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THE CONNECTIONS BETWEEN POSTURAL REACTIONS, SCOLIOSIS POSTURES AND SCOLIOSIS IN GIRLS AGED 12-15 YEARS OLD EXAMINED USING THE SPEARMAN'S RANK ORDERCORRELATION

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ABSTRACT

The aim of the research was to analyse the Spearman's Rank Order Correlation between the postural reactions, scoliosis postures and scoliosis in girls aged 12-15 years old. Throughout the whole group of girls, positive correlations between attitude parameters in the frontal plane and the postural reactions were observed: The angle of primary curvature/anteroposterior speed with which eyes closed, angle of primary curvature /average speed with which eyes closed, angle of primary curvature /path length eyes closed, absolute value shoulders angle line/mean loading point X eyes closed, absolute value pelvic inclination angle/lateral speed eyes closed. Negative correlations occurred in cases: absolute value angle of secondary curvature/ mean loading point X eyes open, depth of secondary curvature/mean loading point X eyes open, length of secondary curvature/mean loading point X eyes open, angle of secondary curvature/mean loading point X eyes closed. Statistically significant correlations occurred more frequent when the Romberg's test was held with eyes closed (CE): angle of primary curvature/anteroposterior speed, torso inclination angle/mean loading point X, angle of primary curvature/average speed, angle of primary curvature/path length, absolute value shoulders angle line/mean loading point X, absolute value pelvic inclination angle/ lateral speed, angle of secondary curvature/mean loading point Y. Among the correlations with eyes closed six were positive: angle of primary curvature/ anteroposterior speed, torso inclination angle/mean loading point X, angle of primary curvature/ average speed, angle of primary curvature/ path length, absolute value shoulders angle line/mean loading point X, absolute value pelvic inclination angle/lateral speed, and one was negative: angle of secondary curvature/ mean loading point Y. Among the correlations with eyes open (OE) only three negative correlations occurred: absolute value angle of secondary curvature/mean loading point X, depth of secondary curvature/ mean loading point X, length of secondary curvature/mean loading point X.
Key words: postural reactions, scoliosis postures, scoliosis, Spearman's Rank Order Correlations.

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INTRODUCTION

In postural scoliosis, especially in scoliosis, there are discrete neurological changes [1-18]. According to postural reactions, is it possible to say something about the etiology of scoliosis postures and scoliosis? The aim of the research was to analyse the Spearman's Rank Order Correlation between the postural reactions, scoliosis postures and scoliosis in girls aged 12-15 years.

MATERIAL AND METHODS

The study included 247 girls aged 12-15 years of age from Primary School No. 13 and School No. 4 in Starachowice. The research was conducted in November 2005. There were 60 12-year-old girls (24,29%), 60 13-year-old (24,29%), 65 14-year-old (26,32%), and 62 15-year-old girls (25,10%). There was a random selection of respondents. The studies of posture included the spatial photogrammetric technique, which applied the moiré projection effect [19,20,21]. This method consists of using a refracted light beam, where the raster is necessary.

The resulting image of the back of the examined person is received by the optical system with a camera, and then transmitted to an analog monitor and computer. With the appropriate card and program, the computer performs a proper analysis of the posture. The measuring station consisted of a computer with a Frame Grabber card installed, together with a monitor and printer, and projection-receiving device with a CCD/f=8mm camera and analog monitor.

On the back of the examined person, the following anthropometric points were marked with a marker: spinous processes from C7 to S1, acromions, inferior angles of the scapulas and posterior superior iliac spines. Then the body posture was evaluated by a visual method, after which the tested person remained in their habitual posture in a designated place, with their back to the projection-receiving device at distance of 3,2 m.

Tab. 1.

Posture parameters in the frontal plane.

Posture parameters	Full parameter name	Description of the method determining a parameter
APC	The angle of primary curvature	The angle between the tangent of the curve at both ends of primary bending
LPC	The length of primary curvature	The distance between the points of primary inflection
DPC	The depth of primary curvature	The maximum transverse distance of the spine line from the straight line joining the ends of primary arc
ASC	The angle of secondary curvature	The angle between the tangents of the curve at both ends of secondary deflection
LSC	The length of secondary curvature	The distance between the points of secondary inflection
DSC	The depth of secondary curvature	The maximum transverse distance of the spine line from the straight line joining the ends of secondary arc
SARA	Shoulders asymmetry – right above [mm]	The difference in shoulder height (right above)
SALA	Shoulders asymmetry – left above [mm]	The difference in shoulder height (left above)
SAL	Shoulders angle line [°]	Lowering the left shoulder (value -) Lowering the right shoulder (value +)
SCAR	Scapula asymmetry – right above [mm]	The height difference of vertex angle of the scapulas (right above)
SCAL	Scapula asymmetry – left above [mm]	The height difference of vertex angle of the scapulas (left above)
PIA	Pelvic inclination angle [°]	Lowering the left side of the pelvis (value -) Lowering the right side of the pelvis (value +)
PTA	Pelvic turning angle [°]	Turning of the pelvis clockwise (value +) Turning of the pelvis counterclockwise (value -)
CASP	Coefficient of asymmetry shoulder – pelvis [%]	The percentage ratio distance left shoulder - right point of the pelvis to the distance of right shoulder – left point of the pelvis
CASK	Coefficient of asymmetry shoulder – KK [%]	The percentage ratio distance of left and right shoulder from point KK
CASC	Coefficient of asymmetry shoulder – C_7 [%]	The percentage ratio distance of left and right shoulder from point C_7
TIA	Torso inclination angle	The angle between the vertical line and a straight- C_7 KK> 0 right

To prevent distortions, the measuring device was adjusted so that the projector lenses were aligned with the the middle of the body. Stripes were projected on to the back of the examined person, and a calibration of the projector lens allowed the obtainment of a moiré effect type image on the monitor screen.

The measurement and sharpness setting of the image was performed by an automatically controlled projection-receiving device. Further analysis took place without the participation of the examined person. After entering the picture, and pointing the mouse on the main reference points, the proper elaboration was followed.

On the screens there were presented various options, some of which were selected by a researcher. Image analysis was performed separately for each plane of the body. Different graphic options presented during the analysis, facilitated the selection of certain reference points, especially in doubtful cases.

The device allowed an analytical assessment of attitudes in three planes of motion to be made: sagittal, frontal and transverse, specifying precise irregularities occurring within each of these planes. For this purpose, various parameters were established such as length, depth and angular. Each selected segment of the spine was measured in this manner, and appropriate indicators reflecting the intersegmental relations calculated.

Measurements of the following plane parameters also gave information about the spatial location of the entire spine and its various sections. The computer produced a 3-D image of the back and analyzed 45 parameters (table 1) [21].

For the equivalent reactions test, the Cosmogamma platform by Emildue R 50300 was used (figure 2). The test was taken as a standard free standing Romberg's test. It consisted of two 30-second consecutive trials: first with opened eyes (OE - open eyes), and the second with eyes closed (CE - close eyes).

Measurements were taken in the morning. Each examined person was thoroughly instructed about the test run. The examination was carried out in total silence as auditory stimuli, acting on the human in terms of attention, can significantly interfere the postural reflexes. The individual undergoing the tests was reassured as to the harmlessness nature of the performed examination.

During the test, the researcher was positioned behind the examined person all the time, and did not communicate with them. During the measurements with opened eyes (OE), the tested person was asked to fixate her sight on a reference point located on the computer screen. The center of macular vision was located at a distance of 1 meter from the person undergoing examination.

Before starting the eyes closed (CE) test, the researcher made sure that the examined person is able to maintain an upright posture without visual control. The observed person stood on a platform barefoot as shoes can interfere with their attitude. The feet were positioned with a careful accuracy: heels 2 cm apart, feet set at an angle of 30°, so that the center of mass of a polygon base (O) lied in the sagittal axis of the platform at a distance of 4 cm from the center (C).

The point of intersection of the vertical and horizontal axes corresponding to the position of the ankles, was concurring with the center of the platform (C), indicated on the screen as a static-dynamic diagram. In order to facilitate the correct positioning of the tested person, the platform was equipped with a spacing feet pattern. The tested person received and maintained the position with arms at her sides and head upright.

The investigator checked the coordinates COP on the monitor, and then, after their stabilisation, determined the most appropriate sensitivity scale. The test started when the examined person adopted a stable posture, and on the screen the inclination of a line in the center of feet exerting pressure on the mat was displayed.

To describe the postural reactions, the following terms were used: path length which is the route traveled by the COP in both planes during oscillation (mm); mean loading point X provides lateral coordinates X (mm); mean loading point Y gives anteroposterior coordinates Y (mm); lateral speed which gives the average rate of oscillation along the X axis (mm/s); anteroposterior speed provides the average speed of COP along the Y axis (mm/s); average speed which is the standard oscillation rate of the COP along the X and Y axes (mm/s); mean sway X gives the average distance between the extreme inclination of the center of feet exerting pressure in the lateral plane along the X axis (mm); mean sway Y gives the average distance between the extreme inclination of the center of feet exerting pressure in the sagittal plane along the Y axis (mm) [22,23,24].

Arithmetic means (x) and standard deviations (s) were used for statistical analysis. The distributions of a variables were analyzed by the Liliefors test. Postural reactions were verified in terms of normality by the Kolmogorov-Smirnov test. If the distribution of the sample were significantly different from the normal, to determine the correlation of two features, the non-parametric Spearman's Correlation test was used. The level of significance was $p < 0.05$ [25,26,27].

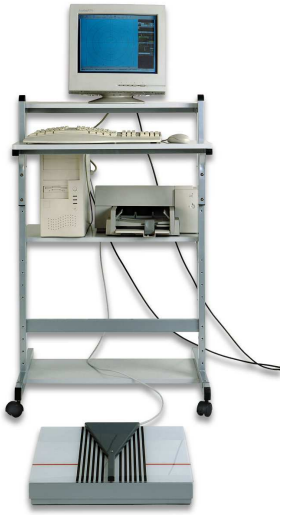

Fig. 2. Cosmogamma platform by Emildue R 50300 [23].

RESULTS

Girls average body height was 161,45 cm, average weight 50,84 kg, average BMI 19,43. Distributions in the age groups didn't differ significantly (table 2).

Tab. 2.

Height, weight and BMI of the subjects.

Age	Body hight		Body mass		BMI	
	x	s	x	s	x	s
Total	161,45	7,35	50,84	9,04	19,43	2,78
12	156,33	7,73	47,28	9,96	19,22	3,12
13	159,98	5,54	49,30	7,91	19,23	2,70
14	163,72	6,55	52,42	8,67	19,51	2,81
15	165,45	5,97	54,13	8,14	19,74	2,49

In the study group of girls, positive correlations (proportionally) between attitude parameters in the frontal plane and postural reactions occurred in the case of: APC/PP (CE), (R= 0,162), (p= 0,01019), APC/GP (CE), (R= 0,135), (p= 0,03444), APC/PL (CE), (R= 0,134), (p= 0,03529), ABSSAL/MLPX (CE), (R= 0,130), (p= 0,04060), ABSPIA/LS (CE), (R= 0,128), (p= 0,04500).

In the whole group of girls' negative correlations occurred in the cases of: ABS ASC/MLPX (OE) (R= -0,160) (p= 0,01019), DSC/MLPX (OE), (R= -0,161), (p= 0,01110), LSC/MLPX (OE) (R= 0,162), (p= 0,01162), ASC/MLPY (CE) (R= -0,128), (p= 0,04474) (table 3).

Tab. 3.

Correlations between posture parameters in the frontal plane and postural reactions in all girls with eyes open (OE) and closed eyes (CE).

Correlated parameters	Importance of N	R Spearman	t (N-2)	Level p
ABSASC/MLPX (OE)	247	-0,163	-2,590	0,01019
APC/LS (CE)	247	0,162	2,572	0,01071
DSC/MLPX (OE)	247	-0,161	-2,559	0,01110
LSC/MLPX _(OE)	247	-0,160	-2,542	0,01162
TIA/MLPX (CE)	247	0,151	2,384	0,01790
APC/AS (CE)	247	0,135	2,127	0,03444
APC/PL (CE)	247	0,134	2,117	0,03529
ABS SAL/MLPX (CE)	247	0,130	2,058	0,04060
TIA/MLPX CE)	247	-0,130	-2,047	0,04174
ASC/MLPY (CE)	247	-0,128	-2,017	0,04474
ABS PIA/LS (CE)	247	0,128	2,015	0,04500

In the group of girls aged 12 years all correlations were positive (proportionally): ABSPTA/LS (CE), (R= 0,336), (p= 0,01438), ABSPTA/AS (CE), (R= 0,315), (p= 0,01432), ABSPTA/PL (CE), (R= 0,315) (p= 0,01438), LPC/MLPX (CE), (R= 0,313), (p=0,01481), ABSASC/ MLPY (OE) (R= 0,307) (p= 0,01686), PTA/AS (CE) (R= 0,294) (p= 0,02269), ABSAPC/LS (OE) (R= 0,286) (p= 0,02668), CASC/MLPX (OE) (R= 0,273) (p= 0,03508), DPC/LS (OE) (R= 0,269) (p= 0,03780), PTA/AS (CE) (R= 0,262) (p= 0,04315), PTA/PL (CE) (R= 0,262) (p= 0,04328), DSC/ MLPY (CE) (R= 0,261) (p= 0,04416) (table 4).

Tab. 4.

Correlations between posture parameters in the frontal plane and postural reactions in girls aged 12 years with eyes open (OE) and closed (CE).

Correlated parameters	Importance of N	R Spearman	t (N-2)	Level p
ABS PTA/AS (CE)	60	0,336	2,713	0,00877
ABS PTA/AS (CE)	60	0,315	2,525	0,01432
ABS PTA/PL (CE)	60	0,315	2,523	0,01438
LPC/ MLPX (CE)	60	0,313	2,512	0,01481
ABS ASC/MLPY (OE)	60	0,307	2,461	0,01686
PTA/AS (CE)	60	0,294	2,341	0,02269
ABSAPC/LS (OE)	60	0,286	2,274	0,02668
CASC/MLPX (OE)	60	0,273	2,158	0,03508
DPC/LS (OE)	60	0,269	2,126	0,03780
PTA/AS (CE)	60	0,262	2,068	0,04315
PTA/PL (CE)	60	0,262	2,066	0,04328
DSC/MLPY (CE)	60	0,261	2,057	0,04416

In the group of girls aged 13 years, positive correlations (proportionally) occurred in cases: LSC/LS (OE), (R= 0,267), (p=0,03925), ABSPIA/AS (CE), (R=0,264), (p= 0,04131), TIA/AS (OE), (R= 0,306), (p= 0,01742), TIA/PL (OE), (R= 0,283), (p= 0,02816), TIA/AS (OE), (R= 0,282), (p= 0,02889).

There was only one negative correlation (inversely proportional) in the case of LSC/MLPX (OE), (R= -0,313), (p= 0,00334) (table 5).

Tab. 5.

Correlations between posture parameters in the frontal plane and postural reactions in girls aged 13 years with eyes open (OE) and closed (CE).

Correlated parameters	Importance of N	R Spearman	t (N-2)	Level p
LSC/LS (OE)	60	0,267	2,109	0,03925
ABS PIA/LS (CE)	60	0,264	2,087	0,04131
TIA/AS (OE)	60	0,306	2,448	0,01742
TIA/PL (OE)	60	0,283	2,251	0,02816
TIA/AS (OE)	60	0,282	2,241	0,02889
LSC/MLPX (OE)	60	-0,373	-3,061	0,00334

In the group of girls aged 14 years, positive correlations (proportionally) occurred in cases: CASC/LS (CE), (R= 0,339), (p= 0,00576), CASC/PL (CE), (R= 0,322), (p= 0,00890), CASC/AS (CE), (R= 0,321), (p= 0,00918), ABSSAL/MLPX (OE) (R= 0,301), (p= 0,01495), APC/MLPY (CE) (R= 0,294), (p= 0,01736), SARA/AS (CE) (R= 0,259), (p= 0,03733), ABSSAL/MLPX (CE) (R= 0,254), (p= 0,04100). Negative correlations (inversely proportional) in this age group occurred in cases: ABSPIA/MLPY (CE), (R= -0,348), (p= 0,00454), ABSPIA/MLPY (OE), (R= -0,344), (p= 0,00498), DSC/MLPX (OE), (R= -0,261), (p= 0,03574), LSC/MLPX (OE), (R= -0,254), (p= 0,04100), ASC/MLPY (CE), (R= -0,249), (p= 0,04580), ABSASC/MLPX (OE), (R= -0,248), (p= 0,04607), TIA/AS (OE), (R= -0,245), (p= 0,04924) (table 6).

Tab. 6.

Correlations between posture parameters in the frontal plane and postural reactions in girls aged 14 years with eyes open (OE) and closed (CE).

Correlated parameters	Importance of N	R Spearman	t (N-2)	Level p
ABS PIA /MLPY (CE)	65	-0,348	-2,943	0,00454
ABS PIA/MLPY (OE)	65	-0,344	-2,910	0,00498
CASC/LS (CE)	65	0,339	2,859	0,00576
CASC/PL (CE)	65	0,322	2,700	0,00890
CASC/AS (CE)	65	0,321	2,688	0,00918
ABS SAL/MLPX (OE)	65	0,301	2,502	0,01495
APC/MLPY (CE)	65	0,294	2,443	0,01736
DSC/MLPX (OE)	65	-0,261	-2,146	0,03574
SARA/AL (CE)	65	0,259	2,127	0,03733
LSC/MLPX (OE)	65	-0,254	-2,086	0,04100
ABS SAL/MLPX (CE)	65	0,254	2,086	0,04100
ASC/ MLPY (CE)	65	-0,249	-2,038	0,04580
ABS ASC/MLPX (OE)	65	-0,248	-2,035	0,04607
TIA/AS (OE)	65	-0,245	-2,005	0,04924

In the group of girls aged 15 years, positive correlations (proportionally) occurred in cases: APC/AS (CE), (R=0,270), (p=0,03349), APC/AS (CE), (R= 0,270), (p=0,03349), ABSAPC/AS (CE), (R= 0,264), (p= 0,03782), APC/AS (CE), (R=0,260), (p=0,04116), APC/PL (CE), (R=0,260), (p=0,04165), ABSAPC/PL (CE), (R= 0,259), (p= 0,04249), ABSAPC/AS (CE), (R= 0,258), (p= 0,04281) (table 7). There was only one negative correlation (inversely proportional), this being in the CASC/MLPY (OE) parameter, (R= -0,258), (p= 0,04284) (table 7).

Tab. 7.

Correlations between posture parameters in the frontal plane and postural reactions in girls aged 15 years with eyes open (OE) and closed (CE).

Correlated parameters	Importance of N	R Spearman	t (N-2)	Level p
APC/AS (CE)	62	0,270	2,176	0,03349
ABS APC/AS(CE)	62	0,264	2,124	0,03782
APC/AS(CE)	62	0,260	2,087	0,04116
APC/PL (CE)	62	0,260	2,082	0,04165
ABS APC/PL (CE)	62	0,259	2,073	0,04249
ABS APC/AS (CE)	62	0,258	2,070	0,04281
CASK/ MLPY (OE)	62	-0,258	-2,069	0,04284

DISCUSSION

The Spearman's rank correlation is one of the non-parametric monotonic measurements of the statistical dependence between random variables. It always accepts the value range (from -1 to +1). Their interpretation is similar to the classic coefficient Pearson's correlation [27].

Throughout the whole group of girls, positive correlations (proportionally) between the attitude parameters in frontal plane and postural reactions occurred in cases: APC/AS (CE), (R= 0,162), (p= 0,01019), APC/AS (CE), (R= 0,135), (p= 0,03444), APC/PL (CE), (R= 0,134), (p= 0,03529), ABSSAL/MLPX (CE), (R= 0,130), (p= 0,04060), ABSPIA/LS (CE), (R= 0,128), (p= 0,04500). Throughout the whole group of girls, negative correlations occurred in cases: ABS ASC/MLPX (OE) (R= -0,160) (p= 0,01019), DSC/MLPX (OE), (R= -0,161), (p= 0,01110), LS /MLPX (OE) (R= 0,162), (p= 0,01162), ASC/MLPX (CE) (R= -0,128), (p= 0,04474) (table 3).

In the group of girls aged 12, all correlations were positive (proportionally) occurred in cases: ABSAPC/AS (CE), (R= 0,336), (p= 0,01438), ABSPTA/AS (CE), (R= 0,315), (p= 0,01432), ABSPTA/PL (CE), (R= 0,315) (p= 0,01438), LPC/MLPX (CE), (R= 0,313), (0,01481), ABSASC/MLPY (OE) (R= 0,307) (p= 0,01686), PTA/AS (CE) (R= 0,294) (p= 0,02269), ABSAPC/LS (OE) (R= 0,286) (p= 0,02668), CASC/MLPX (OE) (R= 0,273) (p= 0,03508), DPC/LS (OE) (R= 0,269) (p= 0,03780), PTA/AS (CE) (R= 0,262) (p= 0,04315), PTA/PL (CE) (R= 0,262) (p= 0,04328), DSC/MLPY (CE) (R= 0,261) (p= 0,04416) (table 4).

In the group of girls aged 13, correlations were positive (proportionally) in cases: LSC/LS (OE), (R= 0,267), (p= 0,03925), ABSPIA/AS (CE), (R= 0,264), (p= 0,04131), TIA/AS (OE), (R= 0,306), (p= 0,01 742), TIA/PL (OE), (R= 0,283), (p= 0,02816), TIA/AS (OE), (R= 0,282), (p= 0,02889). Only one correlation (inversely proportional) was negative: LSC/MLPX (OE), (R= -0,313), (p= 0,00334) (table 5).

In the group of girls aged 14, positive correlations (proportionally) occurred in cases: CASC/LS (CE), (R= 0,339), (p= 0,00576), CASC/PL (CE), (R= 0,322), (p= 0,00890), CASC/AS (CE), (R= 0,321), (p= 0,00918), ABSSAL/MLPX (OE) (R= 0,301), (p= 0,01495), APC/MLPY (CE) (R= 0,294), (p= 0,01736), SARA/AS (CE) (R= 0,259), (p= 0,03733), ABSSAL/MLPX (CE) (R= 0,254), (p= 0,04100).

Negative correlations (inversely proportional) in this age group occurred in the cases: ABSPIA/ MLPY (CE), (R= -0,348), (p= 0,00454), ABSPIA/MLPY (OE), (R= -0,344), (p= 0,00498), DSC/MLPX (OE), (R= -0,261), (p= 0,03574), LSC/MLPX (OE), (R= -0,254), (p= 0,04100), ASC/MLPY (CE), (R= -0,249), (p= 0,04580), ABSASC/MLPX (OE), (R= -0,248), (p= 0,04607), TIA/AS (OE), (R= -0,245), (p= 0,04924) (table 6).

In the group of girls aged 15, positive correlations (proportionally) occurred in cases: APC/AS (CE), (R=0,270), (p=0,03349), APC/AS (CE), (R= 0,270), (p=0,03349), ABSAPC/AS (CE), (R= 0,264), (p= 0,03782), APC/AS (CE), (R=0,260), (p=0,04116), APC/PL (CE), (R=0,260), (p=0,04165), ABSAPC/ PL (CE), (R= 0,259), (p= 0,04249), ABSAPC/AS (CE), (R= 0,258), (p= 0,04281) (table 7).

There was one negative correlation (inversely proportional): CASK/ MLPY (OE), (R= -0,258), (p= 0,04284) (table 7).

In the whole group of girls statistically significant correlations were more frequent when the Romberg's test was held with the eyes closed (CE): APC/AS (CE), (R= 0,162), (p= 0,01071), TIA/MLPX (CE) (R= 0, 0,151), (p= 0,01790), APC/AS (CE), (R= 0,135), (p= 0,03444), APC/PL (CE), (R= 0,134), (p= 0,03529), ABSSAL/MLPX (CE), (R= 0,130), (p= 0,04060), ABSPIA/LS (CE), (R= 0,128), (p= 0,04500), ASC/MLPY (CE) (R= -

0,128), (p= 0,04474). Among the correlations with closed eyes (CE) six were positive (proportionally): APC/AS (CE), (R= 0,162), (p= 0,01019), TIA/MLPX (CE) (R= 0, 0,151), (p= 0,01790), APC/AS (CE), (R= 0,135), (p= 0,03444), APC/PL (CE), (R= 0,134), (p= 0,03529), ABSSAL/MLPX (CE), (R= 0,130), (p= 0,04060), ABSPIA/LS (CE), (R= 0,128), (p= 0,04500) and one negative: ASC/MLPY (CE) (R= -0,128), (p= 0,04474).

Among the correlations with eyes open (OE) three correlations were negative: ABS ASC/MLPX (OE) (R= -0,163) (p= 0,01019), DSC/MLPX (OE), (R= -0,161), (p= 0,01110), LSC/MLPX (OE) (R= 0,162), (p= 0,01162) (table 3).

CONCLUSIONS

- In the whole group of girls, positive correlations between attitude parameters in frontal plane and the postural reactions occurred in the following cases: angle of primary curvature/anteroposterior speed eyes closed, angle of primary curvature /average speed eyes closed, angle of primary curvature /path length eyes closed, absolute value shoulders angle line/mean loading point X eyes closed, absolute value pelvic inclination angle/lateral speed eyes closed. Negative correlations occurred in the following cases: absolute value angle of secondary curvature/ mean loading point X eyes open, depth of secondary curvature/mean loading point X eyes open, length of secondary curvature/mean loading point X eyes open, angle of secondary curvature/mean loading point X eyes closed.
- Statistically significant correlations occurred more frequent when the Romberg's test was held with eyes closed (CE): angle of primary curvature/anteroposterior speed, torso inclination angle/mean loading point X, angle of primary curvature/average speed, angle of primary curvature/path length, absolute value shoulders angle line/mean loading point X, absolute value pelvic inclination angle/lateral speed, angle of secondary curvature/mean loading point Y.
- Among the correlations with eyes closed, six were positive: angle of primary curvature/ anteroposterior speed, torso inclination angle/mean loading point X, angle of primary curvature/average speed, angle of primary curvature/path length, absolute value shoulders angle line/mean loading point X, absolute value pelvic inclination angle/lateral speed, and one was negative: angle of secondary curvature/mean loading point Y.
- Among the correlations with eyes open only three negative correlations occurred: absolute value angle of secondary curvature/mean loading point X, depth of secondary curvature/mean loading point X, length of secondary curvature/mean loading point X.

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