American Journal of Sports Science and Medicine, 2015, Vol. 3, No. 5, 85-89
Available online at http://pubs.sciepub.com/ajssm/3/5/1
© Science and Education Publishing
DOI:10.12691/ajssm-3-5-1

The Effect of Swimming Exercise on Motor Development Level in Adolescents with Intellectual Disabilities

Elif Top*

Faculty of Sport Sciences, Usak University, Turkey
*Corresponding author: elif.top@usak.edu.tr

Abstract **Objectives:** In this study, it was aimed to analyze the effect of swimming exercise on motor development level in adolescents with intellectual disabilities. **Methods:** A total of 30 mild intellectual disability (MID) individuals between 15-18 age groups participated the study. Bruininks–Oseretsky Test of Motor Proficiency-Second Edition (BOT-2)- Short Form were performed to determine basic motor characteristics of children. BOT-2-Short Form was applied to the participants before and after the ten-month swimming exercise program (60 dk/ 3 days /10 week). **Results:** According to research findings, in terms of body weight, manual dexterity, speed and agility, upper limb coordination, and BOT-2 total point parameters, there was no statistically significant difference found between groups, measurements (pre-test and post-test), groups and their measurements ($p>0.05$). In terms of fine motor precision, and fine motor integration parameters, while there was no statistically significant difference found between groups ($p>0.05$); a significant statistical difference was found between measurements (pre-test and post-test), groups and their measurements ($p<0.05$). In terms of bilateral coordination parameter, while there was no statistically significant difference found between measurements (pre-test and post-test), groups and their measurements ($p>0.05$); a significant statistical difference was found between groups ($p<0.05$). In terms of balance parameter and strength, while there was no statistically significant difference found between groups, groups and measurements ($p>0.05$); statistically significant difference was found between measurements (pre-test and post-test) ($p<0.05$). **Conclusion:** Consequently, regularly applied exercise programmes improve life quality level of individuals with MID by contributing to their motor development level.

Keywords: *motor development, intellectual disabilities, exercise*

Cite This Article: Elif Top, "The Effect of Swimming Exercise on Motor Development Level in Adolescents with Intellectual Disabilities." *American Journal of Sports Science and Medicine*, vol. 3, no. 5 (2015): 85-89. doi: 10.12691/ajssm-3-5-1.

1. Introduction

Motor development has been identified as one of the important areas of a child's development [1]. Human motor development is a process of changes continuously. Motor development is seen as a progressive change in movement behaviour and occurs over the human life cycle. However, specialist defined motor development as a study of changes in human behaviour that occur in life, the processes that cause these changes and the factors that influence it [2]. According to data published by schools, the highest population among handicapped students belongs to children with intellectual disabilities (ID) [3]. Intellectual disabilities are characterized by limitations in cognitive functioning and includes severe deficits or limitations in an individual's skills in several areas such as cognitive, motor, psychosocial, language and specific activities of daily living (4]. Limitations in motor abilities is a common characteristic in persons with ID, since ID is a condition of deficient brain development, which affects the cognitive as well as the motor functions [4,5]. According to some research, children with MID showed delays in the development of motor skills [6,7,8]. Moreover, results of study showed that the level of motor and cognitive functioning are related in children with ID [8]. Alongside impairments in cognitive and motor function, individuals with ID also account lower levels of physical fitness at all stages of life because of inactive life style, less opportunities for physical exercise, the ID condition itself [9,10]. Individuals with ID have also lower physical fitness levels than general population [11,12,13]. The reason for low level of physical fitness of mentally handicapped children compared to their peers would be that they practice less physical activity models [14]. Since handicapped children survive a sedentary life style, they are exposed to health risk as well [15]. It is reported that physical fitness is necessary for health. Studies reveal that individuals with ID have low level of physical fitness in comparison with their non-handicapped peers [12,16]; and they are statistically in higher risk group in terms of disease, death, and health problem [17]. When individuals with ID participated in planned exercise programs, could improve motor performance parameters, daily activities and quality of life [9,18,19]. Therefore, the present study is conducted to investigate effect of 10-week swimming exercise on motor development levels of individuals with ID aged 15-18.

2. Material and Methods

2.1. Participants

A total of 30 adolescents (age = 17.23 ± 1.43 years) with ID participated in the study. Participants were divided into groups of experimental (6 females, 8 males) and control (5 females, 11 males). Fourteen of the students (mean age = 17.43 ± 1.55 years, height = 156.00 ± 10.60 cm, body weight = 61.85 ± 14.80 kg) comprised the experimental group and attended a 10 week swimming exercise program. Sixteen participants (mean age = 17.06 ± 1.34 years, height = 161.25 ± 10.94 cm, body weight = 60.06 ± 15.73 kg) comprising the control group followed their regular school schedule. Ethical approval was obtained from the University Human Ethics Committee. Parents of all children were informed through form about the study and a written consent was taken from each family about participation in study. It was ensured that all participants received health report for each participant from health institutions before 10-week swimming exercise.

2.2. Level of Intelligence

Before commencement of the study, The intelligence quotients (IQ) of the participants was determined with a Weschler Intelligence Scale test by the Guidance and Research Center of the Uşak City National Education Directorship. Scores obtained through these test were not published since it is not ethical; only educational diagnosis of participants was presented. Based on these diagnosis studies, the participants had intelligence quotients (IQ) that was within a range for individuals with mild intellectual disability (50-70 IQ).

3. Measurements

3.1. Motor Assessment

For motor development evaluation of participants, the BOT-2 Test (Short Form) was utilized. The BOT-2 (Short Form) consists of 14 test items from 8 subtests: (1) Fine motor precision: drawing line through crooked paths and folding paper; (2) Fine motor integration: copying a square and copying a star; (3) Manual dexterity: transferring pennies; (4) Bilateral coordination: jumping in place - same side synchronized and tapping feet and fingers - same sides synchronized; (5) Balance: walking forward on a line and standing on one leg on a balance beam - eyes open; (6) Speed and Agility: jumping on one leg; (7) Upper limb coordination: dropping and catching a ball with both hands, and dribbling a ball with alternating hands; (8) Strength: knee push-ups and sit ups. BOT-2 (Short Form) is a well-known measure of motor proficiency designed to provide clinicians, educators and researchers with useful information to assist them in evaluating the motor skills in students ranging from those who are normally developing to those with moderate motor skill deficits aged 4-21 years [20].

Height: Height measurements of participants were taken while they are standing on a flat surface with bare foot; their body weights were measured as it is distributed equally on both legs while their toes are adjoined and it was contacting with height measurement tool, while their head is on the Frankfort plan, and arms released from shoulders freely on both sides. Two measurements were taken and their averages were calculated and registered [21].

Body Weight: Measurement of body weight was conducted by means of Jawon Make (Model IOI-353) brand body composition analyzer. This device is a system that has a clean steel surface on which bare foot contacts and is capable of making analysis through 5, 50, 250 KHz frequency from one leg to another [22]. Weight was measured with sensitivity of 0.1 while participants were in a light dress and on bare feet.

3.2. Swimming Exercise Program

During 10-week swimming exercises, activities performed by the individuals with ID were prepared based on the Special Olympics Swimming Guide and other resources about swimming [23,24]. Exercises were performed under supervision of 20 helpers and a head coach who are trained about swimming (60 minutes/3 days/10 weeks).

3.3. Statistical Analysis

Windows SPSS IBM 21.0 statistical software is utilized in statistical analysis. For statistical analysis, results were displayed as average values and standard deviation. In comparisons, α= 0.05 significance level is taken into consideration. In order to determine whether there is significant difference among groups in terms of age and height values, T-test was conducted for two independent groups. Time-dependent change in all parameters was tested by means of Repeated Measure Anova test in repeated measurements.

4. Results

Results of the study showed that there was no significant difference between average heights of the study group (156,00 ± 10,60 cm) and the control group (161,25 ± 10,94 cm) (t.(28); 1,330). Moreover, there was no significant difference between study group (17,43 ± 1,55 years) and the control group (17,06 ± 1,34 years) in terms of average age (t.(28); ,494) (P>0.05, Table 1).

Table 1. T test Results of Groups Regarding to Height and Age

	Groups	*N*	*Mean*	*Sd*	*MD*	*SE*	*t*	*Sig.*
Height	*Experimental*	14	156.00	10.60	-5.250	2.834	1.330	.194
	Control	16	161.25	10.94		2.736		
Age	*Experimental*	14	17.43	1.55	.366	.416	.693	.494
	Control	16	17.06	1.34		.335		

*p< 0.05.

According to research findings, in terms of body weight parameter, there was no statistically significant difference found between groups, measurements (pre-test and post-test), groups and their measurements (p>0.05). In terms of

fine motor precision and fine motor integration parameter, while there was no statistically significant difference found between groups (p>0.05); a significant statistical difference was found between measurements (pre-test and post-test), groups and their measurements (p<0.05) (Table 2).

Table 2. Variance Analysis Results Regarding to Body Weight, Fine motor precision and Fine

			Groups	N	df	Mean	Sd	F	Sig.
Body Weight	*Group*		*Experimental*	14	1	61.84	4.08	.036	.850
			Control	16	28	60.77	3.82		
	Measurements		*Measurement 1*		*1*	*60.96*	*2.80*	*1.970*	*.171*
			Measurement 2		*28*	*61.65*	*2.81*		
	*Group*Measurement*	*Experimental*	*Measurement 1*		*1*	*61.85*	*4.09*	*2.135*	*.155*
			Measurement 2		*28*	*61.82*	*4.11*		
		Control	*Measurement 1*		*1*	*60.06*	*3.82*		
			Measurement 2		*28*	*61.48*	*3.85*		
Fine motor precision	*Group*		*Experimental*	*14*	*1*	*7.42*	*.99*	*.067*	*.798*
			Control	*16*	*28*	*7.78*	*.93*		
	Measurements		*Measurement 1*		*1*	*6.75*	*.68*	*18.155*	*.000**
			Measurement 2		*28*	*8.45*	*.73*		
	*Group*Measurement*	*Experimental*	*Measurement 1*		*1*	*6.14*	*1.00*	*4.905*	*.035**
			Measurement 2		*28*	*8.71*	*1.06*		
		Control	*Measurement 1*		*1*	*7.37*	*.94*		
			Measurement 2		*28*	*8.18*	*.99*		
Fine motor integration	*Group*		*Experimental*	*14*	*1*	*5.71*	*.68*	*.479*	*.494*
			Control	*16*	*28*	*5.06*	*.64*		
	Measurements		*Measurement 1*		*1*	*5.00*	*.52*	*6.895*	*.014**
			Measurement 2		*28*	*5.77*	*.46*		
	*Group*Measurement*	*Experimental*	*Measurement 1*		*1*	*5.00*	*.76*	*4.855*	*.036**
			Measurement 2		*28*	*6.42*	*.67*		
		Control	*Measurement 1*		*1*	*5.00*	*.71*		
			Measurement 2		*28*	*5.12*	*.62*		

*p< 0.05.

According to research findings, in terms of manual dexterity parameter, there was no statistically significant difference found between groups, measurements (pre-test and post-test), groups and their measurements (p>0.05). In terms of bilateral coordination parameter, while there was no statistically significant difference found between measurements (pre-test and post-test), groups and their measurements (p>0.05); a significant statistical difference was found between groups (p<0.05). In terms of balance parameter, while there was no statistically significant difference found between groups, groups and measurements (p>0.05); statistically significant difference was found between measurements (pre-test and post-test) (p<0.05) (Table 3).

Table 3. Variance Analysis Results Regarding to Manual dexterity, Bilateral coordination and Balance

			Groups	N	df	Mean	Sd	F	Sig.
Manual dexterity	*Group*		*Experimental*	14	1	3.53	.50	.000	.995
			Control	16	28	3.53	.47		
	Measurements		*Measurement 1*		*1*	*3.66*	*.36*	*1.825*	*.188*
			Measurement 2		*28*	*3.40*	*.35*		
	*Group*Measurement*	*Experimental*	*Measurement 1*		*1*	*3.64*	*.53*	*.063*	*.803*
			Measurement 2		*28*	*3.42*	*.52*		
		Control	*Measurement 1*		*1*	*3.68*	*.49*		
			Measurement 2		*28*	*3.37*	*.48*		
Bilateral coordination	*Group*		*Experimental*	*14*	*1*	*3.71*	*.63*	*6.077*	*.020**
			Control	*16*	*28*	*1.56*	*.59*		
	Measurements		*Measurement 1*		*1*	*2.48*	*.47*	*.722*	*.403*
			Measurement 2		*28*	*2.79*	*.47*		
	*Group*Measurement*	*Experimental*	*Measurement 1*		*1*	*3.28*	*.68*	*2.401*	*.132*
			Measurement 2		*28*	*4.14*	*.68*		
		Control	*Measurement 1*		*1*	*1.68*	*.64*		
			Measurement 2		*28*	*1.43*	*.64*		
Balance	*Group*		*Experimental*	*14*	*1*	*5.57*	*.56*	*.551*	*.464*
			Control	*16*	*28*	*5.00*	*.52*		
	Measurements		*Measurement 1*		*1*	*4.85*	*.45*	*5.973*	*.021**
			Measurement 2		*28*	*5.71*	*.38*		
	*Group*Measurement*	*Experimental*	*Measurement 1*		*1*	*5.21*	*.66*	*.166*	*.687*
			Measurement 2		*28*	*5.92*	*.56*		
		Control	*Measurement 1*		*1*	*4.50*	*.62*		
			Measurement 2		*28*	*5.50*	*.52*		

*p<0 .05.

Based on the results of the present study, in terms of speed and agility parameter, and upper limb coordination, there was no statistically significant difference found between groups, measurements (pre-test and post-test),

groups and their measurements (p>0.05). The results of strength showed that there was a significant difference in measurements (pre-test and post-test) (p<0.05), while it was no found significant difference between groups, and groups and measurements (p>0.05) (Table 4).

According to the results of test parameters of BOT-2 total point, there was no statistically significant difference found between groups, measurements (pre-test and post-test), groups and their measurements (p>0.05) (Table 5).

Table 4. Variance Analysis Results Regarding to Speed and Agility, Upper limb coordination and Strength

			Groups	*N*	*df*	*Mean*	*Sd*	*F*	*Sig.*
Speed and Agility	*Group*		*Experimental*	14	1	4.35	.68	.843	.366
			Control	16	28	3.50	.63		
	Measurements		*Measurement 1*		*1*	*3.80*	*.46*	*.396*	*.534*
			Measurement 2		*28*	*4.05*	*.54*		
	*Group*Measurement*	*Experimental*	*Measurement 1*		*1*	*4.35*	*.67*	*.396*	*.534*
			Measurement 2		*28*	*4.35*	*.80*		
		Control	*Measurement 1*		*1*	*3.25*	*.63*		
			Measurement 2		*28*	*3.75*	*.75*		
Upper limb coordination	*Group*		*Experimental*	*14*	*1*	*8.28*	*.98*	*4.146*	*.051*
			Control	*16*	*28*	*5.53*	*.92*		
	Measurements		*Measurement 1*		*1*	*7.42*	*.69*	*3.957*	*.057*
			Measurement 2		*28*	*6.38*	*.75*		
	*Group*Measurement*	*Experimental*	*Measurement 1*		*1*	*8.85*	*1.01*	*.039*	*.846*
			Measurement 2		*28*	*7.71*	*1.10*		
		Control	*Measurement 1*		*1*	*6.00*	*.94*		
			Measurement 2		*28*	*5.06*	*1.03*		
Strength	*Group*		*Experimental*	*14*	*1*	*5.96*	*.84*	*1.223*	*.278*
			Control	*16*	*28*	*4.68*	*.78*		
	Measurements		*Measurement 1*		*1*	*6.62*	*.73*	*15.577*	*.000**
			Measurement 2		*28*	*4.03*	*.58*		
	*Group*Measurement*	*Experimental*	*Measurement 1*		*1*	*7.92*	*1.07*	*4.167*	*.051*
			Measurement 2		*28*	*4.00*	*.85*		
		Control	*Measurement 1*		*1*	*5.31*	*1.00*		
			Measurement 2		*28*	*4.06*	*.79*		

*p< 0.05.

Table 5. Variance Analysis Results Regarding to Total Point

			Groups	*N*	*df*	*Mean*	*Sd*	*F*	*Sig.*
Total Point	*Group*		*Experimental*	14	1	44.57	4.77	1.467	.236
			Control	16	28	36.65	4.46		
	Measurements		*Measurement 1*		*1*	*40.62*	*3.33*	*.000*	*.991*
			Measurement 2		*28*	*40.60*	*3.30*		
	*Group*Measurement*	*Experimental*	*Measurement 1*		*1*	*44.42*	*4.87*	*.066*	*.799*
			Measurement 2		*28*	*44.71*	*4.82*		
		Control	*Measurement 1*		*1*	*36.81*	*4.55*		
			Measurement 2		*28*	*36.50*	*4.51*		

*p< 0.05.

5. Discussion

This study investigated the effect of swimming exercise on motor development level in adolescents with intellectual disabilities. Results of the study showed that there was no statistically significant difference found in terms of body weight, manual dexterity, speed and agility, upper limb coordination, and BOT-2 total point parameters between groups, measurements (pre-test and post-test), groups and their measurements. But, Westendorp et al. [4] found that in the MID group, the object-control subtest scores of the children who participated in sports were significantly higher than the scores for those who did not participate in sports. Moreover, the locomotor skill scores between sports participants and non-participants were not significantly different in the MID group. In a similar study, motor performance on the sub-scale ball skills showed motor problems in 63.6% and 44.3%, in children with mild ID and borderline intellectual functioning, respectively [8]. As stated by Westendorp et al. [4] that even a small problem in intellectual functioning leads to poor object-control skills. Object-control skills are usually practiced in complex play and sport settings that require adaptation to changing environmental circumstances [25].

Muscle strength and balance is essential for many mobility tasks. In terms of fine motor precision, and fine motor integration parameters, while there was no statistically significant difference found between groups; a significant statistical difference was found between measurements (pre-test and post-test), groups and their measurements. In terms of bilateral coordination parameter, while there was no statistically significant difference found between measurements (pre-test and post-test), groups and their measurements; a significant statistical difference was found between groups. In Carmeli et al. [26] study, Group A who received specific muscle and balance exercises, had significantly higher values in balance and muscle strength parameters than the pre training values and Group B who received general exercises. Strength decreases in both group, could be explained lack of motivation of individuals with ID during testing and tendency to stop when uncomfortable in this study [27]. In

terms of balance and strength parameter, while there was no statistically significant difference found between groups, groups and measurements; statistically significant difference was found between measurements (pre-test and post-test). Giagazoglou et al. [5] stated that the hippotherapy intervention program resulted in significant improvements in strength parameters, and on the more complex balance task. Blomqvist et al. [28] found that adolescents with ID had significantly lower scores in the balance and muscle performance tests. In a study by Giagazoglou et al. [10], trampoline intervention resulted in significant improvements of participants' performance in all motor and balance tests. Limitations in mobility reported to be common in persons with ID, which suggests that the prevalence of balance problems is also high. There are many reasons which might contribute to limitations in balance and gait capacities with ID. Firstly, ID is a condition of arrest or deficient development of the mind, which does not only affect cognitive functions, but motor functions as well. A second mechanism is premature aging [29].

Low motor performans in children with ID and motor problems could be explained with avoid participation in culturally normative activities like sports [19,30], social and communication problems [30], ID itself, sedentary life style. Therefore, extra training, preferably task-specific is recommended to improve the gross and fine motor skills of children with mild ID. Furthermore, the development of these skills should be an important component of the physical education lessons at schools to promote long-term physical activity and sports participation. In general, it could be said that exercise model which used in this study, had positive effect on the level of individuals' motor development. Consequently, regularly applied exercise programmes improve life quality level of individuals with MID by contributing to their motor development level.

References

[1] Hazel MYL. Assessment of preschoolers' gross motor proficiency: Revisiting Bruininks-Oseretsky Test of Motor Proficiency. Early Child Development and Care (2011); 181(2):189-201.

[2] Borhannudin A, Wan MWJ, Ahmad FMA. The development of gross motor analysis system software: A preliminary concept. Procedia- Social and Behavioral Sciences (2012); 64:501-506.

[3] Faison-Hodge J, Poretta D. Physical activity levels of students with mental retardation and students without disabilities. Adapted Physical Activity Quarterly (2004); 21:139-152.

[4] Westendorp M, Houwen S, Hartman E, Visscher C. Are gross motor skills and sports participation related in children with intellectual disabilities? Research in Developmental Disabilities (2011); 32:1147-1153.

[5] Giagazoglou P, Arabatzi F, Dipla K, Liga M, Kellis E. Effect of a hippotherapy intervention program on static balance and strength in adolescents with intellectual disabilities. Research in Developmental Disabilities (2012); 33:2265-2270.

[6] Rarick GL (ed.). Motor performance of mentally retarded children. In: Physical Activity: Human Growth and Development (ed. G. L. Rarick) (1973); pp. 225-56. Academic Press, NewYork.

[7] Bouffard M. Movement problem solutions by educable mentally handicapped individuals. Adapted Physical Activity Quarterly (1990); 7: 183-97.

[8] Vuijk PJ, Hartman E, Scherder E, Visscher C. Motor performance of children with mild intellectual disability and borderline intellectual functioning. Journal of Intellectual Disability Research (2010); 54(11):955-965.

[9] Frey, G.C., Stanish, H.I., Temple, V.A. (2008). Physical activity of youth with intellectual disability: Review and research agenda. Adapted Physical Activity Quarterly, 25:95-117.

[10] Giagazoglou P, Kokaridas D, Sidiropoulou M, Patsiaouras A, Karra C, Neofotistou K. Effects of a trampoline exercise intervention on motor performance and balance ability of children with intellectual disabilities. Research in Developmental Disabilities (2013); 34:2701-2707.

[11] Temple VA, Frey GC, Stanish HI. Physical activity of adults with mental retardation: Review and research needs. American Journal of Health Promotion (2006); 21(1):2-12.

[12] Pitetti KH, Yarmer DA, Fernhall B. Cardiovascular fitness and body composition of youth with and without mental retardation. Adapted Physical Activity Quarterly (2001); 18:127-141.

[13] Pitetti KH, Yarmer DA. Lower body strength of children and adolescents with and without mental retardation: A comparison. Adapted Physical Activity Quarterly (2002); 19:68-81.

[14] Pitetti KH, Beets MW, Combs C. Physical activity levels of children with intellectual disabilities during school. Medicine and Science in Sports and Exercise (2009); 41(8):1580-1586.

[15] Ayvazoglu NR, Ratliffe T, Kozub FM. Encouraging lifetime physical fitness. Teaching Exceptional Children (2004); 37(2): 16-20.

[16] Gillespie, M. (2003). Cardiovascular fitness of young Canadian children with and without mental retardation. Education and Training in Developmental Disabilities, 38, 296-301.

[17] Phillips AC, Holland AJ. Assessment of objectively measured physical activity levels in individuals with intellectual disabilities with and without Down's Syndrome. PLoS ONE (2011); 6(12).

[18] Chanias AK, Reid G, Hoover ML. Exercise effects on health-related physical fitness of individuals with an intellectual disability: A meta-analysis. Adapted Physical Activity Quarterly (1998); 15:119-140.

[19] Wall AET. The developmental skill-learning gap hypothesis: Implications for children with movement difficulties. Adapted Physical Activity Quarterly (2004); 21:197-218.

[20] Bruininks RH, Bruininks BD. Bruininks-Oseretsky Test of Motor Proficiency (2nd ed.). Windsor: NFER-Nelson (2005).

[21] Lohman TG, Roche AF, Martorell R. Anthropometric Standardization Referance Manual. Illinois: Human Kinetics Books Champaigne (1988).

[22] Chen YC, Tu YK, Huang KC, Chen PC, Chu DC, Lee YL. Pathway from central obesity to childhood asthma. Physical fitness and sedentary time are leading factors. American Journal of Respiratory and Critical Care Medicine (2014); 189(10): 1194-1203.

[23] Special Olympics. Aquatics Coaching Guide. specialolympics.org/soi/files/sports/Aquatics+Coaching+Guide (2004).

[24] Maglischo EW. Swimming Fastest: The essential reference on technique, training, and program design. Champaign, IL: Human Kinetics (2003).

[25] Houwen S, Visscher C, Hartman E, Lemmink KAPM. Gross motor skills and sports participation of children with visual impairments. Research Quarterly for Exercise and Sport (2007); 78:16-23.

[26] Carmeli E, Vaknin TZ, Morad M, Merrick J. Can physical training have an effect on well-being in adults with mild intellectual disability?. Mechanisms of Ageing and Development (2005); 126:299-304.

[27] Graham A, Reid G. Physical fitness of adults with an intellectual disability: A 13-year follow-up study. Research Quarterly for Exercise and Sport (2000); 71: 152-161.

[28] Blomqvist S, Olsson J, Wallin L, Wester A, Rehn B. Adolescents with intellectual disability have reduced postural balance and muscle performance in trunk and lower limbs compared to peers without intellectual disability. Research in Developmental Disabilities (2013); 34:198-206.

[29] Enkelaar L, Smulders E, Valk HSL, Geurts ACH, Weerdesteyn V. A review of balance and gait capacities in relation to falls in persons with intellectual disabilities. Research in Developmental Disabilities (2012); 33: 291-306.

[30] Hartman E, Houwen S, Scherder E, Visscher C. On the relationship between motor performance and executive functioning in children with intellectual disabilities. Journal of Intellectual Disability Research (2010); 54(5):468-477.