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Research Article

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Restitution of the Value of Posture Features in the Sagittal and Transversal Planes After Carrying the Schoolbag on the Back and its Relationships with Physical Fitness in 7-Year-Old Children of Both Sexes

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Abstract

Introduction: The analysis of the student's environment is a set of stressors in the field of human ecology.

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 loading, 3rd - one minute after the load removal, 4th - two minutes after the load removal. Physical fitness was measured with the Sekita test.

Results: The significance of differences between 1st and 3rd, 1st and 4th, 2nd and 3rd and 4th measurement were analyzed to determine changes in the value of the features after loading the body and their relationship with physical fitness.

Conclusions

a) After the load removal of carrying school supplies, there was an incomplete statistically significant restitution after the first and second minute.

b) In carrying the schoolbag on the back, restitution is most often associated with endurance and speed among boys, and with endurance among girls. Among boys, the features of physical fitness most often show a significant relationship in the restitution of the size of the pelvic tilt angle to the left (KSM-) and the angle of the convexity of the lower angles of the shoulder blades, where the left angle is more convex (UB-), and in girls with the angle of the pelvic tilt to the left (KSM-) and the depth of thoracic kyphosis. Physical fitness is more frequently associated with the restitution of the value of posture features among boys.

c) Due to the incomplete restitution of the value of the posture features, carrying of school supplies on the back with the mass of 4kg is not recommended by children aged 7 years. The physical fitness of children does not lead to full restitution of the examined posture features, which proves its low level and immature corrective and compensatory processes.

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

Introduction

Due to the lack of Polish standards regarding the weight of the school backpack, the Regulation of the Council of Ministers of December 1st, 1990, on the list of works forbidden to adolescents (Journal of Laws No. 85, item 500, as amended) was initially applied and it was assumed that a boy under the age of 16 years must not be overloaded with a backpack of more than 5kg, and girls more than 3kg. The State Sanitary Inspectorate adopted 3 kg as the permissible weight of a school bag for schoolchildren, which is about

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6.3-16.7% of the average body weight of a student. According to the reports of Grajda et al., 44.2% of school bags for urban children and 37.7% of school bags for rural children significantly exceed the adopted weight of a backpack. The highest exceedance was observed in 52.8% of nine-year-old children from the city and 46.7% from the countryside [1]. In 2004, the Regulation of the Council of Ministers on the list of works forbidden to adolescents was repealed by a new legal act (Journal of Laws No. 200, item 2047), in which there are no regulations concerning workload for people under 16 years of age. Therefore, there is no legal act that could be the basis for claims for postural defects during carrying the school supplies. In November 2003, the Ombudsman for Children, because of permanent civic prompt notes, sent a request to the Minister of National Education and Sport to find a definitive solution to the problem of the mass of the school backpack. One year later, because of the lack of reaction he resented his message. The reply did not contain a legal act that would clearly regulate the weight of the school backpack. The American Academy of Pediatrics, the Pediatric American Orthopedic Society of North America, and the American Academy of Orthopedic Surgeon reported that the weight of the backpack should not exceed 20% of the student's body weight. The American Physical Therapy Association and the American Occupational Therapy Association recommend 15% of body weight, and the American Chiropractic Association recommends up to 10% of body weight.

The American Academy of Pediatrics, the Pediatric American Orthopedic Society of North America, the American Occupational Therapy Association, and the American Academy of Orthopedic Surgeon have developed recommendations for safe use of a schoolbag [1]. The research by Jakubowicz-Bryx shows that, in accordance with the recommendations of the Minister of National Education, to unweight the school bag and care for the proper somatic development of a student, it is possible to leave at least some textbooks and accessories in a school building. In the study group, school principals and early school education teachers created a place for school supplies in classrooms in the form of cabinets, shelves, drawers, and separate shelves. After a few months, it was shown that 97% of respondents leave their textbooks and school supplies in lockers, 94% of respondents keep them on shelves, 76% in drawers, and 71% on separate shelves. To prevent disturbances in the statics of body posture, in the study group, educators pay attention to a suitably profiled satchel with a stiffened back support with the lower part convex, which was confirmed by 94% of respondents. It was also confirmed in the case of a soft, adjustable, and wide harness - 91%, the content of a school bag - 86%, carrying a school bag on both shoulders - 86% and having pockets that allow even distribution of the weight - 79% [2].

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.

The aim of the research was to demonstrate the restitution of the values of selected posture features in the sagittal and transversal planes after removing the weight of school supplies carried on the back and its relationship with physical fitness.

Research Material

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. Body posture defects and disturbances were not criterions 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 6 years, 6 months and 1 day old and under 7 years, 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 [3]. 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

Before the measurements started, the children were instructed 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, always with the same tools, under the same conditions and by the same people. 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.

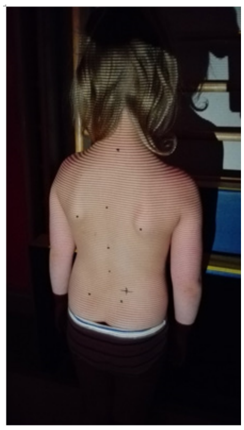
Overall Physical Fitness

The Wroclaw Physical Fitness Test for 3-7-year-old children was used to diagnose physical fitness [4]. 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 [5]. 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 4x5 m with carrying blocks), power (standing long jump), speed (running at 25 m), and force (a 1 kg 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 300 m. 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 a score of "0". The run took place on a recreational path with a hardened surface, keeping all safety rules [6] Visualization [7].

Body Posture

The applied method using the projection moire 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 [8,9].

A custom-designed diagnostic frame was provided to ballast the body posture (utility model no. W.125734) (photo 2). The presence of an assistant during the examination was dictated by the need to minimize 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 [10]. 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 4 positions. The first position - habitual position, (Picture 1). Second position - posture after 10 minutes of asymmetric loading on the back (in the last 5 seconds), (Picture 2). Third position - posture one minute after the load removal, Picture 1. Fourth position - posture two minutes after the load removal, Picture 1.



Picture 1: 1st, 3rd, and 4th position: habitual posture.

Picture 2: 2nd position: posture with asymmetrical axial load on the back.

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 [11]. 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, 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.

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 planes apart from the assessment of the torso asymmetry in the frontal plane [12].

The following test procedure was developed to minimize the risk of making mistakes in the measurements of selected posture features [3]:

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 (C7), 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 S1 vertebra. A white necklace was put on the subject's neck to clearly mark the B1 and B3 points. Long hair up to reveal C7 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).

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 [5].

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 us to fully identify the measured discriminants, (Table 1), (Figures 1-5).

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

Producent aparatury do Komputerowego Badania Postawy Ciała, stdp,...:
CQ Elektronik System, mgr inż. Artur Świerc, ul.Na Niskich Łąkach 19/2, Wrocław, tel. 0601 794162

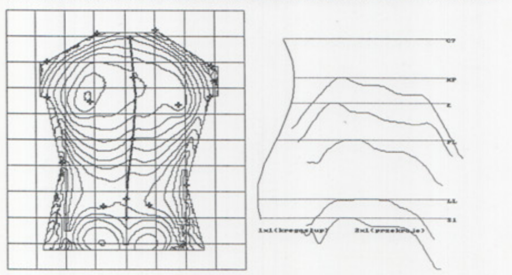
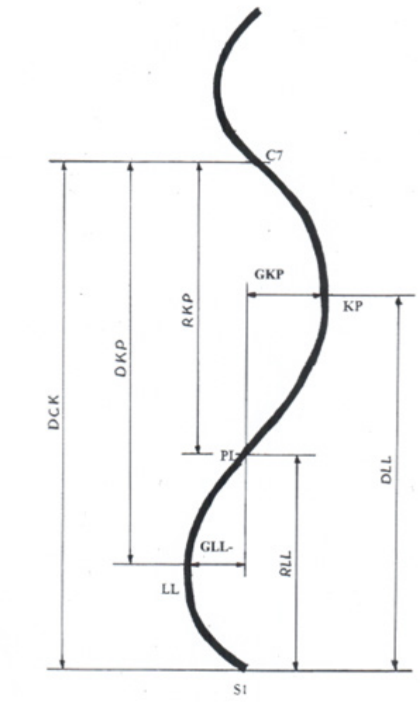


Figure 1: An example of a record sheet of measurements of the posture features of the spine-pelvis syndrome.



Note*: Own research.
Figure 2: Selected linear features of the spine in the sagittal plane.

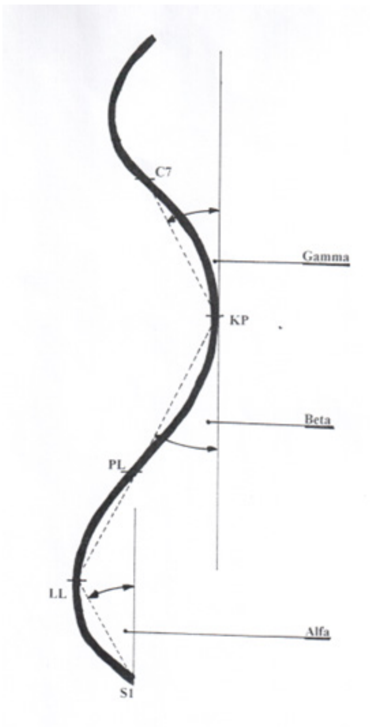


Figure 3: Selected angular features of the spine in the sagittal plane.

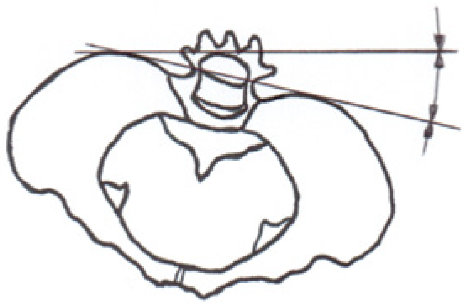
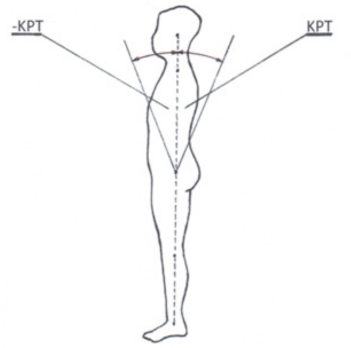


Figure 4: The pelvis tilt in the transversal plane.



Note*: Own research.

Figure 5: Torso bend (-KPT) and extension angle (KPT) in the sagittal plane.

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

No	Symbol	Parameters		
		Label	Name	Description
Sagittal plane				
1	Alfa	degrees	The inclination of lumbosacral 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 C_7-S_1 line from the vertical (backwards)
6	KPT -	degrees	Torso bend angle	It is determined by the inclination of C_7-S_1 line from the vertical (forwards)
7	DKP	mm	The length of thoracic kyphosois	The distance between LL a C_7 points
8	KKP	stopnie	The angle of thoracic kyphosois	KKP = 180 – (Beta+Gamma)
9	RKP	mm	The height of thoracic kyphosois	The distance between C_7 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 S_1 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 S_1 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 UB_1 - UB_2. The UB_2 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 UB_1 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. PLLB = LLB - PLB
16	UB	degrees	The angle of convex line of lower shoulder blades, where the right is more convex	
17	KSM	degrees	Pelvic tilt to the left	The angle between a line crossing M_1 point and being simultaneously perpendicular to the camera axis and a straight-line crossing M_1 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 M_1 and MP points
19	DCK	mm	Total length of the spine	The distance between C_7 and S_1 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	

Source*: Own research.

Research Questions and Hypotheses

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

a. Does the adopted method of carrying the weight of school supplies, significantly influencing the value of posture features in the sagittal and transversal planes cause a sex-dependent restitution of the value of these features?

b. Does physical fitness significantly affect the amount of restitution after the first and second minute? and does it depend on the analyzed way of carrying and gender?

c. Our own research results and the analysis of the available literature suggest that:

d. The adopted way of carrying the weight of school supplies, significantly affecting the statics of body posture in the sagittal and transversal planes causes incomplete and gender-independent restitution of the value of the disturbed features.

e. After the first and second minute, the following factors like agility, power, speed, and the least - strength affect the restitution of the value of the posture features.

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 analysis 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 1st and 3rd, 1st and 4th, 2nd and 3rd and 3rd and 4th with the measurement of the school bag carried on the back. 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 2nd and 3rd, 3rd and 4th, 1st and 3rd and 1st and 4th measurements separately for boys and girls was also performed. Only those individuals, who had both physical fitness tests and appropriate body posture measurements were considered. 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 24.46 kg, Body Height (Wc) 123.87, and among boys: 24.56 kg and 123 cm, respectively. All children had a slender body type according to the Rohrer Weight and Growth Index (IR).

Information was also obtained through a survey conducted among 65 parents of children reported to the research project [10].

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 [13-15]. The phenomenon of sexual dimorphism in the studied group of 7-year-olds of both sexes was not confirmed [6].

When analyzing the obtained results of measurements in carrying a schoolbag on the back by boys and girls, the Wilcoxon rank test showed a statistically significant difference between 3rd and 1st, 2nd and 3rd, and 3rd and 4th measurements in terms of all analyzed variables, (Tables 2,3).

Table 2: Restitution of value of posture features in sagittal and transversal planes between 1st and 2nd, 2nd and 3rd, and 3rd and 4th measurement after the back loading among boys.

Varaibles	Measurement				Wilcoxon's test			
	1	2	3	4				
	Me	Me	Me	Me	1/3 p	1/4 p	2/3 p	3/4 p
DCK	314,05	292,65	303,40	311,60	<0,001**	<0,001**	<0,001**	<0,001**
Alfa	8,45	4,85	6,60	7,90	<0,001**	<0,001**	<0,001**	<0,001**
Beta	9,75	21,70	15,60	11,30	<0,001**	<0,001**	<0,001**	<0,001**
Gamma	11,20	9,00	10,00	10,90	<0,001**	<0,001**	<0,001**	<0,001**
Delta	29,65	35,40	32,10	29,70	<0,001**	<0,001**	<0,001**	<0,001**
KPT-	4,15	6,40	5,05	4,40	<0,001**	<0,001**	<0,001**	<0,001**
KPT	4,75	16,50	5,55	5,10	0,005**	0,005**	0,005**	0,005**
DKP	279,00	273,10	276,05	278,15	<0,001**	<0,001**	<0,001**	<0,001**

KKP	159,00	148,90	153,60	157,75	<0,001**	<0,001**	<0,001**	<0,001**
RKP	185,30	180,50	183,45	184,60	<0,001**	<0,001**	<0,001**	<0,001**
GKP	19,95	15,35	17,65	19,70	<0,001**	<0,001**	<0,001**	<0,001**
DLL	247,00	242,90	245,40	246,05	<0,001**	<0,001**	<0,001**	<0,001**
KLL	161,95	153,35	157,55	161,25	<0,001**	<0,001**	<0,001**	<0,001**
RLL	135,60	131,55	133,65	134,75	<0,001**	<0,001**	<0,001**	<0,001**
GLL	24,45	32,65	26,20	25,25	<0,001**	<0,001**	<0,001**	<0,001**
UB-	3,30	4,75	4,05	3,50	0,012**	0,012**	0,011**	0,012**
UB	4,00	5,05	4,85	3,90	<0,001**	0,001**	<0,001**	<0,001**
KSM-	2,45	4,20	3,85	3,50	0,012**	0,012**	0,011**	0,011**
KSM	5,50	7,75	7,30	6,60	<0,001**	<0,001**	<0,001**	<0,001**

Source*: own research.

Table 3: Restitution of value of posture features in sagittal and transversal planes between 1st and 3rd, 1st and 4th, 2nd and 3rd, and 3rd and 4th measurement after the back loading among girls.

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
DCK	294,10	280,50	288,80	293,35	<0,001**	<0,001**	<0,001**	<0,001**
Alfa	8,90	4,85	6,95	8,05	<0,001**	<0,001**	<0,001**	<0,001**
Beta	11,20	23,10	17,85	13,00	<0,001**	<0,001**	<0,001**	<0,001**
Gamma	11,15	9,05	10,20	10,90	<0,001**	<0,001**	<0,001**	<0,001**
Delta	31,00	37,70	34,75	31,85	<0,001**	<0,001**	<0,001**	<0,001**
KPT-	4,10	6,40	5,30	4,70	<0,001**	<0,001**	<0,001**	<0,001**
KPT	4,20	16,40	5,20	4,70	<0,001**	<0,001**	<0,001**	<0,001**
DKP	276,25	272,00	274,65	275,25	<0,001**	<0,001**	<0,001**	<0,001**
KKP	157,70	147,60	152,85	156,50	<0,001**	<0,001**	<0,001**	<0,001**
RKP	176,90	171,55	174,85	176,05	<0,001**	<0,001**	<0,001**	<0,001**
GKP	20,45	15,55	17,80	19,80	<0,001**	<0,001**	<0,001**	<0,001**
DLL	248,15	245,55	244,65	246,15	<0,001**	<0,001**	<0,001**	<0,001**
KLL	159,90	151,45	155,60	158,65	<0,001**	<0,001**	<0,001**	<0,001**
RLL	129,15	124,65	126,65	127,60	<0,001**	<0,001**	<0,001**	<0,001**
GLL	23,40	33,65	26,00	24,65	<0,001**	<0,001**	<0,001**	<0,001**
UB-	2,70	4,20	3,80	3,50	<0,001**	<0,001**	<0,001**	<0,001**
UB	2,80	4,20	3,80	3,50	0,003**	0,001**	0,001**	0,009**
KSM-	2,90	5,60	5,10	4,30	<0,001**	<0,001**	<0,001**	<0,001**
KSM	4,10	6,50	5,40	5,20	0,001**	0,001**	0,001**	0,001**

Source*: Own research.

Below, an analysis of the correlation of the results of physical fitness tests and the difference between the 2nd and 3rd, 3rd and 4th, 1st and 3rd and 1st and 4th measurement after carrying the weight of the backpack on the back, separately for girls and boys. Only those people who underwent physical fitness tests and appropriate measurements of body posture were included. 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 $p <0.01$were marked **, and correlations statistically significant at the level of $p <0.05$ were marked *. The individual tables included only those variables (in the rows), which at least one statistically significant result was recorded for.

Considering the boys and the differences between the 2nd and 3rd measurements, it turned out that the greater the strength, the smaller the differences in the Torso Extension Angles (KPT), and the greater in the angles of the convexity lines of the lower angles of the shoulder blades, where the left is more convex (UB-), in the pelvic tilt to the left (KSM-). The higher the speed, the smaller the differences in the angles of convexity of the lower angles of the shoulder blades, where the left is more convex (UB-), and in the angles of the pelvic tilt to the left (KSM-). The greater the force, the smaller the differences in the length of the lumbar lordosis (DLL), and greater in the angles of the convex lines of the lower angles of the shoulder blades, where the left is more convex (UB-), and the angles of the pelvic tilt to the left (KSM-). The greater the power, the greater the differences in the angles of the convex lines of the lower angles of the shoulder blades, where the left is more convex (UB-), and the angles of the pelvic tilt to the left (KSM-). The greater the agility, the greater the differences in the angles of the convexity lines of the lower angles of the shoulder blades, where the left is more convex (UB-), and the angles of the pelvis tilt to the left (KSM-). The greater the overall efficiency, the greater the differences in the angles of the convex lines of the lower shoulder angles, where the left is more convex (UB-), and the pelvic tilt to the left (KSM-) (Table 4).

Table 4: Correlations of the value of physical fitness features and restitution between 2nd and 3rd and 3rd and 4th measurement of the value of posture features in the sagittal and transversal planes after the back loading among boys.

Variables	The difference between 2nd and 3rd measurement						The difference between 3rd and 4th measurement					
	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
DCK	0,13	0,27	0,37	0,28	0,42	0,38	-0,28	-0,49	-0,04	0,25	-0,12	-0,09
Beta	0,39	0,33	0,00	0,11	-0,13	0,11	-0,68**	-0,33	-0,06	-0,25	-0,19	-0,31
Gamma	0,04	0,36	0,09	-0,03	0,06	0,10	-0,24	-0,13	-0,17	-0,72**	0,11	-0,26
Delta	0,41	0,13	0,27	-0,06	0,27	0,35	-0,58*	-0,36	0,02	0,13	-0,24	-0,22
KPT-	-0,04	0,17	0,66	0,55	0,49	0,51	0,26	-0,23	-0,39	-0,60	0,00	-0,21
KPT	-0,88*	-0,61	-0,25	-0,05	-0,34	-0,65	0,03	0,19	-0,59	-0,10	-0,19	-0,38
KKP	0,36	0,17	-0,06	0,10	-0,08	0,07	-0,60*	-0,23	0,00	-0,03	-0,25	-0,21
RKP	0,03	-0,02	-0,08	0,14	-0,39	-0,19	0,20	-0,04	0,31	-0,05	0,54*	0,41
DLL	0,42	0,04	-0,53*	0,01	-0,43	-0,24	-0,01	0,17	0,16	0,46	0,01	0,17
RLL	0,29	0,06	-0,08	0,19	0,22	0,12	0,01	-0,05	-0,27	0,05	-0,52*	-0,28
GLL	-0,16	-0,48	0,12	0,25	0,24	0,13	0,36	0,53*	0,12	-0,39	0,01	0,11
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**

Source*: Own research.

By analyzing the differences between the 3rd and 4th measurement, it turned out that the greater the strength, the smaller the differences in the angles of the thoracolumbar segment (Beta), the sum of the angles (Alpha + Beta + Gamma = Delta), thoracic kyphosis (KKP) angles, and the angles convexity line of the lower angles of the shoulder blades, where the left is more convex (UB-), and the pelvic tilt to the left (KSM-). The faster the speed, the greater the differences in the depths of lumbar lordosis (GLL), the angles of the convexity lines of the lower scapulae angles, where the left is more convex (UB-), and the pelvic tilt to the left (KSM-). The greater the force, the smaller the differences in the angles of the convexity lines of the lower angles of the shoulder blades, where the left is more convex (UB-), and the pelvic tilt to the left (KSM-). The greater the power, the smaller the differences in the angles of the upper thoracic spine (Gamma), the angles of the convexity lines of the lower scapulae angles, where the left is more convex (UB-), and the pelvic tilt to the left (KSM-).

The greater the agility, the smaller the differences in the height of the lumbar lordosis (RLL), the angles of the convex lines of the lower angles of the shoulder blades, where the left is more convex (UB-), the pelvic tilt to the left (KSM-), and greater in the height of the thoracic kyphosis (RKP)). The greater the overall efficiency, the smaller the differences in the angles of the convexity lines of the lower scapulae angles, where the left is more convex (UB-), and the pelvic tilt to the left (KSM-) Table 4.

Considering the differences between the 1st and 3rd measurement, it turned out that the greater the strength, the smaller the differences in the sum of angles (Alpha + Beta + Gamma = Delta), length of lumbar lordosis (DLL), angles of lumbar lordosis (KLL), angles of convex lines of the lower angles of the shoulder blades, where the left is more convex (UB-), and the pelvic tilt to the left (KSM-). The higher the speed, the smaller the differences in the sum of angles (Alpha + Beta + Gamma = Delta), lumbar lordosis angles (KLL), and greater in the depths of lumbar lordosis (GLL-), the angles of the convex lines of the lower angles of the shoulder blades, where the left is more convex (UB-), and pelvic tilt to the left (KSM-). The greater the force, the smaller the differences in the angles of the convexity lines of the lower angles of the shoulder blades, where the left is more convex (UB-), and the pelvic tilt to the left (KSM-). The greater the power, the smaller the differences in the angles of the upper thoracic spine (Gamma), depths of lumbar lordosis (GLL-), the angles of the convexity lines of the lower angles of the shoulder blades, where the left is more convex (UB-), and the pelvic tilt to the left (KSM -).

The greater the agility, the smaller the differences in the angles of convexity of the lower angles of the shoulder blades, where the left is more convex (UB-), and the pelvic tilt to the left (KSM-). The greater the general fitness, the smaller the differences in the angles of lumbar lordosis (KLL), the angles of the convexity lines of the lower.

By examining the differences between the 1st and the 4th measurements, it turned out that the greater the strength, the smaller the differences in the angles of the upper thoracic spine (Gamma), the length of the lumbar lordosis (DLL), and the pelvic tilt to the left (KSM-), and the greater in the angles of the convexity line of the lower angles of the shoulder blades, where the left is more convex (UB-). The higher the speed, the smaller the differences in the angles of the convex lines of the lower angles of the shoulder blades, where the left is more convex (UB-), and greater in the inclination angles of the lumbosacral spine (Alpha), and pelvic tilt to the left (KSM-). The greater the force, the smaller the differences in lumbar lordosis (KLL) angles, pelvic tilt to the left (KSM-), and greater in the angles of convexity of the lower angles of the shoulder blades, where the left is more convex (UB-). The greater the power, the smaller the differences in the pelvic tilt to the left (KSM-), and the greater the differences in the angles of the convexity of the lower angles of the shoulder blades, where the left is more convex (UB-). The greater the agility, the smaller the differences in the pelvic tilt to the left (KSM-), and the greater in the angles of the convexity line of the lower angles of the shoulder blades, where the left is more convex (UB-). The greater the overall efficiency, the smaller the differences in the pelvis tilt to the left (KSM-), and the greater the differences in the angles of the convexity of the lower angles of the shoulder blades, with the left more convex (UB-), (Table 5).

Table 5: Correlations of the value of physical fitness features and restitution between 1st and 3rd and 1st and 4th measurement of the value of posture features in the sagittal and transversal planes after the back loading among boys.

Variables	The difference between 1st and 3rd measurement						The difference between 1st and 4th measurement					
	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
Alfa	0,11	0,49	0,25	-0,24	0,18	0,23	0,09	0,60*	0,45	-0,10	0,39	0,40
Gamma	-0,28	-0,19	-0,17	-0,64*	0,05	-0,27	-0,59*	-0,39	-0,32	-0,24	-0,34	-0,44
Delta	-0,74**	-0,53*	-0,21	0,27	-0,38	-0,39	-0,10	-0,30	-0,48	0,14	-0,22	-0,34
DLL	-0,64**	-0,40	0,14	0,20	0,09	-0,10	-0,58*	-0,44	0,06	-0,08	0,06	-0,18
KLL	-0,84**	-0,62*	-0,33	-0,05	-0,33	-0,53*	-0,19	-0,38	-0,55*	0,08	-0,33	-0,44
GLL	0,41	0,67**	-0,02	-0,52*	-0,02	0,03	0,40	0,51	-0,35	-0,24	-0,34	-0,18
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**

Source*: Own research.

Considering the differences among girls between the 2nd and 3rd measurements, it turned out that the higher the strength, the greater the difference in left torsion angles (KSM-). The greater the force, the greater the difference in the depths of thoracic kyphosis (GKP). The greater the power, the greater the difference in lengths of lumbar lordosis (DLL). The greater the agility, the greater the differences in the depths of thoracic kyphosis (GKP) and the pelvic tilt to the left (KSM-). The greater the total efficiency, the greater the difference in left torsion angle (KSM-). Analyzing the differences between the 3rd and 4th measurements, it turned out that the greater the agility, the greater the difference in the height of thoracic kyphosis (RKP), (Table 6).

Table 6: Correlations of the value of physical fitness features and restitution between 2nd and 3rd and 3rd and 4th measurement of the value of posture features in the sagittal and transversal planes after the back loading among girls.

Variables	The difference between 2nd and 3rd measurement						The difference between 3rd and 4th measurement					
	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
Gamma	0,26	0,10	0,43	0,22	0,47	0,33	0,14	0,30	0,35	-0,21	0,50	0,32
RKP	0,24	0,08	-0,14	-0,02	-0,13	-0,10	0,43	0,42	0,47	-0,12	0,58*	0,55
GKP	0,24	0,15	0,65*	0,29	0,61*	0,47	-0,24	0,21	-0,28	-0,49	-0,24	-0,18
DLL	0,16	-0,31	-0,05	0,82**	-0,22	-0,03	-0,16	0,34	-0,13	-0,43	0,12	-0,01
KSM-	0,97**	0,36	0,87	0,80	0,97**	0,97**	-0,67	-0,82	-0,46	-0,23	-0,56	-0,56

Source*: own research.

The analysis of the differences between the 1st and 3rd measurements showed that the greater the strength, the greater the difference in height of the lumbar lordosis (RLL). The study of the differences between 1st and 4th measurement showed that the greater the strength, the smaller the differences in the length of thoracic kyphosis (DKP), the pelvic tilt to the left (KSM-), and the greater the differences in the height of the lumbar lordosis (RLL) and the pelvic tilt to the right (KSM +). The higher the power, the smaller the difference in length of lumbar lordosis (DLL) and the greater in the inclination angles of the lumbar-sacral spine (Alpha). The greater the agility, the smaller the difference in the height of thoracic kyphosis (RKP), (Table 7).

Table 7: Correlations of the value of physical fitness features and restitution between 1st and 3rd and 1st and 4th measurement of the value of posture features in the sagittal and transversal planes after the back loading among girls.

Variables	The difference between 1st and 3rd measurement						The difference between 1st and 4th measurement					
	WY	SZ	SI	MO	ZW	OG	WY	SZ	SI	MO	ZW	OG
Alfa	0,32	0,10	0,32	0,15	0,32	0,38	0,42	-0,25	0,14	0,76**	0,02	0,18
KPT-	-0,63	-0,18	-0,63	-0,88*	-0,34	-0,45	0,36	0,53	0,22	0,00	-0,05	0,40
DKP	-0,21	-0,03	0,36	-0,20	0,01	0,05	-0,59*	-0,14	-0,11	-0,29	-0,43	-0,39
RKP	0,22	0,34	0,16	-0,27	0,29	0,33	-0,38	-0,33	-0,50	0,07	-0,60*	-0,42
DLL	-0,20	0,10	-0,08	-0,57	0,06	-0,04	-0,20	0,06	0,11	-0,61*	0,12	0,03
RLL	0,62*	0,18	0,14	0,35	0,26	0,43	0,59*	0,25	0,02	0,41	0,18	0,34
KSM-	-0,80	-0,50	-0,37	-0,34	-0,60	-0,60	-0,90*	-0,20	-0,58	-0,67	-0,80	-0,80

Source*: own research.

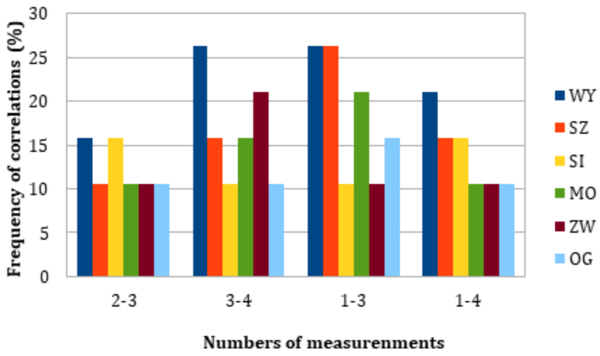
Discussion

A review of the literature on the subject revealed sporadic research on the restitution of significantly altered features of posture under the influence of external stress. The authors focused more on exploring the consequences of loading the spine with school supplies carried on one of the shoulders or back, or on the effects of various weight of the supplies themselves [16-20]. Studies by Walicka-Cupryś et al. have shown that carrying a backpack heavier than 10% of body weight may result in shallowing of the lumbar lordosis and a tendency to vertical positioning of the sacrum. The authors note that monitoring the weight of children's school backpacks and allowing them to leave books and notebooks at school has likely benefits in reducing the daily strain on the children's spine [21]. Own research on the restitution of the value of body posture features in the sagittal and transversal planes after dragging a backpack by left or right hand for a 7-year-old child showed that there was a statistically significant incomplete restitution after the first and second minute when carrying has stopped. In the case of carrying the bag with school supplies with their right hand by boys, only endurance is significantly related to the restitution of the value of the posture features, and among girls, speed, and agility additionally.

The abovementioned abilities play the greatest role in the restitution of shoulder asymmetry, the width of the waist and pelvis triangles. Overall fitness, strength and power do not matter. In the case of girls, physical fitness is more frequently associated with the restitution of the value of posture features. In the case of carrying the bag with school supplies with the left hand by boys, with restitution after the first minute, endurance, power, agility and general physical fitness were significantly associated with it, and after the second minute it was strength, whereas among girls it was with strength, power and endurance. After the second minute in girls, it related to speed and agility additionally.

Among boys, the examined abilities show a significant relationship with the restitution of asymmetry of the shoulders, pelvis, the height of the waist triangles, the line of the spine spinous processes, whereas among girls, the asymmetry of the distance of the angles of the lower shoulder blades from the line of the spinous processes and the width of the waist triangles, additionally. In the case of girls, physical fitness shows slightly more frequent relations with the restitution of the value of posture features compared to boys. Due to incomplete restitution after 1st and 2nd minute, asymmetric carrying is not recommended by students aged 7 years. The physical fitness of children does not lead to full restitution of the examined posture features, which proves its low level and immature corrective and compensatory processes [22]. The statements quoted by *Bittman and Badtke* [23] should also be 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 [24].

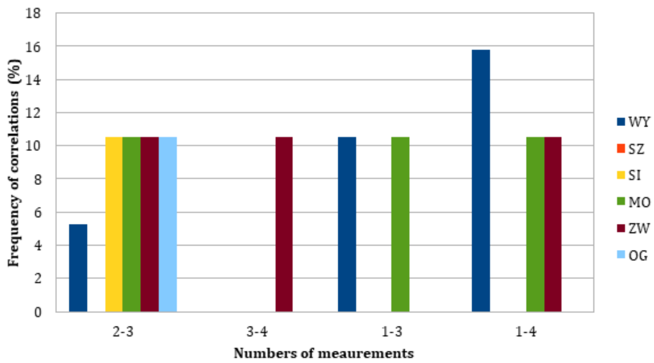
A detailed analysis of the boys' results showed that strength and agility were the most common in the first minute (third measurement) with the restitution of the value of posture features after carrying the backpack on the back, and strength and agility in the second minute (fourth measurement). The analysis of restitution in terms of features of habitual posture (first measurement) and the end of the first minute after load removal (third measurement) showed that endurance and speed were the most frequently related to the restitution of the value of posture features. In terms of features of habitual posture (first measurement) and the end of the second minute after the load removal (fourth measurement), showed that endurance, speed, and strength were the most frequently associated with the restitution of the value of posture features, (Figure 6).



Note*:
2-3 Restitution of the values of body posture features after first minute of the load removal (between 2nd and 3rd measurement)
3-4 Restitution of the values of body posture features after second minute of the load removal (between 3rd and 4th measurement)
1-3 Restitution of the values of habitual posture features after first minute of the load removal (between 1st and 3rd measurement)
1-4 Restitution of the values of habitual posture features after second minute of the load removal (between 1st and 4th measurement)
WY - Endurance; SZ - Speed; SI - Strength; MO - Force; ZW - Agility; OG - Overall Practice

Figure 6: Frequency of signifficant correlations of physical fitness features with restitution of body posture features among 7-year-old boys n=65N=30.

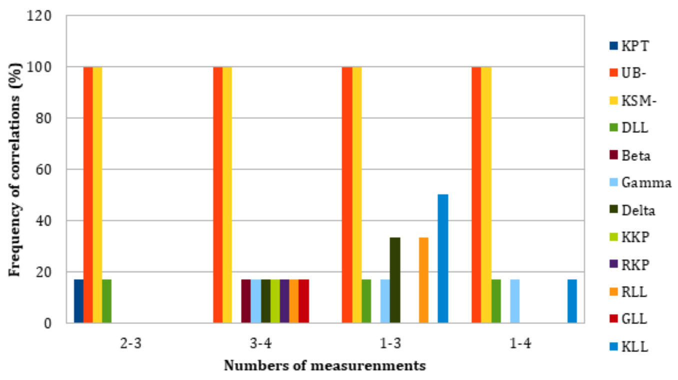
Among girls with a progressive restitution of the value of posture features in the first minute (third measurement), speed, power, agility, and overall efficiency showed the most frequent relationship, but only slightly above 10%. With restitution in the second minute (fourth measurement) only agility mattered. The analysis of restitution in terms of features of habitual posture (first measurement) and the end of the first minute after the load removal (third measurement) showed that endurance and power were most often associated with the restitution of the value of posture features. In terms of features of habitual posture (first measurement) and the end of the second minute after the load removal (fourth measurement), endurance, power and agility were the most frequently related to the restitution of the value of posture features, (Figure 7).



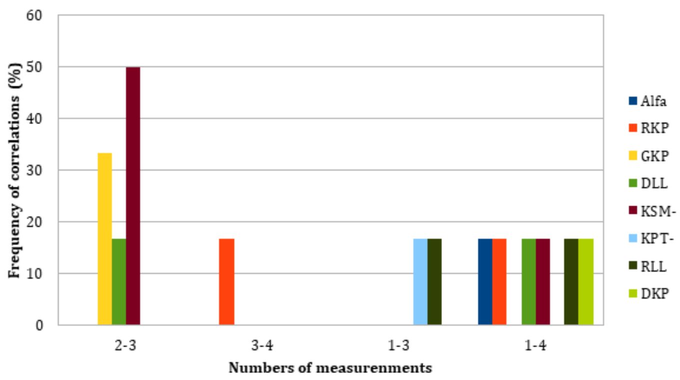
Note*:
2-3 Restitution of the values of body posture features after first minute of the load removal (between 2nd and 3rd measurement)
3-4 Restitution of the values of body posture features after second minute of the load removal (between 3rd and 4th measurement)
1-3 Restitution of the values of habitual posture features after first minute of the load removal (between 1st and 3rd measurement)
1-4 Restitution of the values of habitual posture features after second minute of the load removal (between 1st and 4th measurement)
WY - Endurance; SZ - Speed; SI - Strength; MO - Force; ZW - Agility; OG - Overall Practice

Figure 7: Frequency of signifficant correlations of physical fitness features with restitution of body posture features among 7-year-old girls n=65 N=35.

A detailed analysis of the boys' results showed that in the restitution of the value of posture features with all fitness features in the first minute (third measurement) and in the second minute (fourth measurement), the most frequent relationship was between the asymmetry of the verticality of the torso (KPT) and the angle of the pelvic tilt to the left (KSM-). The analysis of restitution in terms of features of habitual posture (first measurement) and the end of the first minute after the load removal (third measurement) showed that the amount of restitution of the vertical asymmetry of the trunk (KPT), the angle of pelvic tilt to the left (KSM -) and the lumbar lordosis angle (KLL) were the most frequently related features of physical fitness. In terms of features of the habitual posture (first measurement) and the end of the second minute after the load removal (fourth measurement), restitution of the value of the torso vertical asymmetry features (KPT) and pelvic tilt to the left (KSM-), were the most frequently related results, (Figure 8).



Note*:
Description of abbreviations 0f body posture features - Table 1
2-3 Restitution of the values of body posture features after first minute of the load removal (between 2nd and 3rd measurement)
3-4 Restitution of the values of body posture features after second minute of the load removal (between 3rd and 4th measurement)
1-3 Restitution of the values of habitual posture features after first minute of the load removal (between 1st and 3rd measurement)
1-4 Restitution of the values of habitual posture features after second minute of the load removal (between 1st and 4th measurement)
Figure 8: Frequency of signifficant correlations of restitution of body posture features with physical fitness features among 7-year-old boys N=30.



Note*:
Description of abbreviations 0f body posture features - Table 1
2-3 Restitution of the values of body posture features after first minute of the load removal (between 2nd and 3rd measurement)
3-4 Restitution of the values of body posture features after second minute of the load removal (between 3rd and 4th measurement)
1-3 Restitution of the values of habitual posture features after first minute of the load removal (between 1st and 3rd measurement)
1-4 Restitution of the values of habitual posture features after second minute of the load removal (between 1st and 4th measurement)
Figure 9: Frequency of signifficant correlations of restitution of body posture features with physical fitness features among 7-year-old girls n=65 N=35.

Among girls, the same analysis showed that only in the first minute of restitution (third measurement), pelvic tilt to the left (KSM-) and the depth of thoracic kyphosis (GKP) were the most frequently related features of physical fitness. The relationships in the remaining intervals were of a significantly lower frequency, at the level of about 15%, (Figure 9).

It should be believed that the undertaken research is one of the first attempts to determine the restitution of postural static disorders. It is an attempt to draw attention not only to the consequences of an asymmetric load, but also to the time of returning to the habitual posture.

Conclusions

a. There was an incomplete statistically significant restitution, when the load of the carried mass of school supplies was removed after the first and second minute.

b. Restitution is most often related to endurance and speed in boys carrying the bag with school supplies on the back, and among girls it relates to endurance. Among boys, the features of physical fitness most often show a significant relationship in the restitution of the size of the pelvic tilt to the left (KSM-) and the angle of the convexity of the lower angles of the shoulder blades, where the left angle is more convex (UB-), and in girls with the pelvic tilt to the left (KSM-) and the depth of thoracic kyphosis. Among boys, physical fitness is more frequently associated with the restitution of the value of posture features.

c. It is not recommended for children aged 7 years to carry a 4-kg schoolbag due to the incomplete restitution of the value of posture features. The physical fitness of children does not lead to full restitution of the examined posture features, which proves its low level and immature corrective and compensatory processes.

Acknowledgement

None.

Conflict of Interest

None.

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