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The posture of a body and the visual-motor coordination measured by Piórkowski's electrometer on the thirteen-year-old children

The visual-motor coordination is an element of time-space orientation. This skill enables proper changes of a position and movements of the whole body in space, referring to an area of activity or a moving object. It makes us being aware of the position of our own body in space and time on certain occasions. So, it allows efficacious control and regulation of the movement course in space. Its base consists of some defining functions of the central and peripheral nervous system. Among many factors that regulate the level of this motor ability, the visual stimulus plays a dominant role. This ability has also an essential role in regulations of postures. Forming this ability is an important element of posture re-education (1,3,4,5). The aim of this research was to show the connection between the posture and the visual-motor coordination. The aim of this research was to show the connection between the posture and the visual-motor coordination.

MATERIAL AND METHODS

Ninety-eight students including 46 girls and 52 boys from the Primary School No 11 in Starachowice took part in it. In this research the photogrametric method of Moiré was used. Technical development made the usage of computers in diagnostics and therapy of a faulty posture possible. Thanks to a special card and programme, the computer makes the proper analysis of a posture. It eliminates time-consuming calculations and enables precise and universal elaboration of a gained picture as well as a proper documentation of every examined person. It is worth mentioning that computer methods are exact and non-invasive. As they have close convergence with clinic and radiology researches, they can eliminate some unnecessary and harmful radiology examinations and they enable more frequent, objective control of people suffering from faulty postures.

The photogrametric method of Moiré uses the raster that makes a refraction of a light bundle. Gained picture of an examined person's back with so-called Moiré's stripes is picked up by a special optical system with a camera, and then it is passed on the analogue monitor and into the computer. Moiré's stripes are nothing else but deformed pictures made by the interference of light waves. This method is based on taking computer photos. Thanks to a special optical system the computer makes a three-dimensional picture of the person's back and exactly analyses more than fifty parameters in the frontal and sagittal planes. The final result of this programme is a collection of space coordinates (three-dimensional) of the body area and its laminar map.

Suitable software enables a precise analysis of the posture, including the anthropometer index. The computer makes a part of the analysis automatically. In this situation stripes are projected on the person's back and the regulation of the lens' sharpness of the receiver projector makes Moiré's picture, which is seen on the analogue screen. Further analysis is made without the participation of the examined person. After introducing the picture and clicking proper reference points a peculiar picture is worked out. Different options are displayed on the next screens and some of them are left for the examiner to choose. A routine analysis of the picture is done separately for every plane of the body. During this analysis presented graphic options make it easier for the operator to choose some definite reference points, particularly in some doubtful cases. Angular indexes, linear dimensions and symmetries in frontal and sagittal planes are the most often used: C7 – spinous process of the seventh cervical vertebra, KP – the top of breast kyphosis, PL – a transition of kyphosis into lordosis, LL – the top of lumbar lordosis, S1 – spinous process of the first lumbar vertebra, ŁL, ŁP – the lower angles of shoulder-blades (left, right), M1, MP – posterior superior iliac spines (left, right), T1, T2 – the left waist's line, T3, T4 – the right waist's line, B1, B2 – the left shoulder, B3, B4 – the right shoulder.

The examined person stands in a marked place, backwards to the receiver in order to be in a visual area of the camera and to make the picture visible on the computer's screen. The set should be arranged on a height that assures the vision of people of different heights. The examined line on which a patient stands is 2.5 meters away from the plane of the casing of the light projector. It is also advisable to check the proper level of the projector and set the sharpness of the stripes on the person's back.

From several pictures that are automatically registered in the memory, the examiner chooses one, which shows the patient in a suitable arrangement. On the ground of the memorized picture and introduced data of the patient the computer enables getting some three-dimensional coordinates of the examined area. At the same time it calculates the parameters which define the posture of the body in the frontal, sagittal and crosswise plane together with graphic display of the results. The time of the measurement is 0.03 seconds and it is repeated every 0.3 seconds. An average time of one examination is one minute. Thanks to this measurement we can appoint the following parameters:

1. UK – the maximum deviation of spinous process line from the line C7-S1. The computer seeks the biggest deviation of spinous process from the line connecting points C7 and S1. This distance is defined on the horizontal axis X. If the chosen process is on the right side of the line C7-S1, the result is positive. If it is on the left, the result is negative. Turning on the option of counting value causes that the result does not contain the sign.

2. KNT – an angle of a trunk bend. It defines in degrees the aberration of the line C7-S1 from the perpendicular in the frontal plane (on the right, on the left). If the point C7 is situated on the right from the point S1, the result is positive. If it gravitates to the left, the result is negative.

3. TT – the height difference of waist's triangles. The parameter is counted in the frontal plane. The result = odl1 – odlp.

4. OL – the difference of the distance of the lower scapula from the spine. Straight lines mark a sector between points of spinous process. The result = odl1 – odlp (6,7).

The examination of the visual-motor coordination on Piórkowski's test. The test was conducted by using the computer and a standard keyboard as well as a black and white screen (VGA). The test was played from a CD with the programme which works properly in Microsoft Windows. Applied tests correspond to the laboratory tests on Piorkowski's electrometer. The research shows that computer tests are closely connected to the results gained on the "original" devices (the correlation index from 0.80 to 0.95) (5).

The course of the research. Test's exercises were not accessible for training exercises. Multiple repetitions of tests in a short period of time lower their diagnostic value. Each time the programme was started from the enclosed CD disk, so only a person responsible for the research had an access to it. Test's exercises were conducted before noon. The examined people were in a state of relaxation and in good mood. The measurements were not preceded by any physical or mental effort. Bad health conditions excluded a person from the research. During the research the following conditions were made in order to give the examined people a possibility of concentration on the exercises: • not big, quiet room where there were only two people: an examined person and the researcher, • the screen was set up in a position which excluded light reflexion from different sources, • the keyboard was set up in the middle, on the bottom of the screen, • the screen was set up perpendicularly to the sight direction, 50 centimetres away from the examined person's head.

Every test was repeated twice after 3 minutes' interval. A resting break between tests lasted 5 minutes. Always the best result was recorded. The examined people were not allowed to watch other people's measurements. The researcher did all activities connected with the service of the programme. The activities of the examined person were connected only with pressing any key after seeing the "start" signal and doing the test.

The description of Piórkowski's test:

a) the active keys were in a row: 1,2,3,4,5,6,7,8,9,0 on the keyboard. The keys were specifically marked: on the black background covering the whole area of the keys there were white digits which were as big as 80% of the key's height. The digits were analogical to the original numbers on the keyboard with a small exception – the key with "0" was marked "10". The rest of the keyboard was covered with a white cardboard.

b) when the "star" appeared on the screen, the examined person had to press as fast as possible a key which corresponded to its position. The right key was the one which had the same number as the number above which the "star" was displayed. During the test the keys were pressed by the index finger of one, more skilful hand. The faster the test was done, the better the result was.

c) the person who was conducting the research at the beginning showed the task and did the "sample test" and then he gave the instruction and explained the task. The examined person did the "sample" test first and next he/she did the proper one. Before the second trial all explanations as well as the "sample" test were omitted.

d) the examined person set his/her hand above the keyboard, so that it did not have a support on the desk. The index finger was pushed out in the direction of the keys with number "5" and "6", the remaining fingers were closed.

e) the signals were shown in a constant sequence. The programme counted the time from the moment when the first signal appeared to the moment when after the last signal a proper key was pressed. The result was rounded off with the precision to one second.

f) after finishing the trail, the time of the test, the number of the mistakes and the number of incorrect reactions (pressing the key which did not relate to the signal on the screen) were given.

g) in order to make the result honest and reliable the researcher used 80 impulses at one trial and the number of the mistakes could not be bigger than 4 (5).

RESULTS

In the research the following things were put into consideration: the body mass, the height, the length of the whole spine, the angle of a trunk inclination, the angle α, the angle β, the angle γ, the angle δ, the length of breast kyphosis, RKP, the depth of breast kyphosis, the length of lumbar lordosis, the angle of breast lordosis, RLL, the depth of lumbar lordosis, the asymmetry of shoulders, the line of shoulders, the asymmetry of lower angles of scapulas, the angle of pelvis inclination, the angle of pelvis twisting, the asymmetry of waist's triangles, the length of the primary curvature, the depth of the primary curvature, the angle of the primary curvature, the length of the secondary curvature, the depth of the secondary curvature, the angle of the secondary curvature (in millimetres) (Table 1 and 2).

The statistic analysis does not show any important differences between boys and girls in the postures of the body, for the posture index d= -0.05 (Table 1). Further analysis does not show any essential differences between boys and girls in the postures of the body. In the visual-motor coordination girls got a bit better results than boys: girls 92.83 s, boys 93.13s (Table 2). In the examined group the posture KI were dominant – there were 58 of them including 25 at girls and 33 at boys. Besides, there were three postures of the RII type at one girl and at two boys, and twenty lordotic types including one type of Lordotic 1 at girls and three at boys, and one type of lordotic 2 at one girl and at five boys. There were also five flat backs at eight girls and nine boys (Table 3).

Table 1. The features of build and posture

Examined features	Girls		Boys		d
	-X	SD	-X	SD	
Body mass	44.30	7.84	45.29	9.55	-1.01
Height	1560	73.36	1566	78.95	-0.6
Angle of the trunk inclination	5.80	2.41	5.51	2.46	-0.29
Angle α	20.04	3.74	18.55	4.19	1.49
Angle β	7.36	3.80	7.64	3.90	-0.28
Angle γ	16.84	3.89	17.42	4.02	-0.58
Angle δ	44.30	6.84	43.63	6.67	0.67
Asymmetry of shoulders	7.67	5.49	7.61	5.12	0.06
Angle of the shoulders line	1.47	1.02	1.50	1.07	-0.03
Asymmetry of scapulas	5.52	5.45	5.97	5.46	-0.45
The angle of pelvis inclination	1.71	1.40	1.68	1.49	0.03
The angle of pelvis twisting	3.93	2.76	4.26	3.16	-0.33
Posture index	10.23	2.45	10.28	2.16	-0.05

Table 2. The features of posture and build and the visual-motor coordination

Examined features	Girls		Boys		d
	-X	SD	-X	SD	
Length of the whole spine	428.71	30.42	425.10	31.36	3.61
Length of breast kyphosis	328.32	35.23	329.56	31.47	-1.24
Angle of breast kyphosis	155.78	5.41	154.94	5.44	0.84
RKP	223.63	25.24	224.71	23.23	-1.08
Depth of breast kyphosis	9.80	5.67	10.76	6.12	-0.96
Length of lumbar lordosis	313.06	26.64	306.72	27.59	6.34
Angle of lumber lordosis	152.83	4.72	153.97	5.02	-1.14
RLL	205.02	19.03	200.33	21.39	4.69
Depth of lumber lordosis	18.26	9.32	17.10	8.64	1.16
Length of the primary curvature	289.48	76.45	277.12	73.87	12.36
Depth of the primary curvature	4.74	2.47	4.75	2.80	-0.01
Angle of the primary curvature	7.73	4.14	7.88	4.77	-0,15
Piórkowski's test	92.83	11.75	93.13	11.50	-0.3

Table 3. Types of postures

Type of posture	Girls	Boys
Kyphotic I	25	33
Kyphotic II	0	0
Kyphotic III	0	0
Balanced I	0	0
Balanced II	1	2
Balanced III	0	0
Lordotic I	1	3
Lordotic II	11	5
Lordotic III	0	0
Flat back	8	9

Table 4. The correlation index between the features of build and posture, and the visual-motor coordination

The features of build and posture	Girls	Boys
	r	r
Mass of body	0.02	-0.008
Height of body	0.10	-0.24
Length of all-out backbone	-0.30	0.12
Corner α	-0.13	0.02
Corner β	0.38**	-0.08
Corner γ	-0.09	0.38**
Corner δ	0.09	0.20
Asymmetry of shoulder	0.10	0.15
Corner of line of shoulder	0.06	0.05
Asymmetry scapule	0.14	0.18
Corner of inclination	0.22	-0.20
Corner of twisting	0.10	0.08
Index of posture	0.48***	0.58***

$p < 0.05$*, $p < 0.01$**, $p < 0.001$***

The analysis of the correlation indexes between the features of build and posture and the visual-motor coordination shows that as far as the girls are concerned there is some dependence among the posture index (r=0.48), the angle β (r=0.38). As far as boys are concerned this dependence appears among the posture index (r=0.58), the angle γ (r=0.38) (Table 4). Further analysis of the correlation index between the features of build and posture and the visual-motor coordination shows that as far as the girls are concerned there is some dependence among RKP (r=0.29), the depth of breast kyphosis (r=0.38). As far as the boys are concerned this dependence appears between the angle of the primary curvature (r=0.27) (Table 5).

Table 5. The correlation index between the features of build and posture, and the visual-motor coordination

Examined features	Girls	Boys
	r	r
Length of the whole spine	0.07	-0.16
Length of breast kyphosis	0.16	-0.02
Angle of breast kyphosis	-0.22	-0.22
RKP	0.29*	-0.12
Depth of breast kyphosis	0.38**	-0.08
Length of lumbar lordosis	-0.24	-0.03
Angle of lumbar lordosis	-0.11	0.04
RLL	-0.26	-0.12
Depth of lumbar lordosis	0.26	-0.08
Length of the primary curvature	0.13	-0.05
Depth of the primary curvature	0.17	0.26
Angle of the primary curvature	0.06	0.27*

$p< 0.05$*, $p< 0.01$**

DISCUSSION

Some authors claim that in the posture re-education morphological factors are the most important, while others think that neurophysiological, environmental and will-emotional factors play the most essential part (8). It seems obvious that it is right to look at the discussed problem through the prism of multi-system posture control in the statistic as well as dynamic conditions, and to pay attention to forming and stabilising a habit of correct posture (6). Practical realization of this process is still quite unclear and it requires further researches. In the selection of corrective methods four basic factors need to be taken into consideration: neurophysiological, morphological, environmental and will-emotional. All presented results show that there is some essential connection between the visual-motor coordination and the body posture. There is a great need for some exercises improving the visual-motor coordination in posture re-education.

CONCLUSIONS

1. There is some dependence between the quality of the body posture and the visual-motor coordination as far as girls as well as boys are concerned.
2. There are no essential differences in the body posture and the visual-motor coordination between boys and girls.
3. There is a great need for some exercises improving the visual-motor coordination in posture re-education.

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SUMMARY

The visual-motor coordination is an element of time-space orientation. This skill enables proper changes of a position and movements of the whole body in space, referring to an area of activity or a moving object. It makes us becoming aware of the position of our own body in space and in time on some certain occasions. So, it allows efficacious control and regulation of the movement course in space. Its base consists of some defining functions of the central and peripheral nervous system. Among many factors that regulate the level of this motor ability, the visual stimulus plays a dominant role. This ability has also an essential role in regulations of postures. Forming this ability is an important element of posture re-education. The aim of this research was to show the connection between the posture and the visual-motor coordination. Ninety-eight students including 46 girls and 52 boys from the Primary School No 11 in Starachowice took part in it. In this research the photogrametric method was used. In this method, thanks to a special card and programme, the computer makes the proper analysis of a posture. The visual-motor coordination was tested by using the computer and a standard keyboard as well as a black and white screen (VGA). Tests were played from a CD with the programme on it. Offered tests correspond to the laboratory tests on Piórkowski's electrometer. The tests clearly show that there is some dependence between the quality of the posture and the visual-motor coordination in the examined boys as well as girls. That is why there is a great need for extending corrective exercises by introducing some activities improving the examined ability.

Postawa ciała a koordynacja wzrokowo-ruchowa mierzona testem Piórkowskiego u dzieci 13-letnich

Koordynacja wzrokowo-ruchowa jest elementem orientacji czasowo-przestrzennej. Zdolność ta umożliwia odpowiednie zmiany położenia oraz ruch całego ciała w przestrzeni w odniesieniu do pola działania lub poruszającego się obiektu. Pozwala na uświadamianie położenia własnego ciała w przestrzeni i czasie w danych okolicznościach. Umożliwia skuteczne sterowanie i regulację przebiegu ruchu w przestrzeni. Jej podłożem są określone funkcje centralnego i obwodowego UN. Dominujące znaczenie wśród informacji warunkujących poziom tej zdolności motorycznej przypada bodźcom wzrokowym. Zdolność ta odgrywa także istotną rolę w regulacji postaw ciała. Kształtowanie tej zdolności jest ważnym elementem reedukacji posturalnej. Celem badań było wykazanie związku między postawą ciała a koordynacją wzrokowo-ruchową. Badaniami objętych zostało 98 uczniów, w tym 46 dziewcząt oraz 52 chłopców ze Szkoły Podstawowej Nr 11 w Stara-

chowicach. W badaniach postawy ciała zastosowano metodę fotogrametryczną, w której dzięki odpowiedniej karcie i programowi komputer dokonuje właściwej analizy postawy. Koordynację wzrokowo-ruchową testowano z zastosowaniem komputera i użyciem standardowej klawiatury oraz czarno-białego monitora (VGA). Testy odtwarzano z płyty z programem. Proponowane testy odpowiadają laboratoryjnym próbom na elektrometrze Piórkowskiego. Istnieje wyraźna zależność między jakością postawy ciała a koordynacją wzrokowo-ruchową zarówno u badanych dziewcząt, jak i chłopców. Istnieje potrzeba szerszego wprowadzenia do programów gimnastyki korekcyjnej ćwiczeń doskonalących badaną zdolność.