Art. #2273, 10 pages, https://doi.org/10.15700/saje.v44n1a2273

The effects of a manipulative skills intervention programme on the motor proficiency of adolescents with intellectual disabilities

Aleksandra Aleksić Veljković, Marija Stojanović and Nenad Stojiljković
Faculty of Sport and Physical Education, University of Nis, Niš, Serbia
aleksic.veljkovic@gmail.com

With this study we aimed to investigate the impact of a 12-week manipulative skills exercise programme on the motor proficiency of young individuals with intellectual disabilities. A total of 32 learners diagnosed with mild intellectual disabilities, with an average age of 17.81 ± 1.44 years, were divided into 2 equal-sized groups: a control group and an experimental group engaged in a manipulative skills intervention programme. Motor proficiency was assessed using the short form of the Bruininks-Oseretsky Test of Motor Proficiency Second Edition (BOT™-2), while the participants' coordination level was evaluated using the Body Coordination composite of the BOT™-2. Results show that the manipulative skills intervention programme led to significant improvements in the experimental group's total motor proficiency score on the short form BOT™-2 (45.31 ± 12.01 vs. 37.12 ± 7.00, ANCOVA: $F = 48.65$, $p = 0.00$) as well as the Body Coordination composite (42.69 ± 11.31 vs. 39.84 ± 11.75, ANCOVA: $F = 44.35$, $p = 0.00$). These findings suggest that the experimental exercise programme had a positive effect on enhancing the motor proficiency of young individuals with mild intellectual disabilities.

Keywords: Bruininks-Oseretsky Test; intellectual disabilities; motor skills; physical education

Introduction

Young individuals with intellectual impairments (ID) commonly experience notable restrictions in their intellectual functioning and adaptive behaviour (Maïano, Hue & April, 2019). Intellectual functioning pertains to cognitive capabilities such as reasoning, problem-solving, and learning, which typically fall below average compared to their peers. On the other hand, adaptive behavior encompasses the practical skills required for everyday living and social interaction (Top, 2015). Motor problems are a common issue in people with intellectual disabilities because intellectual disabilities have been known as one of the frequent causes of cognitive and motor function impairment (Cleaver, Hunter & Ouellette-Kuntz, 2009; Hartman, Houwen, Scherder & Visscher, 2010). In addition to these deficiencies, individuals with intellectual disabilities are known to exhibit reduced motor skill proficiency across all ages, due to a sedentary lifestyle, fewer opportunities for physical exercise and the nature of the disability itself (Lotan, Isakov, Kessel & Merrick, 2004; Stanish, Temple & Frey, 2006).

The significance of enhancing motor skill performance in children with borderline and mild intellectual disabilities (ID) is underscored in a study conducted by Vuijk, Hartman, Scherder and Visscher (2010). There was a correlation between the degree of ID and the performance of manual dexterity, ball skills, and balancing skills in children with ID and a substantial increase in borderline and definite motor impairments compared to the normative sample (Vuijk et al., 2010). The findings of this study provide evidence supporting the idea that there is a connection between the level of motor and cognitive functioning in children with ID. This is because having sufficient motor skills can contribute to long-term engagement in physical activities, participation in sports, and the adoption of healthy lifestyles, ensuring a lifelong enjoyment of such pursuits (Vuijk et al., 2010).

Literature Review

The vast majority of earlier motor studies focused on how children's motor systems functioned (Hartman et al., 2010; Jenni, Fintelmann, Caflisch, Latal, Rousson & Chaouch, 2015; Vuijk et al., 2010; Wuang, Wang, Huang & Su, 2008), whereas only a small number of studies have had adolescents as their main respondents (Ninot, Bilard & Delignières, 2005; Ninot, Bilard, Delignières & Sokolowski, 2000; Top, 2015). Maïano et al. (2019) conducted a systematic review where they examined the results of 14 studies in which the impact of motor skill interventions on fundamental movement skills (FMS) in children and adolescents with intellectual disabilities (ID) were investigated. The review found that most of the studies focused on children with ID and their balance skills. The findings from these studies strongly indicate that motor skill interventions are highly effective in improving balance skills in children with ID (Maïano et al., 2019). In other words, the results suggest that children with ID showed a significant improvement in their balance skills when participating in motor skill interventions.

According to Han, Fu, Cobley and Sanders (2018), the most beneficial duration and training load (session duration and frequency), as well as the exact measure of long-term sustainability of motor skill interventions, remain unknown. The authors of the study (Han et al., 2018) recommend that future research should focus on examining these matters in more detail, with a particular emphasis on enhancing the methodology of motor skill interventions for younger individuals with intellectual disabilities.

Theoretical/Conceptual Framework

At this point, according to Maïano et al. (2019), insufficient evidence was available to clearly indicate whether motor skill interventions were in fact effective with regard to the improvement of locomotor and object control skills in children and adolescents with intellectual disabilities. The effects of motor skill interventions on the fundamental motor skills of children and adolescents with intellectual disabilities should be more systematically investigated in subsequent studies (Han et al., 2018). Işık and Zorba (2020) have conducted a research study reporting that the balance and coordination capacities of individuals with intellectual disabilities can be improved by implementing basic training programmes. These training programmes, however, must take into account an adequate level of exercise and the degree of the disability. In this respect, Işık and Zorba (2020) clearly demonstrate the effectiveness of the basic training programme of hemsball as a sport, especially in the case of those individuals diagnosed with moderate intellectual disabilities. According to the international education system, as advocated by Hall and Theron (2016), the most equitable approach to supporting individuals with intellectual disabilities (ID) is by integrating them into regular mainstream education.

Inclusion pertains to the practice of educating learners with disabilities, including intellectual disabilities (ID), in regular classrooms alongside their typically developing peers providing them with the necessary support and accommodations to address their individual needs (Hall & Theron, 2016).

As practice has shown, modern medicine cannot guarantee the treatment of intellectual disability (Jankowicz-Szymanska, Mikolajczyk & Wojtanowski, 2012). However, additional opportunities are available to significantly improve the quality of life of people with intellectual disabilities. These opportunities include engaging in physical exercise to improve coordination, posture, and overall daily functioning, as highlighted by Bertelli and Brown (2006). Different models of physical exercise have thus shown to have a notable impact on the overall improvement of motor skills (Bertelli & Brown, 2006). Further research on the effects of various exercise programmes can help identify those that are particularly effective for this population. However, none of the motor skills interventions reviewed in earlier studies have focused on the locomotor and object control skills of adolescents with ID. The aim with our study was, therefore, to determine the effects of a 12-week manipulative skills exercise programme on the motor efficiency and body coordination in adolescents diagnosed with mild intellectual disabilities.

Method

Participants

The participants in the study included 32 learners from the special school “14 October” in Nis, Serbia, who were diagnosed with mild intellectual disabilities. The sample consisted of 22 male and 10 female participants, with an average age of 17.81 ± 1.44 years at the beginning of the study, or 18.06 ± 1.33 years at the final measurement. The average body mass was 70.40 ± 17.53 kg, the average height was 170.89 ± 11.52 cm and the average Body Mass Index (BMI) was = 24.19 ± 6.20 kg / m^2. The sample was randomly divided into two smaller subsamples. An impartial researcher was assigned the task of generating random numbers (using a computer-generated randomisation method) in order to allocate participants into groups. The researcher conducting this task was unaware of the group assignments, maintaining blinding throughout the process. The experimental group consisted of 16 learners (11 male and five female participants) aged 17.70 ± 1.33 at the initial measurement (i.e., 17.95 ± 1.53 years at the final measurement). The weight and height of the individuals were assessed using a calibrated electronic scale. The measurements were taken while the participants were wearing lightweight sports clothing and without shoes. The average body mass in this group was 69.64 ± 18.87 kg, body height 186.34 ± 13.30 cm and BMI 24.86 ± 7.46 kg/m^2. The members of the experimental group took part in an experimental exercise programme during the physical education classes. The exercise sessions occurred twice a week for a duration of 12 weeks, with each session lasting 45 minutes. It is worth mentioning that, given the sensitivity of the population involved, the attendance rate in the experimental exercise programme was notably high. On average, the attendance rate was 77.46% (specifically, 79.63% for girls and 76.39% for boys). At the beginning of the research, the inclusion criteria for attendance were established at 75%.

A total of 16 learners comprised the control group, 11 of whom were male and five female. At the initial measurement, their average age was 17.87 ± 1.56 years (or 18.12 ± 0.90 years at the final measurement). The members of the control group had an average body mass of 69.91 ± 17.42 kg, body height of 173.28 ± 9.15 cm, and BMI of 23.14 ± 5.05 kg/m^2. These individuals participated in general physical education sessions, attending twice a week for a duration of 12 weeks, with each session lasting 45 minutes.

The participant selection was authorised through a decision by the Ethics Board at the Faculty of Sport and Physical Education, University of Nis. After obtaining the required approval, the learners’ guardians provided informed consent forms, which included medical reports confirming their suitability for participation in the programme. Following this, a meeting was conducted with the parents of the 32 learners with intellectual disabilities to provide them with detailed information about the study.

Testing Procedures

The measurement tools used to evaluate motor skills consisted of the short form of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT™-2) (Bruininks & Bruininks, 2010), along with two specific subtests from the BOT™-2: the bilateral coordination and balance test battery. These assessments were employed to gauge the participants' development in terms of body coordination. The BOT™-2 test was specifically designed to detect minor to moderate motor coordination impairments in individuals aged 4 to 21. All the subtests within the bilateral coordination and balance section were collectively referred to as "33 total motor composites of body coordination." Qualified professionals who were experienced in working with adolescents with mild intellectual disabilities administered both the pre- and post-tests and the intervention programme. To ensure consistency, all participants were required to visit the gym and undergo the testing procedures at the same time of day. The gym was appropriately illuminated and air temperature of 22 °C was maintained.

The Manipulative Skills Intervention Programme

The exercise programme used in the experimental group encompassed not only exercises targeting the enhancement of manipulation skills but also exercises aimed at improving various motor abilities, such as strength, speed, bilateral coordination, upper body coordination, balance, manual dexterity, running speed, and agility.

The exercise programme included polygons with balls from a variety of sports such as basketball, volleyball, handball and tennis. The experimental exercise programme lasted for 3 months (12 weeks), with 2 additional weeks that served to facilitate the initial and the final measurement of the participants' overall motor proficiency. The experimental exercise programme was integrated into the regular physical education classes and held twice a week for 45 minutes. Prior to the start of the programme, an initial measurement was conducted. The participants in the experimental group followed a specifically designed exercise programme outlined in Table 1. On the other hand, the control group participants engaged in the standard activities programme, which was a part of the regular physical education classes offered in secondary schools as recommended by the Ministry of Education of the Republic of Serbia. The final measurement was carried out upon the conclusion of the experiment.

Table 1 Manipulative skills intervention programme (The first 4 weeks of the exercise programme as a sample)

Exercise programme			
First week	Second week	Third week	Fourth week
• different walking and standing (on both legs) tasks along the line and Swedish beam; • bouncing and catching a tennis ball with one (dominant and non-dominant hand) or both hands in place and walking; • game of passing a tennis ball; • bouncing a tennis ball against a wall with one (dominant and non-dominant hand) or both hands; • shooting a target on the wall with a tennis ball from a distance of 6 feet; • perform all exercises with a basketball, except for shooting a target on the wall, which is performed with a volleyball; • fingering a volleyball in a circular formation with the teacher involved; • targeting the basket (hoop) from the free throw line; • **Polygon 1**: dribbling with the pass of a basketball in two lines as a competitive game (divide the learners into two equal lines facing each other).	• different forms of walking on the Swedish bench and the reverse Swedish bench; • standing along a line on one or both legs with eyes closed; • various simple games of throwing and catching a tennis ball in a circular formation with a teacher in the centre (dominant, non-dominant hand and both hands); • throwing, bouncing and catching a basketball and volleyball against a wall in the pairs (game "you throw-I'll catch"); Balance exercises: standing on both or one leg with eyes open or closed; walking on a low beam with different hand positions; standing along a low beam on one leg and with eyes open; • bouncing on the floor of different balls with one hand or alternating them in place; • dribbling the different types of balls in motion (walking, jogging) with dominant and with non-dominant hand; • **Polygon 2**: group game of throwing and catching the basketball with both hands and targeting the hoop from the paint zone line. The game includes five to six pupil and the nearest to the hoop targeting it. Make rotations until each of the learners is in the position for targeting the hoop.	• Balance exercises – different variations: on the line, on the Swedish bench, inverted Swedish bench, low beam on one or both legs, with eyes open or closed; • Do all the exercises that were done in the previous week; • one hand bouncing a tennis ball in place (10 times with dominant and 10 times with non-dominant hand; three repetitions each); • dribbling the different types of balls (tennis ball, handball, volleyball and basketball) in motion (walking, jogging, running) across the width of the hall (twice dominant and twice non-dominant hand); • throwing and catching a tennis ball with or without bouncing in a circular formation (two rotations with the dominant hand and two rotations with the non-dominant hand); • **Polygon 3**: (the game of dribbling a tennis ball in pairs) – the learners are arranged opposite each other in two rows at a width of the hall distance; learners in one row have tennis balls that they dribble with the dominant hand to their teammate, give it to him and stay in that place. A teammate dribbles the same tennis ball moving to the place of the first learner.	• Balance exercises – different variations: on the line, on the Swedish bench, inverted Swedish bench, low beam on one or both legs, with eyes open or closed; • one hand bouncing a tennis ball in place with the dominant and with the non-dominant hand; • alternately bouncing different types of balls (tennis ball, handball, volleyball and basketball) in place; • polygon 3; polygon 1; polygon 2; • **Polygon 4**: (rotation game at the basketball paint zone) – the learners are placed in five positions along the racket line and each of them has one basketball in their hands. At the teacher's voice instruction, the learner targets the basket from his position, the teacher returns the ball to him with both hands and the learner catches it in the same way. One rotation is completed when each learner has completed the same task; • **Polygon 5**: (rotation game at the basketball court three-point zone) – it is the same, except that learners are on the three-point line (one rotation); • **Polygon 6**: all learners stand in a line at the starting position on the baseline. The first learner dribbles the ball with the dominant hand along the three points line, reaches the paint zone line, targets the basket, catches the bounced ball regardless of the outcome and passes it to the next learner in the row.

The members of the control group attended regular physical education classes at school, twice a week for 45 minutes. Throughout the experimental period, the control group participants did not engage in any additional exercise programme apart from the one prescribed by their regular physical education classes.

Statistical Analysis

The collected data from the study were analysed using Statistical Package for the Social Sciences (SPSS) 20.0 for Windows. The results of the Kolmogorov-Smirnov test indicate that the data followed a normal distribution ($p > .005$). To assess the differences between the two groups, analysis of variance (ANOVA) and analysis of covariance (ANCOVA) were employed. Statistical significance was considered at a threshold of $p \leq 0.05$.

Results

Table 2 presents the descriptive statistics for both groups of participants and the results of the ANOVA analysis. The absence of statistically significant differences in age and BMI indicates the overall similarity between the two groups being examined.

In addition, Table 2 also displays the mean, standard deviations, and between-group differences for the pre-training and post-training measurements. No statistically significant differences were observed between the two groups during the initial measurement. However, the final measurements showed a significant difference in the total score of the BOT™-2 short form ($F = 5.54$, $p = 0.025$), as well as in the balance, bilateral coordination, and coordination composite score.

Table 2 Descriptive statistics, ANOVA and ANCOVA

		Initial measurement				Final measurement					
				Anova				Anova		Ancova	
Variable	Group	*M*	*SD*	*F*	*p*	*M*	*SD*	*F*	*p*	*F*	Sig.
F	Experimental	38.562	9.959	2.778	.106	45.312	12.015	5.545	.025*	48.655	.000
	Control	33.312	7.717			37.125	7.004				
	Total	35.937	9.161			41.219	10.530				
Bilateral coordination	Experimental	6.500	3.286	3.105	.088	10.438	5.125	.283	.599	27.301	.000
	Control	4.625	2.705			7.563	4.351				
	Total	5.562	3.110			9.000	4.899				
Balance	Experimental	9.125	4.177	.283	.599	13.375	5.875	.030	.864	64.370	.000
	Control	10.125	6.259			13.000	6.356				
	Total	9.625	5.259			13.188	6.024				
Body coordination composite	Experimental	32.250	6.445	.151	.700	42.000	12.149	1.080	.307	44.358	.000
	Control	31.250	8.021			37.688	11.312				
	Total	31.750	7.175			39.844	11.753				

Note. *M* – Mean; *SD* – standard deviation; *F*– ratio of two variances (Anova), *F* *$p < .005$, Sig. = statistical significance.

Discussion

A fairly limited number of studies exist in which changes in motor abilities of children and adolescents with mild intellectual disabilities, especially after the implementation of an experimental exercise programme were examined. Referring to children or adolescents with intellectual disabilities, the most frequent approach is the screening of either specific motor abilities or overall motor skill proficiency (Jeoung, 2018). The lack of consistency in the use of certain test batteries, aimed at evaluating motor abilities of children and younger people with mild to moderate intellectual disabilities, makes it difficult to monitor and compare the results obtained by different studies (Frey, Stanish & Temple, 2008). The short form of the BOT™-2 test battery allows researchers to analyse the overall results using standardised values. Our study expands on the standardised data and also considers the ages of the participants. While only one variable (the BOT™-2 short form total motor proficiency score) showed statistically significant differences between groups in the initial analysis, the ANCOVA analysis revealed differences in all the variables examined.

The experimental exercise programme consisted of numerous tasks involving tennis balls (throwing, catching, rebounding, target-based shooting, etc.), contributing to a significant improvement in the individuals' manual abilities. Thus, the obtained results are in line with the results of the research conducted by Top (2015) and Wuang et al. (2008). In the latter two research studies the authors also found a statistically significant change in the composites of the Manual Coordination and Fine Manual Control (Wuang et al., 2008). This was also the case in the two additional subtests, i.e. the Fine Motor Precision and Fine Motor Integration (Top, 2015), respectively. Wuang, Ho and Su (2013) examined the impact of a 20-week long individual home therapy on the motor abilities of children with mild intellectual disabilities aged 6 to 12 years. The exercise programme was conducted individually at home, with each participant dedicating 15 minutes to daily sessions. The results showed that after 10 weeks, there was no significant difference in motor abilities between the experimental and control groups. However, after 20 weeks, statistically significant differences were found in specific areas. The composites of fine manual control and manual coordination showed a significant difference (p = 0.02). However, no significant differences were observed in the other composites, namely body coordination (p = 0.42) and strength and agility (p = 0.30).

Similar to our study, Top (2015) examined changes in the motor skills of a population of young people with mild intellectual disabilities (aged 17.43 ± 1.55) after a 10-week swimming programme implemented three times a week, for 60 minutes. The programme itself was prescribed by the Special Olympics movement. The obtained data were interpreted using subtests rather than composites. Nevertheless, similar results to those of our study were obtained. A statistically significant difference was observed between the experimental and the control group in the final subtest testing, i.e., in the fine motor precision (p = 0.035), and fine motor integration (p = 0.036). However, in contrast to the results of our study, no statistically significant difference was found with reference to the total motor proficiency score (p = 0.799).

Furthermore, it should be noted that all members of the experimental group, irrespective of gender, actively took part in the exercise programme, attending approximately 77.46% of all the classes. Among the boys, the attendance rate was 76.39% of classes, while girls had a slightly higher attendance rate of 79.76% of classes. This represents a noteworthy precedent, considering the fact that girls tend to avoid physical education classes once they enter puberty (Duncan, 2007). Owing to such heightened motivation, learners in our study seemed to have performed more complex tasks without major difficulties. As a result, this may have played a role in the positive outcomes observed in the intervention exercise programme.

Although a large number of balance and polygon exercises, aimed at improving body coordination, were included in the experimental exercise programme, no statistically significant changes were observed in this particular motor ability. Similar results were obtained by Top (2015) and Wuang et al. (2013) in their research studies. Nevertheless, the studies conducted by Giagazoglou, Arabatzi, Dipla, Liga and Kellis (2012) and Giagazoglou, Kokaridas, Sidiropoulou, Patsiaouras, Karra and Neofotistou (2013) demonstrate that adequate exercise programmes have the potential to enhance balance abilities. Giagazoglou et al. (2012) examined the impact of a 12-week trampoline exercise programme on the motor abilities of children with moderate intellectual disability with a mean age of 10.3 ± 1.6. In terms of frequency, the exercise programme was carried out on a daily basis, for 20 minutes and it was customised to meet the needs of individual participants. In an additional study, Giagazoglou et al. (2013) examined the effect of a 10-week riding therapy programme in a sample of children with a mean age of 15.3 ± 2.1, who were diagnosed with intellectual disabilities. Both studies employed an electronic platform to test balance and in both cases there were statistically significant changes in the balance variables: standing on one leg with open eyes, and standing on one leg with closed eyes. As the findings of the last-mentioned two studies suggest, it is possible for an experimental exercise programme to influence balance. This, however, was not the case in our study. One of the interfering factors in the ability monitoring domain in our study may have been the choice of the balance tests for the short form of BOT™-2 (provided by Bruininks & Bruininks, 2010). The previous body of research (Dehghani & Gunay, 2015; Kachouri, Borji, Baccouch, Laatar, Rebai & Sahli, 2016; Mehralitabar, Mirjalali, Minoei & Fadaee, 2015) shows a significant improvement in the intervention group, and Gupta, Rao and Kumaran (2011) and Işık and Zorba (2020) report a significantly higher post-test balance skills value, or pre-test to post-test change value in balance skills in the intervention groups compared to the control groups. Finally, a significant pre-test to post-test improvement in the balance skills was reported in the intervention group that was a part of the study by Işık and Zorba (2020).

Based on an analysis of the implemented exercise programme, the resulting outcomes, and a comparison with previous relevant research studies, it can be concluded that the programme used in our study demonstrated effectiveness in enhancing overall motor skills and body coordination. In addition, no health and psychological deterioration was observed in the group with mild intellectual disabilities. All the exercise programmes analysed above in the available, as well as in our research, were implemented in three different ways alone: within regular physical education classes, post regular classes, or individually at home on a daily basis. These three settings should be taken as guidelines for further research.

Increased body awareness resulting from the overall enhancement of motor skills facilitates greater engagement in physical activities, whether it be during physical education classes, sports, or recreational pursuits (Best, 2010). This applies regardless of whether individuals participate alongside peers with impairments or younger individuals without impairments. The practical significance of our research study is that it provides practical guidelines on how certain aspects or the entire experimental exercise programme can be readily implemented within physical education classes in inclusive high schools. In addition, learners in our study seemed to readily accept this exercise programme, which, as this study shows, contributes to the overall increase in motivation thus leading to the heightened in-class exercising. The evidence that the application of the described experimental exercise programme had a positive effect on manual coordination, fine manual control and overall strength, implies that it can be applied to significantly improve the performance of younger populations with mild intellectual disabilities.

Conclusion

Our research study is in line with the global contemporary trends in the monitoring of the effects of various exercise programmes on the improvement of motor skills, components of physical fitness, and increased physical activity of children and youths with intellectual disabilities. The contribution of this research is reflected in the analysis and the explanation of the practical effects that a specially designed exercise programme can have on the motor proficiency of adolescents with mild intellectual disabilities.

Although the aforementioned study offers valuable insights into the impact of a 12-week manipulative skills exercise programme on the motor proficiency of young individuals with intellectual disabilities, it is important to acknowledge certain limitations. One such limitation is the small sample size, with only 32 participants divided into two groups. This limited sample size could restrict the generalisability of the findings and weaken the statistical power of the study. To enhance the reliability of the results, it would be advantageous to have a larger and more diverse sample. Also, the study involved a 12-week exercise programme, which may be considered relatively short for assessing long-term effects. It would be beneficial to conduct follow-up assessments after the intervention period to evaluate whether the improvements in motor proficiency are sustained over time. Addressing these limitations in future studies would enhance the validity, generalisability, and practical implications of the findings related to the effects of manipulative skills exercise programmes on motor proficiency in populations with intellectual disabilities.

Acknowledgement

We would like to express our sincere gratitude to the participants who generously contributed to this study. Special thanks are extended to the staff of the Special School “14 October” in Nis, Serbia, for their cooperation and support throughout the research process. Additionally, we would like to acknowledge the Faculty of Sport and Physical Education, where we are learners and employees, for providing the necessary resources and encouragement for the successful completion of this work.

Authors’ Contributions

All authors conducted the exercise programme and tested the participants. AAV and MS wrote the manuscript, and NS conducted all statistical analyses. All authors reviewed the final manuscript.

Notes

ii. DATES: Received: 18 September 2021; Revised: 15 November 2023; Accepted: 19 January 2024; Published: 29 February 2024.

References

Bertelli M & Brown I 2006. Quality of life for people with intellectual disabilities. *Current Opinion in Psychiatry*, 19(5):508–513.

https://doi.org/10.1097/01.yco.0000238479.81528.9f

Best JR 2010. Effects of physical activity on children's executive function: Contributions of experimental research on aerobic exercise. *Developmental Review*, 30(4):331–351. https://doi.org/10.1016/j.dr.2010.08.001

Bruininks RH & Bruininks BD 2010. *Bruininks-Oseretsky test of motor proficiency* (2nd ed). Circle Pines, MN: AGS Publishing.

Cleaver S, Hunter D & Ouellette-Kuntz H 2009. Physical mobility limitations in adults with intellectual disabilities: A systematic review. *Journal of Intellectual Disability Research*, 53(2):93–105. https://doi.org/10.1111/j.1365-2788.2008.01137.x

Dehghani M & Gunay M 2015. The effect of balance training on static and dynamic balance in children with intellectual disability. *Journal of Applied Environmental and Biological Sciences*, 5(9):127–131. Available at https://www.researchgate.net/profile/Mahrokh-Dehghani/publication/343059419_The_Effect_Of_Balance_Training_On_Static_And_Dynamic_Balance_In_Children_With_Intellectual_Disability/links/5f14ac8fa6fdcc3ed715c78c/The-Effect-Of-Balance-Training-On-Static-And-Dynamic-Balance-In-Children-With-Intellectual-Disability.pdf. Accessed 23 February 2024.

Duncan MC 2007. Sociological dimensions of girls' physical activity participation. In Tucker Center for Research on Girls & Women in Sport (ed). *The 2007 Tucker Center Research Report, Developing physically active girls: An evidence-based multidisciplinary approach*. Minneapolis, MN: Tucker Center for Research on Girls & Women in Sport, College of Education + Human Development, University of Minnesota. Available at https://conservancy.umn.edu/bitstream/handle/11299/48566/2007-Tucker-Center-Research-Report.pdf?sequence=1#page=49. Accessed 23 February 2024.

Frey GC, Stanish HI & Temple VA 2008. Physical activity of youth with intellectual disability: Review and research agenda. *Adapted Physical Activity Quarterly*, 25(2):95–117. https://doi.org/10.1123/apaq.25.2.95

Giagazoglou P, Arabatzi F, Dipla K, Liga M & Kellis E 2012. Effect of a hippotherapy intervention program on static balance and strength in adolescents with intellectual disabilities. *Research in Developmental Disabilities*, 33(6):2265–2270. https://doi.org/10.1016/j.ridd.2012.07.004

Giagazoglou P, Kokaridas D, Sidiropoulou M, Patsiaouras A, Karra C & Neofotistou K 2013. Effects of a trampoline exercise intervention on motor performance and balance ability of children with intellectual disabilities. *Research in Developmental Disabilities*, 34(9):2701–2707. https://doi.org/0.1016/j.ridd.2013.05.034

Gupta S, Rao BK & Kumaran S 2011. Effect of strength and balance training in children with Down's syndrome: A randomized controlled trial. *Clinical Rehabilitation*, 25(5):425–432. https://doi.org/10.1177/0269215510382929

Hall AM & Theron L 2016. How school ecologies facilitate resilience among adolescents with Intellectual Disability: Guidelines for teachers. *South African Journal of Education*, 36(2):Art. # 1154, 13 pages. https://doi.org/10.15700/saje.v36n2a1154

Han A, Fu A, Cobley S & Sanders RH 2018. Effectiveness of exercise intervention on improving fundamental movement skills and motor coordination in overweight/obese children and adolescents: A systematic review. *Journal of Science and Medicine in Sport*, 21(1):89–102. https://doi.org/10.1016/j.jsams.2017.07.001

Hartman E, Houwen S, Scherder E & Visscher C 2010. On the relationship between motor performance and executive functioning in children with intellectual disabilities [Special issue]. *Journal of Intellectual Disability Research*, 54(5):468–477. https://doi.org/10.1111/j.1365-2788.2010.01284.x

Işık M & Zorba E 2020. The effects of hemsball on the motor proficiency of students with intellectual disabilities. *International Journal of Developmental Disabilities*, 66(2):104–112. https://doi.org/10.1080/20473869.2018.1488534

Jankowicz-Szymanska A, Mikolajczyk E & Wojtanowski W 2012. The effect of physical training on static balance in young people with intellectual disability. *Research in Developmental Disabilities*, 33(2):675–681. https://doi.org/10.1016/j.ridd.2011.11.015

Jenni OG, Fintelmann S, Caflisch J, Latal B, Rousson V & Chaouch A 2015. Stability of cognitive performance in children with mild intellectual disability. *Developmental Medicine & Child Neurology*, 57(5):463–469. https://doi.org/10.1111/dmcn.12620

Jeoung B 2018. Motor proficiency differences among students with intellectual disabilities, autism, and developmental disability. *Journal of Exercise Rehabilitation*, 14(2):275–281. https://doi.org/10.12965/jer.1836046.023

Kachouri H, Borji R, Baccouch R, Laatar R, Rebai H & Sahli S 2016. The effect of a combined strength and proprioceptive training on muscle strength and postural balance in boys with intellectual disability: An exploratory study. *Research in Developmental Disabilities*, 53–54:367–376. https://doi.org/10.1016/j.ridd.2016.03.003

Lotan M, Isakov E, Kessel S & Merrick J 2004. Physical fitness and functional ability of children with intellectual disability: Effects of a short-term daily treadmill intervention [Special issue]. *The Scientific World Journal*, 4:449–457. https://doi.org/10.1100/tsw.2004.97

Maïano C, Hue O & April J 2019. Effects of motor skill interventions on fundamental movement skills in children and adolescents with intellectual disabilities: A systematic review. *Journal of Intellectual Disability Research*, 63(9):1163–1179. https://doi.org/10.1111/jir.12618

Mehralitabar H, Mirjalali F, Minoei A & Fadaee E 2015. The impact of Handball Techniques on improving gross motor skills in educable mentally retarded children. *International Journal of Sport Studies*, 5(12):1243–1248. Available at https://silo.tips/download/the-impact-of-handball-techniques-on-improving-gross-motor-skills-in-educable-me. Accessed 21 February 2024.

Ninot G, Bilard J & Delignières D 2005. Effects of integrated or segregated sport participation on the physical self for adolescents with intellectual disabilities. *Journal of Intellectual Disability Research*, 49(9):682–689. https://doi.org/10.1111/j.1365-2788.2005.00407.x

Ninot G, Bilard J, Delignières D & Sokolowski M 2000. Effects of integrated sport participation on perceived competence for adolescents with mental retardation. *Adapted Physical Activity Quarterly*, 17(2):208–221. https://doi.org/10.1123/apaq.17.2.208

Stanish HI, Temple VA & Frey GC 2006. Health-promoting physical activity of adults with mental retardation [Special issue]. *Mental Retardation and Developmental Disabilities Research Reviews*, 12(1):13–21. https://doi.org/10.1002/mrdd.20090

Top E 2015. The effect of swimming exercise on motor development level in adolescents with intellectual disabilities. *American Journal of Sports Science Medicine*, 3(5):85–89. https://doi.org/10.12691/ajssm-3-5-1

Vuijk JP, Hartman E, Scherder E & Visscher C 2010. Motor performance of children with mild intellectual disability and borderline intellectual functioning. *Journal of Intellectual Disability Research*, 54(11):955–965. https://doi.org/10.1111/j.1365-2788.2010.01318.x

Wuang YP, Ho GS & Su CY 2013. Occupational therapy home program for children with intellectual disabilities: A randomized, controlled trial. *Research in Developmental Disabilities*, 34(1):528–537. https://doi.org/10.1016/j.ridd.2012.09.008

Wuang YP, Wang CC, Huang MH & Su CY 2008. Profiles and cognitive predictors of motor functions among early school-age children with mild intellectual disabilities. *Journal of Intellectual Disability Research*, 52(12):1048–1060. https://doi.org/10.1111/j.1365-2788.2008.01096.x