DIFFERENCES IN THE LEVEL OF BODY EQUILIBRIUM BY SEX IN EARLY SCHOOL-AGE CHILDREN

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ABSTRACT

Equilibrium represents the motor capability responsible for the performance of virtually all functional movements. Thus, the importance of early diagnosis of equilibrium levels in boys and girls was recognized as the key factor for the prevention of motor deficits and muscles misbalances later in life. *Purpose*: The purpose of this paper was to show the difference between boys and girls aged 7–10 years in the level of unilateral static balance of the take-off leg. *Methods***:** Research was conducted at the Kvarner Athletics Club Rijeka, and it involved 80 children aged 7–10 years (38 boys and 42 girls). Measurement of static unilateral equilibrium was obtained using Gyko Inertial System (Microgate, Bolzano, Italy). Three attempts were made in 20 seconds and two motor variables were observed: medio-lateral and antero-posterior trajectories of the body. For both variables, the arithmetic mean, the minimum and maximum score and standard deviation were calculated. Moreover, a non-parametric method of the Mann-Whitney U test was used to determine statistical significance between boys and girls. Statistical significance was set at $p < 0.05$. *Results*: Statistically**,** girls have significantly better results compared to boys, both in the medio-lateral trajectory variable (M_Sumg = 335.1, M_Sumb = 479.34) and the antero-posterior trajectory variable (M_Sumg = 291.14, M_Sumb = 411.71). *Conclusion*: The results of this study showed that girls aged 7–10 years achieved significantly better results compared to boys in observed motor variables (medio-lateral and antero-posterior trajectory of the body), when performing a static unilateral take-off leg balance test. These results are consistent with previous research. Indications for such results stem from different perspectives, among which the most common one refers to the earlier maturation of the systems responsible for postural control in female bodies. Recommendation for further research is to conduct examination on a larger sample of subjects, in younger children (pre-school age) and with both legs.

Keywords: static unilateral balance; early school-age children; take-off leg

Introduction

Quality diagnostics of motor capabilities is the foundation for planning and programing transformation processes. Considering the fact that equilibrium presents a motor capability responsible for the performance of all functional movements, the importance of its diagnostics has been recognized. The ability of maintaining balance presumes the central integration of information coming from several centres, primarily from vestibular system, visual system and various sensory cells from the periphery (Trošt Bobić, 2012). Riach and Hayes (1987) stated that children use visual information for equilibrium control differently than adults and they start approaching the similar use only after the age of 7. The key age for the development of postural control is between the ages of 1 and 7 (Nougier et al., 1998), while Reconsvalles et al. (2005) advocated the extension of that period to the age of 8 or 9. As mentioned by Sá (2018), ability to maintain stable position in children firstly occurred on the visual system, than proprioceptive and finally vestibular system, reaching functional maturity at nine years of age. Milanović (2003) has defined equilibrium as a capability which is manifested in establishing and maintaining the position of balance by successfully resisting the forces which distort it and can further be defined as dynamic and static equilibrium. The evaluation of equilibrium level is rarely conducted in athletic clubs, especially among early school-age children. The deficit in equilibrium level can hinder the performance of different motor performances, while muscle asymmetries can lead to injuries. By the use of timely diagnostics it is possible to act preventively, and consequentially, on the entire motor system through training process. The aim of this study is to present the differences between boys and girls between the ages of 7 and 10 years in the level of unilateral static balance of the take-off leg.

Methods

Sample of participants

The research included 80 children (38 boys and 42 girls) aged 7–10 years. The children were members of the Kvarner Athletics Club from Rijeka. The participants were measured in February 2018. Prior to testing procedure parents were informed about protocol and they gave written consent for their children.

Sample of variables

Two variables were used for the evaluation of equilibrium motor capability: the antero-posterior (AP) and the medio-lateral (ML) trajectory of the body (cm).

Measurement protocol

Prior to the testing, the participants had a 10-minute standardized warm-up which consisted of running, the athletic school of running and stretching and were also introduced to the testing protocol. Static unilateral equilibrium of the take-off leg was measured and Gyko inertial system (Microgate, Bolzano, Italy) was used to obtain data. For the purpose of system calibration, the height of the device was measured on participant's body. The take-off leg was determined during practices prior to the testing. Three attempts were measured, each lasting 20 seconds.

Data processing methods

Statistica 14.0 program package was used for data processing. Basic descriptive indicators were calculated and non-parametric method of Mann-Whitney U test was used for further analysis of differences between the groups.

Results

Table 1 shows the basic descriptive indicators (Mean, Minimum, Maximum, Std. Dev.) obtained from measuring the antero-posterior (AP) and the medio-lateral (ML) trajectory of the body. It is evident from the table that both boys and girls achieved the best results in the first attempt in both variables (ML_G_1 = 101.97, ML_B_1 = 150.20; AP_G_1 = 90.72, AP_B_1 = 130.78). The largest body oscillations in boys were in the third attempt in the ML variable (ML_B_3 = 165.35) and the AP variable (AP_B_3 = 149.67), while the largest oscillations in girls were noted in the third attempt in the ML variable (ML_G_3 = 117.95), and in the second attempt in the AP variable (AP_G_2 = 101.87). In minimum values girls achieved better overall values than boys in both measured variables (SUM_ML_ming = 116.76; SUM_ML_minb = 125.38; SUM_AP_gmin = 116,87; SUM_AP_bmin = 132.00). Both boys and girls demonstrated the smallest oscillations in the ML variable in the third attempt, and the largest in the second attempt (ML_2_ming= 37.66; ML_2_minb= 47.06; ML_3_ming= 33.63; ML_3_minb= 37.39). In maximum values, girls also achieved better total values than boys in both measured variables (SUM_ML_maxg = 1270.62; SUM_ML_maxb = 1846.36; SUM_AP_maxg = 1061.61; SUM_AP_maxb = 1245.18). The greatest changes in body stability were observed in boys in the third attempt in both variables (ML_3_maxb = 737.68; AP_3_maxg = 694.86) and in girls in the MP variable in the third attempt (ML_3_maxg = 659.65) and in the AP variable in the second attempt (AP_2_maxg = 569.30). Standard deviation, i.e. results variability in the ML movements in the first attempt in both sexes exhibited the lowest values (ML_G_1 = 59.23; ML_B_1 = 105.74). Also, the lowest results variability in the first attempt was noted in the AP movement in girls, while in boys it was in the second. Girls had less variability of results in every attempt and overall and also managed to maintain a more stable body position.

Table 1 *Descriptive statistics*

Variable	Descriptive Statistics							
	Me		Min		Max		Std.Dev.	
Sex	G	B	G	B	G	B	G	B
ML_1 (cm)	101.97	150.20	38.02	40.93	307.65	479.18	59.23	105.74
ML_2 (cm)	115.18	163.78	37.66	47.06	638.26	683.80	97.97	145.60
ML_3 (cm)	117.95	165.35	33.62	37.39	659.65	737.68	106.47	131.53
SUM_ML (cm)	335.10	479.34	116.76	125.38	1270.62	1846.36	214.40	362.31
AP_1 (cm)	90.72	130.78	32.96	45.47	259.86	461.84	49.25	79.95
AP_2 (cm)	101.87	131.26	38.00	50.63	569.30	330.48	83.73	69.11
AP_3 (cm)	98.56	149.67	35.68	35.90	476.07	694.86	71.58	110.49
SUM_AP (cm)	291.14	411.71	116.87	132.00	1061.61	1245.18	165.72	230.05

(M- mean, Min- minimum, Max- maximum, G-girls, B-boys, Std.Dev.-standard deviation, Sum-sumarum)

From Table 2 where Mann-Whitney U test was conducted it is evident that the values in both variables in concern are significant in all attempts. Girls achieved significantly better results ($p < 0.05$) in variables ML and AP in the test of unilateral equilibrium of the take-off leg in each of the positions but also in the sum of all three attempts (SUM_ML_U = 571.00; SUM_ML_Z = -2.18; SUM_AP_U = 426.00; SUM_AP_Z = -3.57924).

Table 2 *Mann-Whitney's U-test*

Variable	**Mann-Whitney U Test (w/ continuity correction) (Balance)** **By variable sex** **Marked tests are significant at p < 0.05**				
	Valid N	Valid N	U	Z	p-value
ML_1	42	38	544.00	-2.44	0.02*
ML_2	42	38	587.00	-2.03	0.04*
ML_3	42	38	542.00	-2.46	0.01*
SUM_ML	42	38	571.00	-2.18	0.03*
AP_1	42	38	430.00	-3.54	0.00*
AP_2	42	38	466.00	-3.19	0.00*
AP_3	42	38	389.00	-3.94	0.00*
SUM_AP	42	38	426.00	-3.58	0.00*

* Marked values show statistical significance of differences between groups of participants

Discussion

It is evident from the results in Table 1 that both girls and boys achieved the best results in the first attempt in variables ML and AP. It is also evident that in both variables (except in variable AP_2 in girls) the results became more and more variable with each attempt. This trend in results shows that children manage to maintain the stable body position in the initial attempts of the testing. Every subsequent attempt of maintaining/keeping equilibrium caused lesser concentration and body instability. Also, such results may indicate the occurrence of muscle fatigue. Muscle fatigue is defined as a decrease in the ability to produce force (Wan et al., 2017) and as such, it can hinder motor performances. Johnston et al. (1998) studied whether lower extremities fatigue influences the equilibrium of an individual. The sample included 20 healthy individuals aged 20–39 years. The analysis of the results of equilibrium before and after fatigue showed a significant decrease in performance in all participants. Similar results were obtained by Shimpi Apurva et al. (2014) from which they concluded that fatigue significantly influences the decrease in static equilibrium levels, dynamic equilibrium levels and lumbar core strength. In this research, a statistically significant difference was determined in equilibrium between sexes. Girls achieve significantly better results than boys their age (Smith, Wong and Ulmer, 2012; Lee and Lin, 2007; Nolan, Grigorenko and Thorstensson, 2005). The authors of such studies ascribe results to improved sensory integration (Steindl et al., 2006), advanced neuromuscular development (Eguchi and Takada, 2014), application of strategies for maintaining postural control more similarly to those used in the adulthood (Smith, Ulmer and Wong, 2012), earlier maturation of responsible systems (neurological, visual, vestibular, proprioceptive systems), which is related to precocious puberty (Alves Faco et al., 2013; Malina and Bouchard, 2002; Cratty, 1970) and differences in anthropometric characteristics (Dorneles, Pranke and Mota 2013; Lee and Lin, 2007; Rivas and Andries, 2007). Certain studies obtained different results than this study (Erkut Atilgan et al., 2012; Mickle, Munro and Steele, 2011), which indicates the need for further and more detailed research. Erkut Atilgan et al. (2012) explained the results in which boys achieve better results than girls through the possibility of boys being physically more active than girls, which positively influences equilibrium due to the enhanced muscle strength. It is certainly important to mention the notion of biological maturity, which might partly explain the obtained results of the research. Although it is a fact that in average, girls reach their biological maturity earlier than boys, which is also closely related to sensitive developmental phases of motor abilities and emotional control all of which makes the obtained results logical, equilibrium can still be defined as an exceptionally complex ability. The motor ability of equilibrium integrates psychological, physiological and biomechanical components which are used in every movement, on a conscious or an unconscious level (according to Roguljić, 2015).

Conclusion

The results of this study revealed that girls achieve significantly better results than boys in both motor variables observed (medio-lateral and antero-posterior trajectory of the body) while performing a static unilateral equilibrium test with a take-off leg in the age of 7–10 years. Although there are some studies which disagree with the findings of this study, the number of studies in accordance with the obtained results is significantly larger. The indications for such results start from different viewpoints and the most common refer to the earlier maturation of systems responsible for postural control. Besides for athletes, early diagnostics of equilibrium levels is also important for people who are not engaged in some form of organised physical exercise (sports clubs, fitness, etc.). As it was already mentioned in the text, every movement cannot be functional without an optimal equilibrium level. Therefore, by developing equilibrium one can act preventively, enable the development of other motor abilities and often use it for rehabilitation purposes. Further research should be directed towards the procedures of determining equilibrium levels in a larger sample of pre-school children. Furthermore, for the purpose of more detailed analyses it is necessary to observe the differences in sexes in equilibrium tests conducted by standing on dominant and non-dominant leg.

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