BALANCE AND SYMMETRY OF LOAD IN LOWER LIMBS AMONG MALE AND FEMALE POPULATION AT SCHOOL AGE CATEGORY

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- balance,
- symmetry,
- stabile graph,
- load on lower limb,
- deuce.

Abstract:
The importance of research with stabile graph is connected with problem of not objective assessment of functional man's asymmetry, that has a very important cognitive meaning. Asymmetry of stabilization activity features in one of lower limb probably is the cause of unbalanced load - supporting asymmetry. In functional asymmetry there is important difference muscle strength and range of motion in the joints and morph-dynamic ontogenetic development between girls and boys. Obtained results in the course of the study have made it possible to assess balance and load of right and left lower limb, based on stability graphic's measurements with eyes control and out of eyes control among girls and boys. There were not statistically significant differences between girls and boys at school age in balance of right and left lower limb with eyes control, although right lower limb is loaded more. Otherwise, boys at 11 and 12 more than girls present higher statistically significant values in position without eye control.

INTRODUCTION

The ability to maintain balance has been evaluating and depends on each child's age (Sobera 2010, Wit 2012, Mazur-Rylska, Czarny 2015). Each child grows up in individual rate. Rapid maturation changes conditions of body stabilization, and dimorphial diversification testifies to faster maturation of functional girls static equilibrium (Mleczko 1995). Equivalent reactions are highly inherited among male and they are more labile among girls (Cieśla 2005). The importance of research with stabile graph is connected with problem of not objective assessment of functional man's asymmetry. There have been reports of the literature evaluating the asymmetry of equilibrium while standing on two legs arranged on two platforms, which has very important cognitive meaning (Sikora 2001, Audu and co-authors 2007, Kidoń and co-authors 2008, Strzecha and co-authors 2008, Kalisz, Żukow 2010, Sobera 2010).

Among adults, movements of changing weight from one lower limb to the other are almost unnoticeable during calm standing two-legged position. While motor ataxia characteristic for young age manifests in a variable-pressure feet, swinging reverse body in standing position (Berger and co-authors 1995, Hay, Redon 1999).

Lateralization has its genetic and environmental foundation (Jędrzejowska 2009). Genetic factor manifests itself as predisposition to given type of stronger side, and

environmental factor made up of the process of upbringing and cultural patterns, completes the process of determining a phenotype (Dębicka 2004). The efficiency of the mechanism of equilibrium is subject to improvement within systematically performed exercise aimed at coordination exercises (Era and co-authors 1996, Sienkiewicz 2001, Perrin and co-authors 2002, Noe, Paillard 2005, Sobera, Siedlecka 2009, Mazur-Rylska, Ambroży 2010, Bujas and co-authors 2012, Handke and co-authors 2012).

Sexual dimorphism in terms of the balance indicators appears at age of 11 (Mazur-Rylska, Czarny 2015). At age of 11 puberty - increase begins among girls (Wolański 1983, Czarny 2008, Malinowski 2009). Differences in balance reactions may be due to the maturation, what starts faster among girls. Reports of certain authors concern also fact that differences in body stabilization among girls and boys are very small, despite the existing differences in morphology and physique (Nolan and co-authors 2005, Peterson and co-authors 2006, Sobera 2010).

PURPOSE AND SCOPE OF WORK

Analysis of the balance and difference in balance concerns 165 children aged 10-12. The purpose of the work is to examine the level of asymmetry of stabilization function of the lower extremities between girls and boys by analysis of symmetry in loading of the lower limbs (body balance) and the difference in the balance between the right and left lower limb in position with eyes open and closed.

MATERIAL AND METHODS

The analysis covered the 165 children aged 10-12. Counts of the individual age groups, taking into account gender breakdown is presented in the following table.

Tab. 3. Description of groups participating in the survey

Age [years]	**Sex**		Total
	female	**male**	
10	27	29	56
11	43	19	62
12	25	22	47
Total	95	70	165

Tab. 4. Anthropometric characteristics of children participating in the survey (height, weight)

Age [years]	**Height [centimeter]**											
	Sex											
	female						**male**					
	$\bar{x}$	Me	*s*	min	max	*V*	$\bar{x}$	Me	*s*	min	max	*V*
10	142,6	142,0	7,3	127	155	5,1%	143,2	144,0	5,8	129	155	4,1%
11	147,3	149,0	6,6	134	160	4,5%	149,7	151,0	8,3	135	161	5,6%
12	156,3	157,0	7,3	142	170	4,7%	151,7	149,0	7,3	144	168	4,8%
Age [years]	**Weight [kilograms]**											
	Sex											
	female						**male**					
	$\bar{x}$	Me	*s*	min	max	*V*	$\bar{x}$	Me	*s*	min	max	*V*
10	34,8	33,7	7,6	23,5	53,1	21,9%	33,5	33,2	4,8	26,1	42,9	14,3%
11	38,7	37,2	7,9	27,0	64,9	20,5%	39,7	38,2	8,3	26,7	58,2	21,0%
12	44,9	44,0	8,7	31,1	59,9	19,3%	41,4	40,9	7,1	28,0	52,4	17,2%

In the trial balance stabile metrical Computer Platform CQ Stab. 2 p was used. Measurement of the balance consisted of two trials in a variety of positions, in which there are 30 seconds changes in balance of body to the right and left lower limb: the basis for open (heel separately in a relaxed attitude) eyes open (EO) and closed (EC).

The data were subjected to statistical analysis with using the Statistic package. Descriptive statistics were used with registered variables (Stanisz 2006, Łomnicki 2014). For differences of DB balance, coefficient of variation could not be determined due to the fact of admission by the variable negative values. Among different calculations performed by platform, following data were analyzed:

BalanceL%EO- balance on left limb (EO) and (EC),

BalanceP%EO- balance on right limb (EO) and (EC),

DB- differences in balance [%] (EO i EC): MNDB- arithmetic mean of difference in balance, MinDB- minimum balance difference, MaxDB- maximum balance difference.

Comparison of the parameters concerned compare of stabile graph parameters between girls and boys in older age of children 10-12. In order to determine the normal schedules tests of Shapiro-Wilk and Kołmogorow – Smirnow were used. Because schedules much dissent from normal distributions and it has not been shown for oneness of variance, not parametric test U Mann Whitney was used for dependent variable in the analysis of specific female and male groups. Analysis of the differences in the levels of significance is made on three levels of significance: $p<0,1$ *- result of the statistically significant, $p<0,01$** - result of highly statistically significant, $p<0,001$***- result of very highly statistically significant. An illustration of a graphical chart represent the type of box-whiskers, which shows the value of the arithmetic mean, 95% of confidence interval, and the typical range of individual variation in separate groups.

RESULTS AND DISCUSSION

Comparison of balance parameters and balance variations of girls and boys in different age categories in position with eyes open (EO).

Parameters measured in position EO for boys and girls do not differentiate test group in any of the age categories (Tab.3, Fig.1).

Tab.3. Value of balance to left and right limb and balance variety (arithmetic mean, median, standard deviation, minimum and maximum value, variability) among girls and boys 10-12 years in position with eyes open (EO), p - Mann-Whitney test.

Balance (eyes open)	**Sex- 10-12 lat**										***p***
	female (*N* = 95)					**male (*N* = 70)**					
	$\bar{x}$	*s*	min	max	*V*	$\bar{x}$	*s*	min	max	*V*	
Balance L [%]	48,9	5,0	30	60	10%	48,8	4,1	40	58	8%	0,5181
Balance P [%]	51,1	5,0	40	70	10%	51,2	4,1	42	60	8%	0,5181
Balance (variety) [%]	7,6	6,7	0	40	88%	7,0	4,8	0	20	68%	0,8994
MNDB	-1,9	9,2	-29	20	×	-2,1	7,8	-19	17	×	0,5714
MinDB	-5,9	9,7	-45	16	×	-6,5	7,9	-27	9	×	0,4389
MaxDB	2,0	9,4	-25	26	×	2,4	8,4	-16	26	×	0,8832
Balance (eyes open)	**Sex - 10 lat**										***p***
	female (*N* = 27)					**male (*N* = 29)**					
	$\bar{x}$	*s*	min	max	*V*	$\bar{x}$	*s*	min	max	*V*	
Balance L [%]	49,7	3,7	42	57	7%	49,0	3,7	41	57	8%	0,3528
Balance P [%]	50,3	3,7	43	58	7%	51,0	3,7	43	59	7%	0,3528
Balance (variety) [%]	5,8	4,6	0	16	79%	6,5	4,1	0	18	63%	0,3877
MNDB	-0,4	6,7	-14	14	×	-1,6	6,5	-16	11	×	0,4342
MinDB	-4,4	6,5	-18	11	×	-5,4	6,7	-21	9	×	0,4636
MaxDB	3,8	7,3	-11	22	×	2,2	6,8	-12	15	×	0,4060
Balance (eyes open)	**Sex - 11 lat**										***p***
	female (*N* = 43)					**male (*N* = 19)**					
	$\bar{x}$	*s*	min	max	*V*	$\bar{x}$	*s*	min	max	*V*	
Balance L [%]	48,3	5,9	30	59	12%	49,6	5,0	40	56	10%	0,4395
Balance P [%]	51,7	5,9	41	70	11%	50,4	5,0	44	60	10%	0,4395
Balance (variety) [%]	9,2	8,1	0	40	89%	8,5	4,9	2	20	58%	0,6716
MNDB	-3,1	10,7	-29	18	×	-0,5	9,7	-19	11	×	0,3239
MinDB	-7,0	11,7	-45	16	×	-5,8	10,6	-27	8	×	0,8559
MaxDB	0,7	10,6	-25	22	×	5,1	10,1	-16	18	×	0,1164
Balance (eyes open)	**Sex - 12 lat**										***p***
	female (*N* = 25)					**male (*N* = 22)**					
	$\bar{x}$	*s*	min	max	*V*	$\bar{x}$	*s*	min	max	*V*	
Balance L [%]	49,3	4,4	40	60	9%	48,0	3,6	43	58	7%	0,2225
Balance P [%]	50,7	4,4	40	60	9%	52,0	3,6	42	57	7%	0,2225
Balance (variety) [%]	6,8	5,4	0	20	80%	6,3	5,3	0	16	84%	0,8410
MNDB	-1,3	8,6	-21	20	×	-4,2	7,5	-14	17	×	0,1453
MinDB	-5,5	8,6	-25	16	×	-8,5	6,7	-22	4	×	0,2658
MaxDB	2,4	9,1	-17	26	×	0,3	8,4	-12	26	×	0,2943

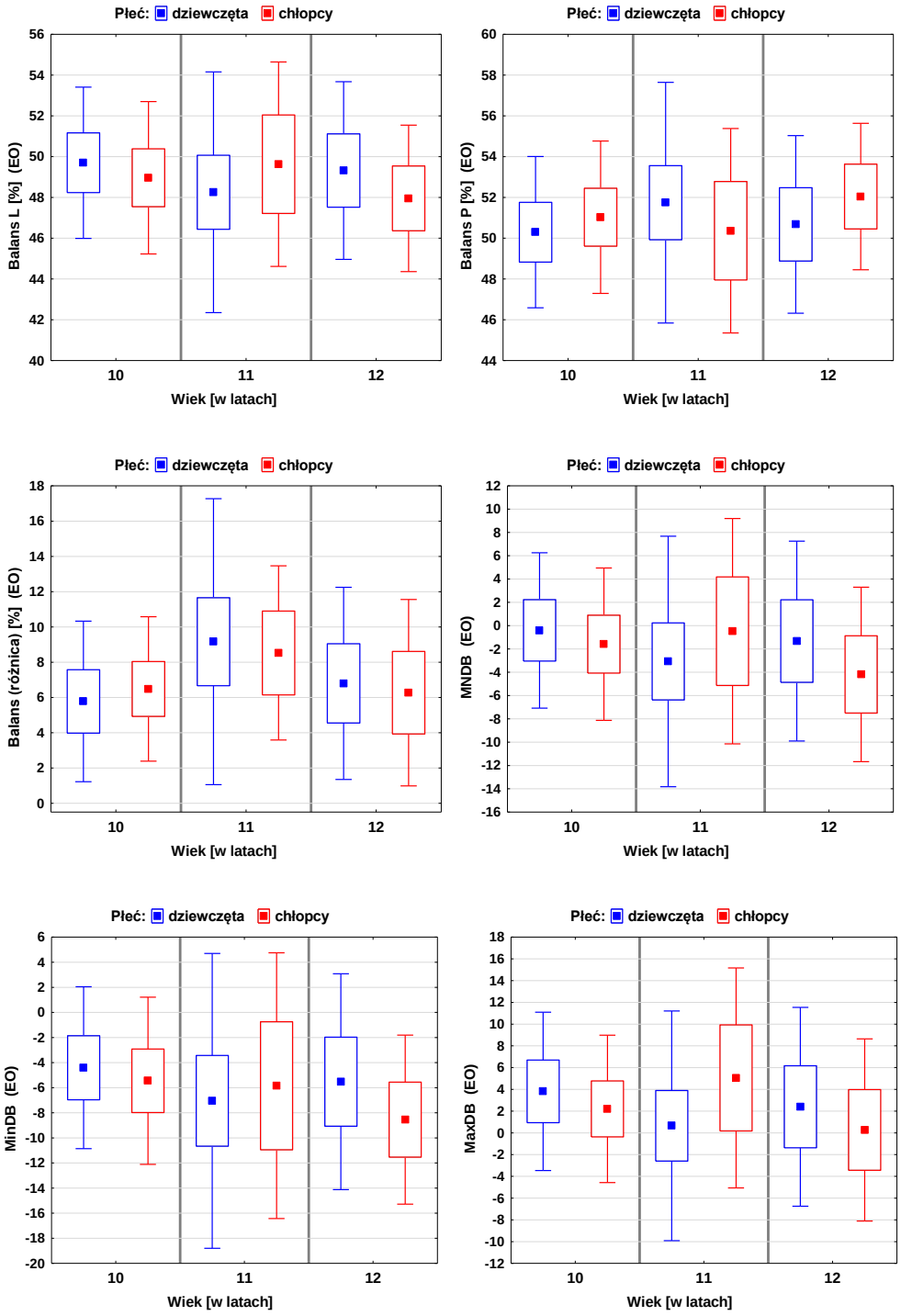

Fig. 1. Comparison of loading lower limbs between girls and boys of 10-12 years in the position with eyes open (EO)

Figure 1 translation:Płeć: dziewczęta – sex (female), Płeć: chłopcy – sex (male), Wiek (w latach) - age (years), Balans – balance, Balans (różnica) – balance (variation)

Comparison of balance parameters and balance variations of girls and boys in different age categories in position with eyes closed (EC)

Lack of visual inspection has significant impact on the differences in balance between boys and girls at age of 12 years. The differences relate to balance on left lower limb (49,5% / 47,5%), balance on right lower limb (50,5% / 52,5%) and minimum, maximum and average balance difference (Tab.4, Fig. 2).

Tab.4. Value of balance to left and right limb and balance variety (arithmetic mean, median, standard deviation, minimum and maximum value, variability) among girls and boys 10-12 years in position with eyes closed (EC), p - Mann-Whitney test

Balance (eyes closed)	**Sex - 10-12 lat**										***p***
	female (*N* = 95)					**male (*N* = 70)**					
	$\bar{x}$	*s*	min	max	*V*	$\bar{x}$	*s*	min	max	*V*	
Balance L [%]	49,2	4,2	33	59	9%	48,9	4,4	39	61	9%	0,2891
Balance P [%]	50,8	4,2	41	67	8%	51,1	4,4	39	61	9%	0,2891
Balance (variety) [%]	6,4	5,7	0	34	89%	7,3	5,4	0	22	75%	0,1987
MNDB	-1,4	7,9	-24	17	×	-1,9	7,9	-15	19	×	0,3691
MinDB	-5,8	8,0	-35	12	×	-7,2	8,4	-24	13	×	0,1627
MaxDB	3,1	8,3	-22	24	×	3,1	9,0	-11	27	×	0,6347
Balance (eyes closed)	**Sex - 10 lat**										***p***
	female (*N* = 27)					**male (*N* = 29)**					
	$\bar{x}$	*s*	min	max	*V*	$\bar{x}$	*s*	min	max	*V*	
Balance L [%]	49,7	4,0	41	56	8%	49,0	4,2	43	58	8%	0,3877
Balance P [%]	50,3	4,0	44	59	8%	51,0	4,2	42	57	8%	0,3877
Balance (variety) [%]	6,4	4,6	0	18	72%	7,0	4,7	0	16	67%	0,5578
MNDB	-0,5	7,2	-17	11	×	-1,8	7,2	-12	13	×	0,3968
MinDB	-4,9	6,9	-21	4	×	-6,9	7,9	-23	11	×	0,2816
MaxDB	3,9	7,5	-12	15	×	3,2	8,3	-10	19	×	0,6842
Balance (eyes closed)	**Sex - 11 lat**										***p***
	female (*N* = 43)					**male (*N* = 19)**					
	$\bar{x}$	*s*	min	max	*V*	$\bar{x}$	*s*	min	max	*V*	
Balance L [%]	48,8	4,5	33	56	9%	50,3	4,6	43	57	9%	0,3165
Balance P [%]	51,2	4,5	44	67	9%	49,7	4,6	43	57	9%	0,3165
Balance (variety) [%]	6,5	6,7	0	34	103%	7,6	5,0	0	14	66%	0,1909
MNDB	-2,6	8,1	-24	13	×	0,6	8,8	-14	13	×	0,1909
MinDB	-7,0	8,8	-35	8	×	-5,7	9,4	-23	7	×	0,7853
MaxDB	2,2	8,2	-22	17	×	6,8	9,8	-10	24	×	0,0564*
Balance (eyes closed)	**Sex - 12 lat**										***p***
	female (*N* = 25)					**male (*N* = 22)**					
	$\bar{x}$	*s*	min	max	*V*	$\bar{x}$	*s*	min	max	*V*	
Balance L [%]	49,5	4,1	41	59	8%	47,5	4,4	39	61	9%	0,0580*
Balance P [%]	50,5	4,1	41	59	8%	52,5	4,4	39	61	8%	0,0580*
Balance (variety) [%]	6,4	5,2	0	18	81%	7,4	6,8	0	22	92%	0,8576
MNDB	-0,3	8,2	-17	17	×	-4,4	7,6	-15	19	×	0,0504*
MinDB	-4,6	7,7	-19	12	×	-8,9	8,2	-24	13	×	0,0585*
MaxDB	3,9	9,6	-15	24	×	-0,2	8,2	-11	27	×	0,0548*

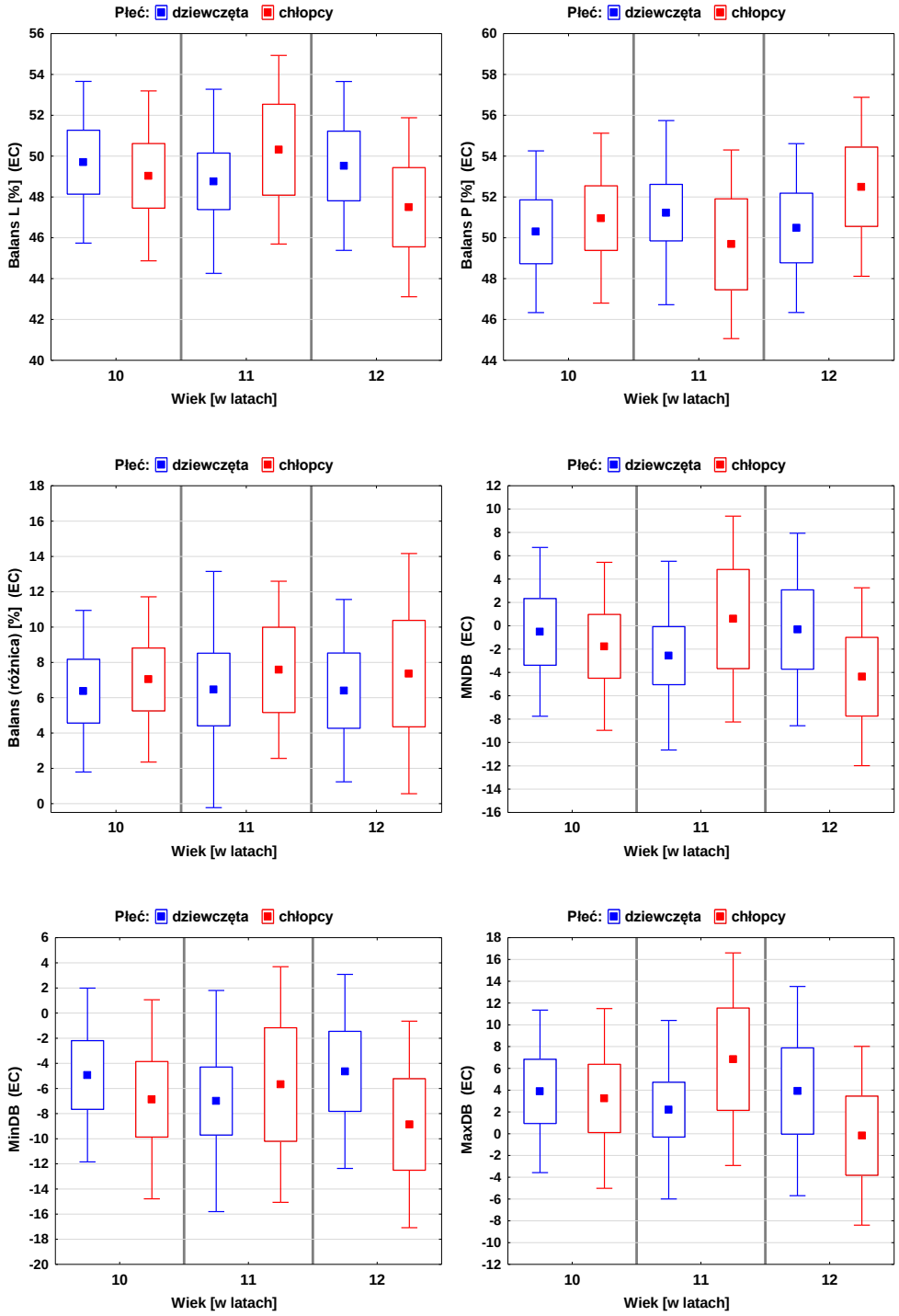

Fig.2. Comparison of loading lower limbs between girls and boys of 10-12 years in the position with eyes closed (EC)

Figure 2 translation: Płeć: dziewczęta – sex (female), Płeć: chłopcy – sex (male), Wiek (w latach) - age (years), Balans – balance, Balans (różnica) – balance (variation)

CONCLUSIONS

In the ontogenetic development human balance control is used in various schemes of the position of the body segments and it is changed depending on the reference system. To maintain balance important is not only the geometric location of the body, but also the distribution of the masses of the individual parts of the body, because it consists for the maintenance of the projection in center of body mass inside the position of the support feet

(Massion 1998, Strzecha 2008). The height and weight of children 7-14 years show a systematic increase in both gender groups with higher rate to the female sex (Fugiel 2002) and may be affected by differences in the distribution of weight. Obtained in the course of the study results have made it possible to assess balance of right and left lower limb on the basis of stabile graph measurements in position EO and EC among girls and boys at age of 10-12. Most of the surveyed attempts are characterized by a very small minority of asymmetry of the distribution in burdens of lower limbs, but greater load is on right lower limb as a not dominated limb.

The researched population loads more intensive right lower limb regardless of the control eyes and age, but statistical significance is exiguous. That tendency is statistically significant if one compare boys and girls at 11 and 12, but boys present statistically significant higher values than girls especially in the EC position. Only in this age category greater effect of sight on results of stabile graph trials was found. This may be due to the differences arising from the stage of puberty among boys and girls.

Boys at 11and 12 more than girls present statistically significant values in position without eyes control.

The tendency of differences in the surveyed age group is adequate to earlier research, where it was shown the differences between boys and girls in category of 11-12 years old (Mazur-Rylska, Czarny 2015). Also, Nolan and co-authors (2005) researches prooved that sexual dimorphism does not play a significant role in the process of maintaining balance on preschool children, and later growth age, especially the age of puberty may be significant for controlling of body posture.

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