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THE EFFECT OF CLASSICAL AND COMPUTER ASSISTED INSTRUCTION ON THE FUNDAMENTAL MOVEMENT SKILLS OF MILDLY INTELLECTUALLY DISABLED MALE CHILDREN

O EFEITO DA INSTRUÇÃO CLÁSSICA E ASSISTIDA POR COMPUTADOR NAS COMPETÊNCIAS MOTORAS FUNDAMENTAIS DE CRIANÇAS DO SEXO MASCULINO COM DEFICIÊNCIA INTELECTUAL LEVE

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ABSTRACT

The lifelong participation of individuals with disabilities in physical and sporting activities requires the development of fundamental movement skills from an early age. Thus this study aims to investigate the effects of classical and computer-assisted instruction on the physical characteristics, locomotor skills, and object control skills of mildly intellectually disabled (MID) boys. A total of 60 mildly intellectually disabled children participated in this study. Participants were divided into three groups: classical instruction (CI), classical instruction plus computer-assisted instruction (CI + CAI), and control (C) groups. The CI and CI + CAI groups received training for 10 weeks, three hours per week, and one hour per day. Ulrich's gross motor skills tests were administered during the pre-test and post-test. Due to the lack of normal distribution of data, the Kruskal-Wallis test was used for comparisons between the three groups, while the Wilcoxon test was used to determine the differences between pre- and post-test measurements within each group. This study showed no significant difference among three gropus during the pre-test. However, significant differences were found in favor of the CI and CI+CAI groups in locomotor and object control skills during the post-test. The CI+CAI group demonstrated the highest improvement in all locomotor and object control skills. It can be concluded that fundamental movement education is effective in improving the physical characteristics, locomotor skills, and object control skills of MID boys, and that CI + CAI is more effective than CI alone.

Keywords: Intellectually disabled children, locomotor and object control skills, classic and computer aided instruction.

RESUMO

A participação ao longo da vida de indivíduos com deficiência em atividades físicas e desportivas requer o desenvolvimento de competências motoras fundamentais desde cedo. de objetos. Um total de 60 crianças com deficiência intelectual ligeira participaram neste estudo. Os participantes foram divididos em três grupos: instrução clássica (IC), instrução clássica mais instrução assistida por computador (IC + CAI) e grupos de controlo (C). Os grupos CI e CI + CAI receberam formação durante 10 semanas, três horas por semana e uma hora por dia. Os testes de capacidades motoras brutas de Ulrich foram administrados durante o pré-teste e o pós-teste. Devido à falta de distribuição normal dos dados, foi utilizado o teste de Kruskal-Wallis para as comparações entre os três grupos, enquanto o teste de Wilcoxon foi utilizado para determinar as diferenças entre as medidas pré e pós-teste dentro de cada grupo. Este estudo não mostrou diferença significativa entre os três grupos durante o pré-teste. No entanto, foram encontradas diferenças significativas a favor dos grupos IC e IC+CAI nas capacidades locomotoras e de controlo de objetos durante o pós-teste. O grupo CI+CAI demonstrou a maior melhoria em todas as capacidades locomotoras e de controlo de objetos. Pode concluir-se que a educação motora fundamental é eficaz na melhoria das características físicas, das capacidades locomotoras e das capacidades de controlo de objetos dos rapazes MID, e que a IC + CAI é mais eficaz do que a IC isolada.

Palavras-chave: Crianças com deficiência intelectual, capacidades locomotoras e de controlo de objetos, instrução clássica e assistida por computador.

Introduction

Physical activity is essential for healthy growth, development, and quality of life, with particular benefits for children and youth with disabilities (Hills, King, & Armstrong, 2007; Taub & Greer, 2000). Participation in physical activity during childhood and adolescence is a critical predictor of habitual physical activity in adulthood (Telama et al., 2005). Developing a positive attitude towards physical activity and acquiring appropriate skills early in life is crucial, as physical activity requires effort and intention.

In early childhood, the development of fundamental movement skills (FMS) is essential for active participation in lifelong physical and sporting activities, for both typically developing children and those with intellectual disabilities. These skills are categorized as manipulative (e.g., throwing, catching), locomotor (e.g., hopping, running), and stability skills (e.g., balance, weight transfer) (Goodway, Ozmun, & Gallahue, 2021). Proficiency in these fundamental movements forms the foundation for efficient and effective movement in a variety of contexts. It's important to prioritize the accuracy of skill execution over speed or distance, especially in children (Barnett et al., 2016; Logan et al., 2018; Goodway et al., 2021).

Early intervention is key for addressing delays or limitations in gross motor skills, which are common among children with disabilities (Cunningham, 2015). Early childhood is a critical period for learning FMS and reaching biological potential. Delays or deficiencies in intervention during this time may not be fully remediated later in development (Balyi, 2001). Movement training in early childhood can improve quality of life for both children with disabilities and their families. When children with disabilities can participate in play with their peers, it fosters self-confidence and social skills (Cunningham, 2015).

Children with intellectual disabilities have significant limitations in mental and adaptive behaviors, including conceptual, social, and practical skills (Schalock, Luckasson, & Shogren, 2007). Children with an IQ of 50 to 75 are classified as mildly intellectually disabled (MID) (Krebs, 2005). Research indicates that children and adolescents with intellectual disabilities often have lower average locomotor and object control skills compared to their typically developing peers (Gkotzia, Venetsanou, & Kambas, 2017; Westendorp et al., 2011; Rintala & Loovis, 2013; Zikl et al., 2013).

Given that FMS are foundational for various physical and sporting activities, limitations in these skills may lead to decreased willingness and participation in such activities among children with intellectual disabilities. This can result in an inactive lifestyle, increasing the risk of health problems. Young people with intellectual disabilities are known to be less active and have higher rates of overweight and obesity (Hinckson & Curtis, 2013; Maïano, Hue, Morin, & Moullec, 2016). Therefore, improving FMS in this population may increase sports and physical activity participation, reduce health problems, and enhance movement efficiency (Hills et al., 2007; Taub & Greer, 2000).

Traditional instruction, with direct teacher control, is often used in physical education. However, information and communication technologies can also positively impact students' active participation and allow for more personalized learning styles (Stanescu et al., 2011). Computer-aided teaching can provide interactive and instant feedback tailored to individual needs, such as learning speed, readiness, and visual or auditory preferences (Lehmann et al., 1999).

Video modeling, a form of computer-aided instruction, is a promising method for teaching motor skills. It involves demonstrating a skill through lifelike images, allowing learners to observe and imitate correct performance (Jambor, 1996; Darden & Shimon, 2000; Schmidt, 1991).

While the effectiveness of motor skill interventions for children with intellectual disabilities is acknowledged, the impact of these interventions on FMS in this population, particularly in early childhood, hasn't been systematically reviewed (Maïano, Hue, & April, 2019).

Therefore, this study aims to investigate the effects of a 10-week intervention using both classical and computer-aided instruction on the morphological characteristics, locomotor skills, and object control skills of educable intellectually disabled boys aged 6 to 7 years.

Method

Participants

Data were collected from 60 MID boys aged 6-7 years. Participants were randomly assigned to one of three groups: classical instruction (CI), classical instruction plus computer-assisted instruction (CI + CAI), or control (C), with 20 participants in each group.

Inclusion and Exclusion Criteria

Participants were included if they met the following criteria:

- Male, aged 6-7 years
- Living in the city center of Mersin, Turkey
- Diagnosed with mild intellectual disability by a specialist physician
- No diagnosed physical or physiological disabilities

Participants not meeting all criteria were excluded from the study.

Exercise Program and Implementation

Following approval from the Social and Human Sciences Ethics Commission (approval number 2018/004, dated January 16, 2018) and obtaining informed consent from parents, participants engaged in a 10-week planned and structured fundamental movement skills (FMS) intervention. Sessions were conducted on Mondays, Wednesdays, and Fridays for 60 minutes each. The CI + CAI group received both classical (face-to-face) instruction and computer-aided visual instruction, while the CI group received only classical instruction. The control group did not receive any intervention.

Each week, two skills were introduced and practiced, with repetition at the week's end. Overall, each skill was practiced four times throughout the 10-week program. Activities, daily programs, and games were adapted from Walkley, Armstrong, and Clohesy (1998). All groups were assessed before and after the intervention, with two observers evaluating the participants and achieving 96% interobserver reliability.

Measurement Tool

The Test of Gross Motor Development – Second Edition (TGMD-2) was used to assess the motor skills of the participants. This test, standardized for the Turkish population by Tepeli (2007), measures locomotor and object control skills, each with four sub-skills. Locomotor skills include hop, sprint, leap, and side gallop, while object control skills consist of throw, catch, kick, and two-hand strike.

Each skill is assessed based on performance criteria consisting of three to five movement phases. Participants perform each skill twice, receiving one point for correct execution and zero points for incorrect execution (Ulrich, 2000). All skill performances were video-recorded for detailed analysis and to minimize scoring errors.

Statistical Analysis

Following a Kolmogorov-Smirnov test for normality, Kruskal-Wallis tests were used for between-group comparisons. Wilcoxon signed-rank tests were used to determine within-group differences between pre- and post-test measurements. Effect sizes were calculated to determine the magnitude of changes resulting from the intervention using the formula $r = z/\sqrt{N}$ (Rosenthal, 1994).

Results

Table 1 presents the pre-test comparison of physical characteristics (height, weight, BMI) and fundamental movement skills (FMS) among the classical instruction (CI), classical instruction plus computer-assisted instruction (CI + CAI), and control (C) groups. No statistically significant differences were observed in any of these measures among the three groups during the pre-test.

Table 2 shows the post-test comparison of physical characteristics and FMS among the three groups. As in the pre-test, no statistically significant differences were found in physical characteristics after the 10-week intervention. However, there were significant differences in FMS, favoring the CI + CAI group. Specifically, the CI + CAI group had significantly higher post-test FMS scores compared to both the CI and C groups. The CI group also had significantly higher FMS scores than the C group. Overall, the CI + CAI group demonstrated the highest mean values, followed by the CI group and then the C group.

Table 3 presents the pre-test to post-test comparison of physical characteristics and FMS within each group. The Wilcoxon signed-rank test was used to analyze these changes. The CI + CAI group exhibited the greatest training effect in FMS compared to the CI and C groups after the 10-week intervention. Additionally, the CI group, as an exercised group, showed a greater training effect on body height than the control group. For body weight, the CI + CAI group had a larger training effect compared to the CI and C groups. The control group had the highest increase in mean BMI, followed by the CI + CAI group, while the CI group had the lowest increase.

The CI + CAI group demonstrated greater improvements in sprint, hop, leap, and side gallop compared to both the CI and C groups. Notably, the C group showed a decrease in sprint and hop performance. The CI + CAI group also showed greater improvement in two-hand strike and catch compared to the CI and C groups, and in throw compared to the C group. Furthermore, the CI + CAI group showed substantial improvement in kick, a skill the C group was unable to execute.

Overall, the CI and CI + CAI groups significantly improved in all locomotor and object control skills after the 10-week intervention, while the control group's mean values decreased in most skills. The CI + CAI group exhibited the greatest improvements across all assessed locomotor and object control skills.

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Table1 – Comparison of physical characteristics and Fundamental Movement Skills among Classical Instruction (CI), Classical Instruction+ Computer Aided Instruction (CI+CAI) and Control (C) groups in males MID children during pre-test.

Variables	CI n=20		CI+CAI n=20		C n=20		df	Asymp. Sig.	Groups	p
	X̄	SD	X̄	SD	X̄	SD				
Age (in years)	6,94	0,58	7,05	0,52	7,10	0,41	2	,824	N.D.	
Body Height (cm)	128,75	8,77	126,75	7,50	125,45	8,99	2	,420	N.D.	-
Body Weight (kg)	28,55	7,26	27,70	7,69	26,55	7,43	2	,527	N.D.	-
BMI	16,94	2,58	16,97	3,35	16,80	4,14	2	,761	N.D.	-
Sprint	0,80	0,89	0,95	1,05	1,00	0,92	2	,771	**N.D.**	**-**
Hop	1,63	2,02	0,80	1,47	1,05	1,73	2	,457	**N.D.**	**-**
Leap	0,45	0,83	0,15	0,49	0,15	0,37	2	,228	**N.D.**	**-**
Side Gallop	1,80	2,04	2,10	2,00	2,20	2,02	2	,838	**N.D.**	**-**
Two Hand Strike	1,63	1,39	0,90	1,07	1,40	1,14	2	,157	**N.D.**	**-**
Catch	2,25	1,92	1,25	1,41	1,90	1,62	2	,187	**N.D.**	**-**
Kick	2,75	1,92	2,05	1,28	2,45	0,89	2	,152	**N.D.**	**-**
Throw	1,00	1,74	0,65	1,18	1,05	1,36	2	,284	**N.D.**	**-**

ND=No significant difference among groups. *p<.05, **p<.01.2.

Tablo 2 – Comparison of physical characteristics and Fundamental Movement Skills among Classical Instruction (CI), Classical Instruction + Computer Aided Instruction (CI+CAI) and Control (C) groups in males MID children during post-test.

	CI n=20		CI+CAI n=20		C n=20		df	Asymp. Sig.	Groups	p
Variables	**X̄**	**SD**	**X̄**	**SD**	**X̄**	**SD**				
Age (in years)	6,94	0,58	7,05	0,52	7,10	0,41	**2**	824	N.D.	
Body Height (cm)	128,75	8,77	126,75	7,50	125,45	8,99	**2**	,384,	N.D.	-
Body Weight (kg)	28,55	7,26	27,70	7,69	26,55	7,43	**2**	**,510**	N.D.	-
BMI	16,94	2,58	16,97	3,35	16,80	4,14	**2**	,741	N.D.	-
Sprint	0,80	0,89	0,95	1,05	1,00	0,92	**2**	,000**	**CI<CI+CAI; CI<C; CI+CAI<C**	000** .000** .000**
Hop	1,63	2,02	0,80	1,47	1,05	1,73	**2**	,000**	**CI-CI+CAI; CI-C; CI+CAI -C**	.025* .000** .000**
Leap	0,45	0,83	0,15	0,49	0,15	0,37	**2**	,000**	**CI-CI+CAI; CI-C; CI+CAI -C**	.000** .000** .000**
Side Gallop	1,80	2,04	2,10	2,00	2,20	2,02	**2**	,000**	**CI-CI+CAI CI-C CI+CAI -C**	.000** .000** .000**
Two Hand Strike	1,63	1,39	0,90	1,07	1,40	1,14	**2**	,000**	**CI-CI+CAI CI-C CI+CAI -C**	.001** .000** .000**
Catch	2,25	1,92	1,25	1,41	1,90	1,62	**2**	,000**	**CI-CI+CAI CI-C**	.002** .000**
Kick	2,75	1,92	2,05	1,28	2,45	0,89	**2**	,000**	**CI-CI+CAI CI-C CI+CAI-C**	.000** .000** .000**
Throw	1,00	1,74	0,65	1,18	1,05	1,36	**2**	,000**	**CI-CI+CAI CI-C CI+CAI -C**	.000** .000** .000**

ND=No significant difference among groups. *p<.05, **p<.01.2.

Tablo 3 – Comparison of physical characteristics and Fundamental Movement Skills between pre-test and post-testforClassical Instruction (CI), Classical Instruction + Computer Assisted Instruction (CI+CAI) and Control (C) groups in males MID male children.

Variables	Groups	Pre-test		Post-test		Diff.	% Diff.	z-Value	Asymp. Sig.	ES
		X̄	SD	X̄	SD					
Body Height (cm)	CI (n=20)	128,75	8,77	129,55	8,41	0,8	0,62	-3,771	,000**	-0,843‡
	CI+CAI (n=20)	126,75	7,50	127,95	7,13	1,2	0,94	-3,619	,000**	-0,809‡
	C (n=20)	125,45	8,99	126,10	8,68	0,65	0,52	-3,606	000**	-0,806‡
Body Weight (kg)	CI (n=20)	28,55	7,26	28,85	6,42	0,3	1,04	-1,100	,272	-0,246
	CI+CAI (n=20)	27,70	7,69	28,35	7,07	0,65	2,29	-2,804	,005**	-0,627‡
	C (n=20)	26,55	7,43	27,10	6,91	0,55	2,03	-1,853	,064	-0,414†
Body Mass İndex (BMI)	CI (n=20)	16,94	2,58	16,97	2,19	0,03	0,18	-,763	,446	-0,171
	CI+CAI (n=20)	16,97	3,35	17,10	2,94	0,13	0,76	-1,250	,211	-0,280
	C (n=20)	16,80	4,14	16,99	3,74	0,19	1,12	-1,045	,296	-0,234
Sprint	CI (n=20)	0,80	0,89	1,28	0,94	0,48	37,50	-2,557	,011*	-0,572‡
	CI+CAI (n=20)	0,95	1,05	4,40	1,27	3,45	78,41	-3,970	,000**	-0,888‡
	C (n=20)	1,00	0,92	0,85	0,80	-0,15	-17,65	-1,857	,063	-0,415†
Hop	CI (n=20)	1,63	2,02	1,80	2,05	0,17	9,44	-1,823	,068	-0,408†

	CI+CAI (n=20)	0,80	1,47	3,28	1,77	2,48	75,61	-4,027	,000**	-0,900‡
	C (n=20)	1,05	1,73	1,00	1,62	-0,05	-5,00	-1,000	,317	-0,224
Leap	CI (n=20)	0,45	0,83	0,68	1,02	0,23	33,82	-2,081	,037*	-0,465
	CI+CAI (n=20)	0,15	0,49	2,80	0,70	2,65	94,64	-3,998	,000**	-0,894‡
	C (n=20)	,15	0,37	,15	0,37	0	0,00	,000	1,000	0,000
Side Gallop	CI (n=20)	1,80	2,04	2,83	1,95	1,03	36,40	-3,831	,000**	-0,857‡
	CI+CAI (n=20)	2,10	2,00	5,80	1,24	3,7	63,79	-3,944	,000**	-0,882‡
	C (n=20)	2,20	2,02	2,30	1,92	0,1	4,35	-1,414	,157	-0,316†
Two Hand Strike	CI (n=20)	1,63	1,39	2,35	1,52	0,72	30,64	-2,941	,003**	-0,658‡
	CI+CAI (n=20)	0,90	1,07	4,03	1,15	3,13	77,67	-3,969	,000**	-0,887‡
	C (n=20)	1,40	1,14	1,28	1,09	-0,12	-9,37	-1,633	,102	-0,365+
Catch	CI (n=20)	2,25	1,92	2,58	1,87	0,33	12,79	-2,530	,011*	-0,566†
	CI+CAI (n=20)	1,25	1,41	4,35	1,04	3,1	71,26	-3,958	,000**	-0,885‡
	C (n=20)	1,90	1,62	1,80	1,69	-0,1	-5,56	-2,000	,046*	-0,447
Kick	CI (n=20)	2,75	1,92	3,25	1,82	0,5	15,38	-2,913	,004**	-0,651†

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	CI+CAI (n=20)	1,70	1,45	5,20	1,28	3,5	67,31	-3,971	,000**	-0,888‡
	C (n=20)	2,45	0,89	2,45	0,89	0	0,00	,000	1,000	0,000
	CI (n=20)	1,00	1,74	1,55	1,88	0,55	35,48	-3,276	,001**	-0,733†
Throw	CI+CAI (n=20)	0,65	1,18	4,15	1,31	3,5	84,34	-3,979	,000**	-0,890‡
	C (n=20)	1,05	1,36	1,00	1,17	-0,05	-5,00	-1,000	,317	-0,224

*p<.05; **p<.01. **Diff** =Difference.
Effect size (ES),
ES is lower if ES value is 0,1.
†ES is moderato if ES value is 0,3.
‡ES is large if ES value is equal 0,5.

Discussion

Deficits in movement skills among children with intellectual disabilities can lead to challenges in personal and social development, as well as adaptive functioning. Implementing fundamental movement skill (FMS) exercise programs during early childhood can enhance quality of life for both these children and their families (Cunningham, 2015). By participating in physical activities at a similar level to their peers, children with intellectual disabilities can develop the self-confidence and self-esteem necessary for social interaction (Cunningham, 2015). Understanding the unique perspectives of individuals with learning disabilities is crucial for fostering empathy and providing appropriate support, as they often need assistance to feel empowered (Siregar et al., 2021).

This study examined the effect of classical and computer-assisted instruction (CAI) on physical characteristics (body height, weight, and BMI) and fundamental movement skills (locomotor and object control) in educable intellectually disabled children.

It is generally accepted that fitness centers and gymnasiums are equipped with visual recording tools and computers for both teacher and student use. The increasing development of computer-assisted instruction and virtual reality practices has expanded opportunities to provide knowledge in sports, physical fitness, and physical education (Mohnsen, 2008; Silverman, 1997).

Similar to the our study, recent research highlights the importance of fundamental movement skills (FMS) for children with intellectual disabilities (ID). A meta-analysis revealed significant differences in FMS proficiency between children with ID and typically developing children (Kavanagh et al., 2023). Interventions targeting FMS in young children have shown positive effects, with factors such as comprehensive skill coverage and intervention length influencing effectiveness (Koolwijk et al., 2023). FMS proficiency is positively associated with moderate-to-vigorous physical activity levels in children with ID, with gender and age moderating this relationship (Wang et al., 2022). Studies have explored various intervention approaches, including digital mattress training for jumping and hopping skills (Septaliza et al., 2022) and computer-assisted gamification for children with autism spectrum disorder (Lee & Gutierrez, 2023).

This study found no significant differences among the CI, CI+CAI, and control groups regarding physical characteristics during either the pre- or post-test. Similarly, at pre-test, physical characteristics, object control, and locomotor skills were comparable among the three groups of MIDboys. However, after 10 weeks of intervention, statistically significant differences emerged, favoring the CI and CI+CAI groups in object control and locomotor skills. The CI+CAI group demonstrated the greatest improvement, followed by the CI group. These results align with existing research indicating that physical activity is not only essential for typical growth, development, and well-being in young people, but also offers particular benefits for children with MID (Hills, King, & Armstrong, 2007; Taub & Greer, 2000).

Imamoglu and Ziyagil (2017) compared the effects of computer-assisted instruction (CAI) and traditional instruction (TI) within an eight-week exercise program that incorporated games to promote the development of locomotor and object control skills in typically developing children aged 5-6 years. They found that CAI was more effective than TI for improving locomotor skills in boys, whereas TI was more effective for object control skills and overall TGMD-2 scores in boys. Conversely, CAI was more effective than TI in both locomotor and object control skills in girls.

Promoting CAI to enhance fundamental movement competencies in boys with mild intellectual disability (MID) appears promising, as it may facilitate better integration into school environments and promote greater independence, autonomy, and overall effectiveness. The findings from Imamoglu and Ziyagil's (2017) study, which showed the superiority of CAI in improving locomotor skills specifically in boys, align with the results of our study.

In the within-group evaluation, both the CI and CI+CAI groups showed significant improvements in physical characteristics and TGMD-2 scores after the 10-week intervention (Table 3). The CI+CAI group demonstrated greater gains in all physical, locomotor, and object control skills compared to the CI group, except for body height. In contrast, the control group, who did not participate in the exercise program, showed moderate increases in body weight and body mass index over the 10 weeks, with no significant changes in leap or kick skills. Minor decreases were observed in sprint, hop, two-hand strike, catch, and throw skills, with the exception of side gallop.

While children with intellectual disabilities (ID) may have limitations in cognitive and adaptive behaviors, including conceptual, social, and practical skills (Schalock, Luckasson, & Shogren, 2007), our study demonstrated that computer-assisted instruction (CAI) applied to the CI+CAI group led to greater improvements than classical instruction (CI) alone for children with mild intellectual disability (MID). Specifically, CAI proved more effective than CI in the development of locomotor and object control skills. This is noteworthy considering that Rintala and Loovis (2013) reported that while none of the children with ID in their study achieved mastery in certain locomotor skills (hopping, leaping, horizontal jump) or object control skills (striking a stationary ball, underhand rolling), 15% to 20% did demonstrate mastery in galloping, running, and sliding.

In general, they reported that the level of mastery was significantly lower in four of the six locomotor skills including leaping, running, horizontal jump, and sliding in the intellectual disabilities than children with typical development (Rintala & Loovis (2013). The present study showed that after 10 weeks of intervention, the CI+CAI group in locomotor skills had a 94% increase in leap, 78.41% in sprints, 75.61% in hop and 63.79 % side gallop, respectively. On the other hand, increases in object control skills were observed 84.34% in throw, 77.67% in two hand strike, 71.26% in catch and 67.31% in kick. Leap and sprint in locomotor skills, throw and two-hand strike in object control skills showed the highest improvement. Our results related to the hopping, leaping, and striking a stationary ball were not in consistent with the results of the study carried out by Rintala & Loovis (2013).

Another study supporting the superiority of computer-aided instruction (CAI) highlighted the growing use of modern technologies in both general and special education. These tools show promise in helping adults with intellectual disabilities better integrate into society and live more independently, autonomously, and effectively (Mezzalira et al., 2021). With the emergence of artificial intelligence, CAI has evolved into intelligent computer-assisted instruction (ICAI) (Teng & Cai, 2021). ICAI not only addresses many limitations of traditional (classical or face-to-face) physical education teaching but also significantly enhances teaching effectiveness and efficiency. Additionally, physical education teachers can utilize computers during instruction to demonstrate target skills at slower speeds or in slow motion, allowing students to observe, analyze, and make necessary corrections to master basic movement skills.

Students MID may have difficulty understanding verbal explanations and instructions provided by physical education teachers. Computer-assisted instruction (CAI) can address this challenge by presenting instructional content that is difficult to convey through language alone, such as experimental demonstrations and situational simulations. By utilizing sound, light, color, and shape within the computer environment, CAI can enhance the effectiveness of instruction (Jago & Mcmurray, 2009).

In teaching fundamental motor skills, the use of computers and video recorders to provide instant visual feedback on student performance is crucial. This feedback serves multiple purposes beyond simply informing students about their performance. It can motivate students, offer a comprehensive view of skill practice, and provide realistic examples for comparison (Rink, 2014). By understanding which level of movement skill is adequate and making necessary corrections, instructors can enhance the effectiveness of their teaching.

Primary school-aged children with MID consistently demonstrate delayed motor development compared to their typically developing peers, with this gap often widening as they age (Sacks & Buckley, 2003). Rintala and Loovis (2013) reported average developmental delays of 5.3 years for boys and 6.5 years for girls with MID. However, this delay is more likely attributable to insufficient environmental stimulation than to inherent biological factors (Goodway, Ozmun, & Gallahue, 2021). Early detection and intervention programs have shown promise in improving motor function in young children with MID (Ulrich, Angulo-Barroso, & Yun, 2001; Ulrich et al., 2011).

The importance of monitoring the development of fundamental movement skills (FMS) in 6-7-year-old children with MID was emphasized in several studies (Cavanaugh, 2017; Ozmun & Gallahue, 2017). These studies suggest providing activities like independent sitting, standing, and walking to improve reflexive behavior and facilitate FMS acquisition in children with MID.

Research has shown that both classical and computer-assisted instruction (CAI) can significantly impact the development of fundamental movement skills (FMS) in mildly intellectually disabled boys. Classical instruction, which involves direct, face-to-face teaching and physical practice, improves motor skills through structured guidance and repetition. On the other hand, CAI offers an engaging and interactive approach that can be tailored to individual needs, providing immediate feedback and motivation through game-like elements. Studies indicate that integrating both methods can enhance the overall effectiveness of FMS development by leveraging the strengths of each approach (Chou, 2012; Dobell et al., 2023; Simonson & Thompson, 1994).

In our study, the superiority of computer-assisted instruction over classical instruction may be due to its advantages, such as providing immediate visual feedback, detailed performance information, increased student motivation, and effective presentation of the entire skill.

Conclusion

The results of our study demonstrated that the 10-week exercise program significantly improved locomotor and object control skills in the mildly intellectually disabled boys, with the CI+CAI (combined classical and computer-assisted instruction) group showing greater gains across all movement skills compared to the CI (classical instruction) group.

Promoting computer-assisted instruction appears to be a highly effective method for enhancing fundamental movement competencies in MID boys. This approach may enable them to better integrate into their family, school, and social environments, ultimately leading to greater independence and autonomy.

Further research is needed to investigate the development of fundamental movement skills resulting from short-, medium-, and long-term exercise programs in inactive boys and girls, both with and without intellectual disabilities, across childhood and adolescence.

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