Sport Sciences and Health Research

University of Tehran
Faculty of
Physical Education and Sport Science

The effectiveness of cognitive rehabilitation and physical exercise on locomotor movement skill of children with developmental coordination disorder

Ayoub Hashemi[1], Robabeh Rostami[2]*, Habib Hadianfard[3]

1. Department of Motor Behavior, Faculty of Sports Science, University of Tehran, Tehran, Iran.
2. Department of Motor Behavior, Faculty of Education and Psychology, Shiraz University, Shiraz, Iran. (Corresponding author, Email: rostami@shirazu.ac.ir)
3. Department of Clinical Psychology, Faculty of Education and Psychology, Shiraz University, Shiraz, Iran.

Article Info

Original Article

Article history:

Received: 24 December 2020

Revised: 30 January 2020

Accepted: 1 February 2020

Published online: 1 July 2020

Keywords:
cognitive rehabilitation, developmental coordination disorder (DCD), fundamental skills, locomotor movement skill, physical exercise.

Abstract

Introduction: The purpose of this study was to evaluate the effectiveness of cognitive rehabilitation and physical exercise on locomotor movement skill of children with developmental coordination disorder.

Martials and Methods: The present study is a quasi-experimental study with a pre-posttest design with a control group. Eighty boys aged 6-10 years (mean age: 8.68±1.2) were selected from primary school students in Shiraz using multi-stage cluster sampling method and were randomly divided into three experimental (TDCS, Physical exercises and Combined group) and control groups. Developmental Coordination Disorder Questionnaire (DCDQ7), Raven Intelligence Test and Movement Assessment Battery for Children (MABC-2) were used to screen children. The Ulrich Gross Motor Skills Development Test (TGMD-2) was used to assess locomotor movement skills. Experimental groups performed the interventions for 8 weeks (3 sessions per week and 45 min per session). Paired t-test and analysis of covariance were used to analyze the data.

Results: The results showed that the locomotor movement skill score in the groups of cognitive rehabilitation, physical exercise and combined intervention from the pre-test to post-test stages increased significantly (P<0.05). While in the control group no significant difference was observed (P>0.05). The results also showed that locomotor movement skill in the combined groups and physical exercise in the post-test were significantly higher than the cognitive rehabilitation and control groups (P<005).

Conclusion: Concomitant use of cognitive rehabilitation-related interventions with physical exercise is more effective in improving locomotor movement skill in children with developmental coordination disorders.

Cite this article: Hashemi A, Rostami R, Hadianfard H. "The effectiveness of cognitive rehabilitation and physical exercise on locomotor movement skill of children with developmental coordination disorder". *Sport Sciences and Health Research*. 2020, 12(2): 197-205. doi: 10.32598/JESM.12.2.8.

EISSN: 2717-2422 | Web site: https://sshr.ut.ac.ir/ | Email: sshr@ut.ac.ir

 Publisher: University of Tehran, Faculty of Sport Sciences and Health

1. Introduction

Some children, despite their natural appearance, perform less well when compared to their peers in terms of performing motor skills, and often do not have the motor skills needed to perform daily motor activities in life and at school [1]. According to the latest version of the Diagnostic Statistical Manual of Mental Disorders, Fifth Edition, this problem is called Developmental Coordination Disorder (DCD) [2, 3]. The prevalence of this disorder in children aged 4 to 11 years has been reported between 5% and 18% and the prevalence is higher in boys than girls [4]. DCD is one of the most obvious deficiencies in the development of motor skills in preschool and primary school children. DCD is initially manifested as a problem in learning or having skills being required for motor coordination. The other problems of these children are divided into two categories of physical-motor and behavioral [2]. Physical-motor problems include poor physical awareness, impaired gross and fine motor skills, delayed learning of fundamental motor skills, and impaired performance of activities that require constant body posture and activities being required for coordination on both sides of the body [2, 5].

The studies of different researchers examining activity patterns and biological and familial factors in children with and without DCD concluded that children with DCD are significantly more inactive, with lower levels of physical fitness, less muscle strength, and a higher body mass index than their peers [1]. Impairment in the fundamental motor skills is one of the disorders observed in children with DCD [1, 3, 4]. Children with DCD are generally interpreted as clumsy or poorly coordinated and are weaker than their peers due to difficulty in fine and gross motor skills [6, 7]. Motor skills are the basis of performing sports skills that can be very important because of the effect it has on individual and group activities of children in childhood as well as in adulthood [8].

Deficiency in fundamental motor skills creates significant problems in the academic, cognitive, social and motor performance of children with DCD [6, 7]. DCD has been a constant concern of some parents, educators, teachers, and researchers in motor science and rehabilitation [9]; To the extent that various interventions have been performed to improve or at least reduce the symptoms in these children.

Previous researches have shown that exercise interventions are effective in improving motor and perceptual development in children with DCD [1, 4, 9]. Cognitive rehabilitation is an effective approach that improves people's performance by targeting cognitive domains [10, 11]. One of the complementary and facilitative methods of cognitive and therapeutic rehabilitation and learning of motor skills is the use of direct transcranial electrical stimulation (TDCS) [10, 12]. TDCS has been widely used over the past decade as a non-invasive, inexpensive, and safe complement method; It has been tested to change the excitability of the cerebral cortex by altering the resting potential of cortical neurons [12, 13]. Research on different samples has shown that TDCS can modify behavior [14], accelerate learning [15] and increase performance [13]. Researchers also believe that non-invasive brain stimulation combined with adjuvant therapies can be used as an emerging strategy in nerve rehabilitation to increase neuroplasticity [11, 15].

Recently, intervention methods based on cognitive-motor activities have attracted a lot of attention including both motor and cognitive parts, but if they are in the form of activities that simultaneously affect the motor and cognitive aspects, they will be most useful [16]. Researchers have found that cognitive-motor training relies on a process called neural elasticity, during which the brain can make new neural connections [17]. Exercise-motor interventions can play a major role in improving motor disability in children with DCD, but the use of new methods and complementary therapies facilitating the effect of exercise on improving motor skills in children and reducing the duration of exercise interventions is important [12, 13].

Recent research, on the other hand, has shown that when TDCS is used in conjunction with standard training methods or movement protocols their effectiveness increases significantly [14, 15]. Because many of these children are receiving medication and report significant side effects, the spread of non-pharmacological methods is important, and parents, like these children, often prefer alternative methods. Also, information about the use of this type of intervention (cognitive-motor) in children, especially children with DCD is very limited.

Therefore, the aim of this study was to investigate the effect of cognitive rehabilitation and physical exercise (PE) on locomotor movement skill of children with DCD.

2. Materials and Methods

The present study was quasi-experimental and applied in terms of results. In this research, a pre-post test design with a control group has been used. The statistical population of the present study consisted of all male students aged 6 to 10 years in Khonj city. Due to the nature of the research that accompanies the intervention, the research samples were selected as multi-stage clusters. Initially, children suspected of having DCD were identified through school physical education teachers and educators, and then the Developmental Coordination Disorder Questionnaire (DCDQ7) was given to parents to complete.

According to the research, scores below 47 are reported as children with DCD [1, 17]. Then, to confirm the diagnosis and ensure the existence of developmental coordination disorder, Movement Assessment Battery for Children (MABC-2) test was used. Final confirmation was done by a specialist psychiatrist.

After obtaining parental consent and obtaining a written consent form, 80 of these students entered the study as a sample. After taking the pre-test, they were randomly divided into four groups of 20 people, including (1) TDCS intervention group, (2) PE group, (3) TDCS & PE intervention group, and (4) control group. Parents were assured that all information about their children would be kept confidential. Obtaining consent from parents, score obtained in the Developmental Coordination Disorder Questionnaire less than 47, normal IQ in Raven IQ test and no physical limitations, including conditions for entering the research and not participating in pre-test and post-test stages and missing more than 2 sessions in training programs and unwillingness to participate in the continuation of the research were the criteria for excluding people from the present study.

After collecting the demographic characteristics (age, height, weight), the researcher was allowed to intervene by the

parents. Prior to the exercise program, the purpose of the study was explained to the subject's parents and written consent was obtained. In the pre-test, the Ulrich Motor Skills Test (TGMD-2) was used to assess children's locomotor movement skill. After taking a pre-test from the subjects, the experimental group received the research intervention for 8 weeks (3 sessions per week). PE (Spark trainings) includes a set of specialized exercises that affect the body and mind and, while increasing the strength and endurance of all body parts, target the deepest muscles of the body and include exercise, games and active creativity for children [1, 17].

In this study, a two-channel electrical excitation device (Chattanooga) was used and adjusted the current intensity to an accuracy of 0.1 milli Ampere (mA). Subjects in the TDCS & PE groups received electrical stimulation (1 mA) in each session combined with PE. In such a way that three people were present in each training session and simultaneously with PE (Spark trainings), each person received electrical stimulation from the skull for 20 min (anodic stimulation on the left DLPFC (F3) and cathode stimulation on the right DLPFC (F4) was placed) [10, 15]. The location of negative and positive electrodes was determined by a clinical psychologist and according to international systems, the placement of 10-20 electrodes on the desired sites. The group of PE and fake electrical stimulation, in each session along with PE (Spark trainings, 45 min per session), electrical stimulation was induced as a placebo; thus, along with PE, they received electrical stimulation for 30 sec, and after 30 sec, the device turned off automatically. The actual electrical stimulation group received only electrical stimulation for 20 min per session, and the control group resumed their daily and normal activities.

At the end of the last intervention session, the development of locomotor movement skill of children was assessed using the tools mentioned in the pre-test and the pre-test and post-test scores were compared. The present study was conducted under the supervision of a clinical psychologist who is licensed by the Psychological System Organization and registered with the ethics code IR-KHU.KRC.1000.142 in the ethics committee of the Research Institute of Motor Sciences.

In this study, the mean, standard deviation was used to analyze the data and the dependent t-test. The analysis of covariance was used to determine the effectiveness of the interventions at a significance level of a= 0.05 with SPSS software version 22. Also, for statistical analysis, Shapiro-Wilk test was used to check the normality of the data. Homogeneity of variance was also assessed by Levin test.

Table 1. Demographic profile of participants

Groups	Mean ± SD			t	*P*
	Age (y)	Height (cm)	Weight (kg)		
TDCS group (n=20)	8.64±1.3	130±2.70	30.45±2.80	0.149	0.901
PE group (n=20)	8.68±1.2	131±1.95	31.09±1.67	0.325	0.760
TDCS + PE group (n=20)	8.69±1.1	132±2.32	31.50±1.87	0.938	0.361
Control group (n=20)	8.66±1.2	131±1.90	30.67±2.49	0.653	0.431

3. Results

First, in the descriptive statistics section, demographic characteristics were examined. Table 1 presents the values related to the descriptive indicators of the participants, such as the Mean±SD age, height, and weight of all participants in the research groups.

Table 2 shows the mean and standard deviation of groups' performance skills in the pre-test and post-test stages. As can be seen in Table 2, locomotor movement skill in the groups of TDCS, PE and combined (TDCS & PE) from pretest to posttest increased significantly (P<0.05) while in the control group, no significant change was observed (P>0.05).

Before performing the analysis of covariance, the assumptions of this test were tested. The results of Shapiro-Wilk test (F= 0.941, P= 0.184), Levin (F= 0.987, P= 0.327) and regression homogeneity test (F= 0.636, P= 0.3329) showed that the researcher is able to use the analysis of covariance to compare the effect between experimental and control groups in the post-test. The results of this test are presented in Table 3.

Table 2. Mean and standard deviation of locomotor movement skill

Groups	Measurement steps		Variation	Intragroup comparisons		
	Pre-test	Post- test		t	DF	*P*
TDCS	17.50±2.30	21.40±1.70	3.90±2.10	8.50	19	0.002*
PE	17.42±2.59	23.10±1.29	5.68±2.15	11.80	19	0.004*
TDCS + PE	17.10±2.13	25.87±1.70	8.77±1.83	13.59	19	0.001*
Control	17.50±2.69	17.73±2.21	0.23±1.34	-0.340	19	0.429

*P<0.05

Table 3. Summary of covariance analysis results to compare locomotor movement skill

Resources	Sum of square	DF	Mean od square	F	*P*	Eta square	Power
Pretest effect	34.20	1	34.20	0.368	0.409	0.009	0.080
Group	1049.69	3	349.34	20.29	0.001*	0.87	0.99
Error	986.90	75	13.20				
Total	2069.70	80					

*P<0.05

In general, the results of the present study showed that after controlling the pre-test level, the effect of the group on the performance of locomotor movement skill is significant (P= 0.001). This means that there is a significant difference between the study groups in the post-test (P<0.05). According to the adjusted means, the locomotor movement performance of the combined and PE groups were significantly higher than the TDCS and control groups (P<0.05). The performance of the TDCS group was higher than the control group and the combined intervention group had more progress than all research groups.

4. Discussion

The aim of this study was to investigate the effect of cognitive rehabilitation and PE on locomotor movement skill of children with DCD. The results showed that the performance of locomotor movement skill increased after cognitive rehabilitation and PE interventions. The experimental group being selected under the intervention of PE

showed a significant advantage over the control group. In line with the results of this study, McDonough et al. (2020) [19], Navarro et al. (2021) [10] and Sit et al. (2019) [20] also confirm the increase in performance of locomotor movement skill due to PE.

McDonough et al. (2020) in a review study examined the effect of PE on the development of motor skills in children aged 6 to 12 years. The results of a review of articles published between 2000 and 2020 showed that PE has a positive effect on children's motor skills [18].

Navarro et al. (2021) investigated the effect of 6 weeks of selected PE on improving the motor fitness of DCD preschool children. Based on the results, a specific PE program performed by a specialist will help improve manipulation, targeting, and balance skills, as well as better performance in the motor skills of preschool children with mobility problems [9].

Sit et al. (2019) examined the effect of school based physical activity on the development of fundamental motor skills of 131 DCD children and showed that 8 weeks of school based PE improves the fundamental motor of these children [19].

There are many therapeutic approaches including occupational therapy, physiotherapy, medicine, nutrition and education to improve children with DCD; one of which is PE interventions [1, 9]. This approach emphasizes close senses, including sensory, tactile, and vestibular senses, and states that providing appropriate stimuli to help these children requires activities that promote movement throughout the body and provide training in specific motor and perceptual skills [9, 18, 19].

In general, therapeutic approaches fall into three categories: process-oriented, task-oriented, and occupational therapy [6, 8]. Process-oriented approaches believe that improving body functions such as sensory integration and muscle strength can improve an individual's ability in daily life [20].

As a result, it can be said that the practice intervention of the present study as a process-oriented therapy with the involvement of the individual in a perceptual motor process can improve the locomotor movement skill of children with DCD [19, 21]. Specialized exercises related to fundamental motor skills with increasing levels of motivation, variety of movements and enjoyment of physical activity, have led to the development of physical self-concept in children, which in turn leads to participation in organized sports activities in the future [2, 5].

The results of the present study can also be explained by relying on ecological theories, such as the view of dynamic systems; because these perspectives emphasize that the factors affecting motor development include the characteristics of motor task in relation to the individual and the environment (factors of experience and learning) and these factors are effective in the development of stable motor skills, locomotor and object control skills [8, 19]. On the other hand, the results of the present study showed that cognitive rehabilitation (TDCS) is an appropriate intervention to improve the locomotor movement skill of children with DCD. The experimental group that underwent TDCS showed a significant advantage over the control group in locomotor movement skill. The results of the present study are in line with the findings of Grohs et al. (2020) [13], Cole et al. (2018) [22], Arias et al. (2016) [11], and Wade and Hammond (2015) [12]. Arias et

al. (2016) examined the effect of TDCS of the primary motor cortex on a rapid arm targeting task and showed that electrical stimulation of the brain reduces pre-movement time and fatigue during fast motor tasks [10]. Wade and Hammond (2015) also showed that TDCS facilitates reaction time when performing a sequential behavioral test [11]. Grohs et al. (2020) [13] and Cole et al. (2018) [22] also reported the positive effect of TDCS intervention on improving motor function of children with DCD.

In the effect of electrical stimulation on the improvement of motor performances, modulation of cortical motor excitability, cortical ductility as well as excited motor potentials in the area under the anode electrode have been mentioned [10]. The electric field generated by TDCS causes the displacement of polar molecules and most of the neurotransmitters and receptors in these areas of the brain, and increases motor learning by improving the activity of these areas [14, 15]. Transcranial electrical stimulation of the brain can reduce the amount of inhibitory nerve carriers or increase the excited nerve carriers. By improving the parameters that stimulate cortical stimulation, it increases mobility [22, 23].

Abdelmoula et al. (2016) stated that when direct electric current is stimulated from the skull to the motor area, the sensory-motor area is also stimulated at the same time. Since the sensory-motor area is responsible for receiving and processing, it is responsible for information and emotions from the environment. It can be said that the effects of direct cranial stimulation on adjacent areas may have improved motor performance by affecting sensory-motor integration [24]. The results of the present study on the significant effect of PE on locomotor movement skill are in contradiction with the findings of Williams and Hodges (2005) [25] and Saraco (2000) [26]. Williams and Hodges (2005) believe that participation in motor activities had no effect on improvement fundamental motor skills. While confirming the theory of maturity, they pointed out that fundamental motor skills are improved only on the basis of age and maturity [25]. Saraco (2000) also reported that there was no significant difference in the performance of some selected games and activities between children who had completed preschool and children who had not [26]. These conflicting findings may be due to different training protocols or due to limited time.

Finally, the results of the present study regarding the significant effect of cognitive rehabilitation intervention (TDCS) on locomotor movement skill are in contradiction with the findings of Foerster et al. (2017) [16], Kaminski et al. (2017) [27], and Zandvliet et al. (2018) [28]. The discrepancy between the results of the present study and these studies may be due to the intervention protocol used. For example, the number of intervention sessions, the frequency used, the number and location of the electrodes, whether the electrode is a cathode or anode; or be a measurement tool in pre-test and post-test or even subjects in the research. Despite the positive results of the present research interventions (PE and TDCS), among the limitations of this research include being monogamous (boys), not paying attention to the socio-economic differences of the research samples and also not performing the retention test (elimination of temporary effects of research intervention).

5. Conclusion

Overall, the results of the present study

showed that TDCS and PE can have a positive effect on the locomotor movement skill of children with DCD. These interventions as a non-pharmacological treatment can be used in these people and can be useful and effective in improving the fundamental motor skills which is one of the major problems of people with DCD. According to the research results, it can be said that because childhood is the most important period of motor development and it is a good year to diagnose children's problems, timely intervention and prevention of their emotional, social and educational problems, so intervention in this age compared to other periods is fruitful and more useful in order to prevent future problems for children.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

Conceptualization & Methodology: all author; Investigation: Ayoub Hashemi; Writing– original draft: Ayoub Hashemi, Robabeh Rostsmi; Writing– review & editing: all author; Supervision: Robabeh Rostami, Habib Hadianfard.

Ethical considerations

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

Funding

The present article is an extract from the postdoctoral plan of the first author of the research, which was carried out with the support of the National Elite Foundation and Shiraz University.

Acknowledgments

The authors would like to thank all students and teachers who participated in this study accurately and kindly.

References

[1] Smits-Engelsman B, et al., "Evaluating the evidence for motor-based interventions in developmental coordination disorder: A systematic review and meta-analysis". *Research in Developmental Disabilities*, 2018; 74: 72-102.

[2] Derikx DF, Schoemaker MM. "The nature of coordination and control problems in children with developmental coordination disorder during ball catching: A systematic review". *Human Movement Science*, 2020; 74: 102688.

[3] RahimiSani S. et al., "Effects of virtual reality training intervention on predictive motor control of children with DCD–A randomized controlled trial". *Research in Developmental Disabilities*, 2020; 107: 103768.

[4] Neto J.L.C., Steenbergen B, Tudella E. "Motor intervention with and without Nintendo® Wii for children with developmental coordination disorder: protocol for a randomized clinical trial". *Trials*, 2019; 20(1): 1-12.

[5] Biotteau M, Chaix Y, Albaret JM. "What do we really know about motor learning in children with developmental coordination disorder?" *Current Developmental Disorders Reports*, 2016; 3(2): 152-160.

[6] Harrowell I. et al. "The impact of developmental coordination disorder on educational achievement in secondary school". *Research in Developmental Disabilities*, 2018; 72: 13-22.

[7] Zwicker JG, Harris S, Klassen A. "Quality of life domains affected in children with developmental coordination disorder: a systematic review". *Child: Care, Health and Development*, 2013; 39(4): 562-580.

[8] Goodway JD, Ozmun JC, Gallahue DL. *Understanding motor development: Infants, children, adolescents, adults*. Jones & Bartlett Learning, 2019.

[9] Navarro-Patón R. et al. "Effect of a 6-week physical education intervention on motor competence in pre-school children with developmental coordination disorder". *Journal of Clinical Medicine*, 2021, 10(9): 1936.

[10] Arias P, et al. "Bilateral tDCS on primary motor cortex: Effects on fast arm reaching tasks". *PLoS One*, 2016; 11(8): e0160063.

[11] Wade S, Hammond G. "Anodal transcranial direct current stimulation over premotor cortex facilitates observational learning of a motor sequence". *European Journal of Neuroscience*, 2015; 41(12): 1597-1602.

[12] Grohs MN et al. "Effects of transcranial direct current stimulation on motor function in children 8–12 years with developmental coordination disorder: A randomized controlled trial". *Frontiers in Human Neuroscience*, 2020.

[13] Mortezanejad M, et al. "Comparing the effects of multi-session anodal trans-cranial direct current stimulation of primary motor and dorsolateral prefrontal cortices on fatigue and quality of life in patients with multiple sclerosis: a double-blind, randomized, sham-controlled trial". *Clinical Rehabilitation*, 2020; 34(8): 1103-1111.

[14] Cheng PWC, et al. "The effects of transcranial direct current stimulation (tDCS) on clinical symptoms in schizophrenia: A systematic review and meta-analysis". *Asian Journal of Psychiatry*, 2020; 53: 102392.

[15] Foerster Á, et al. "Cerebellar transcranial direct current stimulation (ctDCS) impairs balance control in healthy individuals". *The Cerebellum*, 2017; 16(4): 872-875.

[16] Janssen CP, Brumby DP. "Strategic adaptation to performance objectives in a dual-task setting". *Cognitive Science*, 2010; 34(8): 1548-1560.

[17] Schott N, El-Rajab I, Klotzbier T. "Cognitive-motor interference during fine and gross motor tasks in children with Developmental Coordination Disorder (DCD)". *Research in Developmental Disabilities*, 2016; 57: 136-148.

[18] McDonough DJ, Liu W, Gao Z. "Effects of Physical Activity on Children's Motor Skill Development: A Systematic Review of Randomized Controlled Trials". *Biomed Research International*, 2020.

[19] Sit CHP, et al. "A school-based physical activity intervention for children with developmental coordination disorder: a randomized controlled trial". *Research in Developmental Disabilities*, 2019; 89: 1-9.

[20] Neto JLC, et al. "Wii training versus non-Wii task-specific training on motor learning in children with developmental coordination disorder: A randomized controlled trial". *Annals of Physical and Rehabilitation Medicine*, 2021; 64(2): 101390.

[21] Jane JY, Burnett AF, Sit CH. "Motor skill interventions in children with developmental coordination disorder: a systematic review and meta-analysis". *Archives Of Physical Medicine and Rehabilitation*, 2018; 99(10): 2076-2099.

[22] Cole L, et al. "Effects of high-definition and conventional transcranial direct-current stimulation on motor learning in children". *Frontiers in Neuroscience*, 2018; 12: 787.

[23] Zewdie E, et al. "Safety and tolerability of transcranial magnetic and direct current stimulation in children: prospective single center evidence from 3.5 million stimulations". *Brain Stimulation*, 2020; 13(3): 565-575.

[24] Abdelmoula A, Baudry S, Duchateau J. "Anodal transcranial direct current stimulation enhances time to task failure of a submaximal contraction of elbow flexors without changing corticospinal excitability". *Neuroscience*, 2016; 322: 94-103.

[25] Williams AM, Hodges NJ. "Practice, instruction and skill acquisition in soccer: Challenging tradition". *Journal of Sports Sciences*, 2005; 23(6): 637-650.

[26] Saraco M. "Comparison between integrated physical education and motor skills children, teaching elementary physical education". *Journal Quarterly*, 2000; 74(4): 45-54.

[27] Kaminski E, et al. "Anodal transcranial direct current stimulation does not facilitate dynamic balance task learning in healthy old adults". *Frontiers in Human Neuroscience*, 2017; 11: 16.

[28] Zandvliet SB, et al. "Short-term effects of cerebellar tDCS on standing balance performance in patients with chronic stroke and healthy age-matched elderly". *The Cerebellum*, 2018; 17(5): 575-589.