, i.e. when the ratio of backpack weight and body weight is higher than 15%, was observed in 51 elementary school pupils and one junior high school student, which represents 14% of all respondents. The author also checked whether schools had provided students with the option of leaving some textbooks and school supplies in the facility. This obligation was imposed by the ordinance of the Minister of National Education of 25 August 2009 amending the ordinance on safety and hygiene in public and non-public schools and institutions (Journal of Laws No. 139, Item 1130). Schools, where the loading of students with backpacks was assessed, fulfilled this obligation. The authors concluded that the correct weight of the school bag / backpack is the consequence of the activities performed by school, parents and students. They highlighted that school should inform parents and students about health damage resulting from overloaded backpacks. Overloaded backpacks, in addition to the lack of physical activity, are one of the reasons for posture defects among young people. A too heavy backpack can cause back pain, disrupt the proper spinal development and lead to its curvature as well as to reduce lung capacity [1].

Bogdanowicz [1], Hagner et al. [3], and Annetts [4] dealt with the issue of the impact of loading with school supplies. A review of the literature on the problem showed that the restitution of the value of postural features after loading was investigated by Mrozkowiak et al. [5, 6, 7] and Romanowska [8]. Other authors including Bajorek et al. [9], Barczyk-Pawelec et al. [10], Dolata-Łubkowska et al. [11], Drzał-Grabiec et al. [12], Grabara et al. [13, 14], Słoniewski et al. [15], Ślężyński et al. [16], Utake et al. [17], Wojtków et al. [18], Zeyland-Malawka [19], and Żurek et al. [20] mainly studied the impact of specific physical work on selected values of body posture features. The works referred to above have led to a general conclusion that every physical effort modulates the course of posturogenesis, in particular, intense workout. It is the body posture that becomes typical for a sport discipline, so it will be different for gymnasts, swimmers, athletes, horse riders, shooters or archers.

The author's interest in this issue results from the increasingly 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 improper transporting of school supplies. The general purpose of the research program is an attempt to determine the influence of the weight load of transported school supplies, 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 restitution of the values of selected postural features after removing the load of a container with school supplies pulled with the left or right hand in the transverse and sagittal planes.

Material and methods

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 study, the preschool teacher's assistant of the examined group was always present 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 subjects). 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).

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 [22]. According to the author, the test has a high degree of reliability and is adequate in terms of discrimination power and difficulty level [23]. The 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 body posture was diagnosed using the mora projection method. 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. Children and their parents were also encouraged to maintain the anthropometric points marked on the skin. 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 and amounted to 4kg. A habitual posture was diagnosed in the first position, while in the second position a spring dynamometer imitating the mass of carried school supplies 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 ranged from 40° to 45°. The pulling force indicated by the dynamometer was from 1 kg to 2 kg.

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

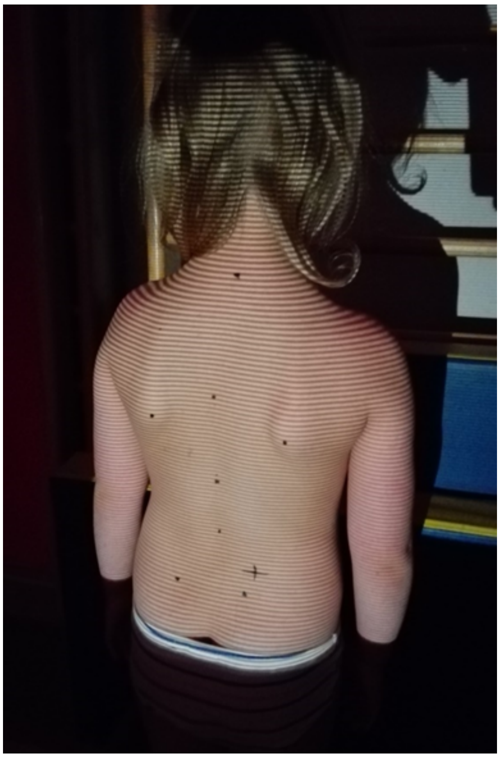

Fig. 1. Position 1: habitual posture

Fig. 2. Position 2: demonstration of a posture with asymmetrical loading pulled with the left hand

Fig. 3. Position 2: demonstration of a posture with asymmetrical loading pulled with the right hand

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. The place where the subject was standing and the camera were spatially oriented according to the camera's spirit levels and in relation 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 [24]. 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. In this method, the most essential is the simultaneous measurement of all real values of the spatial location of individual body sections.

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.

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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

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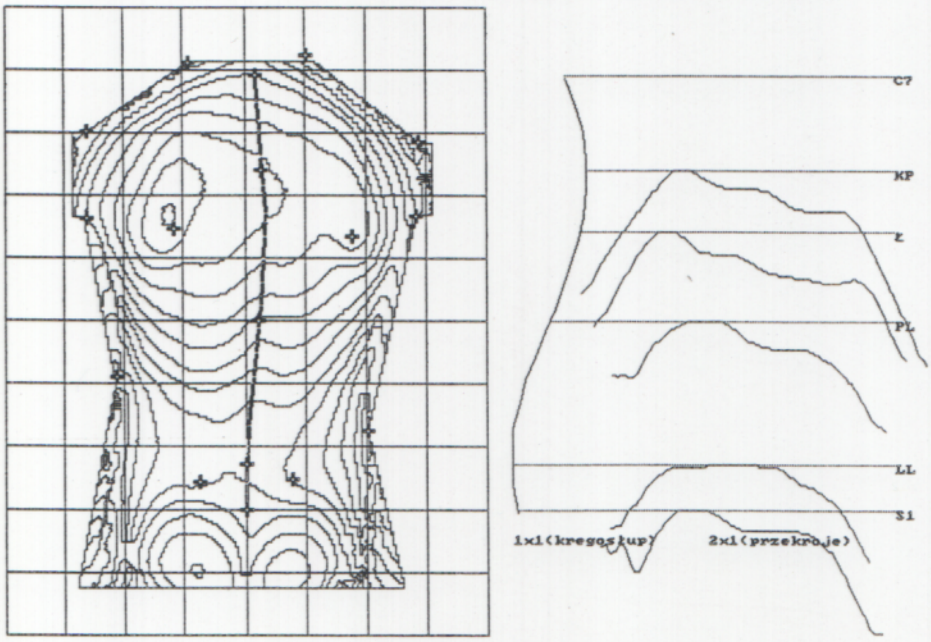

Fig. 4. Worksheet of measurement results for body posture features of the pelvis-spine complex

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.

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. 19 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.

Tab. 1. List of recorded trunk and morphological parameters

Parameters				
No.	Symbol	Unit	Name	Description
Sagittal plane				
1	Alfa	degrees	Lumbosacral slope	
2	Beta	degrees	Thoracolumbar slope	
3	Gamma	degrees	Upper thoracic slope	
4	Delta	degrees	The sum of angles	Delta = Alfa + Beta + Gamma
5	KPT	degrees	Torso extension angle	Determined by the declination of the C_7-S_1 line from the vertical
6	KPT–	degrees	Torso flexion angle	Determined by the declination of the C_7-S_1 line from the vertical
7	DKP	mm	Thoracic kyphosis length	Distance between points C_7 and LL
8	KKP	degrees	Thoracic kyphosis angle	KKP = 180 – (Beta + Gamma)
9	RKP	mm	Thoracic kyphosis height	Distance between points C_7 and PL
10	GKP	mm	Thoracic kyphosis depth	Distance measured horizontally between vertical lines passing through points PL and KP
11	DLL	mm	Lumbar lordosis length	Distance between points KP and S_1

No.	Symbol	Unit	Parameters Name	Description
12	KLL	degrees	Lumbar lordosis angle	KLL = 180 – (Alfa + Beta)
13	RLL	mm	Lumbar lordosis height	Distance between points PL and S_1
14	GLL–	mm	Lumbar lordosis depth	Distance measured horizontally between vertical lines passing through points PL and LL, at the level of point LL
			Transverse plane	
15	UB–	degrees	The angle of the prominence line of the lower angles of the scapulae, more prominent on the left	Difference in angles UB_1–UB_2. Angle UB_2 is between: a line passing through point LS and being simultaneously perpendicular to the camera axis and the straight line passing through Łl and Łp. Angle UB1 is between: a line passing through point Łp and being simultaneously perpendicular to the camera axis and a straight line passing through Łp and Łl PLLB = LLB – PLB
16	UB	degrees	The angle of the prominence line of the lower angles of the scapulae, more prominent on the right	
17	KSM	degrees	Pelvis turned to the right	The angle between a line passing through point Ml and being simultaneously perpendicular to the camera axis and a straight line passing through ML and MP
18	KSM–	degrees	Pelvis turned to the left	The angle between a line passing through point Mp and being simultaneously perpendicular to the camera axis and a straight line passing through ML and MP
19	DCK	mm	Total spine length	Distance between C_7 and S_1, measured in vertical axis
			Morphological features	
20	Mc	kg	Body mass	Measurement of body height and weight conducted by means of a digital medical scale
21	Wc	cm	Body height	

Source: the author's own study

Research questions and hypotheses

The following research questions arise from the author's own experience and the analysis of the relevant literature:

1. Does the adopted method of carrying the mass of school supplies, significantly affecting the statics of body posture in the sagittal and transverse planes, cause the subsequent restitution of the values of the disturbed features?
2. Which element of physical fitness most significantly affects the size of restitution after the first, and which after the second minute and does it depend on the right or left hand thrust?

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

1. The adopted method of carrying the mass of school supplies, significantly affecting the statics of body posture in the sagittal and transverse planes, causes restitution of the values of the disturbed features and does not depend on gender.
2. After the first and second minute, restitution is most significantly affected by endurance, agility, power, and speed, and least affected by strength.

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 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 3, and measurement 3 and 4 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 concerning the differences. Owing to such an approach no variables are over- or underrepresented in the average result.

Results

The total of 65 subjects of both genders were involved in the study, which allowed to record 5,395 values of features describing body posture in habitual position and dynamic positions, body weight and height as well as physical fitness.

Analysis of differences concerning the values of postural features between measurement 2 and 3, and measurement 3 and 4 during the carriage of school supplies in the case of the right- or left-hand thrust among boys and girls using the Wilcoxon rank test showed statistically significant differences in terms of all analysed variables, Tab. 2, 3.

Tab. 2. Restitution of the values of body posture features in the sagittal and transverse plane between measurement 2 and 3, and measurement 3 and 4 in the case of right- and left-hand thrust among boys

No.	Variable	Right hand Measurement			Right hand Wilcoxon Test		Left hand Measurement			Left hand Wilcoxon Test	
		1	2	3			1	2	3		
		Me	Me	Me	2/3 p	3/4 p	Me	Me	Me	2/3 p	3/4 p
1	DCK	287.60	296.50	307.05	< 0.001	< 0.001	298.00	302.90	308.30	< 0.001	< 0.001
2	Alfa	11.25	9.90	9.25	< 0.001	< 0.001	13.10	11.40	10.20	< 0.001	< 0.001
3	Beta	20.50	16.35	14.70	< 0.001	< 0.001	18.20	14.40	11.75	< 0.001	< 0.001
4	Gamma	18.80	15.40	13.20	< 0.001	< 0.001	19.80	17.40	15.20	< 0.001	< 0.001
5	Delta	50.30	41.70	36.15	< 0.001	< 0.001	50.95	43.20	37.30	< 0.001	< 0.001
6	KPT−	1.80	2.55	3.50	< 0.001	< 0.001	12.60	7.60	5.40	< 0.001	< 0.001
7	KPT+	12.65	9.60	5.95	0.005	0.005	0.65	1.35	2.40	0.005	0.005
8	DKP	261.30	270.55	273.20	< 0.001	< 0.001	262.95	270.00	274.00	< 0.001	< 0.001
9	KKP	140.40	148.30	151.90	< 0.001	< 0.001	141.90	148.70	152.45	< 0.001	< 0.001

No.	Variable	Right hand Measurement 1 Me	2 Me	3 Me	Wilcoxon Test 2/3 p	3/4 p	Left hand Measurement 1 Me	2 Me	3 Me	Wilcoxon Test 2/3 p	3/4 p
10	RKP	170.15	178.30	181.35	< 0.001	< 0.001	170.85	178.65	182.20	< 0.001	< 0.001
11	GKP	37.10	27.45	23.10	< 0.001	< 0.001	37.70	29.40	24.85	< 0.001	< 0.001
12	DLL	236.05	241.15	242.20	< 0.001	< 0.001	237.40	242.00	243.70	< 0.001	< 0.001
13	KLL	148.70	154.10	157.60	< 0.001	< 0.001	149.10	153.40	158.35	< 0.001	< 0.001
14	RLL	126.05	128.70	131.85	< 0.001	< 0.001	127.60	129.60	132.55	< 0.001	< 0.001
15	GLL	26.15	25.25	24.65	< 0.001	< 0.001	27.25	25.55	24.85	< 0.001	< 0.001
16	UB−	10.20	5.45	3.85	0.012	0.012	0.75	1.25	2.50	0.028	0.012
17	UB+	0.80	1.20	2.05	< 0.001	< 0.001	12.55	7.70	5.80	< 0.001	< 0.001
18	KSM−	7.75	6.30	3.95	0.012	0.012	0.40	1.50	1.55	0.043	0.018
19	KSM+	0.80	2.10	3.50	< 0.001	< 0.001	16.50	10.55	7.20	< 0.001	< 0.001
20	UK−	13.00	7.60	3.75	0.012	0.012	0.40	0.70	1.10	0.016	0.010
21	UK+	0.75	3.70	4.85	< 0.001	< 0.001	19.10	12.95	10.35	< 0.001	< 0.001

Tab. 3. Restitution of the values of body posture features in the sagittal and transverse plane between measurement 2 and 3, and measurement 3 and 4 in the case of right- and left-hand thrust among girls

No.	Variable	Right hand Measurement 1 Me	2 Me	3 Me	Wilcoxon Test 2/3 p	3/4 p	Left hand Measurement 1 Me	2 Me	3 Me	Wilcoxon Test 2/3 p	3/4 p
1	DCK	271.35	281.45	289.90	< 0.001	< 0.001	278.40	284.45	288.70	< 0.001	< 0.001
2	Alfa	11.50	10.30	9.60	< 0.001	< 0.001	13.75	12.20	9.75	< 0.001	< 0.001
3	Beta	21.10	17.45	14.80	< 0.001	< 0.001	19.40	15.95	13.40	< 0.001	< 0.001
4	Gamma	18.90	15.70	13.70	< 0.001	< 0.001	19.85	17.60	15.45	< 0.001	< 0.001
5	Delta	51.85	43.10	38.10	< 0.001	< 0.001	52.65	45.00	38.85	< 0.001	< 0.001
6	KPT−	1.60	2.40	3.20	< 0.001	< 0.001	12.60	7.10	5.10	< 0.001	< 0.001
7	KPT+	12.50	7.90	5.70	< 0.001	< 0.001	0.60	1.30	2.10	< 0.001	0.006
8	DKP	258.80	264.50	270.80	< 0.001	< 0.001	260.40	267.85	272.35	< 0.001	< 0.001
9	KKP	139.60	147.85	151.45	< 0.001	< 0.001	140.55	146.70	151.60	< 0.001	< 0.001
10	RKP	160.90	169.30	173.30	< 0.001	< 0.001	162.85	169.05	173.00	< 0.001	< 0.001
11	GKP	37.60	26.50	23.10	< 0.001	< 0.001	38.45	29.85	25.40	< 0.001	< 0.001
12	DLL	238.90	241.00	244.60	< 0.001	< 0.001	238.10	242.55	244.90	< 0.001	< 0.001
13	KLL	147.60	152.25	155.55	< 0.001	< 0.001	146.95	152.30	156.60	< 0.001	< 0.001
14	RLL	119.35	122.35	124.55	< 0.001	< 0.001	120.45	124.10	125.95	< 0.001	< 0.001
15	GLL	24.35	24.00	23.60	< 0.001	< 0.001	26.50	24.95	23.75	< 0.001	< 0.001
16	UB−	10.50	5.40	3.20	< 0.001	< 0.001	0.40	1.10	1.90	< 0.001	< 0.001
17	UB+	0.70	1.30	1.90	0.001	0.001	12.70	7.80	4.80	0.001	0.001
18	KSM−	7.90	6.10	4.10	< 0.001	< 0.001	0.30	1.30	2.10	< 0.001	< 0.001
19	KSM+	0.50	1.50	2.70	0.001	0.001	15.40	10.30	5.60	0.001	0.003
20	UK−	12.80	7.60	4.70	< 0.001	< 0.001	0.50	1.30	2.10	< 0.001	< 0.001
21	UK+	0.50	1.70	2.90	0.001	0.001	18.60	12.10	5.70	0.001	0.001

Source: the author's own study

The analysis of correlation between the results of five Sekita physical fitness tests and significant differences in the values of posture characteristics between measurements 2 and 3 and 3 and 4 was also conducted with the division into gender and pulling of a container with an unlike hand. Analyzing the correlation of significant differences between measurements 2 and 3 when pulling a container with the right hand among boys, it turned out that the higher the speed, the smaller the difference of the Alpha variable. The greater the strength, the smaller the differences in the variables: Alpha, DLL and GLL, and the greater the differences in the variable UB+. The greater the overall physical fitness, the smaller the differences in the Alpha and GLL variables, and the greater the difference in the variable UB+. In turn, taking into account the differences between measurement 3 and 4, it turned out that the greater the endurance, the smaller the difference in the variable KPT+. The higher the speed, the greater the difference in the RKP variable. The greater the strength, the greater the difference between Gamma and KPT−. The greater the power, the greater the difference in the variable GKP. The greater the agility, the greater the differences in variables Gamma and KPT−. On the other hand, the higher the overall physical fitness, the greater the difference in the variable Gamma. Considering the differences between measurements 2 and 3 in the left hand thrust, it appeared that the higher the speed, the smaller the difference in KSM+. The greater the strength, the greater the difference in the variable UB−. The higher the power, the smaller the difference in the RKP− variable. The greater the agility, the greater the difference in the UB- variable. However, the greater the overall physical fitness, the greater the difference in the UB− variable and the smaller in the RKP variables. However, the differences between measurement 3 and 4 showed that the greater the endurance, the smaller the difference in the KSM− variable. The higher the speed, the smaller the differences between variab

les Beta and KLL. The greater the agility, the greater the difference in KPT− and the smaller in the KSM− variable. In turn, the greater the overall physical fitness, the smaller the differences in variables: KPT−

Tab. 4. Physical fitness and restitution correlations between measurement 2 and 3 and measurement 3 and 4 concerning postural features in the right-hand thrust among boys

No.	Variable	Difference between measurement 2 and 3						Difference between measurement 3 and 4					
		WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
1	DCK	0.11	0.16	0.20	−0.36	0.11	0.11	0.01	0.04	−0.03	0.16	−0.18	0.03
2	Alfa	−0.41	−0.60*	−0.51*	−0.06	−0.39	−0.56*	−0.11	−0.27	−0.27	−0.21	0.13	−0.18
3	Beta	0.12	0.19	−0.16	0.22	0.01	−0.07	0.05	0.28	0.16	−0.62	0.02	−0.03
4	Gamma	0.00	0.15	0.12	0.10	−0.16	0.07	0.15	0.44	0.63**	−0.03	0.74**	0.60*
5	Delta	−0.07	−0.05	−0.33	0.07	−0.40	−0.40	0.18	−0.09	0.11	−0.29	0.43	0.18
6	KPT−	−0.04	0.22	−0.15	−0.01	−0.49	−0.29	−0.13	0.19	0.80*	0.27	0.77*	0.68
7	KPT+	0.51	0.70	0.03	−0.62	0.07	0.00	−0.85*	−0.68	−0.16	0.30	−0.22	−0.39
8	DKP	−0.06	−0.07	−0.41	−0.04	−0.32	−0.38	0.13	0.19	−0.05	−0.36	−0.04	−0.01
9	KKP	0.27	0.30	−0.21	0.10	−0.10	−0.09	0.17	0.12	0.37	−0.09	0.32	0.30
10	RKP	−0.32	−0.21	0.39	−0.05	0.31	0.23	0.43	0.51*	0.07	0.16	−0.30	0.14
11	GKP	0.19	0.01	−0.14	−0.36	−0.20	−0.14	−0.16	0.03	0.09	0.51*	0.14	0.12
12	DLL	−0.05	−0.21	−0.51*	0.21	−0.36	−0.30	−0.48	−0.06	−0.07	0.09	−0.21	−0.26

No.	Variable	Difference between measurement 2 and 3						Difference between measurement 3 and 4					
		WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
13	KLL	−0.04	−0.16	−0.31	0.33	−0.17	−0.26	0.14	−0.20	−0.19	−0.35	0.02	−0.12
14	RLL	−0.16	−0.31	−0.50	0.14	−0.22	−0.39	0.16	0.36	−0.14	−0.27	0.17	−0.05
15	GLL	−0.09	−0.03	−0.57*	−0.39	−0.52	−0.57*	−0.12	0.08	−0.04	−0.36	−0.27	−0.24
16	UB−	−0.50	0.50	−0.87	−1.00	−1.00	−1.00	−0.50	−1.00	0.87	0.50	0.50	0.50
17	UB+	0.43	0.41	0.60*	−0.27	0.52	0.57*	−0.12	0.09	0.49	0.00	0.33	0.37
18	KSM−	0.50	1.00	−0.87	−0.50	−0.50	−0.50	−1.00	−0.50	0.00	−0.50	−0.50	−0.50
19	KSM+	0.34	0.20	0.01	0.06	0.02	0.16	0.06	0.33	0.09	−0.28	0.37	0.17
20	UK−	0.50	−0.50	0.87	1.00	1.00	1.00	−0.50	0.50	−0.87	−1.00	−1.00	−1.00
21	UK+	0.22	−0.07	−0.06	−0.21	0.27	0.02	−0.33	−0.38	−0.02	0.02	−0.09	−0.16

Tab. 5. Physical fitness and restitution correlations between measurement 2 and 3 and measurement 3 and 4 concerning postural features in the leftt-hand thrust among boys

No.	Variable	Difference between measurement 2 and 3						Difference between measurement 3 and 4					
		WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
1	DCK	0.11	0.30	0.25	−0.23	0.08	0.12	0.02	−0.08	0.16	0.20	0.12	−0.04
2	Alfa	0.01	0.07	0.11	−0.15	0.40	0.13	0.11	0.45	−0.16	−0.42	−0.11	0.07
3	Beta	−0.02	0.16	−0.40	−0.21	−0.40	−0.25	−0.03	−0.60*	−0.10	0.53	−0.16	−0.17
4	Gamma	−0.12	−0.39	−0.13	0.38	−0.20	−0.24	0.08	0.12	−0.27	−0.20	0.03	−0.03
5	Delta	−0.15	−0.22	−0.48	−0.02	−0.32	−0.38	−0.24	−0.50	−0.43	0.11	−0.38	−0.42
6	KPT−	−0.05	−0.32	−0.22	0.37	0.21	−0.10	0.87	0.79	0.78	0.26	0.98**	0.90*
7	KPT+	0.46	0.07	0.58	0.17	0.65	0.56	−0.22	0.40	−0.31	−0.30	−0.29	−0.18
8	DKP	0.23	0.37	0.07	−0.03	0.24	0.28	0.01	−0.45	−0.08	0.24	−0.01	−0.17
9	KKP	−0.16	0.07	−0.31	−0.07	−0.34	−0.27	−0.13	−0.62	−0.24	0.53	−0.23	−0.27
10	RKP	−0.56	−0.11	−0.46	−0.58*	−0.42	−0.59*	0.51	−0.04	0.33	0.57	0.24	0.50
11	GKP	−0.14	0.12	0.38	0.09	0.25	0.17	−0.17	−0.40	−0.42	−0.04	−0.49	−0.44
12	DLL	−0.41	−0.39	−0.51	−0.16	−0.18	−0.51	0.36	0.06	0.29	0.02	0.22	0.38
13	KLL	0.09	0.20	−0.08	−0.19	0.10	0.04	−0.17	−0.56*	−0.27	0.37	−0.40	−0.36
14	RLL	0.16	0.31	−0.01	−0.21	0.33	0.24	−0.35	−0.22	−0.46	−0.12	−0.23	−0.42
15	GLL	−0.21	0.15	0.10	0.24	−0.08	0.01	0.12	−0.15	0.10	0.31	−0.07	0.11
16	UB−	0.82	0.41	0.97**	0.86	0.98**	0.98**	−0.20	−0.40	−0.74	−0.45	−0.50	−0.50
17	UB+	−0.18	−0.38	−0.36	0.06	−0.38	−0.43	−0.01	−0.52	−0.58	0.50	−0.67	−0.51
18	KSM−	0.10	0.50	0.21	0.11	0.20	0.20	−0.98**	−0.36	−0.87	−0.80	−0.98**	−0.98**
19	KSM+	−0.22	−0.76*	−0.63	0.25	−0.44	−0.67	−0.58	−0.56	−0.56	−0.13	−0.44	−0.71
20	UK−	0.80	0.60	0.32	0.11	0.50	0.50	0.21	−0.21	0.65	0.80	0.56	0.56
21	UK+	0.38	0.05	0.09	−0.13	0.31	0.07	−0.44	−0.25	−0.17	−0.757*	−0.10	−0.42

Source: the author's own study

WY – endurance, SZ – speed, SI – strength, MO – power, ZW – agility, OG – general efficiency

Tab. 6. Physical fitness and restitution correlations between measurement 2 and 3 and measurement 3 and 4 concerning postural features in the right-hand thrust among girls

No.	Variable	Difference between measurement 2 and 3						Difference between measurement 3 and 4					
		WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
1	DCK	−0.18	0.19	0.02	−0.06	−0.20	−0.04	−0.04	0.03	−0.11	0.33	−0.27	−0.14
2	Alfa	−0.06	0.41	−0.14	−0.13	−0.38	−0.19	0.01	−0.12	−0.08	0.11	−0.26	−0.12
3	Beta	0.13	−0.16	0.04	−0.13	−0.03	−0.06	−0.12	−0.40	−0.21	0.09	0.10	−0.06
4	Gamma	0.13	0.36	0.20	−0.14	0.17	0.24	0.03	0.15	−0.05	−0.44	−0.08	−0.19
5	Delta	0.02	0.41	0.11	−0.20	−0.16	0.00	−0.20	−0.50	−0.20	−0.15	−0.06	−0.26
6	KPT−	−0.66	−0.36	−0.27	−0.35	−0.13	−0.40	0.34	0.35	0.17	0.36	0.05	0.41
7	KPT+	−0.37	−0.20	−0.67	−0.40	−0.28	−0.78*	−0.29	−0.20	0.51	0.24	0.35	0.36
8	DKP	0.06	−0.21	−0.16	−0.22	−0.20	−0.18	−0.05	0.08	−0.51	−0.17	−0.29	−0.45
9	KKP	0.16	0.18	0.39	0.03	0.18	0.31	−0.14	−0.51	−0.37	−0.06	0.04	−0.26
10	RKP	0.19	0.36	0.50	0.09	0.19	0.47	0.18	0.12	0.08	−0.15	−0.04	0.07
11	GKP	−0.16	−0.19	−0.07	0.17	0.20	−0.03	0.28	0.10	−0.28	0.09	−0.29	−0.14
12	DLL	0.02	−0.07	−0.56*	−0.17	−0.45	−0.40	0.23	−0.06	0.39	0.52*	0.26	0.43
13	KLL	0.01	0.23	−0.12	−0.21	−0.34	−0.22	−0.14	−0.45	−0.16	0.15	−0.01	−0.09
14	RLL	0.02	0.07	−0.13	−0.08	−0.10	−0.16	0.35	0.29	−0.04	−0.02	0.21	0.21
15	GLL	−0.35	−0.33	−0.38	−0.08	−0.45	−0.44	0.59*	0.31	0.10	0.10	0.00	0.22
16	UB−	0.50	1.00	−0.87	−0.50	−0.50	−0.50	0.50	1.00	−0.87	−0.50	−0.50	−0.50
17	UB+	−0.24	−0.25	−0.17	0.00	0.03	−0.13	−0.55	−0.41	−0.62*	−0.06	−0.43	−0.63*
18	KSM−	0.50	−0.50	0.87	1.00	1.00	1.00	0.87	0.87	−0.50	0.00	0.00	0.00
19	KSM+	−0.02	0.13	0.02	0.03	−0.20	−0.09	−0.27	−0.54	−0.21	0.48	−0.53	−0.30
20	UK−	0.50	−0.50	0.87	1.00	1.00	1.00	0.50	−0.50	0.87	1.00	1.00	1.00
21	UK+	0.21	0.33	−0.03	−0.26	0.14	−0.06	−0.50	−0.18	−0.05	−0.01	−0.09	−0.18

Tab. 7. Physical fitness and restitution correlations between measurement 2 and 3 and measurement 3 and 4 concerning postural features in the leftt-hand thrust among girls

No.	Variable	Difference between measurement 2 and 3						Difference between measurement 3 and 4					
		WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
1	DCK	−0.09	0.41	−0.21	−0.19	−0.21	−0.20	0.09	−0.50	0.19	0.50	−0.06	0.06
2	Alfa	0.35	0.45	0.40	−0.16	0.30	0.30	−0.29	0.25	−0.16	−0.10	−0.26	−0.16
3	Beta	0.14	0.67*	0.08	−0.35	0.13	0.20	−0.23	−0.66*	−0.15	0.25	−0.31	−0.27
4	Gamma	−0.11	−0.63*	−0.24	0.54	−0.26	−0.25	0.25	0.67*	0.32	−0.31	0.34	0.43
5	Delta	0.65*	0.64*	0.29	0.19	0.31	0.46	−0.41	−0.02	−0.24	−0.26	−0.33	−0.25
6	KPT−	−0.46	−0.63	−0.45	0.32	−0.87	−0.60	0.21	0.53	0.22	−0.37	−0.05	0.30
7	KPT+	−0.36	0.06	−0.65	−0.39	−0.32	−0.38	−0.01	0.32	−0.01	0.09	−0.12	0.09
8	DKP	−0.28	−0.41	−0.77*	0.16	−0.58*	−0.59*	0.11	0.07	0.56	0.01	0.29	0.34
9	KKP	0.26	0.34	0.04	0.22	0.07	0.22	−0.19	−0.43	0.14	0.00	−0.02	−0.03
10	RKP	0.32	−0.02	−0.01	0.48	−0.16	0.11	0.04	−0.09	−0.18	0.03	−0.06	−0.15
11	GKP	−0.33	0.30	0.10	−0.53	−0.02	−0.01	−0.33	−0.74**	−0.34	0.24	−0.53	−0.52

No.	Variable	Difference between measurement 2 and 3						Difference between measurement 3 and 4					
		WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
12	DLL	−0.45	−0.04	−0.24	−0.35	−0.22	−0.35	−0.20	0.21	0.14	−0.48	−0.01	−0.02
13	KLL	0.46	0.73**	0.25	−0.19	0.27	0.37	−0.59*	−0.51	−0.56	−0.08	−0.68	−0.64*
14	RLL	−0.29	0.08	−0.17	−0.22	0.01	−0.28	0.45	0.14	0.17	0.13	0.20	0.33
15	GLL	0.42	−0.03	0.14	0.58	−0.09	0.22	0.36	0.38	0.46	0.00	0.61*	0.60*
16	UB−	−0.98**	−0.31	−0.68	−0.69	−0.87	−0.87	−0.70	0.10	−0.21	−0.45	−0.50	−0.50
17	UB+	−0.38	0.04	−0.28	−0.09	−0.35	−0.25	0.54	0.43	0.64	−0.33	0.67	0.64
18	KSM−	0.10	0.70	0.53	0.11	0.30	0.30	0.20	−0.10	0.79	0.78	0.60	0.60
19	KSM+	0.60	0.63	0.81*	−0.19	0.84*	0.79*	−0.16	0.18	0.17	−0.20	0.06	0.18
20	UK−	0.70	0.50	0.95*	0.78	0.90*	0.90*	−0.70	−0.90*	−0.53	−0.22	−0.60	−0.60
21	UK+	−0.02	−0.32	−0.23	0.29	−0.02	−0.14	0.42	0.01	−0.03	0.29	−0.32	0.09

Source: the author's own study
WY – endurance, SZ – speed, SI – strength, MO – power, ZW – agility, OG – general efficiency

and KSM−, Tab. 4, 5.
A study of correlation of significant differences in the size of postural features between measurements 2 and 3 in the case of pulling a container with the right hand among girls demonstrated that the greater the strength, the smaller the difference in the variable DLL. In turn, the greater the overall physical fitness, the smaller the difference in the KPT+ variable. Given the differences between measurements 3 and 4, it turned out that the greater the endurance, the greater the difference in variable GLL. The greater the strength, the smaller the difference in the variable UB +. The greater the power, the greater the difference in the DLL variable. However, the greater the overall physical fitness, the smaller the difference in the UB+ variable. Analyzing correlations of significant differences in the values of postural features between measurements 2 and 3 in the case of pulling a container with the left hand among girls, it turned out that the greater the endurance, the smaller the difference in the UB- variable and the larger the variable Delta. The greater the speed, the smaller the Gamma variable is, and the larger the Beta, Delta and KLL variables. The greater the strength, the smaller the difference in the variable DKP and the greater the KSM+ variable. The greater the power, the smaller the difference in the variable DKP. On the other hand, the greater the overall physical fitness, the smaller the difference in the DKP variable and the greater in the variable KSM+. Taking into consideration the differences between 3 and 4 measurements, it turned out that the greater the endurance, the smaller the difference in the KLL variable. The higher the speed, the smaller the differences in variables Beta and GKP, and the greater in the variable Gamma. The greater the agility, the greater the difference in the variable GLL. In turn, the greater the overall physical fitness, the smaller the difference in the variable KLL, and the greater the difference in the variable GLL, Tab. 6, 7.

Discussion

The literature relating to this subject has not provided any investigation into the restitution of significantly changed body posture features under the influence of load, resulting from the carriage of school supplies in the case of pulling a container with the right or left hand by 7-year-old pupils. In the introduction, the authors focused more on exploring the consequences of loading with the weight of school supplies carried on one of the shoulders, on the back, or concentrated on the effects of different weight of school supplies. Undoubtedly, the undertaken research studies are the first attempt to determine the restitution of static body posture disorders, an attempt to pay attention not only to the consequences of asymmetrical loading, but also to the time of returning to individual stability.

Conclusions

1. Having removed the load of the transported weight of school supplies, a statistically significant incomplete restitution occurred after the first and second minute.
2. In right-hand carriage of a container with school supplies among boys, speed and strength significantly correlated with restitution after one minute, and endurance, speed, power, and agility after two minutes. Among girls it was strength after one minute and endurance and strength after two minutes. As far as boys are concerned, the above-mentioned skills significantly correlated with the restitution of angle Alpha, Gamma, DLL, GLL, UB +, KPT +, RKP, GKP, and among girls with: DLL, KPT +, GLL, and UB +. In the case of boys, physical fitness more often correlated with restitution of postural feature values.
3. In left-hand carriage of a container with school supplies among boys, after the first minute, restitution correlated with strength, power, agility and overall physical fitness, and after two minutes with endurance, speed, agility and overall physical fitness. Among girls, endurance, speed, strength, and agility correlated with restitution after one minute, and endurance, speed, agility, and overall physical fitness after two minutes.
4. Due to incomplete restitution of the values of postural features, transport of school supplies using a left- or right-hand thrust is not recommended to children aged 7 years. Physical fitness demonstrated by children at this age does not lead to full restitution of the examined postural features, which proves its low level and immature corrective and compensation processes.

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Piśmiennictwo/ References

1. Raport z badań Powiatowej Stacji Sanitarno-Epidemiologiczna w Ostrowi Mazowieckiej, 2014
2. Bogdanowicz J., Właściwości rozwojowe wieku dziecięcego, PZWL, Warszawa, 1962.
3. Hagner W., Bąk D., Hagner-Derengowska M., Zmiany w postawie ciała u dzieci w pierwszych trzech latach nauki szkolnej, Wybrane Problemy Kliniczne, Via Medica, 2010.
4. Annetts S., Coales P., Colville R., Mistry D., Moles K., Thomas B., van Deursen R., A pilot investigation into the effects of different office chairs on spinal angles, Eur. Spine J. 2012, 21 (Suppl. 2), 165–S170.
5. Mrozkowiak M., Analiza biomechaniczna zmian wybranych parametrów dynamicznych stóp w czasie i po

obciążeniu = Biomechanical analysis of the changes in selected dynamic foot parameters in time and after load. Annales Universitatis Mariae Curie-Skłodowska, Sectio D: Medicina 2007, Vol. 62, Suppl. 18, N. 5, s. 179-183.
6. Mrozkowiak Mirosław, Sokołowski Marek, Kaiser Alicja, Próba określenia wpływu obciążenia osiowego na wybrane cechy postawy ciała szermierzy = An attempt to determine the effect of the axial load on selected posture fencers. Journal of Education, Health and Sport. 2016; 6 (10): 309-320.
7. Mrozkowiak M., Analiza biomechaniczna zmian wybranych parametrów zespołu miednica-kręgosłup w płaszczyźnie czołowej i poprzecznej w czasie i po obciążeniu, [w:] Edukacja w społeczeństwie „ryzyka". Bezpieczeństwo jako wartość. T. 2. Red. nauk. Matylda Gwoździcka-Piotrowska, Andrzej Zduniak. Poznań: Wydawnictwo Wyższej Szkoły Bezpieczeństwa, 2007, s. 339-342. (Edukacja XXI Wieku; 11).
8. Romanowska A., Reakcja kręgosłupa dziecka na obciążenie tornistrem szkolnym. Wychowanie Fizyczne i Zdrowotne, 2009, nr 4, s. 20-26.
9. Bajorek W., Czarny P., Król M., Rzepko G., Sobo A., Litwiniuk A., Assessment of postural stability in traditional karate contestants. Journal of Combat Sports and Martial Arts, 2011, 1 (2); 2: 23-29.
10. Barczyk-Pawelec K., Giemza C., Kształt krzywizn przednio-tylnych w płaszczyźnie strzałkowej dziewcząt uprawiających piłkę ręczną, Acta Bio-Optica et Informatica Medica, Inżynieria Biomedyczna, 2012, v. 18, 4, 237-242.
11. Dolata-Łubkowska W., Kruk J., Wpływ sportu pływackiego na kształtowanie się przednio-tylnych krzywizn kręgosłupa, Wychowanie Fizyczne i Sport, vol. 2, 1996, s. 30-41.
12. Drzał-Grabiec J., Tryszczyńska A. Evaluation of selected postural parameters in children who practice kyokushin karate, Biomedical Human Kinetics, 2014, 6, 69-4.
13. Grabara M., Postawa ciała dziewcząt trenujących gimnastykę sportową, Wychowanie Fizyczne i Sport, 2009, vol. 53 (4), s. 211-215.
14. Grabara M., Hadzik A., Postawa ciała dziewcząt trenujących siatkówkę, Wychowanie Fizyczne i Sport, 2009, vol. 53 (4), s. 211-216.
15. Słoniewski J., Łagan S., Asymetryczne wady postawy w obrębie obręczy barkowej w kończynach górnych u zawodników trenujących łucznictwo oraz sposoby ich minimalizacji, Aktualne Problemy Biomechaniki, 2010 - yadda.icm.edu.pl
16. Ślężyński J., Rottermund J., Wskaźniki somatyczne, postawa ciała i wysklepienie stopy siatkarzy, Wychowanie Fizyczne i Sport, 1991, vol. 4, s. 59-65.
17. Uetake T., Ohsuki F., Tanaka H., Shinto M., The vertebral curvature of sportsmen, J. Sport. Sci. 1998, vol. 16, s. 621-628.
18. Wojtków M., Korcz K., Szotek S., Wpływ uprawiania strzelectwa sportowego na ukształtowanie postawy ciała, Aktualne Problemy Biomechaniki, 2009 – yadda.edu.icm.pl
19. Zeyland-Malawka E., Dębski J., Przednio-tylny kształt, zmiany strukturalne i dolegliwości bólowe kręgosłupa a wzmożona aktywność ruchowa, Postępy Rehabilitacji, 1991, vol. 3, s. 47-55.
20. Żurek G., Błach W., Ignasiak Z., Migasiewicz J., Ocena postawy ciała zawodników uprawiających judo w świetle metody fotogrametrycznej z wykorzystaniem zjawiska Moir'a, Medycyna Sportowa, 2005, vol. 21(4), s. 303-307.
21. Mrozkowiak M., Modulacja, wpływ i związki wybranych parametrów postawy ciała dzieci i młodzieży w wieku od 4 do 18 lat w świetle mory projekcyjnej, Wydawnictwo Uniwersytetu Kazimierza Wielkiego, Bydgoszcz, 2015, t. I, II.
22. Sekita B., Rozwój somatyczny i sprawność fizyczna dzieci w wieku 3–7 lat, [w:] (red.) S. Pilicz, Rozwój sprawności i wydolności fizycznej dzieci i młodzieży – raporty z badań. Warszawa, 1988.
23. Osiński W., Antopomotoryka, AWF Poznań, 2003.
24. Świerc A., Komputerowa diagnostyka postawy ciała – instrukcja obsługi, CQ Elektronik System, Czernica Wrocławska, 2006, 3-4.
25. Bober T., Zawadzki J., Biomechanika układu ruchu człowieka, AWF Wrocław, wyd. II, 2006.