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Research Article

Restitution of the Values of Body Posture Features in Sagittal and Transversal Plane after Carrying the Schoolbag on the Right or Left Shoulder and at the Heteronymous Hip and its Correlations with Physical Fitness Among 7-Year-Old Children of Both Sexes

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Summary

Introduction: Each physical effort modulates the course of post-neurogenesis, sports training, recreation, and the weight of the school backpack.

Material and Method: The body posture tests were carried out in a group of 65 students aged 7 years, using the moiré projection method in 4 positions: 1st-habitual posture, 2nd-posture after a-10-minute of axial symmetrical loading, 3rd-one minute after the load removal, 4th-two minutes after the load removal. Physical fitness was measured with the Sekita test, completed by an endurance test.

Results: The values of body posture features were analyzed to determine the significance of differences between 1st and 3rd, 1st and 4th, 2nd and 3rd as well as 3rd and 4th measurement and their relationship with the values of physical fitness features.

Conclusions:

a) After the first and second minute of the load removal of carrying school supplies in each way, there was an incomplete and sex-independent restitution of the values of body posture features in the sagittal and transversal plane.

b) Physical fitness is related to gender in relation to the restitution of the values of posture features. The relationship is greater among boys than girls. The most frequent correlation of physical fitness was between features of transversal plane among boys, whereby with sagittal plane appears among girls.

Keywords: Children's health, Moiré topography, Physical fitness, Postural asymmetry factor

Introduction

In accordance with the requirements of the curriculum, I, II and III grades should be equipped with audiovisual equipment, a laptop with the Internet access, and teaching aids necessary to conduct classes. A student's workplace should meet the applicable ergonomic standards as children spend a significant part of the day at school. Adjusting the size of the chair, tabletop and their distance from the screen or blackboard has an impact on the course of posturogenesis. Primary school is obliged to provide students with furniture adjusted to their body height, to ensure optimal conditions for writing, reading and listening, as well as prevent posture defects [1]. In accordance with the recommendations of the Minister of National Education, in order to ensure the proper development of a student, they were allowed to leave some textbooks and accessories at school. The research by Jakubowicz-Bryx shows that in the studied primary schools, principals and early school education teachers have created a suitable place for this purpose in classrooms in the form of cabinets, bookshelves, drawers and separate shelves. After a few days, 97% of the surveyed children left their textbooks and school supplies in lockers, 94% of the respondents stored them on shelves, 76% in drawers, and 71% on separate shelves. In order to prevent disturbances in the statics of body posture, in the tested group, teachers also paid attention to a suitably profiled backpack with a stiffened and convex back support in its lower part, which was found in 94% of respondents, and 91% of the respondents had a soft, adjustable and wide stripes, the necessary content of a schoolbag in 86%, wearing a schoolbag on both shoulders in 86% and having compartments enabling an even distribution of the weight in 79% [2].

The problem of the influence of the weight on school supplies was investigated by *Bogdanowicz* [3], *Hagner, et al.* [4], *Annetts* [5]. The conducted literature review showed that *Mrozkowiak, et al.* [6-10] and *Romanowska* [11] dealt with the restitution of the values of postural features after loading with a schoolbag. Other authors like *Bajorek, et al.* [12], *Barczyk-Pawelec, et al.* [13], *Dolata-Łubkowska, et al.* [14], *Drzał-Grabiec, et al.* [15], Grabara, *et al.* [16,17], *Słoniewski, et al.* [18], *Ślężyński, et al.* [19], *Utake, et al.* [20], *Wojtków, et al.* [21], *Zeyland-Malawka* [22], *Żurek, et al.* [23] mainly studied the influence of specific physical work on selected values of posture features. The above-mentioned studies present a general conclusion that each physical effort modulates the course of posturogenesis, especially sports training. Consequently, the body posture is shaped by the sports discipline practiced. It will be different for a gymnast, swimmer, athlete, rider, shooter or an archer.

The author's interest in the issues stems from the persistently high percentage of disorders of the body posture of students from the oldest preschool group and 1st-3rd grades of primary school [3], the constantly proclaimed opinion about the negative impact of the way of carrying school supplies on body postures, and the lack of clear recommendations about the optimal weight and contraindications against the negative way of carrying these utensils. The general objective of the implemented research programme is an attempt to determine the impact of weight of carried school supplies in the following way: obliquely on the right shoulder or left shoulder and at the heteronymous hip, on the left or right shoulder, on the back, on the chest, on the back and chest, pulled with the left or right hand.

Research Material

The study involved children from randomly selected kindergartens in the West Pomeranian and Greater Poland voivodeships. Body posture defects and disturbances were not a criterion that excluded participation in the research programme. The division of the respondents into those from rural and urban environments was abandoned since this feature would never determine the homogeneity of the group and the cultural and economic blurring boundary of both environments. The respondent was qualified to the programme according to the following scheme: if the respondent was 6years, 6months and 1day old and under 7years, he was included in the 7-year-old age group. This allowed to use the previously developed normative ranges appropriate for this age and sex category, diagnosing the quality of the body posture from the test day [24].

In total, 65 students participated in the programme, of which 53.84% (35 people) there were girls and 46.15% boys (30 people).

Research Method

The research was conducted in accordance with the principles of the Helsinki Declaration. For their implementation, there was consent obtained from the student and his legal guardian, tutor and management of the kindergarten, and bioethics commission (KEBN 2/2018, UKW Bydgoszcz). The study involved children from randomly selected kindergartens in the West Pomeranian and Greater Poland voivodeships from May 27th, 2019, always from 9 a.m. to 2 p.m. and in the same properly prepared place. Before the measurements started, the children were instructed in order to avoid the stress associated with the research procedure and the people responsible for it. A preschool teacher's assistant of the study group was always present during the research, which was to ensure the emotional stability of the children. Measurements were carried out in accordance with the developed procedure. The children were also encouraged to keep the anthropometric points marked with a marker on the skin, which was to effectively eliminate deviations in their repeated indication. The research was carried out by a physiotherapist with a 20-year-old experience in the diagnosis of body posture using the moiré projection method.

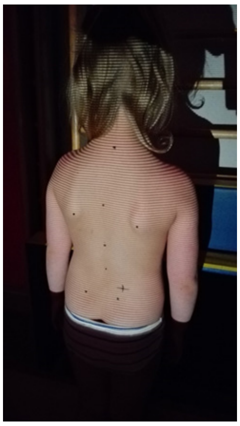
Overall Physical Fitness

The Wroclaw Physical Fitness Test for 3-7-year-old children was used to diagnose physical fitness [25]. According to the author, the test is of a high degree of reliability and is adequate in terms of discriminatory ability and degree of difficulty [26]. The proposed test, which significantly increased the motivation to exercise in the presence of parents, consists of four tests implemented as a part of the Sports Day: agility (pendulous run over 4x5m with carrying blocks), power (standing long jump), speed (running at 25m), and force (a 1kg ball both-hands-throw from the head). The author modified the test by a fifth attempt-endurance. Starting position-high starting stance. Movement-run over 300m. The running time from the start to finish was assessed and converted into points depending on the result and gender. If the child did not finish the race, they got score "0". The run took place on a recreational path with a hardened surface, remaining all safety rules [27]. Visualization [28].

Body Posture

The applied method using the projection moiré phenomenon determines the value of several dozen features describing the body posture. It makes it possible to determine the influence of various methods of carrying a bag with school supplies on body posture, restitution of the value of features after removing the load, and the importance of physical fitness in disorders and restitution of the value of the diagnosed features.

A custom-designed diagnostic frame was provided to ballast the body posture (utility model no. W.125734). The presence of an assistant during the examination was dictated by the need of minimizing the time from the load removal to the second registration of the value of the posture features. Every effort has been made to ensure that the custom-designed loaded frame was individually adapted to the type of child's body structure. The adopted 10-minute load time was the average time to walk from the place of residence given in the questionnaire completed by the parents [29]. However, the load was determined by averaging the weight of school supplies to 4kg carried by first-class children from a randomly selected primary school. Selected features of body posture were measured in 8 positions (four for each way). The first position-habitual position, (Picture 1). Second position-posture after 10 minutes of asymmetric loading on the back (in the last 5 seconds), (Pictures 2,3). Third position-posture one minute after the load removal, (Picture 1). Fourth position-posture two minutes after the load removal, (Picture 1). First day measurements included all children in 1st, 2nd, 3rd and 4th position with an oblique loading from the left shoulder to the right hip, and another in 1st, 2nd, 3rd and 4th position from the right shoulder to the left hip. The load was supposed to imitate the way of carrying school supplies. The subject could move freely. This was in line with the previous results of Mrozkowiak's research, which showed that after this time, the values of posture features could be at the starting point. It could be assumed that it was an appropriate and relatively constant for each student when diagnosing the habitual posture on the first day of the research programme. However, in order to maintain the reliability of the research, it was assumed that any inconsistency with the value of the features from the first stage of the measurements may affect the final test result. Therefore, before pulling the load up destined by the procedure, the features of the habitual posture were always determined as a reference for the subsequent dynamic changes of the diagnosed features. The height and weight of the children as well as the weight of the carried school supplies were measured with a medical balance before the first day of the tests.



Picture 1: Position 1st, 3rd, 4th: Habitual posture.

Picture 2: Posture with an oblique load from the right shoulder to the left hip.

Picture 3: Posture with an oblique load from the left shoulder to the right hip.

The measurement site for the value of selected features of the body posture consists of a computer and a card, a programme, a monitor and a printer, a projection-receiving device with a camera for measuring selected parameters of the pelvis-spine syndrome. The place of the subject and the camera were oriented spatially in accordance with the levels on the camera and in relation to the line of the child's toes. It is possible to obtain a spatial image thanks to the projection of lines on the child's back with strictly defined parameters, which falling on the body are distorted depending on the configuration of its surface. Thanks to the use of the lens, the image of the examined person is taken by a special optical system with a camera, and then transferred to the computer monitor. Line image distortions recorded in the computer memory are processed by a numerical algorithm into a contour map of the tested surface. The obtained image of the back surface enables a multi-layered interpretation of the body posture. It is possible to determine the size of the angular and linear features describing the pelvis and physiological curvatures in the sagittal and transversal plane. The most important aspect of this method is the simultaneous measurement of all real values of the spatial location of individual body sections [30].

The following test procedure was developed in order to minimize the risk of making mistakes in the measurements of selected posture features [24,31,32]:

a) Habitual posture of the subject against the background of a white, lightly illuminated sheet: free, unforced posture, with feet slightly apart, knee and hip joints in extension, arms hanging along the body and eyes looking straight ahead, with the back to the camera at 2.5 meters, toes at a perpendicular line to the camera axis.

b) Marking points on the back skin of the examined: the top of the spinous process of the last cervical vertebra (C_7), the spinous process being the top of the thoracic kyphosis (KP), the spinous process being the top of the lumbar lordosis (LL), the transition place from thoracic kyphosis to lumbar lordosis (PL), the lower angles of the scapulae (Łl and Łp), the posterior upper iliac spines (Ml and Mp), and the S_1 vertebra. A white necklace was put on the subject's neck to clearly mark the B_1 and B_3 points. Long hair up to reveal C_7 point.

c) The digital image of the back was recorded in the computer memory in each of the tested positions from the middle phase of free exhalation after entering the necessary data about the examined person (name and surname, year of birth, weight and body height, comments about the condition of the knees and heels, chest, past injuries, surgical procedures, diseases of the musculoskeletal system, gait, etc.).

d) Processing of the recorded images takes place without the participation of the subject.

e) The value of the features describing the body posture spatially are printed after saving the mathematical characteristics of the photos in the computer memory (Figure 1).

MAGMAR Olsztyn
Mirosław Mrozkowiak
Phone number: 602 529 652
COMPUTERIZED EXAMINATION OF THE BODY POSTURE

Name: Height: 119 cm, Year of birth: 1993
Data: 1SP1MK\0CIOLL00, Date of examination: 2000-12-02, Printout: 2001-01-23
Medical intelligence: Comments:

Global parametres

Length of the spine: DCK 346.6 [mm] meaning 29.1% of height
Tilt angles [deg.]: ALFA 10.1, BETA 15.2, GAMMA 13.9 In total: 39,2 [deg.]
Torso tilt angle: KPT 6.3 [deg.] Compensation rate: 3.8 [deg.]

Thoracic kyphosis

D.LL_C7 DKP 309.9 [mm] (89.4%) KKP angle 150.9 [deg.]
D.PL_C7 RKP 195.7 [mm] (56.5%) GKP depth 32.7 [mm] (WKP 0.167)

Lumbar lordosis

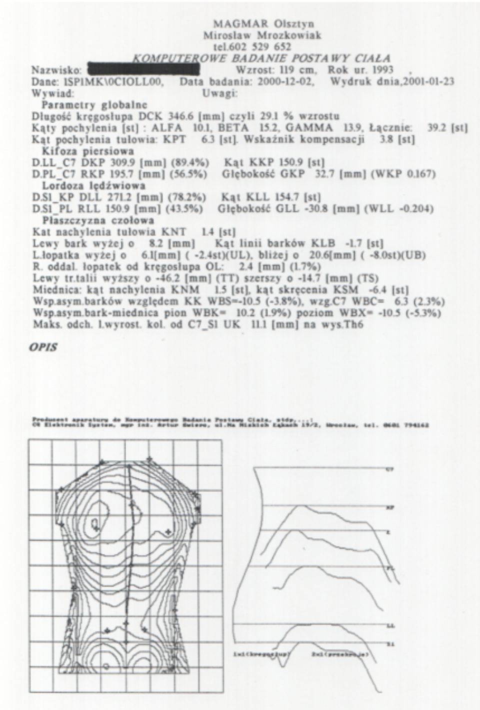
D.S1_KP DLL 271.2 [mm] (78.2%) KLL angle 154.7 [deg.]
D.S1_PL RLL 150.9 [mm] (43.5%) GLL depth -30.8 [mm] (WLL -0.204)

Frontal plane

Torso tilt angle KNT 1.4 [deg.]
Left shoulder higher about 8.2 [mm] Angle of shoulder blades line KLB -1.7 [deg.]
Left shoulder blade higher about 6.1 [mm] (-2.4 deg.) (UL), closer about 20.6 [mm] (-8.0 deg.) (UB)
The difference of the distance of shoulder blades from the spine OL: 2.4 [mm] (1.7%)
Left waist triangle higher about -46.2 [mm] (TT), wider about -14.7 [mm] (TS)
The pelvis: tilt angle KNM 1.5 [deg.], turn angle KSM -6.4 [deg.]
Shoulder's asymmetry rate regarding KK WBS = -10.5 (-3.8%), regarding C7 WBC = 6.3 (2.3%)
Shoulder- pelvis asymmetry rate vertical WBK = 10.2 (1.9%) horizontal WBX = -10.5 (-5.3%)
Maximum deviation of 1. spinous process from C7_S1 UK 11.1 [mm] at Th6 level

DESCRIPTION

The manufacturer of the measuring device of Computerized Examination Of the Body Posture, feet,_:
CQ Electronic System, M.E. Artur Świerc, Na Niskich Lakach street, 19/2, Wroclaw, phone numer: 0601 794162



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

Figure 1: An example of a record sheet of measurements of the posture features of the spine-pelvis syndrome.

Subject of Research

The Wrocław fitness test allowed to measure the strength, power, speed and agility of preschool children. The author modified Sekita's test for a test of endurance. Definitions of the tested physical and complex motor skills are generally available in the literature [26].

The applied method, which uses the phenomenon of the projection moiré, defines several dozen features describing the body posture. For statistical analysis, 19 angular and linear features of the spine, pelvis and torso in the frontal plane as well as body weight and height were selected. It was guided by the need of the most reliable and spatially complete look at the child's body posture, which allowed to fully identify the measured discriminants (Table 1) (Figure 2-4).

Table 1: The list of registered body and morphological features.

No	Symbol	Parametres		
		Label	Name	Description
Sagittal palne				
1	Alfa	degrees	The inclination of limbosacral segment	
2	Beta	degrees	The inclination of thoracolumbar segment	
3	Gamma	degrees	The inclination of upper thoracic segment	
4	Delta	degrees	The total of angles value	Delta=Alfa+Beta+Gamma
5	KPT	degrees	Torso extension angle	It is determined by the inclination of C7-S1 line from the vertical (backwards)
6	KPT-	degrees	Torso bend angle	It is determined by the inclination of C7-S1 line from the vertical (forwards)
7	DKP	mm	The length of thoracic kyphosois	The distance between LL a C7 points
8	KKP	stopnie	The angle of thoracic kyphosois	KKP=180–(Beta+Gamma)
9	RKP	mm	The height of thoracic kyphosois	The distance between C7 a PL points
10	GKP	mm	The depth of thoracic kyphosois	The distance measured horizontally between vertical lines crossing PL and KP points
11	DLL	mm	The length of lumbar lordosis	The distance between S1 a KP points
12	KLL	degrees	The angle of lumbar lordosis	KLL=180–(Alfa+Beta)
13	RLL	mm	The height of lumbar lordosis	The distance between S1 a PL points
14	GLL-	mm	The depth of lumbar lordosis	The distance measured horizontally between vertical lines crossing PL and LL points
Transversal plane				
15	UB-	degrees	The angle of convex line of lower shoulder blades, where the left is more convex	The angle difference of UB1 - UB2. The UB2 angle between a line crossing the Łl point and being simultaneously perpendicular to the camera axis and the straight-line crossing Łl and Łp points. The UB1 angle is between the line crossing the Łp point and being simultaneously perpendicular to the camera axis and the straight-line crossing Łp and Łl points.
16	UB	degrees	The angle of convex line of lower shoulder blades, where the right is more convex	PLLB=LLB-PLB
17	KSM	degrees	Pelvic tilt to the left	The angle between a line crossing M1point and being simultaneously perpendicular to the camera axis and a straight-line crossing M1 and MP points
18	KSM-	degrees	Pelvic tilt to the left	The angle between a line crossing Mp point and being simultaneously perpendicular to the camera axis and a straight-line crossing M1 and MP points
19	DCK	mm	Total length of the spine	The distance between C7 and S1 points measured vertically.
Morphological features				
20	Mc	kg	Body weight	The body height and weight was measured with electrical medical balance.
21	Wc	cm	Body height	

Note*: Own research.

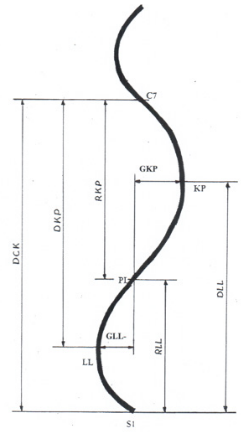


Figure 2: Selected linear features of the spine in the sagittal plane.

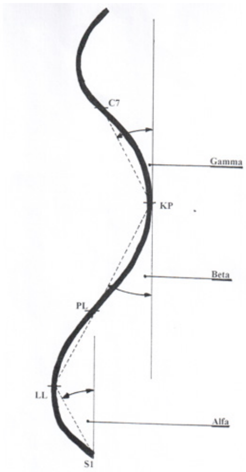


Figure 3: Selected angular features of the spine in the sagittal plane.


Figure 4: Angle of the pelvis tilt in the sagittal plane.

Research Questions and Hypotheses

i. The following research questions arise from the aim of the research:

ii. Will releasing the child from the load, in the adopted way of carrying the school supplies, significantly affect the statics of body posture in the frontal plane, and cause a sex-dependent restitution of the values of the features?

iii. Will physical fitness show significant and sex-dependent relationships with the values of restitution of posture features after the first and second minutes of the load removal?

Our own research results and the analysis of the available literature allow us to believe that:

a) The adopted way of carrying the weight of school supplies, significantly affecting the statics of body posture in the frontal plane, causes incomplete and gender-independent restitution of the values of the tested features.

b) Physical fitness will show significant and gender-dependent relationships with the restitution of the values of posture features after the first and second minutes of the load removal.

Statistical Methods

It was assumed that the standard deviation is a measure of differentiation. The higher it is in relation to the mean, the greater the variation of results is in each group. There was no reference to it in the description of the results, but in analytical practice its application was treated as a concomitant measure of the arithmetic mean. In the used analysis, the reference to SD was abandoned. These were only given in the introductory tables (where M was also given) as a formality. SD was a concomitant measure of M. It was also assumed that the value of SD in the performed studies was not interpreted in any way, especially if the analysis was based on non-parametric tests and median (Me), but not the mean (M). Therefore, SD and M were finally removed in the initial analyzes to concentrate the tables and leave there only necessary issues for the research. Standard deviation is a concomitant measure of the arithmetic mean and therefore it is not valid to put it next to the median.

The analysis of the study results was performed using the IBM SPSS Statistics 26 programme. At the initial stage, the Shapiro-Wilk and Kołmogorow-Smirnow tests were used to ensure if the distributions of the analyzed variables were consistent with the normal distribution. For most of the variables, there were statistically significant deviations from the normal distribution at the level of $p < 0.05$. Therefore, it was decided to use tests and non-parametric coefficients in the statistical analysis. The Wilcoxon rank test was used to determine whether there was a statistically significant difference (change) between two measurements (in the same group) of the quotient variable whose distribution was significantly different from the normal one. The following symbols were used in the tables: M-arithmetic mean, Me-median, SD-standard deviation, Z-Wilcoxon test statistic, "p"-significance of the Wilcoxon test. The level of significance was set at $p < 0.05$, marked as *, and additionally, the significance level $p < 0.01$, marked as **. Thus, if $p < 0.05$ or $p < 0.01$, then the difference between the measurements was statistically significant. The Spearman's rho correlation coefficient was used to determine whether there were statistically significant correlations between the variables measured at the quotient level, which distribution significantly differed from the normal one. The level of statistical significance was set at $p < 0.05$, marked as *, and additionally, the level of significance $p < 0.01$, marked as **. Thus, if $p < 0.05$ or $p < 0.01$, then the correlation between the variables was statistically significant. If the correlation was statistically significant at the level of $p < 0.05$, then the correlation coefficient rho should be interpreted. It could take values from -1 to +1. The more distant it was from 0, and the closer it was to -1 or +1, so the correlation was stronger. Negative values meant that as the value of one variable increased, the value of the other variable decreased. On the other hand, positive values indicated that as the value of one variable increased, the value of the other variable increased, too. In the individual tables of correlation, only the variables were considered (in the rows), which at least one statistically significant result was recorded for.

Individual values of posture features are expressed in different sizes and ranges, so it is not possible to calculate the average difference for all these variables between the two measurements. An analysis performed in such a way would distort the results and make the variables, in which the quantities are higher of greater importance, and the variables, in which the quantities were lower of less importance. Therefore, the correlation between the averaged difference in the value of features between the measurements and physical fitness was made separately for girls and boys, using absolute values, i.e., the calculations did not use exact numerical values concerning the differences, but the ratio of the difference to the initial value. This approach makes the variables not to be overrepresented or underrepresented in the average result.

The analysis included a comparison of the value of posture features between 1^{st} and 3^{rd}, 1^{st} and 4^{th}, 2^{nd} and 3^{rd} and 3^{rd} and 4^{th} with the measurement of the school bag carried on the left shoulder - right hip as well as on the right shoulder - left hip, separately for girls and boys. This was to show the restitution (full or incomplete) of changes in the analyzed posture features in the adopted way of carrying school supplies. To concentrate the results of the analysis as much as possible, the tables include only the medians, and the significance of the Wilcoxon test results. The analysis of the correlation between the results of physical fitness tests and the difference between 2^{nd} and 3^{rd}, 3^{rd} and 4^{th}, 1^{st} and 2^{nd}, 1^{st} and 3^{rd} and 1^{st} and 4^{th} measurements separately for carrying on the left shoulder - right hip and right shoulder - left hip, as weel as separately for boys and girls was also performed. To concentrate the results of the analysis as much as possible, only the correlation coefficients (rho) were included in the tables. Correlations statistically significant at the level of $p < 0.01$ are marked **, and correlations statistically significant at the level of $p < 0.05$ are marked *. The individual tables include only those variables (in the rows), which at least one statistically significant result was recorded for.

Obtained Results

In total, the research carried out in a group of 65 people of both sexes aged 7 years allowed to register 5,395 values of features describing body posture in habitual posture and dynamic positions, body weight and height, and physical fitness.

Average body weight (MC) was as follows: among girls 24.46kg, body height (Wc) 123.87, and among boys: 24.56kg and 123cm, respectively. All children had a slender body type according to the Rohrer Weight and Growth Index (IR) [33].

Information was also obtained through a survey conducted among 65 parents of children reported to the research project [29].

The analysis of the results of the applied Wrocław fitness test and the endurance diagnostic trial showed that the tested group of children represented a sufficient level of physical fitness, assuming grading: insufficient, sufficient, good, very good. This level was significantly lower than the values obtained in the measurements of other authors from 2006, 1996, 1972 and 1967 [34-36]. The phenomenon of sexual dimorphism in the studied group of 7-year-olds of both sexes was not confirmed.

Analysing the results of carrying on the left shoulder - right hip as well as on the right shoulder - left hip counting only boys, the Wilxon's test showed a statistically significant difference between 3rd and 1st, 2nd and 3rd and 3rd and 4th measurement in the range of all analysed variables (Table 2,3).

Table 2: Restitution of the values of body posture features in the frontal plane between 1st and 3rd, 1st and 4th, 2nd and 3rd and 3rd and 4th measurement in carrying on the left shoulder-right hip among boys.

No.	Variables	Measurement				Wilcoxon's Test			
		1	2	3	4				
		Me	Me	Me	Me	1/3 p	1/4 p	2/3 p	3/4 p
1	DCK	314,05	294,30	299,60	311,45	<0,001**	<0,001**	<0,001**	<0,001**
2	Alfa	8,45	13,75	11,20	9,75	<0,001**	<0,001**	<0,001**	<0,001**
3	Beta	9,75	12,85	11,55	10,45	<0,001**	<0,001**	<0,001**	<0,001**
4	Gamma	11,20	18,00	15,80	13,20	<0,001**	<0,001**	<0,001**	<0,001**
5	Delta	29,65	45,00	37,60	33,85	<0,001**	<0,001**	<0,001**	<0,001**
6	KPT-	4,15	7,95	5,70	4,90	<0,001**	<0,001**	<0,001**	<0,001**
7	KPT	4,75	2,05	2,60	3,90	0,005**	0,005**	0,005**	0,005**
8	DKP	279,00	266,95	272,10	275,15	<0,001**	<0,001**	<0,001**	<0,001**
9	KKP	159,00	149,05	152,65	155,80	<0,001**	<0,001**	<0,001**	<0,001**
10	RKP	185,30	175,10	181,05	183,75	<0,001**	<0,001**	<0,001**	<0,001**
11	GKP	19,95	32,85	25,55	22,10	<0,001**	<0,001**	<0,001**	<0,001**
12	DLL	247,00	243,30	245,35	246,55	<0,001**	<0,001**	<0,001**	<0,001**
13	KLL	161,95	153,35	157,25	159,90	<0,001**	<0,001**	<0,001**	<0,001**
14	RLL	135,60	132,15	133,70	135,00	<0,001**	<0,001**	<0,001**	<0,001**
15	GLL	24,45	27,70	25,95	24,60	<0,001**	<0,001**	<0,001**	<0,001**
16	UB-	3,30	1,00	1,95	2,80	0,012*	0,011*	0,028*	0,011*
17	UB	4,00	7,40	5,15	4,40	<0,001**	<0,001**	<0,001**	<0,001**
18	KSM-	2,45	0,75	1,65	2,10	0,011*	0,011*	0,017*	0,011*
19	KSM	5,50	11,30	8,60	6,80	<0,001**	<0,001**	<0,001**	<0,001**

Note*: Own research.

Table 3: Restitution of the values of body posture features in the frontal plane between 1st and 3rd, 1st and 4th, 2nd and 3rd and 3rd and 4th measurement in carrying on the right shoulder-left hip among boys.

No.	Variables	Measurement				Wilcoxona's Test			
		1	2	3	4				
		Me	Me	Me	Me	1/3 p	1/4 p	2/3 p	3/4 p
1	DCK	314,05	294,30	300,70	309,90	<0,001**	<0,001**	<0,001**	<0,001**
2	Alfa	8,45	13,20	11,20	9,70	<0,001**	<0,001**	<0,001**	<0,001**
3	Beta	9,75	12,65	11,60	9,80	<0,001**	0,089	<0,001**	<0,001**
4	Gamma	11,20	17,25	14,45	12,60	<0,001**	<0,001**	<0,001**	<0,001**
5	Delta	29,65	43,30	36,45	32,25	<0,001**	<0,001**	<0,001**	<0,001**
6	KPT-	4,15	7,20	6,10	4,75	<0,001**	<0,001**	<0,001**	<0,001**
7	KPT	4,75	1,80	2,65	4,05	0,005**	0,005**	0,005**	0,005**
8	DKP	279,00	266,15	272,25	277,15	<0,001**	<0,001**	<0,001**	<0,001**
9	KKP	159,00	150,25	153,75	157,10	<0,001**	<0,001**	<0,001**	<0,001**
10	RKP	185,30	175,05	182,95	184,75	<0,001**	<0,001**	<0,001**	<0,001**

11	GKP	19,95	31,45	25,65	21,65	<0,001**	<0,001**	<0,001**	<0,001**
12	DLL	247,00	241,30	245,25	246,20	<0,001**	<0,001**	<0,001**	<0,001**
13	KLL	161,95	154,25	157,40	160,35	<0,001**	<0,001**	<0,001**	<0,001**
14	RLL	135,60	130,55	132,10	133,95	<0,001**	<0,001**	<0,001**	<0,001**
15	GLL	24,45	27,20	25,95	25,05	<0,001**	<0,001**	<0,001**	<0,001**
16	UB-	3,30	5,35	4,45	4,00	0,012*	0,011*	0,012*	0,012*
17	UB	3,65	1,75	2,75	3,25	<0,001**	<0,001**	<0,001**	<0,001**
18	KSM-	2,45	8,60	6,45	3,65	0,012*	0,012*	0,012*	0,012*
19	KSM	5,50	2,60	3,70	4,75	<0,001**	<0,001**	<0,001**	<0,001**

Table 4: Restitution of the values of body posture features in the frontal plane between 1st and 3rd, 1st and 4th, 2nd and 3rd and 3rd and 4th measurement in carrying on the left shoulder-right hip among girls.

No.	Variables	Measurement				Wilcoxon's Test			
		1	2	3	4				
		Me	Me	Me	Me	1/3 p	1/4 p	2/3 p	3/4 p
1	DCK	294,10	280,50	287,45	292,35	<0,001**	<0,001**	<0,001**	<0,001**
2	Alfa	8,90	14,50	12,05	10,60	<0,001**	<0,001**	<0,001**	<0,001**
3	Beta	11,20	14,30	13,15	11,80	<0,001**	<0,001**	<0,001**	<0,001**
4	Gamma	11,25	18,20	15,80	14,00	<0,001**	<0,001**	<0,001**	<0,001**
5	Delta	31,00	46,70	40,95	35,25	<0,001**	<0,001**	<0,001**	<0,001**
6	KPT-	4,10	8,10	5,30	4,60	<0,001**	<0,001**	<0,001**	<0,001**
7	KPT	4,20	2,20	2,80	3,50	<0,001**	<0,001**	<0,001**	<0,001**
8	DKP	276,25	264,85	268,90	273,50	<0,001**	<0,001**	<0,001**	<0,001**
9	KKP	157,70	147,75	150,65	154,55	<0,001**	<0,001**	<0,001**	<0,001**
10	RKP	176,90	166,60	171,45	175,35	<0,001**	<0,001**	<0,001**	<0,001**
11	GKP	20,45	33,70	25,85	22,70	<0,001**	<0,001**	<0,001**	<0,001**
12	DLL	248,15	244,05	245,70	247,55	<0,001**	<0,001**	<0,001**	<0,001**
13	KLL	159,90	150,50	154,50	157,75	<0,001**	<0,001**	<0,001**	<0,001**
14	RLL	129,15	124,70	127,35	128,40	<0,001**	<0,001**	<0,001**	<0,001**
15	GLL	23,40	27,35	25,10	23,90	<0,001**	<0,001**	<0,001**	<0,001**
16	UB-	2,70	0,90	1,30	2,10	<0,001**	<0,001**	0,001**	<0,001**
17	UB	2,80	7,30	5,50	3,50	0,001**	0,001**	0,001**	0,001**
18	KSM-	2,90	0,80	1,40	2,60	<0,001**	<0,001**	<0,001**	<0,001**
19	KSM	4,10	10,40	7,90	5,80	0,001**	0,001**	0,001**	0,001**

Note*: Own research.

Table 5: Restitution of the values of body posture features in the frontal plane between 1st and 3rd, 1st and 4th, 2nd and 3rd and 3rd and 4th measurement in carrying on the right shoulder-left hip among girls.

No.	Variables	Measurement				Wilcoxon's Test			
		1	2	3	4				
		Me	Me	Me	Me	1/3 p	1/4 p	2/3 p	3/4 p
1	DCK	294,10	280,90	286,50	290,70	<0,001**	<0,001**	<0,001**	<0,001**
2	Alfa	8,90	13,75	11,65	10,20	<0,001**	<0,001**	<0,001**	<0,001**
3	Beta	11,20	13,65	12,20	10,95	<0,001**	0,865	<0,001**	<0,001**
4	Gamma	11,25	17,40	15,40	13,15	<0,001**	<0,001**	<0,001**	<0,001**
5	Delta	31,00	44,70	39,40	34,15	<0,001**	<0,001**	<0,001**	<0,001**
6	KPT-	4,10	7,50	6,30	4,80	<0,001**	<0,001**	<0,001**	<0,001**
7	KPT	4,20	2,00	2,80	3,70	<0,001**	<0,001**	<0,001**	<0,001**

8	DKP	276,25	263,55	268,15	275,15	<0,001**	<0,001**	<0,001**	<0,001**
9	KKP	157,70	148,80	152,70	155,80	<0,001**	<0,001**	<0,001**	<0,001**
10	RKP	176,90	166,15	172,40	175,70	<0,001**	<0,001**	<0,001**	<0,001**
11	GKP	20,45	31,70	24,60	22,10	<0,001**	<0,001**	<0,001**	<0,001**
12	DLL	248,15	244,00	244,30	248,00	<0,001**	<0,001**	<0,001**	<0,001**
13	KLL	159,90	152,45	155,40	159,25	<0,001**	0,002**	<0,001**	<0,001**
14	RLL	129,15	123,55	126,85	127,80	<0,001**	<0,001**	<0,001**	<0,001**
15	GLL	23,40	26,50	25,05	24,30	<0,001**	<0,001**	<0,001**	<0,001**
16	UB-	2,70	5,60	4,30	3,10	<0,001**	<0,001**	<0,001**	<0,001**
17	UB	2,80	1,60	2,10	2,70	0,001**	0,001**	0,001**	0,001**
18	KSM-	2,90	8,90	6,50	4,20	<0,001**	<0,001**	<0,001**	<0,001**
19	KSM	4,10	2,10	3,20	4,00	0,001**	0,001**	0,001**	0,001**

Note*: Own research.

Considering carrying on the left shoulder - right hip and counting only girls, the Wilson'test showed a statistically significant difference between 3rd and 1st, 2nd and 3rd and 3rd and 4th measurement of all the analysed variables. On the other hand, carrying on the right shoulder - left hip showed a statistically significant difference between 3rd and 1st, 2nd and 3rd and 3rd and 4th measurement of all the analysed variables but 1st and 4th measurement in the case of the inclination angle of the thoracolumbar spine (Beat), which is not statistically significant (Tables 4,5).

Considering boys and the difference among 2 and 3 measurement in carrying on the left shoulder - right hip it appeared that the greater endurance, strength, force and agility the less asymmetry of angle convexity of the lower shoulder blades (UB-) and greater of pelvis (KSM-). The greater speed the smaller difference of the inclination angle of the lumbar spine (Alfa), the angle of lumbar lordosis (KLL) and less asymmetry of pelvis (KSM-) but greater in the angle convexity of the lower shoulder blades (UB-). The greater the overall fitness the smaller the asymmetry of the angle convexity of the lower shoulder blades (UB-), but greater of pelvis (KSM-). Analysing the differences between 3rd and 4th measurement it appeared that the greater the endurance, agility, strength and overall fitness the smaller the asymmetry of the convexity angles of the lower shoulder blades (UB-), but greater of pelvis (KSM-). The greater the speed the smaller the asymmetry of the pelvis (KSM-) but greater differences of the angle (KLL) and height of lumbar lordosis (RLL) and greater asymmetry of the angle convexity of the lower shoulder blades (UB-). The greater the force the smaller the asymmetry of the torso (KPT-) and the angle convexity of the lower shoulder blades (UB-) but greater of pelvis (KSM-). While examining the differences between the 1st and 2nd measurement, it was observed that the greater the endurance, the smaller the asymmetries of the convexity of the angles of the lower shoulder blades (UB-), but the greater of the torso (KPT +) and the pelvis (KSM-).The greater the speed, the smaller pelvic asymmetry (KSM-) and the greater convexity of the angles of the lower shoulder blades (UB-). The greater the strength, the smaller the differences in the length of the thoracic kyphosis (DKP) and the smaller asymmetries in the convexity of the angles of the lower shoulder blades (UB-), but the greater the differences in the height of thoracic kyphosis (RKP) and the greater asymmetries of the pelvis (KSM-). The greater the force, the smaller the asymmetries of the torso (KPT-) and the convexities of the angles of the lower shoulder blades (UB-), but the greater of the pelvis (KSM-). The greater the agility, the smaller the differences in the length of the thoracic kyphosis (DKP) and the smaller the asymmetries of the convexities of the angles of the lower shoulder blades (UB-), but the greater of pelvis (KSM-). The greater the overall efficiency the smaller the differences in the length of the thoracic kyphosis (DKP) and the smaller the asymmetries of the convexities of the lower angles of the shoulder blades (UB-), but the greater of pelvis (KSM-) (Table 6).

Table 6: Correlations between physical fitness and restitution between 2nd and 3rd, 3rd and 4th and 1st and 2nd measurement of the values of body posture features in carrying on the left shoulder-right hip among boys.

Variables	Difference between 2nd and 3rd measurement						Difference between 3rd and 4th measurement						Difference between 1st and 2nd measurement					
	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
Alfa	-0,31	-0,55*	-0,12	0,31	-0,29	-0,22	0,25	0,41	-0,12	-0,28	-0,03	0,00	-0,35	-0,30	0,23	0,29	-0,13	0,03
KPT-	-0,01	-0,08	0,38	0,06	0,34	0,27	0,03	0,07	-0,10	-0,78*	-0,11	-0,09	-0,03	0,19	-0,06	-0,72*	-0,41	-0,22
DKP	-0,15	-0,28	-0,41	0,10	-0,38	-0,39	0,38	0,45	0,22	-0,34	0,25	0,25	-0,39	-0,33	-0,64**	-0,19	-0,56*	-0,70**
RKP	0,04	0,26	0,39	-0,42	0,36	0,32	0,10	0,17	0,37	0,38	-0,12	0,27	0,22	0,25	0,52*	0,10	0,09	0,47
KLL	-0,28	-0,52*	0,00	0,43	-0,19	-0,11	0,34	0,53*	0,36	-0,16	0,36	0,41	-0,29	-0,27	0,31	0,34	-0,05	0,13
RLL	0,16	-0,06	-0,09	-0,02	0,12	0,01	0,38	0,55*	0,08	-0,03	0,15	0,25	0,29	0,22	0,11	0,13	0,22	0,22

UB-	-1,0 0**	1,0 0**	-1,0 0**	-1,0 0**	-1,0 0**	-1,0 0**	-1,0 0**	1,0 0**	-1,0 0**	-1,0 0**	-1,0 0**	-1,0 0**	-1,0 0**	1,0 0**	-1,0 0**	-1,0 0**	-1,0 0**	-1,0 0**
UB	0,26	0,18	0,11	0,10	0,04	0,20	-0,41	-0,30	-0,57*	-0,20	-0,20	-0,49	-0,16	-0,24	-0,55	-0,08	-0,30	-0,45
KSM-	1,0 0**	-1,0 0**	1,0 0**	1,0 0**	1,0 0**	1,0 0**	1,0 0**	-1,0 0**	1,0 0**	1,0 0**	1,0 0**	1,0 0**	1,0 0**	-1,0 0**	1,0 0**	1,0 0**	1,0 0**	1,0 0**

Note*: Own research.
Legend: WY-endurance, SZ-speed, SI-strength, MO-force, ZW- agility, OG- overall fitness

Considering the differences between the 1st and 3rd measurement, it was observed that the greater the endurance, force and overall efficiency, the smaller the asymmetries of the convexities of the lower angles of the shoulder blades (UB-), but the greater of pelvis (KSM-). The greater the speed, the smaller the pelvic asymmetry (KSM-) but the greater convexities of the angles of the lower shoulder blades (UB-). The greater the strength, the smaller the asymmetry of the convexities of the angles of the lower shoulder blades, where the right (UB +) or left (UB-) angle is more convex but the greater of pelvis (KSM-). The greater the agility, the smaller the differences in the depth of thoracic kyphosis (GKP) and convexities of the angles of the lower shoulder blades (UB-), but the greater of the pelvis (KSM-).

Considering the differences between the 1st and 4th measurement, it turned out that the greater the endurance and agility, the smaller the asymmetries of the convexities of the angles of the lower shoulder blades (UB-), but the greater of pelvis (KSM-). The greater the speed, the smaller the pelvic asymmetry (KSM-) and the greater the convexities of the angles of the lower shoulder blades (UB-). The greater the strength and overall efficiency, the smaller the differences in the length of the thoracic kyphosis (DKP) and the smaller the asymmetries of the convexities of the angles of the lower shoulder blades (UB-), but the greater of pelvis (KSM-). The greater the force, the smaller the differences in the depth of lumbar lordosis (GLL) and the smaller asymmetries of the convexities of the angles of the lower shoulder blades (UB-), but the greater of pelvis (KSM-) (Table 7).

Table 7: Correlations between physical fitness and restitution between 1st and 3rd, and 1st and 4th measurement of the values of body posture features in carrying on the left shoulder-right hip among boys.

Variables	Difference between 1st and 3rd measurement						Difference between 1st and 4th measurement					
	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
DKP	0,12	0,14	-0,17	-0,29	-0,05	-0,10	-0,33	-0,50	-0,63*	-0,07	-0,45	-0,62*
GKP	0,17	0,23	-0,35	0,12	-0,55*	-0,19	-0,01	0,10	-0,13	0,37	-0,38	-0,02
GLL	0,27	0,31	-0,17	-0,42	-0,30	-0,18	0,16	0,20	-0,25	-0,56*	-0,06	-0,23
UB-	-1,00**	1,00**	-1,00**	-1,00**	-1,00**	-1,00**	-1,00**	1,00**	-1,00**	-1,00**	-1,00**	-1,00**
UB	-0,37	-0,25	-0,60*	-0,31	-0,24	-0,54	-0,23	-0,23	-0,57*	-0,43	-0,25	-0,52
KSM-	1,00**	-1,00**	1,00**	1,00**	1,00**	1,00**	1,00**	-1,00**	1,00**	1,00**	1,00**	1,00**

Note*: Own research.
Legend: WY-endurance, SZ-speed, SI-strength, MO-force, ZW- agility, OG- overall fitness

Considering the differences between the 2nd and 3rd measurement in cattying on the right shoulder-left hip, it turned out that the greater the endurance, agility and overall efficiency, the smaller the asymmetries of the convexities of the angles of the lower shoulder blades (UB-), but the greater of the pelvis (KSM-). The greater the speed, the smaller the differences in the size of the angle of the lumbosacral spine (Alpha), the angle of lumbar lordosis (KLL) and the smaller pelvic asymmetries (KSM-), but the greater the convexities of the angles of the lower shoulder blades (UB-). The greater the strength, the smaller the differences in the length of the lumbar lordosis (DLL) and the smaller the asymmetries of the convexities of the angles of the lower shoulder blades (UB-), but the greater of the pelvis (KSM-). The greater the force, the smaller the asymmetries of the torso (KPT-) and convexities of the angles of the lower shoulder blades (UB-), but the greater of the pelvis (KSM-). When examining the differences between the 3rd and 4th measurement, it turned out that the greater the endurance and strength, the smaller the pelvic asymmetry (KSM-), but the greater the convexities of the angles of the lower shoulder blades (UB-). The greater the speed, the smaller the asymmetries of the convexities of the angles of the lower shoulder blades (UB-) and the greater of the pelvis (KSM-). The greater the force, the smaller the pelvic asymmetries (KSM-), but the greater the differences in the length of the lumbar lordosis (RLL) and the greater the asymmetries of the convexity of the angles of the lower shoulder blades (UB-). The greater the agility and overall efficiency, the smaller the pelvic asymmetry (KSM-), and the greater the convexity of the angles of the lower shoulder blades (UB-). Analyzing the differences between the 1st and 2nd measurement, it turned out that the greater the endurance, the smaller the asymmetries of the convexities of the angles of the lower shoulder blades (UB-) and the pelvis (KSM-). The greater the speed, the greater the asymmetries of the convexity of the angles of the lower shoulder blades (UB-) and the pelvis (KSM-). The greater the strength, the smaller the differences in the length of thoracic kyphosis (DKP) and lumbar lordosis (DLL), the smaller the asymmetries of the convexities of the angles of the lower shoulder blades, where the lower angle of the left one is more convex (UB-) and of the pelvis (KSM-), but the greater the convexity of the angles of the lower shoulder blades, where the lower angle of the right one (UB+) is more convex. The greater the force, the smaller the asymmetries of the torso (KPT-) and pelvis (KSM-), and the greater the convexity of the angles of the lower shoulder blades (UB+). The greater the agility, the smaller the differences in the length of the thoracic kyphosis (DKP), the smaller the asymmetries of the convexity of the angles of the lower shoulder blades, where the left angle is more convex (UB-) and of the pelvic angle (KSM-), but the greater the asymmetry of the convexity of the angles of the lower shoulder blades where the angle of the right one is more convex (UB +). The greater the overall efficiency, the smaller the differences in the length of the thoracic kyphosis (DKP), the smaller the asymmetries of the convexities of the angles of the lower shoulder blades, where the angle of the left one is more convex (UB-) and the angle of the pelvis (KSM-), but the greater the asymmetry of the convexities of the angles of the lower shoulder blades where the right one is more convex (UB+) (Table 8).

Table 8: Correlations between physical fitness and restitution between 2nd and 3rd, 3rd and 4th and 1st and 2nd measurement of the values of body posture features in carrying on the right shoulder-left hip among boys.

Variables	Difference between 2nd and 3rd measurement						Difference between 3rd and 4th measurement						Difference between 1st and 2nd measurement					
	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
Alfa	-0,34	-0,62*	0,01	0,26	-0,14	-0,11	-0,01	0,31	0,30	0,07	0,08	0,19	-0,45	-0,41	0,22	0,24	-0,03	0,01
KPT-	-0,11	-0,33	-0,16	-0,82**	-0,11	-0,34	-0,22	0,08	-0,02	-0,51	-0,42	-0,18	-0,23	-0,14	-0,31	-0,83**	-0,49	-0,45
DKP	-0,15	-0,12	-0,04	0,30	-0,26	-0,08	0,12	0,26	-0,06	-0,22	-0,20	0,00	-0,34	-0,28	-0,66**	-0,26	-0,62*	-0,72**
DLL	0,08	0,08	-0,53*	-0,11	-0,37	-0,30	-0,44	-0,24	0,06	0,44	0,10	-0,04	-0,17	-0,15	-0,69**	-0,03	-0,48	-0,50
KLL	-0,41	-0,60*	0,18	0,36	0,15	0,08	0,19	0,25	0,48	-0,05	0,37	0,38	-0,48	-0,48	0,24	0,40	0,02	0,06
RLL	0,52*	0,36	-0,09	-0,39	0,19	0,02	0,19	0,11	0,01	0,60*	-0,02	0,23	0,26	0,28	-0,10	0,10	0,10	0,06
UB-	-1,00**	1,00**	-1,00**	-1,00**	-1,00**	-1,00**	1,00**	-1,00**	1,00**	1,00**	1,00**	1,00**	-1,00**	1,00**	-1,00**	-1,00**	-1,00**	-1,00**
UB	0,20	0,11	0,55	0,14	0,16	0,38	-0,25	-0,16	0,42	0,00	0,30	0,20	-0,01	-0,02	0,56*	0,06	0,31	0,37
KSM-	1,00**	-1,00**	1,00**	1,00**	1,00**	1,00**	-1,00**	1,00**	-1,00**	-1,00**	-1,00**	-1,00**	-1,00**	1,00**	-1,00**	-1,00**	-1,00**	-1,00**

Note*: Own research.
Legend: WY-endurance, SZ-speed, SI-strength, MO-force, ZW- agility, OG- overall fitness

By examining the differences between the 1st and 3rd measurement, it turned out that the greater the endurance and strength, the smaller the pelvic asymmetries (KSM-). The greater the speed, force, agility and overall efficiency, the greater the asymmetries of the convexities of the angles of the lower shoulder blades (UB-) and of the pelvis (KSM-). Considering the differences between the 1st and 4th measurement, it turned out that the greater the endurance, the smaller the differences in the size of the inclination angle of the thoracolumbar spine (Beta), and the smaller asymmetries of the convexity of the angles of the lower shoulder blades (UB-) and of the pelvis (KSM-). The greater the speed and overall efficiency, the smaller the differences in the size of the inclination angle of the thoracolumbar spine (Beta) (Table 9). Considering the differences between the 2nd and 3rd measurement in carrying on the left shoulder-right hip among girls, it turned out that the greater the endurance, the smaller the asymmetries of the convexity of the angles of the lower shoulder blades (UB-). The analysis of the differences between the 3rd and 4th measurement showed that the greater the endurance, the greater the differences in the length of thoracic kyphosis (DKP). Considering the differences between the 1st and 2nd measurement, it turned out that the greater the endurance, the smaller the asymmetries of the convexities of the angles of the lower shoulder blades (UB-), but the greater the differences in height (RLL) and depth (GLL) of the lumbar lordosis. The greater the strength and overall efficiency, the greater the differences in the size of the inclination angle of the thoracic-lumbar spine (Beta) (Table 10).

Table 9: Correlations between physical fitness and restitution between 1st and 3rd, and 1st and 4th measurement of the values of body posture features in carrying on the right shoulder-left hip among boys.

Variables	Difference between 1st and 3rd measurement						Difference between 1st and 4th measurement					
	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
Beta	0,44	0,32	-0,11	-0,07	-0,18	0,00	-0,55*	-0,57*	-0,63*	-0,28	-0,80**	-0,83**
UB-	-1,00**	1,00**	-1,00**	-1,00**	-1,00**	-1,00**	-1,00**	1,00**	-1,00**	-1,00**	-1,00**	-1,00**
KSM-	-1,00**	1,00**	-1,00**	-1,00**	-1,00**	-1,00**	-1,00**	1,00**	-1,00**	-1,00**	-1,00**	-1,00**

Note*: Own research.
Legend: WY-endurance, SZ-speed, SI-strength, MO-force, ZW- agility, OG- overall fitness

Table 10: Correlations between physical fitness and restitution between 2nd and 3rd, 3rd and 4th and 1st and 2nd measurement of the values of body posture features in carrying on the left shoulder-right hip among girls.

Variables	Difference between 2nd and 3rd measurement						Difference between 3rd and 4th measurement						Difference between 1st and 2nd measurement					
	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
Beta	0,08	0,24	0,02	-0,16	0,39	0,11	0,08	-0,17	0,09	0,56	-0,32	-0,03	0,44	0,32	0,76**	0,37	0,52	0,64*
DKP	-0,18	-0,12	-0,23	-0,07	-0,36	-0,21	0,59*	0,29	0,21	0,30	0,44	0,32	0,16	-0,15	0,16	0,11	-0,06	0,05
RLL	-0,07	0,33	-0,32	-0,16	-0,19	-0,23	0,39	0,08	0,19	0,09	0,27	0,36	0,64*	0,20	0,13	0,34	0,27	0,39
GLL	0,00	0,22	0,13	0,02	0,39	0,19	0,53	0,13	0,10	0,12	0,04	0,21	0,66*	0,27	0,33	0,20	0,31	0,52
UB-	-0,90*	-0,20	-0,58	-0,67	-0,80	-0,80	-0,82	-0,05	-0,41	-0,57	-0,67	-0,67	-0,90*	-0,20	-0,58	-0,67	-0,80	-0,80

Note*: Own research.
Legend: WY-endurance, SZ-speed, SI-strength, MO-force, ZW- agility, OG- overall fitness

Analyzing the differences between the 1st and 3rd measurement, it was observed that the greater the speed, the greater the difference in the size of the thoracic kyphosis angle (KKP). The greater the strength, the greater the torso asymmetry (KPT-). Considering the differences between the 1st and 4th measurement, it turned out that the greater the endurance, the greater the difference in height of the lumbar lordosis (RLL). The greater the speed, the greater the differences of the size of the inclination angle of the upper thoracic segment (Gamma), the sum of the angles (Delta) and the angle of thoracic kyphosis (KKP). The greater the force, the smaller the differences in the length of the lumbar lordosis (DLL), but the greater the difference in the height of the lumbar lordosis (RLL) (Table 11).

Table 11: Correlations between physical fitness and restitution between 1st and 3rd, and 1st and 4th measurement of the values of body posture features in carrying on the left shoulder-right hip among girls.

Variables	Difference between 1st and 3rd measurement						Difference between 1st and 4th measurement					
	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
Gamma	-0,17	0,27	-0,34	-0,49	-0,18	-0,20	0,29	0,59*	0,20	-0,36	0,27	0,28
Delta	0,07	0,23	-0,12	-0,26	0,08	0,05	0,23	0,59*	0,29	-0,41	0,37	0,33
KPT-	0,82	0,53	0,89*	0,63	0,56	0,70	0,41	0,58	0,18	0,00	0,08	0,47
KKP	0,11	0,58*	0,07	-0,44	0,10	0,16	0,24	0,71**	0,23	-0,47	0,30	0,32
DLL	-0,07	0,11	0,17	-0,51	0,28	0,10	-0,29	0,02	-0,03	-0,66*	-0,06	-0,10
RLL	0,42	-0,01	0,21	0,23	0,26	0,37	0,76**	0,06	0,32	0,62*	0,29	0,54

Note*: Own research.
Legend: WY-endurance, SZ-speed, SI-strength, MO-force, ZW- agility, OG- overall fitness

When examining the differences between the 2nd and 3rd measurement in carrying on the right shoulder-left hip, it turned out that the greater the strength, the greater the differences in the size of the thoracolumbar inclination angle (Beta). The greater the force, the smaller the torso asymmetry (KPT +) and the greater the difference in the size of the thoracic kyphosis angle (KKP). Considering the differences between the 3rd and 4th measurement, it turned out that the greater the strength, the smaller the differences in the size of the inclination angle of the upper thoracic segment (Gamma). The greater the force, the greater the differences in the height of thoracic kyphosis (RKP). Considering the differences between the 1st and 2nd measurement, it turned out that the greater the strength, the greater the differences in the size of the thoracic kyphosis angle (KKP) and the greater the pelvic asymmetry (KSM-) (Table 12).

Table 12: Correlations between physical fitness and restitution between 2nd and 3rd, 3rd and 4th and 1st and 2nd measurement of the values of body posture features in carrying on the right shoulder-left hip among girls.

Variables	Difference between 2nd and 3rd measurement						Difference between 3rd and 4th measurement						Difference between 1st and 2nd measurement					
	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
Beta	0,41	0,24	0,64*	0,25	0,52	0,57	0,18	0,27	0,42	-0,02	0,37	0,43	0,30	0,13	0,46	0,32	0,19	0,45
Gamma	0,21	-0,21	0,11	0,72**	-0,11	0,12	-0,33	-0,34	-0,71**	-0,04	-0,43	-0,55	0,09	0,10	-0,30	0,01	-0,02	-0,13

KPT	-0,67	0,25	-0,29	-0,96**	-0,09	-0,32	0,00	-0,02	0,38	-0,15	0,29	0,18	-0,11	0,27	0,39	-0,49	0,33	0,18
KKP	0,44	0,05	0,44	0,65*	0,26	0,46	-0,21	-0,11	-0,31	-0,12	-0,06	-0,17	0,58*	0,19	0,45	0,48	0,33	0,57
RKP	-0,10	0,18	-0,31	-0,39	-0,20	-0,23	0,47	-0,44	0,25	0,73**	0,13	0,26	0,33	-0,06	0,05	0,27	0,05	0,13
KSM-	0,10	-0,30	0,63	0,78	0,50	0,50	0,15	0,05	-0,49	-0,34	-0,21	-0,21	0,90*	0,20	0,58	0,67	0,80	0,80

Note*: Own research.
Legend: WY-endurance, SZ-speed, SI-strength, MO-force, ZW- agility, OG- overall fitness

When analyzing the differences between the 1st and 3rd measurement, it was shown that the greater the endurance and force, the greater the differences in the height of thoracic kyphosis (RKP). The greater the speed, the greater the differences in the angle of thoracic kyphosis (KKP). When examining the differences between the 1st and 4th measurement, it was observed that the greater the endurance, the smaller the pelvic asymmetry (KSM +). The greater the speed, the greater the differences in the sum of angles (Delta) and height of thoracic kyphosis (RKP). The greater the strength, the greater the pelvic asymmetry (KPT +) and the convexity of the angles of the lower shoulder blades (UB-). The greater the force, the smaller the differences in the height of thoracic kyphosis (RKP). The greater the agility and overall efficiency, the greater the asymmetries of the convexity of the angles of the lower shoulder blades (UB-) (Table 13).

Table 13: Correlations between physical fitness and restitution between 1st and 3rd, and 1st and 4th measurement of the values of body posture features in carrying on the right shoulder-left hip among girls.

Variables	Difference between 1st and 3rd measurement						Difference between 1st and 4th measurement					
	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
Delta	0,05	0,34	0,03	-0,36	0,29	0,14	0,21	0,63*	0,33	-0,46	0,41	0,30
KPT	0,02	0,24	0,58	-0,22	0,38	0,31	0,27	0,31	0,76*	0,04	0,49	0,50
KKP	0,15	0,66*	0,24	-0,42	0,29	0,32	0,03	0,46	0,16	-0,51	0,16	0,12
RKP	0,60*	-0,28	0,37	0,74**	0,21	0,39	-0,02	0,58*	-0,11	-0,62*	-0,11	-0,03
UB-	0,67	0,82	0,46	0,23	0,56	0,56	0,82	0,41	0,97**	0,86	0,97**	0,97**
KSM	-0,64	-0,34	-0,54	-0,27	-0,40	-0,70	-0,86*	-0,45	-0,39	-0,50	-0,21	-0,63

Note*: Own research.
Legend: WY-endurance, SZ-speed, SI-strength, MO-force, ZW- agility, OG- overall fitness

Discussion

A review of the literature on the subject revealed a few scientific inquiries in the field of restitution of significantly altered features of posture under the influence of load resulting from carrying school supplies on the right or left shoulder and at the heteronymous hip by a 7-year-old student. The authors quoted in the introduction focused more on exploring the consequences of the weight of school supplies carried on one of the shoulders or the back, or the effects of a different weight of the accessories themselves [3-5]. The reason can be found in the lack of tools that measurably diagnosing the features of body posture and the way of distributing the load imitating a school backpack so as to enable an objective measurement.

The undertaken research is one of the few attempts to determine the restitution of static posture disorders [6-11]. It is an attempt to pay attention not only to the consequences of the weight, but also to the returning time to the habitual posture. *Mrozkowiak* [37] analyzed the results of research on the restitution of the values of posture features in the frontal, transversal and sagittal planes in carrying by the left and right hand drag method. The author showed that the value restitution of any of the analyzed features was not complete after the first and second minutes when the carrying was stopped. It proves insufficient physical fitness and slower restitution. The author's survey among parents of 7-year-old preschoolers shows that parents most frequently declare their awareness of their children's health. They believe that the first grader will carry a four-kilogram schoolbag on their back, learn traditionally (without a tablet) and spend about 2 hours improving their physical fitness [31]. According to the author, the accepted lifestyle disagrees with the development of physical fitness and the prevention of static posture disorders. The statements quoted by *Bittman and Badtke* [38] should be also considered and provided by Schild that the changes in the movement system of 5-7-year-old children depend primarily on the genetic determinants of the maturation of the musculo-nervous system. During this period, external factors, including physical activity, do not play a major role. It seems that the influence of external factors on the development of the locomotor system begins to increase with age and maturation of the muscular and nervous systems around the age of 7-8.

The presented results of the research on the restitution of the values of posture features in carrying on the right or left shoulder and at the heteronymous hip show that after the first and second minutes from the load removal, all differences in the values of posture features were statistically significant, which explicitly proves the lack of full restitution. Thus, the time of its full appearance is longer than two minutes. This necessitates postponing the diagnosis of the child's habitual body posture for more than two minutes after removing the external load. Moreover, the presented studies show that the physical fitness represented by the respondents does not lead to a full restitution of the examined posture features. It was also found that the relationships between the examined determinants of physical fitness and the restitution of the values of posture features are much more frequent among boys than girls. Among boys, the most frequent association with the diagnosed posture features was between speed and strength, and endurance among girls. This is in contradiction with the assumed research hypothesis. Among boys, the restitution of the values of the posture features is most often associated with the features of the transversal plane like asymmetry, convexity of the angles of the lower shoulder blades (UB-) and the pelvis tilt to the left (KSM-), and among girls with the features of the sagittal and transversal plane such as angle (KKP) and height (RKP) of thoracic kyphosis and asymmetry of convexity of the angles of the lower shoulder blades (UB-).

Conclusions

1. In every way of carrying a mass of school supplies after the first and the second minute of the load removal, there was a gender-independent and incomplete restitution of the values of the posture features of the sagittal and transversal plane.
2. Physical fitness has a gender-specific relationship with restitution of the values of the posture features and it is greater among boys than girls. Physical fitness is most often associated with the features of the transversal plane among boys, and with the features of the sagittal plane among girls.

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Conflict of Interest

None.

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