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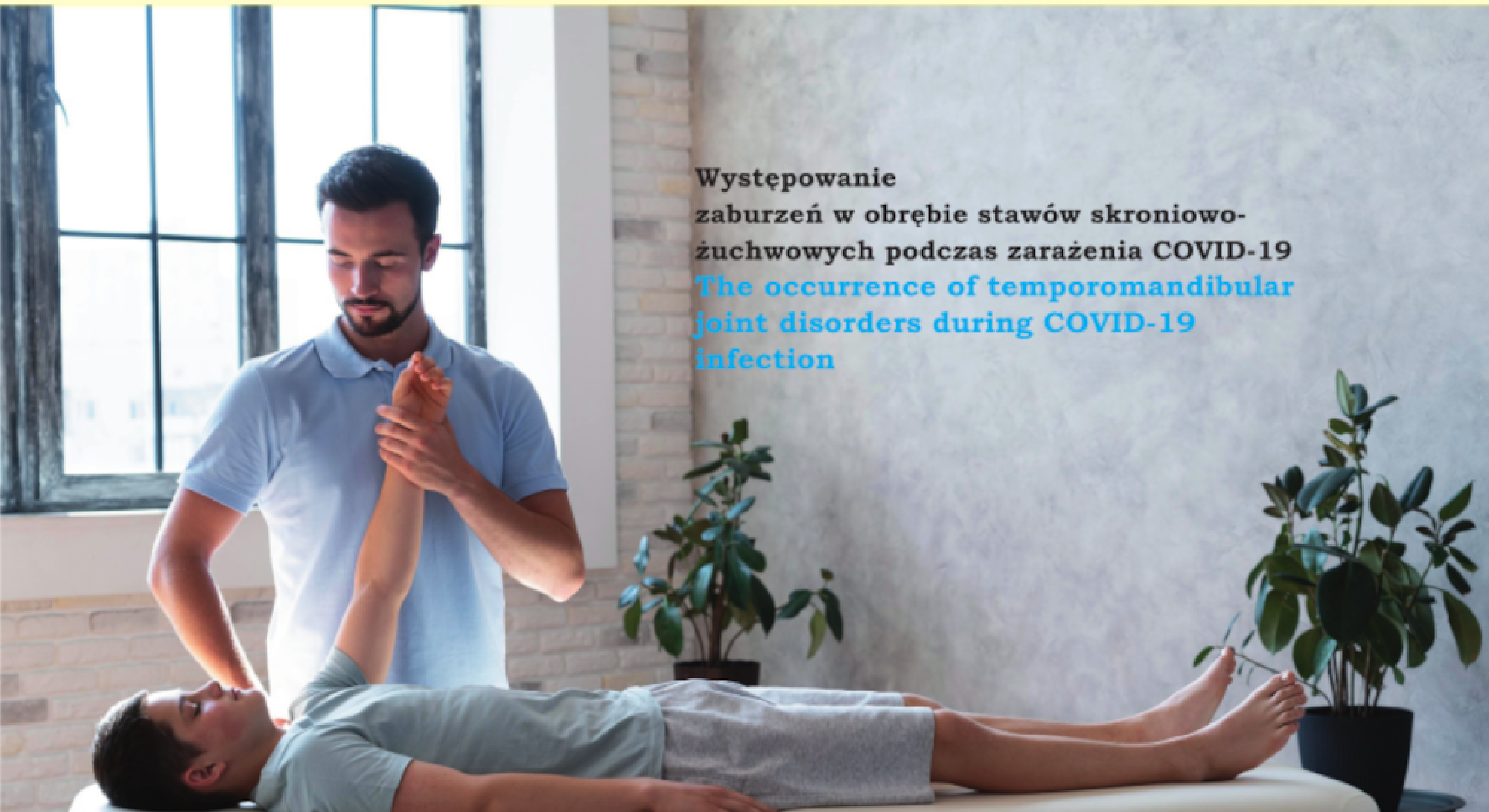

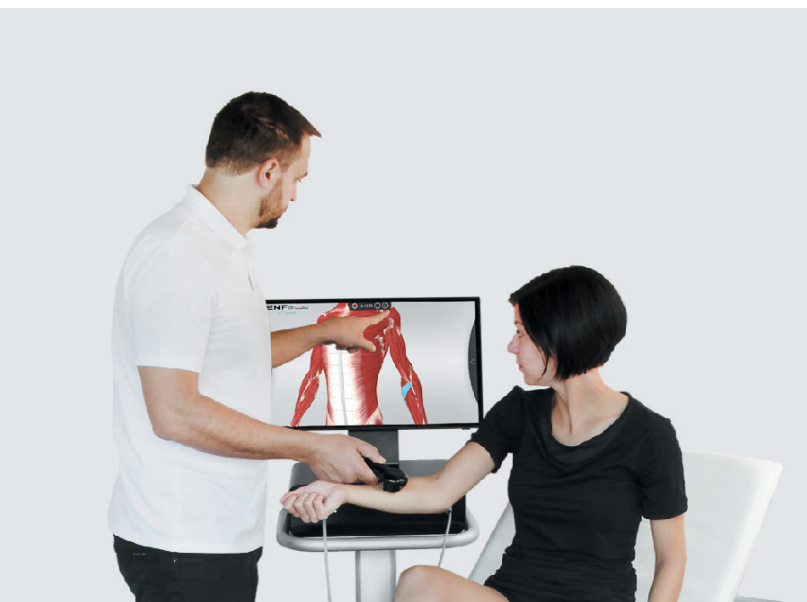

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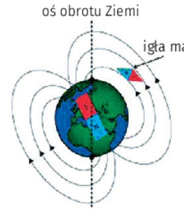

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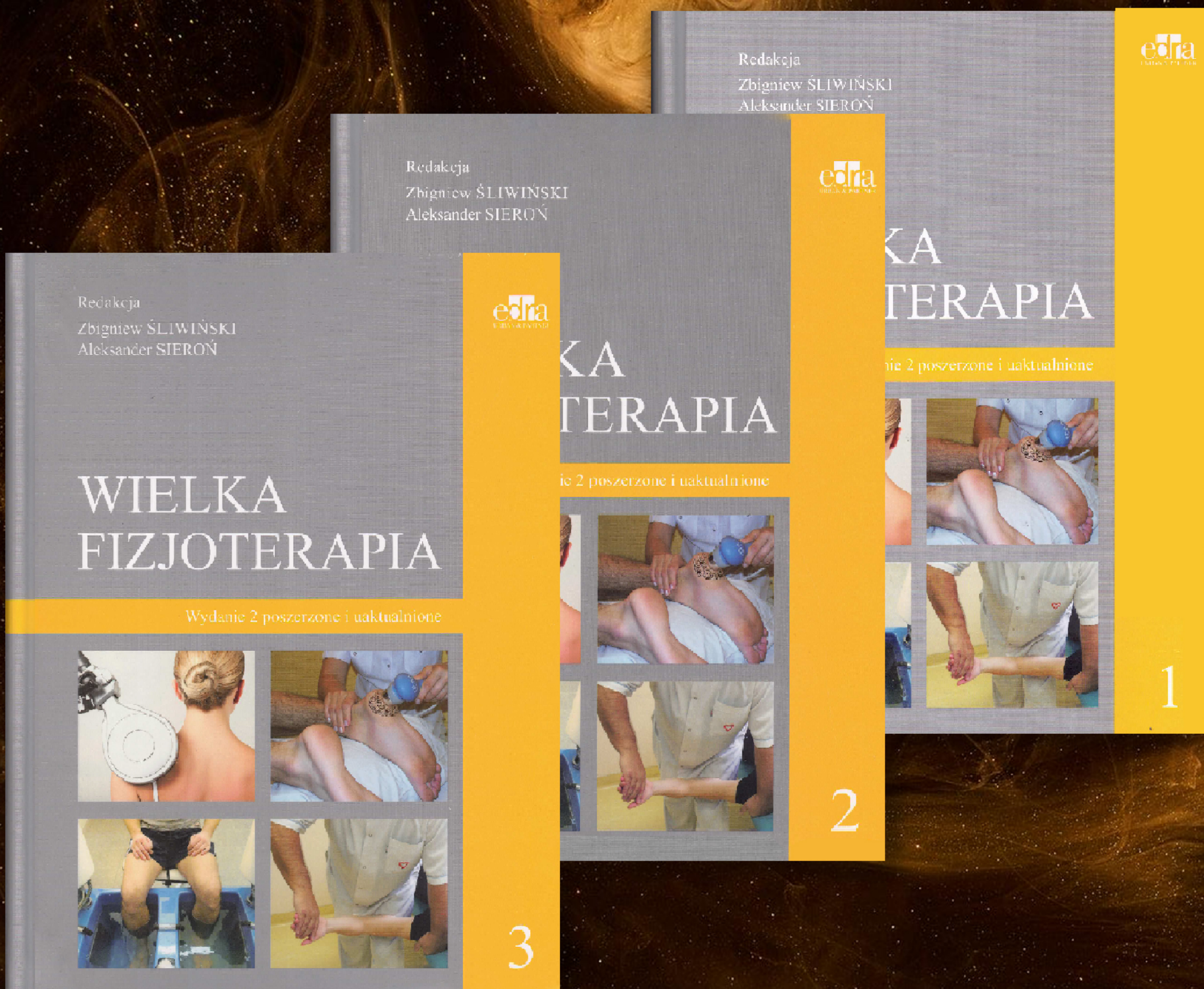

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The difference of the influence of the weight of school supplies on body posture features in carrying on the right or left shoulder by 7-year-old students of both sexes

Różnica wpływu na cechy postawy ciała w transporcie masy przyborów szkolnych na prawym lub lewym barku przez 7-letnich uczniów obojga płci

Mirosław Mrozkowiak(A,B,C,D,E,F,G)

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Abstract

Introduction. Periodically, at the turn of August and September the problem of overloading children with too heavy schoolbags rises and it may initiate various disorders not only around the spine area. Material, method. The research on body posture was carried out in a group of 65 7-year-old students by Projection Moiré in 8 positions. First position – habitual position, second – after 10 min. of asymmetric loading on the left or right shoulder, third – after 1 min. of the load removal, and fourth – after 2 min. of the load removal. Results. There were analyses of significance of the differences between 1st and 2nd, 1st and 3rd, 1st and 4th, 2nd and 3rd, and 3rd and 4th measurement to determine the influence of loading and correlation of the differences with physical activity. It was also measured, which way of carrying disturbs the body posture less.

Conclusions.

1. A four-kilograms load of school supplies carried on the left or right shoulder disturbs significantly and negatively biomechanical body statics of a 7-year-old child, which may cause errors in long term perspective and consequently body posture disorders. Relatedly, this way of carrying school supplies is not recommended to first graders.
2. Physical fitness has more significant meaning in biomechanical body statics disorders in frontal plane than in sagittal and transversal plane, relatedly among boys than girls. Endurance and strength show the most common correlations with changes of values of body posture features. In sagittal and transversal plane speed and strength have the greatest meaning but in frontal plane it is endurance and strength.
3. Restitution of none of the analyzed values of body posture features was not complete after 1 and 2 min. when carrying on the left or right shoulder was terminated, which means low overall fitness and immature corrective-compensatory processes.

Key words:

children's health, moiré topography, physical fitness, postural asymmetry factor

Streszczenie

Wstęp. Periodycznie, na przełomie sierpnia i września, podnosi się problem przeciążania dzieci zbyt ciężkimi plecakami szkolnymi i sugeruje wpływ tego obciążenia na inicjację różnych dysfunkcji, nie tylko w obrębie kręgosłupa.

Materiał, metoda. Badania postawy ciała przeprowadzono w grupie 65 uczniów w wieku 7 lat metodą mory projekcyjnej w 8 pozycjach. Pierwsza – postawa habitualna, druga – po 10-minutowym asymetrycznym obciążeniu na lewym lub prawym barku, trzecia – po jednej minucie od zdjęcia obciążenia, czwarta – po dwóch minutach od zdjęcia obciążenia. Dokonano pomiaru sprawności fizycznej testem Sekity. Wyniki. Analizowano istotność różnic między 1 a 2, 1 a 3, 1 a 4, 2 a 3, 3 a 4 pomiarem dla określenia wpływu obciążenia oraz korelacji różnic ze sprawnością fizyczną. Zbadano także, który sposób transportu mniej zaburza postawę ciała.

Wnioski.

1. Transport 4-kilogramowej masy przyborów szkolnych na lewym lub prawym barku tak samo istotnie i negatywnie zaburza biomechaniczną statykę ciała 7-letniego dziecka, co może w dłuższej perspektywie czasu wywołać błędy, a w konsekwencji wady postawy ciała. W związku z tym nie należy zalecać tego sposobu transportu przyborów szkolnych uczniom klas pierwszych.
2. Sprawność fizyczna ma większe znaczenie w zaburzeniach biomechanicznej statyki postawy ciała w płaszczyźnie czołowej niż w strzałkowej i poprzecznej oraz wśród chłopców niż dziewcząt. Wytrzymałość i siła wykazuje najczęstsze związki ze zmianami wielkości cech postawy ciała, przy czym w płaszczyźnie strzałkowej i poprzecznej największe znaczenie ma szybkość i siła, a w czołowej wytrzymałość i siła.
3. Restytucja wielkości żadnej z analizowanych cech postawy ciała nie była pełna po 1. i 2. minucie od zaprzestania transportu na lewym i prawym barku, co świadczy o niskiej sprawności ogólnej i niedojrzałych procesach korekcyjno-kompensacyjnych.

Słowa kluczowe:

zdrowie dzieci, mora projekcyjna, sprawność fizyczna, wskaźnik asymetrii postawy

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Introduction

Human posturogenesis between the first and seventh year of living is very susceptible to epigenetic factors [1]. Other studies suggest that this period lasts at least until the age of 8-9 [2]. The results of Mrozkowiak's research move the upper limit to the age of 9–10 years [3]. According to Cupryś-Walicka et al., the posture-creative processes of children aged 6–7 are harmonious and there are rather no clear biological factors that would increase the percentage of defective postures. However, the authors further postulate that negative changes can be found at the time of "school shock", including, among others, maladjusted dimensions of desks and chairs, the distance from the blackboard, incorrect sitting position and carrying school supplies [4]. The results of Mrozkowiak's research confirm the role of the chair in shaping body posture [5, 6]. The literature on the impact of a school backpack on a student's body posture is quite extensive. The early works of Romanowska [7] and Mrozkowiak [8] slightly outlined the problem. Repeated popular opinions about the negative impact of the weight of carried school supplies are often based on presumptions, not scientific evidence. The author of this report did not find the results of completed research programs concluding about the impact of the way of carrying a "backpack" on the student's body posture and about the long-term consequences of negligence in this regard. Doctors and physiotherapists present general recommendations, like those of the Chief Sanitary Inspector, that a student should not carry a heavy school bag, and its weight evenly distributed on the back should not exceed 10-15% of body weight. He adds that this principle is often ignored. The Ombudsman reminds that a student's backpack should have an appropriate structure. It must have a hard back support touching the back well and equal wide straps, the length of which can be adjusted to the child's height. It is advisable to fasten the straps at the front of the chest, which stabilizes the backpack. However, he is against trolley backpacks because dragging them requires the use of one hand and causes postural distortions.

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, 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 supplies.

Aim

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, dragged with the left or right hand.

The partial aim was to prove, which way of carrying school supplies, on the right or left shoulder, was better for the body posture of a 7-year-old student.

Material and methods

Research material

The study involved children from randomly selected kindergartens in the West Pomeranian and Greater Poland voivode-

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ships. 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 6 years, 6 months and 1 day old and under 7 years, he was included in the 7-year-old age group. 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 children were instructed to release stress connected with the procedure and people responsible for it before taking the measurements.

Overall physical fitness

The Wroclaw Physical Fitness Test for 3–7-year-old children was used to diagnose physical fitness [9]. 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 [10]. 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 4 × 5 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 score "0". The run took place on a recreational path with a hardened surface, remaining all safety rules [11]. Visualization [12].

Body posture

The examination of body posture was conducted from May 27th, 2019, always from 9 a.m. to 2 p.m. and in the same properly prepared room. There was always a teacher's assistant to help the children to keep emotional balance. The measurements were taken according to the prepared procedure always using the same tools, in 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.
A custom-designed diagnostic frame was provided to ballast the body posture (utility model no. W.125734) (fig. 1a, 2a). Its structure enables to diagnose biomechanical distortions of

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a body posture weighted in a various way. 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 [13]. However, the load was determined by averaging the weight of school supplies to 4 kg carried by first-class children from a randomly selected primary school. Selected features of body posture were measured in 8 positions. The first position – habitual position, pic. 1. Second position – posture after 10 minutes of symmetric loading on the left or right shoulder, fig. 1, 2. Third position – posture one minute after the load removal, fig. 3. Fourth position - posture two minutes after the load removal, fig. 3. On the first day the measurements involved all children in 1, 2, 3, 4 positions loading the right shoulder and next on the left. The load was supposed to imitate the way of carrying school supplies. The subject could move freely. The purpose was to eliminate layering the postural muscles from one side to the other during the procedure. 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 [8]. It could be assumed that it was an appropriate and relatively con-

Fig. 1. Position 2: Demonstration of the right shoulder load

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Fig. 1. Position 2: Demonstration of the left shoulder load

Fig. 3. Position 1: Habitual posture

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stant 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.

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. The most important thing in this method is the simultaneous measurement of all the actual dimensions of the spatial location of individual sections of the body. Due to the research methodology, the examination of a child standing on a strain gauge mat was abandoned [14].

There was the following test procedure was developed to minimize the risk of making errors in the measurements of selected postural features [3]:

1. 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.
2. 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 ($Ł_l$ and Łp), the posterior upper iliac spines (M_l and M_p), 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, pic. 4. Long hair up to reveal C_7 point.
3. The digital image of the back was recorded in the computer memory in each of the four 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

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body height, comments about the condition of the knees and heels, chest, past injuries, surgical procedures, diseases of the musculoskeletal system, gait, etc.).

4. The value of the features describing the body posture spatially are printed after saving the mathematical characteristics of the photos in the computer memory.

5. Processing of the recorded images takes place without the participation of the subject, fig.4.

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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)

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Kat nachylenia tułowia KNT 1.4 [st]
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Miednica: kąt nachylenia KNM 1.5 [st], kąt skręcenia KSM -6.4 [st]
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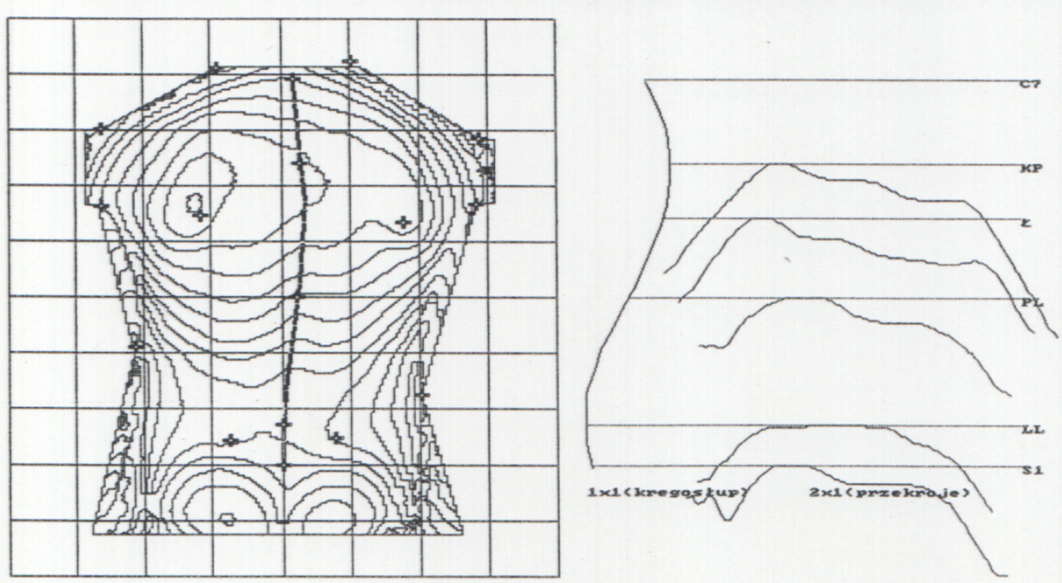

Fig. 4. Worksheet of measurement results for body posture features of the pelvis-spine complex

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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. Strength abilities are values that make it possible to overcome significant external resistance or oppose to it by muscle contraction. Speed abilities are values that allow to complete certain tasks in a short time (they last short and do not cause fatigue). Endurance parameters characterize the individual human ability to undertake long-term efforts of a certain intensity, so they indicate the level of resistance to fatigue. Coordination abilities are conditioned by movement control and regulation; they are characterized by the ability to precisely perform activities that are complex in terms of space-time relations, the capability to opposre and adapt to new and sometimes unexpected situations [15, 16]. Power is the product of strength and speed [17].
The applied method, which uses the phenomenon of the projection moiré, defines several dozen features describing the body posture. For statistical analysis, 36 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, tab. 1, fig. 5.

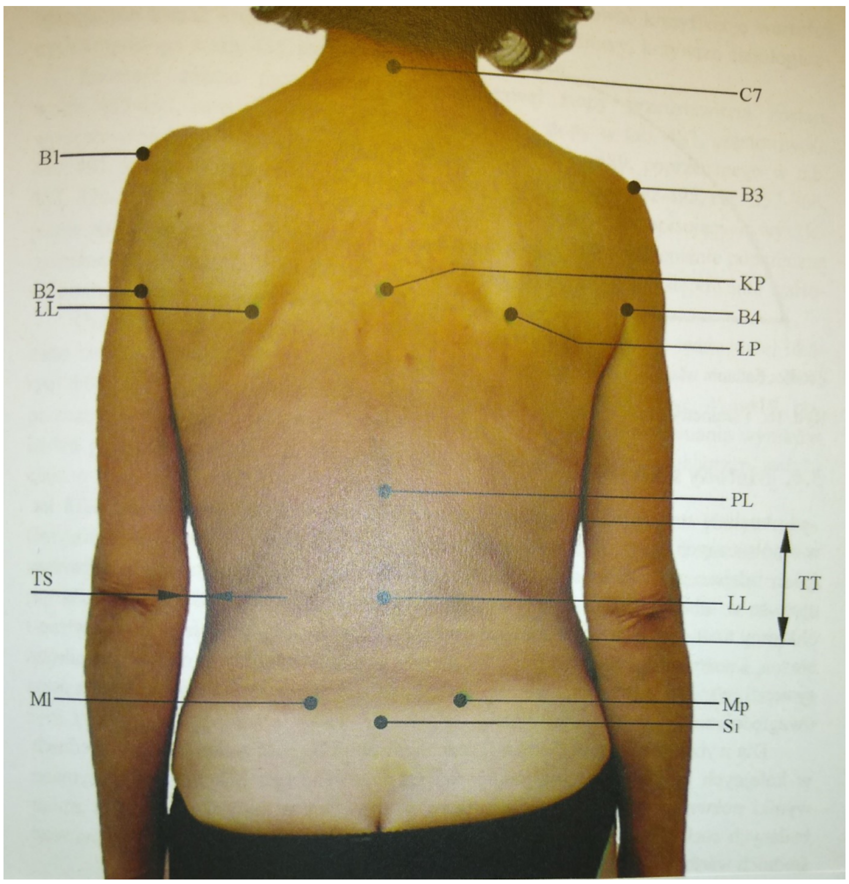

Fig. 5. Location and markings of the torso points in the frontal plane

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Tab. 2. List of registered parameters

No.	Symbol	Label	Name	Description
			Sagittal plane	
1	Alfa	degrees	Lumbosacral slope	
2	Beta	degrees	Nachylenie odcinka piersiowo-lędźwiowego	
3	Gamma	degrees	Upper thoracic slope	
4	Delta	degrees	Suma wartości kątowych	Delta = Alfa + Beta + Gamma
5	KPT	degrees	Torso extension angle	Determined by the declination of the C_7-S_1 line from the vertical (backwards)
6	KPT–	degrees	Torso flexion angle	Determined by the declination of the C_7-S_1 line from the vertical (forwards)
7	DKP	mm	Thoracic kyphosis length	Distance between points C_7 and LL
8	KKP	degrees	Thoracic kyphosis angle	KKP = 180 – (Beta + Gamma)
9	RKP	mm	Thoracic kyphosis height	Distance between points C_7 and PL
10	GKP	mm	Thoracic kyphosis depth	Distance measured horizontally between vertical lines passing through points PL and KP
11	DLL	mm	Lumbar lordosis length	Distance between points KP and S_1
12	KLL	degrees	Lumbar lordosis angle	KLL = 180 – (Alfa + Beta)
13	RLL	mm	Lumbar lordosis height	Distance between points PL and S_1
14	GLL–	mm	Lumbar lordosis depth	Distance measured horizontally between vertical lines passing through points PL and LL, at the level of point LL
			Płaszczyzna czołowa / Frontal plane	
15	KNT–	degrees	Angle of body bent to the side	Defined as deviation of the C_7-S_1 line from the vertical axis to the left
16	KNT	degrees		Defined as deviation of the C_7-S_1 line from the vertical axis to the right
17	KLB	degrees	Angle of shoulder line, right shoulder up	Angle between the horizontal line and the straight line passing through points B_2 and B_4
18	KLB–	degrees	Angle of shoulder line, left shoulder up	

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No.	Symbol	Label	Parameters Name	Description
19	UL	degrees	Angle of scapula line, right scapula up	Angle between the horizontal line and the straight line passing through points $Ł_l$ and $Ł_p$
20	UL−	degrees	Angle of scapula line, left scapula up	
21	OL	mm	Lower angle of left scapula more distant	Difference in the distance of lower angles of scapulas from the line of spinous processes measured horizontally along the lines passing through points $Ł_l$ and $Ł_p$
22	OL−	mm	Lower angle of right scapula more distant	
23	TT	mm	Left waist triangle up	Difference in the distance measured vertically between points T_1 and T_2 and points T_3 and T_4
24	TT−	mm	Right waist triangle up	
25	TS	mm	Left waist triangle wider	Difference in the distance measured horizontally between straight lines passing through points T_1 and T_2 and points T_3 and T_4
26	TS−	mm	Right waist triangle wider	
27	KNM	degrees	Pelvis tilt, right ilium up	Angle between the horizontal line and the straight line passing through points M_l and M_p
28	KNM−	degrees	Pelvis tilt, left ilium up	
29	UK	mm	Maximum inclination of the spinous process to the right	Maximal deviation of the spinous process from the line from S_1. The distance is measured in horizontal line
30	UK−	mm	Maximum inclination of the spinous process to the left.	
31	Nr kręgu/ Vertebra's number		Vertebra's number with maximum deviation to the left or right	Number of the vertebra most deviated to the left or right in the asymmetric line of the spinous processes, counting 1 as first cervical vertebra (C_1). If the arithmetic mean takes the value from 12.0 to 12.5, it is Th_5, if it takes from 12.6 to 12.9, it is Th^6

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No.	Symbol	Label	Parameters Name	Description
			Transversal plane	
32	UB−	degrees	The angle of convex line of lower shoulder blades, where the left is more convex	Różnica kątów UB$_1$ – UB$_2$. Kąt UB$_2$ zawartych między: linią przechodząca przez punkt Łl i będącą jednocześnie prostopadłą do osi kamery a prostą przechodzącą przez Ł$_l$ i Ł$_p$. Kąt UB$_1$ zawarty między linią przechodząca przez punkt Ł$_p$ i będącą jednocześnie prostopadłą do osi kamery a prostą przechodzącą przez Ł$_p$ i Ł$_l$. /
33	UB	degrees	The angle of convex line of lower shoulder blades, where the right 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 Ł$_l$ and Łp points. The UB$_1$ angle is between the line crossing the Ł$_p$ point and being simultaneously perpendicular to the camera axis and the straight-line crossing Ł$_p$ and Ł$_l$ points.
34	KSM	degrees	Pelvic tilt to the right	Kąt między linią przechodząca przez punkt M$_l$ i będącą jednocześnie prostopadłą do osi kamery a prostą przechodzącą przez M$_l$ i MP / The angle between a line crossing M$_l$ point and being simultaneously perpendicular to the camera axis and a straight-line crossing M$_l$ and MP points
35	KSM−	degrees	Pelvic tilt to the left	
36	DCK	mm	Total length of the spine	Odległość pomiędzy punktami C$_7$ a S$_1$ mierzona w linii pionowej/ The distance between C$_7$ and S$_1$ points measured vertically.
			Morphological features	
37	Mc	kg	Body weight	The body height and weight was measured with electrical medical balance.
38	Wc	cm	Body height	

All tables – source: own research

Research questions and hypotheses

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

1. Which way of carrying the weight of school supplies does disturb the body posture statics less?
2. Which way of carrying the weight of school supplies does the physical fitness influence on? Which feature?
3. After which way of carrying the weight of school supplies is the restitution of the values of body posture features complete?

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

1. The way of carrying the weight of school supplies obliquely on the right shoulder and the left hip disturbs the body posture statics less.
2. There is greater influence of physical fitness on carrying the weight of school supplies on the right shoulder and the left hip. Endurance, strength, and speed are values of the greatest influence, but the force is of the least impact.
3. Restitution of the values of body posture features after carrying the weight of school supplies obliquely on the right shoulder and left hip is incomplete.

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Statistical methods

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, which at least one statistically significant result was recorded for.

Obtained results

In total, the research conducted in a group of 65 people of both sexes allowed to register 10,010 values of features describing body posture in habitual posture and dynamic positions, body weight and height, and physical fitness. The values of body posture features were compared between 1st and 2nd, 1st and 3rd, 3rd and 4th, 2nd and 3rd and 3rd and 4th in carrying on the left and right shoulder, considering the sex of the subjects. The aim was to show significant changes in the adopted method of carrying school supplies in the analyzed posture features and prove, which of those two methods of carrying causes less significant changes in posture features. Thus, it can be recommended.
Considering the carrying on the left shoulder and regarding boys only, the Wilcoxon rank test showed a statistically significant difference between the measurement of 1st and 2nd, 3rd and 1st, 2nd and 3rd and 3rd and 4th in terms of all analyzed variables. In the case of a difference between 1st and 4th measurement, statistically significant differences apply to all variables except for OL+, tab. 2. When analyzing the results in carrying on the right shoulder, a statistically significant difference was

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Tab. 2. The significance of differences of the body features values between 1^{st} and 2^{nd}, 1^{st} and 3^{rd}, 1^{st} and 4^{th}, 2^{nd} and 3^{rd}, and 3^{rd} and 4^{th} measurement of the left shoulder load among boys

No	Variable	Measurement 1 Me	Measurement 2 Me	Measurement 3 Me	Me	Wilcoxon Test 1/2	1/3	1/4	2/3	3/4
1	DCK	314.05	301.75	308.00	312.60	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
2	Alfa	8.45	11.70	10.15	9.50	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
3	Beta	9.75	17.40	13.60	10.70	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
4	Gamma	11.20	16.50	13.70	12.35	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
5	Delta	29.65	45.65	37.75	32.70	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
6	KPT−	4.15	9.50	6.50	4.95	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
7	KPT+	4.75	1.50	2.65	3.90	0.005**	0.005**	0.005**	0.005**	0.005**
8	DKP	279.00	264.75	272.65	277.05	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
9	KKP	159.00	146.10	152.40	156.80	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
10	RKP	185.30	174.05	182.15	184.75	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
11	GKP	19.95	34.95	26.85	22.25	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
12	DLL	247.00	240.95	245.15	246.30	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
13	KLL	161.95	151.20	155.85	160.15	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
14	RLL	135.60	129.95	132.20	134.70	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
15	GLL	24.45	29.25	26.50	25.25	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
16	KNT−	1.40	10.25	5.40	2.10	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
17	KNT+	2.35	0.25	0.85	1.60	0.012*	0.018*	0.026*	0.012*	0.028*
18	KLB−	1.90	0.40	1.10	1.55	0.012*	0.012*	0.011*	0.011*	0.012*
19	KLB+	1.05	9.90	5.70	2.10	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
20	UL−	4.15	0.75	2.00	3.70	0.011*	0.011*	0.018*	0.043*	0.012*
21	UL+	1.95	9.50	6.10	2.70	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
22	UB−	3.30	0.80	2.00	2.90	0.012*	0.012*	0.011*	0.028*	0.012*
23	UB+	4.00	9.35	6.95	4.85	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
24	OL−	8.10	11.65	10.25	8.90	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
25	OL+	4.30	0.95	2.75	3.50	0.025*	0.036*	0.068	0.028*	0.025*
26	TT−	4.80	1.35	2.65	4.30	0.012*	0.012*	0.011*	0.012*	0.012*
27	TT+	8.30	17.55	13.00	9.40	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
28	TS−	5.10	11.00	9.10	5.80	0.012*	0.012*	0.012*	0.012*	0.012*
29	TS+	8.35	12.00	9.40	8.95	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
30	KNM−	7.50	14.30	11.40	8.30	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
31	KNM+	3.40	0.20	2.10	3.10	0.008**	0.008**	0.007**	0.008**	0.012*
32	KSM−	2.45	0.40	1.70	2.35	0.012*	0.012*	0.012*	0.042*	0.012*
33	KSM+	5.50	14.30	10.25	6.40	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
34	UK−	1.50	0.40	0.85	1.20	0.012*	0.012*	0.011*	0.017*	0.012*
35	UK+	6.95	14.00	10.45	7.80	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**

found between the measurement of 1^{st} and 2^{nd}, 3^{rd} and 1^{st}, 4^{th} and 1^{st}, 2^{nd} and 3^{rd} and 3^{rd} and 4^{th} in terms of all the analyzed variables, tab. 3. Considering the transport on the left shoulder and regarding girls only, the Wilcoxon rank test showed a statistically significant difference between the measurement of 1^{st} and 2^{nd}, 3^{rd} and 1^{st}, 4^{th} and 1^{st}, 2^{nd} and 3^{rd} and 3^{rd} and 4^{th} in terms of all analyzed variables, tab. 4. When analyzing the results in transport on the right shoulder, a statistically significant difference was shown between the measurement of 1^{st} and 2^{nd}, 3^{rd} and 1^{st} and 4^{th} and 3^{rd} in terms of all analyzed variables. On the other hand, in the case of a difference between 1^{st} and 4^{th} and 2^{nd} and 3^{rd} measurements, significant differences occur for all analyzed variables except for Alpha, tab. 5.

Tab. 3. The significance of differences of the body features values between 1^{st} and 2^{nd}, 1^{st} and 3^{rd}, 1^{st} and 4^{th}, 2^{nd} and 3^{rd}, and 3^{rd} and 4^{th} measurement of the right shoulder load among boys

No	Variable	Measurement 1 Me	Measurement 2 Me	Measurement 3 Me	Me	Wilcoxon Test 1/2	1/3	1/4	2/3	3/4
1	DCK	314.05	290.55	288.45	292.60	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
2	Alfa			11.20	9.75					

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No	Variable	Measurement				TWilcoxon Test				
		1	2	3						
		Me	Me	Me	Me	1/2	1/3	1/4	2/3	3/4
3	Beta	9.75	18.75	15.35	11.90	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
4	Gamma	11.20	14.80	14.40	12.40	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
5	Delta	29.65	43.30	40.30	33.85	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
6	KPT–	4.25	9.40	6.10	4.60	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
7	KPT+	4.75	2.20	2.50	3.20	0.005**	0.005**	< 0.001**	< 0.001**	< 0.001**
8	DKP	279.00	264.20	269.80	275.40	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
9	KKP	159.00	145.95	150.45	155.90	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
10	RKP	185.30	172.95	171.90	175.80	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
11	GKP	19.95	33.95	26.90	22.70	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
12	DLL	247.00	238.90	245.85	247.75	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
13	KLL	161.95	152.35	154.20	158.30	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
14	RLL	135.60	128.40	126.20	128.20	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
15	GLL	24.45	27.00	26.65	24.30	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
16	KNT–	1.40	0.35	5.90	1.70	< 0.001**	< 0.001**	0.001**	0.001**	0.001**
17	KNT+	2.35	8.10	0.50	0.60	0.012*	0.012*	< 0.001**	< 0.001**	0.001**
18	KLB–	1.90	7.70	0.90	1.10	0.012*	0.012*	< 0.001**	< 0.001**	< 0.001**
19	KLB+	1.05	0.30	5.80	1.90	< 0.001**	< 0.001**	0.001**	0.001**	0.001**
20	UL–	4.15	8.00	1.20	2.60	0.012*	0.012*	< 0.001**	< 0.001**	< 0.001**
21	UL+	1.95	0.80	6.10	4.10	0.001**	< 0.001**	0.001**	0.001**	0.001**
22	UB–	3.30	7.75	1.40	2.10	0.012*	0.012*	< 0.001**	< 0.001**	< 0.001**
23	UB+	3.65	1.10	6.90	3.80	< 0.001**	< 0.001**	0.001**	0.001**	0.001**
24	OL–	8.10	2.35	11.20	8.70	< 0.001**	< 0.001**	0.001**	0.001**	0.001**
25	OL+	4.30	8.15	2.50	3.70	0.012*	0.012*	< 0.001**	< 0.001**	< 0.001**
26	TT–	4.80	8.15	2.80	4.10	0.012*	0.012*	< 0.001**	< 0.001**	< 0.001**
27	TT+	8.30	1.50	11.60	5.80	< 0.001**	< 0.001**	0.001**	0.001**	0.001**
28	TS–	5.10	12.45	7.90	5.80	0.012*	0.012*	< 0.001**	< 0.001**	< 0.001**
29	TS+	8.35	1.25	6.80	5.80	< 0.001**	< 0.001**	0.001**	0.001**	0.001**
30	KNM–	7.50	1.10	11.10	3.80	< 0.001**	< 0.001**	0.001**	0.001**	0.001**
31	KNM+	3.40	12.50	1.40	2.50	0.008**	0.008	< 0.001**	0.001**	< 0.001**
32	KSM–	2.45	12.00	1.70	2.60	0.012*	0.012*	< 0.001**	< 0.001**	< 0.001**
33	KSM+	5.50	1.10	9.50	5.30	< 0.001**	< 0.001**	0.001**	0.001**	0.001**
34	UK–	1.50	10.65	1.90	2.90	0.012*	0.012*	< 0.001**	< 0.001**	< 0.001**
35	UK+	6.95	1.15	9.60	4.70	< 0.001**	< 0.001**	0.001**	0.001**	0.001**

Tab. 4. The significance of differences of the body features values between 1st and 2nd, 1st and 3rd, 1st and 4th, 2nd and 3rd, and 3rd and 4th measurement of the left shoulder load among girls

No	Variable	Measurement				Wilcoxon Test				
		1	2	3						
		Me	Me	Me	Me	1/2	1/3	1/4	2/3	3/4
1	DCK	294.10	284.40	288.45	292.60	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
2	Alfa	8.90	12.10	11.20	9.75	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
3	Beta	11.20	18.75	15.35	11.90	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
4	Gamma	11.25	16.75	14.40	12.40	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
5	Delta	31.00	47.20	40.30	33.85	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
6	KPT–	4.10	9.50	6.10	4.60	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
7	KPT+	4.20	1.50	2.50	3.20	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
8	DKP	276.25	263.35	269.80	275.40	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
9	KKP	157.70	144.75	150.45	155.90	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
10	RKP	176.90	165.55	171.90	175.80	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
11	GKP	20.45	35.40	26.90	22.70	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
12	DLL	248.15	242.10	245.85	247.75	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
13	KLL	159.90	148.95	154.20	158.30	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
14	RLL	129.15	122.40	126.20	128.20	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
15	GLL	23.40	29.00	26.65	24.30	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
16	KNT–	0.40	10.40	5.90	1.70	0.001**	0.001**	0.001**	0.001**	0.001**
17	KNT+	0.80	0.20	0.50	0.60	< 0.001**	< 0.001**	< 0.001**	< 0.001**	0.001**
18	KLB–	1.40	0.30	0.90	1.10	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
19	KLB+	1.50	10.30	5.80	1.90	0.001**	0.001**	0.001**	0.001**	0.001**
20	UL–	2.80	0.40	1.20	2.60	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
21	UL+	3.20	9.50	6.10	4.10	0.001**	0.001**	0.001**	0.001**	0.001**
22	UB–	2.70	0.40	1.40	2.10	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
23	UB+	2.80	9.40	6.90	3.80	0.001**	0.001**	0.001**	0.001**	0.001**
24	OL–	7.60	12.50	11.20	8.70	0.001**	0.001**	0.001**	0.001**	0.001**
25	OL+	4.30	0.70	2.50	3.70	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
26	TT–	4.70	1.20	2.80	4.10	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
27	TT+	4.80	15.60	11.60	5.80	0.001**	0.001**	0.001**	0.001**	0.001**
28	TS–	4.90	11.60	7.90	5.80	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**

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No	Variable	Measurement				Wilcoxon Test				
		1	2	3						
		Me	Me	Me	Me	1/2	1/3	1/4	2/3	3/4
29	TS+	5.10	9.80	6.80	5.80	0.001**	0.001**	0.001**	0.001**	0.001**
30	KNM−	2.70	14.30	11.10	3.80	0.001**	0.001**	0.001**	0.001**	0.001**
31	KNM+	2.90	0.20	1.40	2.50	< 0.001**	< 0.001**	< 0.001**	0.001**	< 0.001**
32	KSM−	2.90	0.40	1.70	2.60	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
33	KSM+	4.10	13.60	9.50	5.30	0.001**	0.001**	0.001**	0.001**	0.001**
34	UK−	3.10	0.60	1.90	2.90	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
35	UK+	3.70	13.20	9.60	4.70	0.001**	0.001**	0.001**	0.001**	0.001**

Tab. 5. The significance of differences of the body features values between 1st and 2nd, 1st and 3rd, 1st and 4th, 2nd and 3rd, and 3rd and 4th measurement of the right shoulder load among girls

No	Variable	Measurement				Wilcoxon Test				
		1	2	3						
		Me	Me	Me	Me	1/2	1/3	1/4	2/3	3/4
1	DCK	294.10	276.95	285.10	290.15	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**
2	Alfa	8.90	10.40	10.45	8.90	0.013*	0.019*	0.381	0.798	0.006**
3	Beta	11.20	19.60	15.35	12.50	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**
4	Gamma	11.25	14.85	14.55	13.00	<0.001**	<0.001**	<0.001**	0.004**	<0.001**
5	Delta	31.00	44.40	38.95	34.90	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**
6	KPT−	4.10	9.60	6.50	5.20	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
7	KPT+	4.20	2.30	2.70	3.50	< 0.001**	< 0.001**	< 0.001**	< 0.001**	0.001**
8	DKP	276.25	261.45	267.30	273.95	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
9	KKP	157.70	144.90	150.95	154.70	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
10	RKP	176.90	164.15	171.50	175.00	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
11	GKP	20.45	34.55	26.05	22.60	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
12	DLL	248.15	242.05	242.85	246.60	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
13	KLL	159.90	150.20	155.30	158.30	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
14	RLL	129.15	121.55	124.70	126.90	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
15	GLL	23.40	25.15	24.50	24.10	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
16	KNT−	0.40	0.10	0.20	0.30	0.001**	0.001**	0.001**	0.005**	0.001**
17	KNT+	0.80	7.60	4.40	1.70	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
18	KLB−	1.40	6.80	4.70	2.40	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
19	KLB+	1.50	0.30	0.60	0.90	0.001**	0.001**	0.001**	0.002**	0.001**
20	UL−	2.80	7.60	5.30	3.70	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
21	UL+	3.20	0.90	1.50	2.30	0.001**	0.001**	0.001**	0.001**	0.001**
22	UB−	2.70	7.50	4.80	3.20	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
23	UB+	2.80	0.80	1.40	2.30	0.001**	0.001**	0.001**	0.001**	0.001**
24	OL−	7.60	1.40	4.20	5.60	0.001**	0.001**	0.001**	0.001**	0.001**
25	OL+	4.30	8.70	6.20	5.20	< 0.001**	0.002**	0.003**	< 0.001**	0.001**
26	TT−	4.70	8.40	6.70	5.30	< 0.001**	< 0.001**	0.002**	< 0.001**	< 0.001**
27	TT+	4.80	1.40	2.70	3.80	0.001**	0.001**	0.001**	0.001**	0.001**
28	TS−	4.90	11.60	8.90	6.30	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
29	TS+	5.10	1.20	2.60	4.30	0.001**	0.002**	0.001**	0.001**	0.004**
30	KNM−	2.70	0.70	1.50	2.40	0.001**	0.001**	0.001**	0.001**	0.001**
31	KNM+	2.90	11.50	8.10	4.70	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
32	KSM−	2.90	11.60	7.60	3.90	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
33	KSM+	4.10	0.90	2.80	3.60	0.001**	0.001**	0.001**	0.001**	0.001**
34	UK−	2.40	11.50	6.90	3.80	< 0.001**	< 0.001**	< 0.001**	< 0.001**	< 0.001**
35	UK+	3.70	0.70	2.10	3.10	0.001**	0.001**	0.001**	0.001**	0.001**

From the analysis of correlations between the results of physical fitness tests and the difference between 2nd and 1st measurement, concerning separately transport on the left shoulder and transport on the right shoulder, separately among girls and separately among boys statistically significant correlations at the level of $p < 0.05$ or higher are marked with a gray background.

Considering the boys and the differences between the 1st and 2nd measurement in carrying on the left shoulder, it turned out that the greater the endurance, the greater the differences in the TT+ and TS+ variables. The greater the speed, the greater the difference in the TS+ variable. The greater the strength, the smaller the difference in the DKP variable and the greater in the RKP variable. The greater the force, the smaller the differences in the Gamma and KPT− va-

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riables, and the greater the overall efficiency, the smaller the difference in the DKP variable, tab. 6. When analyzing the differences between the 1st and 2nd measurement in carrying on the right shoulder, it turned out that the greater the strength, the greater the difference in the KKP variable and the smaller in the DLL variable. The greater the force, the smaller the differences in the KPT− and GLL variables. The greater the agility, the smaller the difference in the DKP variable, and the greater the overall fitness, the smaller the difference in the DKP variable and the greater in the KKP variable, tab. 7.

Tab. 6. Correlations between physical fitness and average differences of 1st and 2nd measurement of body posture value in the left shoulder load among boys

Variables	Endurance		Speed		Strength		Force		Agility		Total	
	rho	p	rho	p	rho	p	rho	p	rho	p	rho	p
Gamma	0.387	0.154	0.147	0.600	0.044	0.876	−0.536	0.039	0.248	0.373	0.077	0.784
KPT-	−0.418	0.262	−0.220	0.569	−0.341	0.370	−0.792	0.011	−0.510	0.160	−0.517	0.154
DKP	−0.431	0.108	−0.322	0.241	−0.585	0.022	−0.15	0.594	−0.510	0.052	−0.645	0.009
RKP	0.242	0.385	0.268	0.334	0.544	0.036	0.146	0.603	0.112	0.691	0.501	0.057
TT+	0.626	0.022	0.444	0.128	0.180	0.557	−0.128	0.678	0.064	0.835	0.228	0.453
TS+	0.671	0.012	0.803	0.001	0.239	0.432	−0.342	0.253	0.159	0.604	0.364	0.222

Tab. 7. Correlations between physical fitness and average differences of 1st and 2nd measurement of body posture value in carrying on the right shoulder among boys

Variables	Endurance		Speed		Strength		Force		Agility		Total	
	rho	p	rho	p	rho	p	rho	p	rho	p	rho	p
KPT−	−0.429	0.250	−0.318	0.405	−0.509	0.162	−0.765	0.016	−0.647	0.06	−0.644	0.061
DKP	−0.250	0.369	−0.126	0.655	−0.462	0.083	−0.185	0.510	−0.562	0.029	−0.545	0.036
KKP	0.286	0.301	0.351	0.200	0.650	0.009	0.338	0.218	0.425	0.114	0.576	0.025
DLL	−0.209	0.455	−0.153	0.587	−0.645	0.009	−0.029	0.917	−0.397	0.142	−0.463	0.082
GLL	0.150	0.593	0.281	0.310	−0.153	0.587	−0.525	0.044	−0.163	0.561	−0.224	0.423

Considering the girls and the differences between the 1st and 2nd measurement in carrying on the left shoulder, it turned out that the greater the endurance, the greater the differences in the GLL and KNT− variables. The greater the speed, the greater the difference in TT+ variable. The greater the strength, the greater the differences in the KLB+ and OL+ variables. The greater the force, the greater the difference in the UL− variable and the smaller in the TS− variable. The greater the agility, the greater the difference in the KLB+ variable, and the greater the total efficiency, the greater the difference in the KLB+ variable, tab. 8. When analyzing the differences between the 1st and 2nd measurement in carrying on the right shoulder, it turned out that the greater the endurance, the greater the difference in the UB- variable. The greater the speed, the greater the difference in the KNT+ variable. The greater the force, the smaller the differences in the KLB+ and UL− variables, and the greater in the TT+ variable. The greater the force, the greater the difference in the KKP variable, and the smaller the differences in the TT− and TS+ variables. The greater the agility, the smaller the differences in the KLB+, UL− and TT− variables, and the greater the differences in the TT+ variable. The greater the overall fitness, the smaller the differences in the KLB+, UL−, TT- variables, and the greater the difference in the variable TT+, tab. 9.

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Tab. 8. Correlations between physical fitness and a difference of a body posture value between 1st and 2nd measurement of carrying on the left shoulder among girls

Variables	Endurance		Speed		Strength		Force		Agility		Total	
	rho	p	rho	p	rho	p	rho	p	rho	p	rho	p
GLL	0.579	0.049	0.283	0.373	0.294	0.354	0.286	0.367	0.314	0.321	0.495	0.102
KNT−	0.908	0.005	0.477	0.279	0.372	0.412	0.187	0.688	0.176	0.706	0.546	0.205
KLB+	0.541	0.210	0.703	0.078	0.879	0.009	−0.569	0.182	0.837	0.019	0.821	0.023
UL−	0.500	0.391	−0.300	0.624	0.632	0.252	0.894	0.041	0.700	0.188	0.700	0.188
OL+	0.500	0.391	0.300	0.624	0.949	0.014	0.783	0.118	0.800	0.104	0.800	0.104
TT+	0.655	0.111	0.782	0.038	0.406	0.366	0.259	0.574	0.284	0.536	0.613	0.144
TS−	−0.400	0.505	0.300	0.624	−0.791	0.111	−0.894	0.041	−0.700	0.188	−0.700	0.188

Tab. 9. Correlations between physical fitness and a difference of 1st and 2nd measurement of body posture value in carrying on the right shoulder among girls

Variables	Endurance		Speed		Strength		Force		Agility		Total	
	rho	p	rho	p	rho	p	rho	p	rho	p	rho	p
KKP	0.396	0.203	−0.120	0.710	0.092	0.777	0.618	0.032	−0.088	0.784	0.165	0.609
KNT+	0.000	1.000	0.900	0.037	−0.053	0.933	−0.447	0.450	−0.100	0.873	−0.100	0.873
KLB+	−0.450	0.310	−0.559	0.192	−0.954	0.001	0.312	0.496	−0.982	0.000	−0.893	0.007
UL−	−0.700	0.188	−0.500	0.391	−0.949	0.014	−0.783	0.118	−0.900	0.037	−0.900	0.037
UB−	0.900	0.037	0.700	0.188	0.527	0.361	0.335	0.581	0.700	0.188	0.700	0.188
TT−	−0.700	0.188	−0.100	0.873	−0.949	0.014	−0.894	0.041	−0.900	0.037	−0.900	0.037
TT+	0.418	0.350	0.427	0.339	0.840	0.018	−0.296	0.519	0.927	0.003	0.757	0.049
TS+	−0.306	0.504	0.198	0.670	0.468	0.290	−0.771	0.042	0.418	0.350	0.214	0.645

Considering the boys and the differences between the 2nd and 3rd measurement in carrying on the left shoulder, it turned out that the greater the endurance, the greater the difference in the KNT−, KNT+, KLB−, UL−, OL+, TT−, TS+, KSM− and UK− variables, and smaller in UB- and TS− variables. The greater the speed, the smaller the differences in the variables: KNT+, KLB−, UL−, OL+, TT−, KSM− and UK−, and the greater the differences in the variables UB-, TS- and TS+. The greater the strength, the greater the differences in the KKP, RKP, DLL, KNT+, KLB−, UL−, OL+, TTv, TS+, KSM−, KNM+ and UK variables, and the smaller the differences in the UB− and TS− variables. The grater the force, the greater the differences in the KNT+, KLB−, UL−, OL+, TT−, TS+, KSM−, and UK variables, and the smaller the differences in the UB− and TS− variables. The greater the agility, the greater the differences in the KNT+, KLB−, UL−, OL+, TT−, TS+, KSM− KNM+, and UK variables, and the smaller the differences in the DLL, UB− and TS− variables. The greater the overall fitness, the greater the differences in the RKP, KNT+, KLB−, UL−, OL+, TT−, KNM+, KSM− and UK- variables, and the smaller the differences in the UB− and TS− variables. From the analysis of differences between the 3rd and 4th measurement in carrying on the left shoulder, it turned out that the greater the endurance, the greater the difference in the KNT−, KNT+, KLB−, UL−, OL+, TT−, TS+, KSM− and UK− variables, and smaller in UB− and TS− variables. The greater the speed, the greater the differences in the KNT+, UL−, UB−, TS− and TS+ variables, and the smaller the differences in the KLB−, OL+, TTv, KSM− and UK− variables. The greater the strength, the greater the differences in the KLB−, OL+, TT−, KNM+, KSM− and UK− variables, and the smaller the differences in the

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GKP, KNT+, UL−, UB− and TS− variables. The greater the force, the greater the differences in the KLB−, OL+, TT−, KSM− and UK − variables, and the smaller the differences in the KNT+, UL−, UB− and TS− variables. The greater the agility, the greater the differences in the KLB−, OL+, TT−, KNM+, KSM− and UK− variables, and the smaller the differences in the KNT+, UL−, UB− and TS− variables. Then, the greater the total overall fitness, the greater the differences in the KLB−, OL+, TT−, KNM+, KSM− and UK− variables, and the smaller the differences in the GKP, KNT+, UL−, UB− and TS− variables, tab. 10.

Tab. 10. Correlations between physical fitness and average differences of 2nd and 3rd, and 3rd and 4th measurement of body posture value in the left shoulder load among boys

Variables	Difference between 2nd and 3rd measurement						Difference between 3rd and 4th measurement					
	WY	SZ	SI	M	ZW	OG	WY	SZ	SI	M	ZW	OG
KPT+	−0.64	−0.79	−0.65	−0.03	−0.65	−0.81*	0.60	0.12	−0.09	−0.21	0.06	0.14
KKP	0.18	0.12	0.53*	0.36	0.20	0.44	−0.01	−0.15	−0.45	−0.31	−0.01	−0.28
RKP	0.15	0.26	0.72**	0.20	0.25	0.53*	−0.14	−0.21	−0.01	0.12	−0.31	−0.03
GKP	0.39	0.42	0.02	0.03	0.12	0.17	−0.13	0.03	−0.59*	−0.27	−0.47	−0.57*
DLL	−0.11	−0.33	−0.56*	0.06	−0.60*	−0.43	0.29	0.24	0.23	−0.06	0.30	0.26
KNT−	0.65*	0.37	0.20	−0.11	0.10	0.27	−0.66*	−0.25	−0.17	0.12	−0.15	−0.25
KNT+	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**
KLB−	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**
UL−	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−	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**
OL+	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**
TT−	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**
TS−	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**
TS+	0.63*	0.68**	0.03	−0.31	−0.09	0.12	0.57*	0.71**	0.37	−0.37	0.30	0.47
KNM+	0.50	0.00	1.00**	0.00	1.00**	1.00**	0.50	0.00	1.00**	0.00	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**
UK−	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**

From the analysis of differences between the 2nd and 3rd measurement in carrying on the right shoulder, it turned out that the greater the endurance, the greater the difference in the Alpha, KNT+, KLB−, UL−, OL+, KNM+, KSM and UK− variables, and the smaller in the KPT−, UB−, TT− and TS− variables. The greater the speed, the greater the differences in the Alpha, UB−, TT−, TS− variables, and the smaller in the KLL, KNT+, KLB−, UL−, OL+, KSM− and UK− variables. The greater the strength, the greater the differences in the Gamma, KNT+, KLB−, UL−, UB+, OL+, KSM− and UK− variables, and the smaller the differences in the UB−, TT− and TS− variables. The greater the force, the greater the differences in the KNT+, KLB−, UL−, OL+, KSM− and UK- variables, and the smaller the differences in the DCK, UB−, TT− and TS− variables. The greater the agility, the greater the differences in the KNT+, KLB−, UL−, OL+, KSM− and UK− variables, and the smaller the differences in the UB−, TT− and TS− variables. The greater the overall fitness, the greater the differences in the KNT+, KLB−, UL−, OL+, KSM− and UK− variables, and the smaller the differences in the UB−, TT− and TS− variables. Considering the differences between the 3rd and 4th measurement in carrying on the right shoulder, it turned out that the greater the endurance, the greater the difference in the TT− and TS− variables, and the smaller in the KNT+, KLB-, UL-, UB−, OL+, KNM+, KSM− and UK− variables. The greater the speed, the greater the differences in the KNT+, KLB−, UL−, UB−, OL+, KSM− and UK− variables, and the smaller the differences in the TT− and

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TS− variables. The greater the strength, the greater the differences in the TT− and TS− variables, and the smaller in the KNT+, KLB−, UL−, UB−, OL+, KSM− and UK− variables. The greater the force, the greater the differences in the TT− and TS− variables, and the smaller in the KNT+, KLB−, UL−, UB−, OL+, KSM−, KSM+ and UK− variables. The greater the agility, the greater the differences in the TT− and TS− variables, and the smaller in the KNT+, KLB−, UL−, UB−, OL+, KSM− and UK− variables. The greater the overall fitness, the greater the differences in the TT− and TS− variables, and the smaller the differences in the KNT+, KLB−, UL−, UB−, OL+, KSM− and UK− variables, tab. 11.

Tab. 11. Correlations between physical fitness and restitution of 2nd and 3rd, and 3rd and 4th measurement of body posture value in carrying on the right shoulder among boys

Variables	Difference between 2nd and 3rd measurement						Difference between 3rd and 4th measurement					
	WY	SZ	SI	M	ZW	OG	WY	SZ	SI	M	ZW	OG
DCK	0.12	0.31	0.09	−0.56*	−0.05	−0.06	−0.10	0.07	0.21	0.11	−0.03	0.09
Alfa	0.62*	0.68**	0.21	−0.22	0.30	0.33	0.15	0.00	0.20	0.24	0.46	0.27
Gamma	0.17	0.24	0.68**	0.31	0.30	0.54*	−0.11	−0.09	−0.11	−0.03	0.32	−0.01
KPT−	−0.75*	−0.15	−0.06	0.10	−0.33	−0.30	−0.03	−0.14	−0.18	−0.64	−0.16	−0.22
KLL	−0.41	−0.71**	−0.32	−0.08	−0.12	−0.39	0.32	0.19	0.47	0.17	0.21	0.44
KNT+	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**
KLB−	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**
KLB+	0.62*	0.35	0.52	−0.17	0.41	0.54	0.51	0.11	−0.04	−0.28	−0.04	0.08
UL−	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−	−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+	0.23	0.22	0.59*	−0.16	0.36	0.46	0.10	0.25	0.58*	−0.13	0.35	0.41
OL+	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**
TT−	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**
TS−	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**
TS+	−0.20	−0.41	0.04	−0.06	0.21	0.01	−0.55*	−0.59*	−0.14	0.27	−0.32	−0.37
KNM+	1.00**	−0.87	0.50	0.87	0.50	0.50	−1.00**	0.87	−0.50	−0.87	−0.50	−0.50
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**
KSM+	−0.06	−0.07	−0.10	−0.10	0.10	−0.07	0.04	0.08	0.00	−0.56*	0.35	0.06
UK−	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**

Considering the girls and the differences between the 2nd and 3rd measurement in carrying on the left shoulder, it turned out that the greater the endurance, the greater the difference in the TS+ variable and the smaller in the UB− variable. The greater the speed, the greater the differences in the Beta, Delta and KLL variables, and the smaller in the Gamma variable. The greater the strength, the greater the difference in the OL+, KSM+ and UK− variable, and the smaller in the DKP variable. The greater the force, the greater the differences in the Gamma, UL− and TT+ variables. The greater the agility and overall fitness, the greater the differences in the KSM+ variable. Analyzing the differences between the 3rd and 4th measurement in carrying on the left shoulder, it turned out that the greater the endurance, the greater the difference in the KLB+ and KNM− variables. The greater the speed, the greater the difference in the KLB+ variable and the smaller in the Beta and GKP variables. The greater the strength, the greater the differences in the DKP, KLB+ and UB+ variables. The greater the force, the greater the differences in the UL− and KNM+ variables. The greater the agility, the greater the difference in the KLB+ and UL− variables. The greater the overall physical fitness, the greater the differences in the KLB+ UL− and UB+ variables, Tab. 12.

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Tab. 12. Correlations between physical fitness and restitution of 2nd and 3rd, and 3rd and 4th measurement of body posture value in carrying on the left shoulder among girls

Variables	Difference between 2nd and 3rd measurement						Difference between 3rd and 4th measurement					
	WY	SZ	SI	M	ZW	OG	WY	SZ	SI	M	ZW	OG
Beta	−0.02	0.73**	−0.06	−0.48	0.00	0.11	−0.19	−0.74**	−0.17	0.29	−0.33	−0.24
Gamma	−0.01	−0.80**	−0.10	0.58*	−0.17	−0.19	0.09	0.53	0.04	−0.40	0.21	0.19
Delta	0.57	0.76**	0.34	−0.06	0.35	0.47	−0.28	0.03	−0.30	−0.15	−0.33	−0.20
DKP	−0.19	−0.25	−0.60*	−0.04	−0.44	−0.49	0.23	0.10	0.61*	0.12	0.37	0.39
GKP	−0.22	0.14	0.46	−0.34	0.26	0.17	−0.23	−0.71*	−0.41	0.28	−0.58	−0.50
KLL	0.35	0.83**	0.19	−0.38	0.30	0.31	−0.50	−0.27	−0.40	−0.11	−0.55	−0.50
KLB+	0.16	−0.04	0.28	−0.64	0.35	0.11	0.76*	0.83*	0.82*	0.04	0.78*	0.93**
UL−	0.30	−0.50	0.63	0.89*	0.60	0.60	0.80	0.10	0.79	0.89*	0.90*	0.90*
UB−	−0.89*	−0.11	−0.41	−0.50	−0.67	−0.67	−0.67	0.15	−0.11	−0.34	−0.41	−0.41
UB+	−0.03	0.41	−0.13	0.13	−0.20	0.00	0.60	0.39	0.77*	−0.22	0.74	0.79*
OL+	0.50	0.30	0.95*	0.78	0.80	0.80	0.20	0.40	0.74	0.45	0.50	0.50
TT+	0.45	0.04	−0.09	0.80*	0.04	0.13	0.54	0.61	0.54	−0.11	0.29	0.64
TS−	−0.10	0.80	−0.26	−0.67	−0.30	−0.30	−0.20	−0.40	−0.74	−0.45	−0.50	−0.50
TS+	0.87*	0.11	0.19	0.53	0.08	0.41	0.19	−0.32	−0.14	0.72	−0.09	0.05
KNM−	−0.13	−0.49	0.07	−0.17	0.05	−0.07	0.76*	−0.02	−0.06	0.59	−0.20	0.18
KNM+	0.10	−0.70	0.21	0.45	0.20	0.20	0.40	−0.30	0.79	0.89*	0.70	0.70
KSM+	0.61	0.69	0.81*	−0.15	0.78*	0.81*	0.13	0.08	0.25	−0.19	0.09	0.27
UK−	0.50	0.30	0.95*	0.78	0.80	0.80	−0.30	0.10	−0.63	−0.78	−0.60	−0.60

From the analysis of the differences between 2nd and 3rd measurement in carrying on the right shoulder, it turned out that the greater the endurance, the greater the difference in the KNM+ variable. The greater the strength, the greater the difference in the KNM+ variable and the smaller in the UL− variable. The greater the force, the greater the difference in the KNM+ variable, and the smaller in the KNT− and TS+ variables. The greater the agility, the greater the differences in the TT+ and KNM+ variables, and the smaller in the UL− variable. The greater the overall fitness, the smaller the difference in the UL− variable and the greater in the KNM+ variable. Considering the differences between the 3rd and 4th measurement in carrying on the right shoulder, it turned out that the greater the endurance, the greater the differences in the RLL variable, and the smaller in the UL−, TT− and TT+ variables. The greater the speed, the greater the differences in the GLL and KNT+ variables, and the smaller in the DKP variable. The greater the strength, the smaller the differences in the KNM+ and KSM+ variables. The greater the force, the smaller the difference in the TS+ variable. The greater the agility, the smaller the differences in the Beta, KKP, KLB+, UL and KNM+ variables. The greater the overall fitness, the greater the difference in the GLL variable and the smaller in the UL−, KNM+ and KSM+ variables, tab. 13.

Considering the boys and the differences between the 1st and 3rd measurement in carrying on the left shoulder, it turned out that the greater the endurance, the greater the difference in the KLB−, OL+, TT−, TS+, KSM− and UK− variables, and the smaller in the KNT−, KNT+, UL−, UB− and TS− variables. The greater the speed, the greater the differences in the KTN+, UL−, UB−, TS− and TS+ variables, and the smaller the differences in the KLB−, OL+, TT−, KSM− and UK− variables. The greater the strength, the greater the differences in the KLB−, OL+, TT−, KNM+, KSM− and UK− variables, and the smaller the differences in the KNT+, UL−, UB− and TS− variables. The greater the force, the greater the differences in the KLB−, OL+, TT−, KSM− and UK− variables, and the smaller the differences in the KNT+, UL−, UBv and TSv variables. The greater the agility, the greater the differences in the KLB−, OL+, TT−, KNM+, KSM− and UK− variables, and the smaller the differences in the KNT+, UL−, UB− and TS− variables. The greater the overall

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fitness, the greater the differences in the KLB−, OL+, TT−, KNM+, KSM− and UK− variables, and the smaller the differences in the KNT+, UL−, UB− and TS− variables. From the analysis of differences between the 1st and 4th measurement in carrying on the left shoulder, it turned out that the greater the endurance, the greater the difference in the Gamma, KLB−, UL−, OL+, TT−, TS−, KNM+, KSM− and UK− variables, and smaller in UB− and KNM− variables. The greater the speed, the greater the differences in the OL- and UB− variables, and the smaller the differences in the KLB−, UL−, OL+, TT−, TS−, KNM+, KNM−, KSM− and UK− variables. The greater the strength, the greater the differences in the KLB-, UL-, OL+, TT−, TS−, KSM− and UK− variables, and the smaller the differences in the OL− variable. The greater the force, the greater the differences in the KLL, KLB−, UL−, OL+, TT−, TS−, KSM− and UK− variables, and the smaller in the UB− variable. The greater the agility, the greater the differences in the KLL, KLB−, UL−, OL+, TT−, TS−, KSM− and UK− variables, and the smaller in the UB− variable. The greater the overall fitness, the greater the differences in the KLL, KLB−, UL−, OL+, TT−, TS−, KSM− and UK− variables, and the smaller the differences in the UB−. OL− and KNM− variables, Tab. 14.

Tab. 13. Correlations between physical fitness and restitution of 2nd and 3rd, and 3rd and 4th measurement of body posture value in carrying on the right shoulder among girls

Variables	Difference between 2nd and 3rd measurement						Difference between 3rd and 4th measurement					
	WY	SZ	SI	M	ZW	OG	WY	SZ	SI	M	ZW	OG
Beta	0.34	0.28	0.22	−0.09	0.29	OG	−0.64	−0.74	−0.42	−0.75*	−0.10	−0.66
DKP	0.00	0.14	−0.21	−0.18	0.02	0.29	−0.34	−0.15	−0.27	−0.04	−0.59*	−0.34
KKP	0.21	0.02	−0.01	0.03	0.16	0.00	−0.08	−0.62*	−0.23	0.30	−0.11	−0.26
RLL	−0.40	0.03	−0.45	−0.19	−0.30	0.11	−0.45	−0.52	−0.40	0.29	−0.59*	−0.46
GLL	−0.33	0.38	0.06	−0.28	0.09	−0.45	0.62*	0.04	0.36	0.30	0.41	0.49
KNT-	−0.25	0.18	0.51	−0.91**	0.51	0.05	0.34	0.59*	0.55	−0.10	0.49	0.58*
KNT+	−0.45	0.45	0.00	−0.25	−0.22	0.23	0.32	0.40	0.33	0.00	0.40	0.32
KLB+	0.31	−0.16	−0.24	0.20	−0.49	−0.22	0.70	0.90*	0.53	0.22	0.60	0.60
UL-	−0.70	−0.50	−0.95*	−0.78	−0.90*	−0.15	−0.42	−0.11	−0.73	0.13	−0.83*	−0.69
TT-	−0.87	−0.15	−0.70	−0.80	−0.87	−0.90*	−0.89*	−0.67	−0.82	−0.63	−0.89*	−0.89*
TT+	0.34	0.50	0.62	−0.10	0.77*	−0.87	−0.90*	−0.70	−0.53	−0.34	−0.70	−0.70
TS+	−0.40	0.12	0.23	−0.81*	0.11	0.59	−0.77*	−0.25	0.03	−0.53	0.22	−0.22
KNM+	0.90*	0.30	0.95*	0.89*	1.00**	−0.02	−0.28	0.23	0.43	−0.81*	0.38	0.18
KSM+	−0.32	−0.63	−0.56	0.09	−0.33	1.00**	−0.70	−0.50	−0.95*	−0.78	−0.90*	−0.90*

Tab. 14. Correlations between physical fitness and restitution 1st and 3rd, and 1st and 4th measurement of body posture value in carrying on the left shoulder among boys

Variables	Difference between 1st and 3rd measurement						Difference between 1st and 4th measurement					
	WY	SZ	SI	M	ZW	OG	WY	SZ	SI	M	ZW	OG
Gamma	0.13	0.00	−0.28	−0.32	0.05	−0.21	0.64**	0.41	−0.07	−0.23	0.25	0.18
KLL	−0.06	−0.16	−0.06	0.03	0.09	0.06	0.03	0.22	0.51*	0.10	0.40	0.49
KNT−	−0.60*	−0.28	−0.16	0.24	−0.18	−0.23	0.16	0.08	0.11	0.29	0.18	0.18
KNT+	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**	0.15	0.14	0.21	0.25	0.17	0.16
KLB−	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**
UL−	−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−	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**
OL−	−0.09	−0.09	−0.31	0.00	−0.54	−0.34	−0.13	−0.14	−0.75**	−0.32	−0.52	−0.68*
OL+	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**
TT−	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**
TS−	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**
TS+	0.57*	0.71**	0.38	−0.42	0.35	0.48	0.13	0.44	0.22	−0.44	0.37	0.29
KNM−	−0.14	−0.05	−0.25	−0.08	−0.10	−0.18	−0.68*	−0.75**	−0.44	−0.13	−0.44	−0.62*
KNM+	0.50	0.00	1.00**	0.00	1.00**	1.00**	1.00**	−0.87	0.50	0.87	0.50	0.50
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**
UK−	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**

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Observing the differences between the 1st and 3rd measurement in carrying on the right shoulder, it turned out that the greater the endurance, the greater the difference in the TT− and TS− variables, and the smaller in the KNT+, KLB− UL−, UB−, KNM−, KSM− and UK− variables. The greater the speed, the greater the differences in the KNT+, KLB−, UL−, UB− KSM− and UK− variables, and the smaller the differences in the TT− and TS− variables. The greater the strength, the greater the differences in the KLL, TT−, TS− variables, and the smaller the differences in the KNT+, KLB−, UL−, UB−, KSM− and UK-− variables. The greater the force, the greater the differences in the TT−, TS− variables, and the smaller the differences in the KPT-, KNT+, KLB−, UL−, UB−, KSMv and UK− variables. The greater the agility, the greater the differences in the TT−, TS− variables, and the smaller the differences in the KNT+, KLB−, UL−, UB− KSM− and UK− variables. The greater the overall fitness, the greater the differences in the TT−, TS− variables, and the smaller the differences in the KNT+, KLB−, UL−, UB−, KSM− and UK− variables. When analyzing the differences between measurement 1st and 4th measurement in carrying on the right shoulder, it turned out that the greater the endurance, the greater the difference in the KNT+, KLB-, OL+, TT−, TS− variables, and the smaller in the Delta, UB−, KSM− and UK− variables. The greater the speed, the greater the differences in the UB−, KSM− and UK− variables, and the smaller the differences in the KNT+, KLB−, OL+, TT−, TS−, KNM+ variables. The greater the strength, the greater the differences in the KNT+, KLB−, OL+, TT−, TS− variables, and the smaller the differences in the UB−, KSM− and UK− variables. The greater the force, the greater the differences in the KNM+, KNT+, KLB−, OL+, TT−, TS− variables, and the smaller the differences in the UB-, KSM- and UK− variables. The greater the agility, the greater the differences in the KNT+, KLB−, OL+, TT−, TS− variables, and the smaller the differences in the UB−, KSM− and UK− variables. The greater the overall fitness, the greater the differences in the KNT+, KLB−, OL+, TT−, TS− variables, and the smaller the differences in the UB−, KSM− and UK− variables, tab. 15.

Tab. 15. Correlations between physical fitness and restitution 1st and 3rd, and 1st and 4th measurement of body posture value in carrying on the right shoulder among boys

Zmienne Variables	Różnica między pomiarami 1 i 3 Difference between 1st and 3rd measurement						Różnica między pomiarami 1 i 4 Difference between 1st and 4th measurement					
	WY	SZ	SI	M	ZW	OG	WY	SZ	SI	M	ZW	OG
Delta	−0.18	−0.12	0.43	0.31	0.38	0.33	−0.53*	−0.07	0.26	0.19	0.03	0.05
KPT−	0.03	−0.22	−0.25	−0.91**	−0.17	−0.31	0.04	−0.20	−0.34	0.06	−0.36	−0.33
KLL	0.06	0.33	0.56*	0.31	0.27	0.49	−0.36	0.15	0.21	0.35	0.09	0.11
KNT+	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**
KLB−	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**
KLB+	0.57*	0.22	0.33	−0.32	0.11	0.32	0.31	0.11	0.36	−0.24	0.08	0.28
UL−	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**	0.29	0.1	0.32	0.33	0.05	0.26
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**
OL+	0.04	0.11	0.42	0.29	0.36	0.31	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**
TT−	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**
TS−	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**	1.00**	−1.00**	1.00**	1.00**	1.00**	1.00**
KNM+	−1.00**	0.87	−0.50	−0.87	−0.50	−0.50	0.87	−1.00**	0.00	1.00**	0.00	0.00
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**
UK−	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**	−1.00**	1.00**	−1.00**	−1.00**	−1.00**	−1.00**

From the observation of the results obtained among girls and the differences between the 1st and 3rd measurement in carrying on the left shoulder, it turned out that the greater the endu-

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rance, the greater the difference in the DPT and KNM− variables, and the smaller in the KLL variable. The greater the speed, the greater the difference in the Gamma, KLB+ and TT+ variables, and the smaller in the Beta, KKP, KLL variables. The greater the strength, the greater the difference in the KPT−, DKP, KLB+, OL+ variables, and the smaller in the variable KLL. The greater the force, the greater the differences in the UL− and KNM+ variables. The greater the agility, the greater the differences in the KLB+ and UL− variables and the smaller the differences in the KLL variable. The greater the overall physical fitness, the greater the difference in the KPT−, KLB+, UL− variables, and the smaller the difference in the KLL variable. From the analysis of the differences between the 1st and 4th measurement in carrying on the left shoulder, it turned out that the greater the endurance, the greater the difference in the GLL and OL+ variables, and the smaller in the UB− variable. The greater the speed, the smaller the difference in the KLL variable. The greater the strength, the greater the difference in the KSM− variable. The greater the agility, the greater the difference in the OL+ variable. The greater the overall fitness, the greater the differences in the GLL and OL+ variables, and the smaller the differences in the KLL variable, 16.

Tab. 16. Correlations between physical fitness and restitution 1st and 3rd, and 1st and 4th measurement of body posture value in carrying on the left shoulder among girls

Variables	Difference between 1st and 3rd measurement						Difference between 1st and 4th measurement					
	WY	SZ	SI	M	ZW	OG	WY	SZ	SI	M	ZW	OG
Beta	−0.06	−0.77**	0.06	0.49	−0.02	−0.09	0.11	−0.36	0.37	0.26	0.42	0.16
Gamma	0.05	0.64*	−0.15	−0.55	−0.05	0.04	0.06	0.49	−0.11	−0.33	−0.14	−0.02
KPT−	0.97**	0.74	0.89*	0.63	0.72	0.90*	−0.15	0.00	−0.45	−0.05	−0.41	−0.10
DKP	0.16	0.13	0.58*	−0.07	0.29	0.35	0.00	0.22	0.28	−0.22	0.09	0.24
KKP	−0.04	−0.73**	−0.09	0.32	−0.12	−0.14	0.23	−0.24	0.03	0.21	0.17	0.01
KLL	−0.59*	−0.70*	−0.67*	−0.06	−0.69*	−0.74**	−0.42	−0.62*	−0.44	−0.03	−0.34	−0.58*
GLL	0.40	0.11	0.08	0.38	−0.07	0.31	0.86**	0.30	0.47	0.45	0.47	0.66*
KLB+	0.71	0.81*	0.87*	−0.02	0.83*	0.95**	−0.61	−0.06	−0.30	−0.07	−0.46	−0.33
UL−	0.80	0.10	0.79	0.89*	0.90*	0.90*	0.21	−0.41	0.65	0.86	0.56	0.56
UB−	−0.67	0.15	−0.11	−0.34	−0.41	−0.41	−0.89*	−0.11	−0.41	−0.50	−0.67	−0.67
OL+	0.50	0.30	0.95*	0.78	0.80	0.80	1.00**	0.40	0.74	0.67	0.90*	0.90*
TT+	0.45	0.85*	0.51	−0.06	0.25	0.61	−0.05	0.07	−0.17	0.07	0.09	−0.18
KNM−	0.76*	−0.02	−0.06	0.59	−0.20	0.18	0.00	0.52	0.50	0.08	0.48	0.51
KNM+	0.40	−0.30	0.79	0.89*	0.70	0.70	0.11	−0.22	0.65	0.63	0.45	0.45
KSM−	−0.10	0.00	0.58	0.45	0.30	0.30	0.50	0.30	0.95*	0.78	0.80	0.80

From the interpretation of the differences between the 1st and 3rd measurement in carrying on the right shoulder, it turned out that the greater the speed, the greater the difference in the KNT+ variable. The greater the strength, the smaller the differences in the KLB+ and KNM+ variables. The greater the force, the greater the difference in the RKP variable. The greater the agility, the smaller the difference in the KLB+ and KNM+ variables. The greater the overall fitness, the smaller the difference in the KLB+ and KNM+ variables.

Considering the differences between the 1st and 4th measurement in carrying on the right shoulder, it turned out that the greater the endurance, the greater the difference in the RKP variable, and the smaller in the UL+ and KNM+ variables. The greater the speed, the greater the difference in UB− and the smaller in KLB+ variables. The greater the strength, the greater the difference in the TS− variable and the smaller in the KNT+ and KLB+ variables. The greater the agility, the greater the difference in the Beta variable, and the smal-

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ler the KNT+, KLB+ and KNM+ variables. The greater the overall fitness, the smaller the differences in the KNT+, KLB+ and KNM+, variables tab. 17.

Tab. 17. Correlations between physical fitness and restitution 1st and 3rd, and 1st and 4th measurement of body posture value in carrying on the right shoulder among girls

Variables	Difference between 1st and 3rd measurement						Difference between 1st and 4th measurement					
	WY	SZ	SI	M	ZW	OG	WY	SZ	SI	M	ZW	OG
Beta	−0.25	−0.26	0.17	0.22	−0.16	−0.06	0.31	0.45	0.43	−0.13	0.61*	0.44
RKP	0.52	−0.34	0.38	0.66*	0.28	0.38	0.62*	0.26	0.45	0.31	0.37	0.44
KNT+	0.36	0.97**	0.22	−0.23	0.21	0.21	−0.70	−0.50	−0.95*	−0.78	−0.90*	−0.90*
KLB+	−0.53	−0.61	−0.96**	0.22	−0.96**	−0.94**	−0.35	−0.81*	−0.91**	0.30	−0.80*	−0.88**
UL+	−0.45	0.04	0.28	−0.47	0.47	0.13	−0.90**	−0.26	−0.20	−0.53	−0.04	−0.44
UB−	0.82	0.05	0.41	0.57	0.67	0.67	0.00	0.90*	−0.05	−0.45	−0.10	−0.10
TS−	0.15	0.56	0.65	0.29	0.41	0.41	0.50	0.30	0.95*	0.78	0.80	0.80
KNM+	−0.70	−0.50	−0.95*	−0.78	−0.90*	−0.90*	−0.95*	−0.26	−0.81	−0.82	−0.95*	−0.95*

Discussion

A review of the literature by Janakiraman et al. [18] shows that the optimal weight of a school bag for schoolchildren ranges from 10% to 15% of their body weight. The authors note simultaneously that in addition to the recommended load limit, there have been reports of the role of load placement. In fact, only Mrozkowiak [6] and Romanowska [7] made an attempt to describe the changes under the influence of external load on the student's body posture. The authors in their investigations came to very similar conclusions. The effect of a symmetrical six-kilogram load on the upper limb girdle of 12-year-old girls showed insignificant changes in the values of selected postural features. It also showed full restitution of the value of the diagnosed features after two minutes from the load removal. However, the return to the initial values after the first minute was more intense. The author also concluded that a symmetrically distributed load has a little effect on the spine-pelvis complex in the frontal plane, including right-sided scoliosis at the Th3 level. Other author's research indicates changes in body posture statics in the carrying school supplies by dragging the container with the left or right hand among students of both sexes. There are visible changes in the value of the diagnosed postural features. This is evidenced by significant differences in all features between the 1st and 2nd measurement. These changes are not gender dependent. The analysis also showed the importance of restitution of the value of features describing the body posture. The return of the changed value to its initial state after the first and the second minute was not full. This is evidenced by significant differences between the 1st and 2nd, 3rd and 4th measurements. The author showed the impact of overall physical fitness and individual motor skills on the averaged significant differences in the value of the features between the 1st and 2nd, 3rd and 4th measurement. Among boys, endurance and strength have the greatest impact when dragging a container with the right hand, and speed has a smaller effect. Force and agility, on the other hand, make no difference. Overall physical fitness has a little effect on differences in the value of the features. When dragging the container with the left hand, strength is of the greatest importance, force and agi-

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lity of less importance, and speed of very little importance. Overall physical fitness has an impact on the UK+ variable. On the other hand, among girls, in the case of dragging with the right hand, speed and force have the greatest impact, but strength has a smaller impact. Endurance, agility, and overall physical fitness do not play a role. When dragging the container with the left hand, endurance and agility are of the greatest importance. Speed, strength, force and overall physical fitness are not significant [19]. Studies by Obrębska et al. have shown that the way of carrying luggage has a visible effect on the activity of individual muscles. The symmetrically distributed load required the least muscle activity. When carrying the load, it is important to keep the load as close to the body axis as possible. Therefore, carrying a bag on one shoulder and a handbag on the forearm turned out to be the most unfavorable variants. Additionally, the trapezius muscle is more active on the same side as the load, but the latissimus dorsi muscle, erector spinae, and gluteus medius muscle, is the most active on the opposite side to the load, in most cases. Summing up, the authors conclude that the unsymmetrical load may have an unfavorable effect on the human body, especially when it happens in everyday situations, such as carrying various forms of a hand luggage. At the same time, they postulate that schoolchildren should be pointed at the negative health consequences of the prevailing trends, as it is recommended to carry a hand luggage symmetrically, and not to use bags or handbags carried over one shoulder [20]. Hsu et al. [21] showed that children carrying backpacks on one shoulder had to balance the weight of the bag by tilting their head to the opposite side. The authors state that this strategy induces a large vertical spinal torque, which may initiate scoliosis. Studies by Brackley et al. showed that carrying a backpack on the back around the lumbar spine area reduces torso flexion in the sagittal plane and the craniovertebral angle comparing to the location on the middle and upper part of the spine [22]. This is confirmed by the results of studies by other authors [23, 24, 25, 26]. The results of a randomized and controlled study by Grimmer et al. [23] showed that there was no clear-cut evidence that the 10% limit of body weight was the optimal school bag load. Palumbo et al. [27] argue that the discrepancies found may be due to the ability of the human body to adapt to less load. Further research is therefore needed to determine the appropriate load and placement of the backpack.

The dilemma, which way of carrying the mass of school supplies has a less destructive effect on the body posture, on the left or right shoulder, is basically pointless. The statistical analysis of the value of the measurements of selected posture features clearly shows that none of the methods is right for 7-year-old children. Both ways equally negatively shape the body posture, both significantly disturb its habitual stability. It should be assumed that the longer and more intensive the analyzed way of carrying is, and the greater the weight of the school supplies, the greater the negative adaptive changes are. According to the Arndt-Schultz law, the age of the surveyed students is also significant. Epigenetic factors of the student's environment will affect the ongoing posturogenesis, and each load with the mass of school supplies is an element of this environment. The exposed overall fitness as well as the impact

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of its individual features has different meaning. It is greater among boys in the case of left or right shoulder load. The demonstrated consequences of the considered ways of carrying a backpack in the form of significant changes in the body posture of a 7-year-old student result in clinical implications including the necessary prophylaxis. Considering the high incidence of multifaceted non-normative deviations, it is necessary to establish an appropriate screening test program. Early detection of symptoms of postural defects, including low-grade scoliosis, will prevent the progression of disorders, reduce back pain, and increase the effectiveness of conservative treatment [28]. Recent publications show that proper conservative treatment may reduce the frequency of invasive treatment of scoliosis [29-32].

Conclusions

1. Transporting a 4 kg weight of school supplies on the left or right shoulder equally significantly and negatively disturbs the biomechanical statics of the body of a 7-year-old child, which can cause errors in the long run, and consequently body posture defects. Therefore, this way of carrying school supplies should not be recommended to first graders.
2. Physical fitness is more important in biomechanical disorders of body posture statics in the frontal plane than in the sagittal and transversal planes, as well as among boys than girls. Endurance and strength have the most common correlations with changes in the value of body posture features, whereby speed and strength are the most important in the sagittal and transversal planes, and endurance and strength in are the most important the frontal plane.
3. Restitution of none of the analyzed value of body posture features was complete after 1 and 2 minutes after the carrying on the left and right shoulder terminated, which proves low overall fitness and immature corrective and compensatory processes.

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