THE ABILITY TO MAINTAIN BALANCE IN CHILDREN WITH AUTISM AND CHILDREN FROM TYPICAL POPULATION

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Abstract

Introduction: The ability to maintain balance represents the basic motor function necessary for everyday functioning of a person in a society. Objective: The main objective of this research is to analyze the ability of maintaining postural balance in children with autism and children with typical development. Materials and Methods: The sample included a total of 62 children, aged 7-10, of male gender, out of which 31 children from the experimental group (E-group) had a diagnosis of autism, while the control group (C-group) consisted of 31children of the same age from the typical population. The ability to maintain postural balance in both groups was tested using three tests: Expanded Timed Up and Go Test (ETUGT), Modified Functional Reach Test (M-FRT) and the One–Leg Stance (OLS) with opened and closed eyes. The study was conducted from 2009-2010 at the Department of Psycho-physiological Disorders and Speech Pathology "Prof. Dr. Cvetko Brajović" and elementary school "Braća Baruh", Belgrade, Serbia. Results: The research results show that using ETUG test showed a statistically significant difference between the groups in terms of time given for the execution of the test, while using M-FR test examinees from the e-group achieved significantly lower results than the c-group. When using the OLS test without a blindfold, examinees from the e-group also achieved statistically lower results than the c-group, for both legs, and also achievements of the e-group when performing the actions with left and right leg were significantly lower when the blindfold was used. Conclusion: The results suggest that children with autism achieve, in comparison to their peers from typical population, lower values on all the applied tests for assessing postural balance.

Key words*: postural balance, autism*

Introduction

The ability to maintain the vertical position of the body in space is a basic skill needed for motor development of all people. Balance as the motor ability participates and plays a major role in all movements and motor skills of a person and, consequently, is the foundation and center of the motor functioning of a person. Balance is the ability to keep the body or hold it in a stable position, at rest, so it can be static or in motion, i.e. dynamic balance (Shumway-Cook & Woollacott, 2001). The system of postural balance is a position of unstable balance, because the short and narrow support surface is limited by the outer edges of the feet, the line which connects the tips of both big toes and at the back links the prints of the heels (Stošljević, Rapaić, Stošljević M, & Nikolić, 1997). Therefore, this system is a complex mechanism that requires the interaction of the parts of the musculoskeletal and nervous system such as: visual, somatosensory, and the vestibular system (Shumway-Cook & Woollacott, 2001). The interaction of these systems enables: maintaining the normal position – head in space, head in relation to the body, and the extremities in relation to the body; supporting reactions (resistance); and maintaining a balance in relation to the movement of the body's center (Stošljević, Ilanković & Stošljević M., 1998). According to the American Psychiatric Association (APA, 2005), autism belongs to the group of the five pervasive developmental disorders, which also include the five diagnostic criteria, which, apart from autism as the most typical representative, also include: Rett and Asperger syndrome, children's disintegrative disorder and non-specific pervasive developmental disorder. All these disorders can be defined as autistic spectrum disorders. According to this classification, symptoms can be classified into three major groups: qualitative disorders in the sphere of social interaction, qualitative disorders in communication, and repetitive and stereotyped patterns of behavior, interests and activities. As it can be seen from the above criteria, difficulties in motor functioning are not part of the basic diagnostic symptoms in the diagnosis of autistic spectrum, and the World Health Organization (WHO, 1992) gives them less attention and characterizes them as "associated symptoms". Regardless of the fact that the difficulties in motor functioning are not part of the basic diagnostic criteria for people of autistic spectrum, and because of the fact that they are very frequent in this population (Ming, Brimacombe, & Wagner, 2007), some authors believe that they should be included when making a diagnosis (Liu, 2012; Whyatt & Craig, 2012), and that physical and motor symptoms should have a greater role during the process of profiling (Minshew, Sung, Jones, & Furman, 2004). Over the past two decades, we can find a great number of studies in literature which point to the fact that children with autism spectrum disorders fall behind and are experiencing problems in motor functioning when compared to children with typical development (Green et al., 2002; Berkeley, Zittel, Pitney, & Nichols, 2001; Jansiewicz et al., 2006; Provost, Lopez & Heimerl, 2007).

Motor problems that this population of children is facing are multiple and are associated with clumsiness during the execution of tasks (Whyatt & Craig, 2012), hypotonia (Ghaziuddin & Butler, 1998), walking on toes (Filipek et al., 1999), difficulties in manual dexterity (Green et al., 2009), incoordination of movements (Miyahara et al., 1997), problems in fine and coarse motor skills (Dewey, Cantell, & Crawford, 2007; Kopp, Beckung, & Gillberg, 2010), as well as problems in the planning and execution of movements (Glazebrook, Elliott & Lyons, 2006; Barthélémy, Adrien, Garreau, & Guérin, 1994). From the standpoint of the problem of this study, an extremely important fact is that children with autism spectrum disorders, regardless of the specific form within the diagnosis, have problems with maintaining postural balance (Kohen-Raz, Volkmar, & Cohen, 1992; Molloy, Dietrich & Bhattacharya, 2003; Ting, & Casey, 2013; Fournier et al. 2010). Weimar and colleagues (2001) investigated in their study the possibility of standing on one leg with eyes closed, in children with autism spectrum disorders (Asperger's Syndrome) and children from typical population. The results they have obtained indicate that children from typical population can maintain the required position for a significantly longer period of time, than children with Asperger's syndrome, which leads to the conclusion that in children with Asperger's syndrome the ability to maintain balance was much worse. Kohen-Raz and associates (1992) found in their study that children with autism spectrum disorders are less stable and showed significantly greater swaying in medio-lateral direction while maintaining the vertical position, and swaying in this direction is a factor of postural instability. Some of the mechanisms that can further contribute to difficulties in maintaining postural balance in children with autism spectrum disorders are the changes that are observed at the level of neuroanatomic structure of the brain and which are an important factor for balance (Bauman, & Kemper, 2005). Researches show that in these children the volume of the brain is increased, as well as the volume of the cerebellum and caudate nuclei, but the volume of corpus callosum is reduced (Hrdlicka, 2008; Stanfield et al., 2008; Courchesne, 2002). Also, a disruption in the operation of neurotransmitters is determined, especially of dopamine and serotonin, which may affect the quality of motor functions (Chugani et al., 1999). Since balance is a basic element of motor functioning of humans, difficulties in this area may be manifested in the framework of social functioning, such as the failure to investigate and discover the environment, difficulties in participation and in playing with other children (i.e. ball games), then in the cognitive development and communication, as well as in the increased risk of falls. Therefore, independent and safe movement represents an important link in the performance of daily activities and participation of the person in social activities (WHO, 2001), so it is logical that impairment of postural balance leads to the restrictions in these skills and activities.

The main reason why the authors have chosen this topic for their studies lies in the fact that in literature there is a small number of works dealing with this issue, while the second reason is to fill in the gaps in this area and to provide additional knowledge that would contribute to better understanding of the problem of maintaining postural balance in children with autism spectrum disorders.

Objective

The main objective of the research is to determine the possible differences in the ability to maintain postural balance in children with autism and children with typical development.

Material and methods

The sample included a total of 62 male examinees, ages between 7-10. Due to the equalization of methodology which does not endanger the scope of this study, the entire sample included only male examinees, due to the fact that the prevalence of autism spectrum disorders in relation to gender is in favor of boys, roughly 5 to 1 (Centers for Disease Control and Prevention, CDCP, 2013), and also because of the differences in the pace of motor development between the genders. The sample was divided into two groups, the experimental group consisted of children diagnosed with child autism (n=31), who functioned at the level of mild mental disability (IQ 50-70) and the control group which consisted of 31 examinees (n=31) of male gender, and the same age (7-10 years), with average intelligence. Both groups were equalized by age. Examinees from the experimental group were patients whose treatment was conducted at the Department of Psychophysiological Disorders and Speech Pathology, "Prof. Dr. Cvetko Brajovic" (Belgrade, Serbia), while the examinees from the control group were students from the elementary school "Braca Baruh" (Belgrade, Serbia). The study was conducted during the period 2009-2010. A letter was sent to parents of all examinees, with respect to their age characteristics, in which they were asked for a consent for their child to participate in the study, and only examinees with a signed statement of consent from their parents could participate in the research. Any other relevant information we have received by personal insight into examinees' heteroanamnestic data taken from their parents, as well as by examination of the school and medical records. Criteria for the exclusion from the study in both groups were: the existence of some kind of psychiatric disorder, injury, or damage to the musculoskeletal system, vision impairment (visus≤0.10), sensory deficit in lower extremities (numbness, lack of reflex to stretching or reduced strength in lower extremities), the use of some type of a walking aid, recent acute illness that could affect the results or a neurological condition that may affect the functioning of the vestibular apparatus. In addition, the criterion for the exclusion from the control group was that these patients have not practiced

postural balance through physical activities such as karate, football, basketball, etc. This criterion was applied to the examinees from the control group as a determinant of the usual motor development because it is clear that the inclusion of children who are actively involved in sports would lead to the wrong research methodology.

Testing procedure

Tests for the evaluation of postural balance - three tests were used in both groups in order to examine the ability of maintaining postural balance. All tests were performed without shoes. There was no trial test, and all participants were allowed three attempts with a 30 seconds-break between each performance in all tests. These are: 1) Expanded Timed Up and Go Test, ETUGT (Podsiadło & Richardson, 1991), ETUG test measures the time needed for a person to perform a series of functional tasks, which are important for independent walking. On the examiner's mark "go", the examinee should get up from a sitting position and walk three feet to the marked line, turn around and go back to the chair and sit. Time is measured by a stopwatch, and faster performing of tasks indicates a better postural balance.

During the testing we used an extended version of the test, where examinees walk nine meters, because it was already used on the population of people with intellectual disability (Carmeli, Barchad, Lenger, & Coleman, 2002), 2) Modified Functional Reach Test, M-FRT (Katz-Leurer, Fisher, Neeb, Schwartz, & Carmeli, 2009). This test is a very useful tool for the assessment of postural balance and risk of falling (Perell et al., 2001), and is modified in cases where a person is unable to stand, in various neuropathological conditions such as stroke (Katz-Leurer et al., 2009), spinal cord injury (Lynch, Leahy, & Barker, 1998), vestibulopathy (Mann et al., 1996), as well as in the cases of intellectual disorders, where there is a problem of understanding the orders (Blomqvist, Wester, Sundelin, & Rehn, 2011). The test assesses how far (in centimeters) the person is able to push forward a sliding plate placed on a tripod, without losing postural balance. Each examinee repeated the test three times and the best result was recorded (Duncan, Weiner, Chandler & Studenski, 1990). The same type of procedure was used for the examinees with autism and examinees with typical development because of the equalization of methodology, 3) One-Leg Stance Test, OLS (Bohannon, 1994). This test assesses static postural balance. Examinees are asked to stand first on the left leg, then on the right leg, as long as possible, first with their eyes open, and then with a blindfold (maximum time of 30 sec.). Three attempts are allowed, and the best time is recorded.

Results of the research

Table 1 presents the differences between the experimental and control groups on ETUG and M-FR tests. After examining the results in Table 1 we can see that between the experimental and control groups there are statistically significant differences in the time needed for the examinees to complete ETUG test. This also means that the examinees from the experimental group had poorer performances on this test compared to the control group (ASe=16.15; ASc=15.32; SDe=1.58; SDc=1.47, t-test=2.45, p=0.031).

Table 1 - Differences between the experimental and control group on ETUG and M-FR tests

		N	AS*	SD	t-test	P
ETUG test*	e-group	31	16,15	15,8	2,45	0,031
	c-group	31	15,32	1,47		
M-FR-test**	e-group	31	29,3	5,9	4,73	0,001
	c-group	31	33,9	4,8		

*arithmetic mean given in seconds **arithmetic mean given in centimeters

Table 2 - Differences between the experimental and control group on the OLS test without a blindfold (right leg and left leg)

		N	AS*	SD	t-test	P
OLS test- without a blinfold (right leg)	e-group	31	10,8	5,2	4,94	0,001
	c-group	31	19,4	4,3		
OLS test- bez poveza preko očiju (leva noga)	e-group	31	7,5	5,8	4,73	0,001
	c-group	31	17,4	2,9		

* arithmetic mean given in seconds

Table 3 - differences between the experimental and control group on the OLS test with a blindfold (right leg and left leg)

		N	AS*	SD	t-test	P
OLS test- with a blindfold (right lega)	e-group	31	5,4	4,3	4,73	0,001
	c-group	31	16,1	2,9		
OLS test- with a blindfold (left leg)	e-group	31	3,7	4,2	4,81	0,001
	c-group	31	12,3	2,5		

* arithmetic mean given in seconds

After further analysis of the results shown in Table 1 we can see that there are statistically significant differences between the results of the examinees from the control and experimental groups when performing the M-FR test. The experimental group had lower scores on this test than the control group (ASe=29.3; ASc=33.9; SDe=5.9; SDc=4.8, t-test=4.73, p=0.001). In Table 2 we can see the results obtained when performing the OLS test for the left and right leg, for both groups when they had a blindfold. By analyzing the results we can see that the achievements of the experimental group were significantly lower for the right leg when compared to the control group (ASe=10.8; ASc=19.4; SDe=5.2; SDc=4.3, t-test=4.94, p=0.001), as well as for the left leg (ASe=7.5; ASc=17.4; SDe=5.8; SDc=2.9, t-test=4.73, p=0,001). By analyzing the results in Table 3 we can see that the achievements of the experimental group were significantly lower for the right leg (ASe=5.4; ASc=16.1; SDe=4.3; SDc=2.9, t-test=4.73, p=0.001) when compared to the control group, when the same action was performed with a blindfold, as well as for the left leg (ASe=3.7; ASc=12.3; SDe=4.2; SDc=2.5, t-test=4.81, p=0.001).

Discussion

It can be said that the findings of our research, when summarized, confirm the results of other studies that show that children with autism spectrum disorders (ASD), in contrast to the typical population of children, have problems with maintaining balance. Similar results were obtained by Memari et al. (2013) who examined postural balance in children with ASD and children with typical development. Examiners observed postural motion in medio-lateral and antero-posterior level on a sample of 21 children with ASD and 30 children with typical development, using a specialized computer platform (force platform), which measures the force a person exerts on a surface. The results which were obtained show that children with ASD, as opposed to the peers from typical population, manifest greater swaying in these directions (support surface of the feet, and the average speed of body sway was greater).

These data led the examiners to the conclusion that children with autism, as opposed to the children from typical population, have a higher volatility when maintaining postural balance. Although our research differs in terms of the instruments used, the results are in correlation with the results of Memari et al., the results of our study indicate that the examinees from the experimental group showed significantly lower scores than the control group in all tests used, which suggests that, unlike the typical population of children, children with ASD exhibit difficulties in maintaining postural balance. By using a similar apparatus for data acquisition as Marmari, Molly et al. (2003) investigated in their research the ability of maintaining balance on a computer platform for 30 seconds, in children with ASD and peers from typical population.

The sample was modest and included 8 examinees of male gender, that were 10 years old and had ASD, and the control group equal in number, gender and age of the examinees. Unlike the previous research, Moli et al. modified the senses of the examinees that are responsible for maintaining balance. In the first task, in order to turn off the sense of sight, they put a blindfold over the child's eyes, as we did in our research, forcing the child to rely only on the vestibular apparatus and the proprioceptive system. In the second task, in order to modify the somatosensory afferent inputs, they added a thick layer of sponge on the platform, on which the subjects had to stand first with their eyes open, and then with their eyes closed. The results suggest that children with ASD, when compared to children from typical population, have a larger surface of body swaying. The results of our study confirm the findings of Molly and associates, that children with ASD have difficulties in maintaining static balance, when one of their senses is modified, especially when using OLS test, where children with autism achieved statistically worse results on all tasks within this test, for both legs, with and without the blindfold (see Tables 2 and 3).Forner et al. (2010) examined static and dynamic balance on a sample of 13 examinees with ASD and 12 examinees from population, using, as in the above studies, computer platform for measuring the pressure force of feet on the surface. Significant differences were found between the groups for all three tests used for the assessment of postural control at a state of rest. Children with ASD manifested increased medio-lateral swaying (438% higher in the group of children with autism) in relation to their peers from typical population, as well as increased swaying at the antero-posterior level (104% higher in the group of children with autism). According to some studies, increased swaying in the medio-lareralnom direction is a predictor of postural instability (Maki, Holliday, & Fernie, 1999). The authors concluded that children with ASD had greater difficulties in maintaining balance than the children from typical population. The results of our study confirm the findings of previous researches in the area of ability to maintain static and dynamic balance in children with ASD, because during our research, the experimental group showed poorer results than the control group on the test for assessing balance in a state of rest (OLS test, M-FR test) and balance in a state of motion (ETUG test). As a confirmation of the fact that children with autism have problems in maintaining balance, we can mention the work of Greene and associates (2009) who examined the motor functioning of children with ASD. They used MABC test for collecting data (Movement Assessment Battery for Children), which is an accurate and reliable instrument for determining the difficulties in motor functioning of children, in relation to the expected age norms, and it should be added that it was already used on the population of children with ASD (Brown & Lalor, 2009). The test consists of eight items, divided into three subtests (including static and dynamic balance) and three age groups.

The sample included 101 children, 89 males and 12 females, aged 10-14 with a diagnosis of child autism (45 examinees) and autism spectrum disorders (56 examinees). The results obtained by the researchers show that out of the total sample, 80 examinees (79.2%) had definite motor problems, another 10 examinees (9.9%) manifested limited motor problems, while only 11 examinees (10.9 %) had no problems. By analyzing the results of the examinees on the subtests for assessing the balance on the board (board balance), it can be concluded that children with autism achieved poorer results in comparison to any other set of activities. Similarly as in our study, there was significant difference between the achievements of children with autism and children with typical development in the area of maintaining balance, because the examinees from the experimental group achieved significantly lower results. Finally, we should mention the work of Liu and Casey (2013). who also examined motor skills in children with ASD by using MABC-2 test.

The experimental group consisted of 30 children (25 males and 5 females) divided into three age groups. The results obtained by examiners show that children with ASD in all three areas of motor tasks (manual dexterity, ball skills, static and dynamic balance) achieved significantly lower scores than children from typical population. The results have shown that 80% of children with ASD, in contrast to the control group, have signs of motor delay. By detailed insight into the work, 77% of children with ASD fell within the red zone, which indicates a significant difficulty in maintaining balance, 3% of children were within the yellow zone, which means that they were in a group of children at risk and 20% of children fell within the green zone, i.e. these children had no difficulties in motor functioning. Children with ASD, as opposed to the typical population of children, achieved statistically lower scores on all activities, including the tests for the evaluation of static and dynamic balance ($p<0.001$).

Conclusion

Based on the results obtained in this study we can conclude that children with autism manifest poorer postural balance than their peers from typical population. This information can play a major role in the process of diagnosing autism, because in addition to the difficulties in communication and social relationships, motor skills in these children as one of the integral components of human functioning are not recognized as a diagnostic criterion. Another practical application is related to the early physical intervention in the form of construction of specialized stimulating programs of physical activities that will affect the improvement of physical performances of children with autism. This stimulation may have a multiple importance; first, the already mentioned reason related to the improvement of physical functions and capabilities, primarily the improvement of balance as a conditio sine qua non of all other skills; second, perhaps more important reason lies in the fact that in this way we enable the children to equally participate, communicate with the environment and to take part in joint activities with other children through playing games, thus contributing to their social development.

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SPOSOBNOST ODRŽAVANJA RAVNOTEŽE KOD DJECE S AUTIZMOM I DJECE IZ TIPIČNIH POPULACIJA

Sažetak

Uvod: Sposobnost za održavanje ravnoteže predstavlja osnovnu funkciju motorike potrebne za svakodnevni rad osoba u društvu. Cilj: Cilj ovog istraživanja je analizirati mogućnost održavanja posturalne ravnoteže u djece s autizmom i djece s tipičnim razvojem. Materijali i metode: Uzorak je sadržavao ukupno 62 djece u dobi od 7-10, muškog spola, od kojih je 31 dijete iz pokusne skupine (E-grupa) imalo dijagnozu autizma, dok je u kontrolna skupina (C-grupa) sastavljena od 31 djeteta iste dobi iz tipične populacije. Sposobnost za održavanje posturalne ravnoteže u obje skupine bila je testirana pomoću tri testa: Prošireni "time up and go" test (ETUGT), Modificirani Funkcionalni Reach Test (M-FRT) i stav na jednoj nozi (OLS) s otvorenim i zatvorenim očima. Istraživanje je provedeno od 2009-2010 na Odsjeku za psiho-fiziološke poremećaje i govornu patologiju "Prof. dr Cvetko Brajović" i OŠ "Braća Baruh", Beograd, Srbija. Rezultati: Rezultati istraživanja pokazuju da je ETUG test pokazao statistički značajnu razliku između skupina u smislu vremena određenog za izvršenje testa, dok kod upotrebe M-FRT testa ispitanici iz E-skupine postižu značajno slabije rezultate nego u C-skupini. Kada se koristi OLS test bez poveza, ispitanici iz E-skupine također postižu statistički niže rezultate od C-grupe, na obje noge, a također postignuća E-skupine u obavljanju radnje lijevom i desnom nogom su bila znatno niža kada je korišten povez. Zaključak: Rezultati pokazuju da djeca s autizmom postižu, u odnosu na svoje vršnjake iz tipične populacije, niže vrijednosti na svim primijenjenim testovima za procjenu posturalne ravnoteže.

***Ključne riječi**: posturalna ravnoteža, autizam*

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