Scoping review of ICT interventions for participation in education, communication, and leisure in children/youth with motor disabilities

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INTRODUCTION

Children/youth with motor disabilities face participation restrictions in learning and social leisure activities [1]. Information communication technology (ICT) has been recognized as crucial for promoting learning processes and social inclusion. These technologies encompass computers, the Internet, mobile technologies, broadcasting technologies, and computer-based assistive technology, which are used to transmit, store, create, share, or exchange information [2]. Previous studies have indicated that ICT is a suitable instrument for improving education accessibility and fostering the development of academic, speech, and social skills for children/youth with disabilities [3,4]. However, limited attention has been given to how ICT supports participation for children/youth with motor disabilities, as well as the associated benefits and challenges. In the synthesis by Lidström & Hemmingsson [4], ICT such as computers and specialized software improved writing quality for children/youth with handwriting challenges. In addition, alternative computer access methods, such as switches or keyboard emulators, facilitated computer use and communication/interaction for children/youth with severe motor impairments. Despite these findings, the authors highlighted a lack of research on this population at the time, noting that only nine out of 17 identified studies were intervention-based. Given the rapid ICT advancements over the past decade and the pandemic further institutionalizing their use in education and other contexts, an updated review of ICT interventions is needed to inform future research and clinical practice.

This scoping review aims to examine and synthesize research on ICT interventions for children/youth with motor disabilities to facilitate their participation in education, communication, and leisure. Specifically, it seeks to address the following questions: (1) What types of ICT devices and programs have been applied in intervention studies, and for what purposes? (2) What benefits are reported from the ICT intervention studies, and (3) what implementation challenges are identified?

METHODS

This scoping review follows the recommendations of the JBI Manual for Evidence Synthesis [5] and the PRISMA guideline. A systematic search was conducted across five bibliographic databases: ERIC, PsycINFO, CINAHL, PubMed, and Scopus.

The Population, Concept, and Context approach [5] was applied. The Population was specified as children/youths under 18 years of age with motor disabilities. The Concept was defined as intervention studies utilizing ICT to enhance participation in education, communication, and leisure. The Context included natural settings such as homes, educational settings, and communities. Quantitative and qualitative studies published in English-language peer-reviewed journals between January 2012 and May 2024 were included. Studies were excluded if they focused on children with psychiatric disorders (e.g., autism spectrum disorder), involved prototype testing, or were descriptive studies without at least two data points to evaluate intervention effects.

Two researchers systematically selected, charted, and summarized the studies. Discrepancies were resolved through in-depth discussion, and the third author was consulted when necessary to reach consensus. A total of 20 published articles were identified.

Counts, proportions, and tables were used to summarize the findings. Subsequently, a deductive content analysis [6] was employed to map and summarize the key features of the included studies.

RESULTS

Of the twenty studies, 80% (16 studies) focused on participants with extensive motor disabilities, often combined with complex communication needs, intellectual disabilities, and/or sensory impairments. The remaining four studies involved children/youth with mild motor disabilities. Sample sizes ranged from one to 65, with a total of 184 children/youth across all studies. The study participants were from Europe, North America, Australia, and Asia. The research designs included single-case research design (40%), repeated measures group designs (40%), case studies (15%), and qualitative studies (5%).

Types of ICT and purposes of use

Three types of ICT were identified: (1) Specialized access technology, (2) Specialized programs, and (3) Tailored ICT solutions for specific tasks (Figure 1)

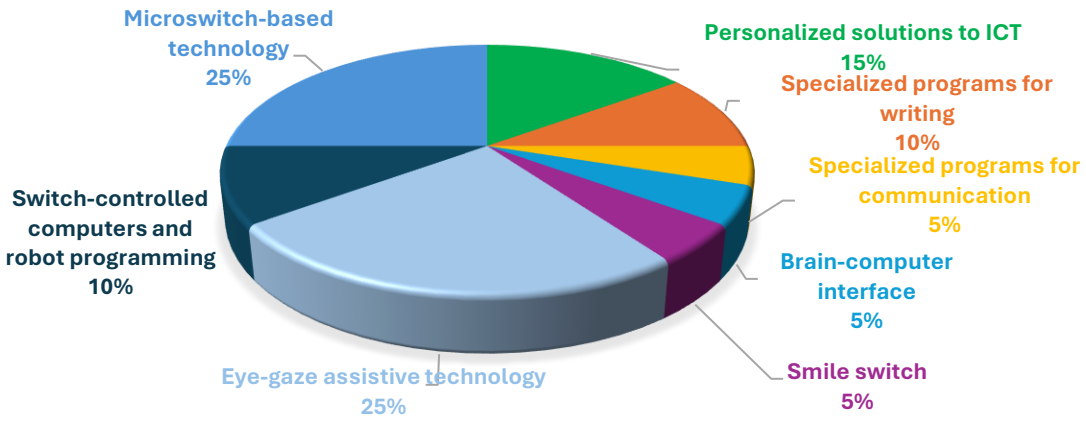

Figure 1. Types of ICT in intervention studies

Alt-text: This figure shows the types of ICT being researched in intervention studies, including specialized access technology, such as microswitch, eye-gaze technology, specialized programs for writing or communication, and personalized solutions to ICT.

Fourteen studies (70%) centered on specialized access technologies to enable computer use for various activities among children with extensive motor difficulties and complex communication needs. Among them, eight studies utilized switches/microswitches controlled by different body parts for making choices, writing words, or controlling robots for science or math learning. Five studies employed eye-gaze assistive technology along with special software for gaming, communicative interactions, and/or educational activities. One study used a commercial brain-computer interface (BCI) for motor imagery tasks.

Three studies (15%) examined specialized programs, focusing on writing and spelling on computers or tablets for children/youth with mild motor disabilities or enhancing communication skills through iPad speech-generating apps.

The remaining three studies (15%) addressed tailored ICT solutions, such as individual-adapted computers and Internet access for children/youth to participate in digital social or educational activities.

Over half of the studies delivered interventions through one-on-one training to teach children/youth how to use access technology or software. However, seven studies (35%) embedded ICT use into everyday activities and provided ongoing support to children/youth and/or their immediate stakeholders. The intervention durations ranged from three weeks to nine to ten months.

Benefits of the ICT interventions

More than half of the studies (55%) reported positive effects on children's communication, including improved choice-making behaviors, expressive communication skills, and information sharing. Additionally, nine studies (45%) highlighted the benefits of participation in educational activities, such as programming in science classes, reading and writing, mathematics learning, or completing homework. Six studies (30%) reported increased computer/ICT usage, noting more opportunities for use, extended durations, and/or expanded activity repertoire. Furthermore, three studies (15%) showed positive impacts on play and gaming through computers. Notably, two studies (10%) reported that ICT interventions enhanced social participation, facilitating existing social relationships and expanding social connections.

Challenges of the ICT interventions

Thirteen studies (65%) identified Implementation challenges, including physical and social barriers, such as less user-friendly programs, unintuitive interfaces, insufficient ICT knowledge among teachers and parents, lack of follow-up support, and funding constraints for sustained ICT use. Child-related factors, including fatigue, illness, operation skills with alternative access methods, and literacy skills, could influence learning curves. However, children's motivation, preference, and positive experiences with ICT usage affected their adoption and the perceived benefits of participation.

DISCUSSION

This scoping review updated the evidence from 2012 and revealed that ICT intervention studies have been developing worldwide over the past decade. However, most studies were small-scale and employed less rigorous designs, indicating their exploratory nature. Despite this, technological advancements such as switch-controlled robots, advanced microswitch applications, eye-gaze technology, and BCI have been employed and assessed. The growing body of evidence also indicates a shift from focusing on technology development to evaluating its practical applications in enhancing children's participation.

The ICT interventions were found to enhance access and engagement in educational activities, communicative interactions, and social and leisure participation for children/youth with motor disabilities. These results confirm ICT as a vital tool for promoting the inclusion of learners with disabilities. A significant proportion of studies (70%) centered on specialized access solutions (e.g., microswitches, eye-gaze technology) as compensatory tools for children/youth with extensive motor difficulties along with complex communication needs. This focus underscores the substantial challenges they encounter in using standard computers and the limited technologies available for communication and learning [7,8]. Access to computers and the Internet through alternative solutions offered opportunities for participation in a range of activities, which could foster their autonomy and promote equity in learning.

Several challenges to ICT implementation were identified, offering insights for future interventions. An essential barrier is the need to increase the customizations of programs and follow-up services to ensure that children/youth can use ICT easily and effectively. In addition, insufficient ICT competencies of teachers and parents pose a common challenge, especially since they are key stakeholders in supporting children's learning [3,4]. Enhancing their technology literacy is essential for integrating ICT strategies and adaptations into everyday contexts, thereby fostering participation among children/youth with motor disabilities.

Clinical implications

ICT interventions, despite their heterogeneity, are beneficial for enhancing involvement in educational tasks, communication, and social connections; therefore, practitioners can integrate ICT into learning contexts to foster education accessibility, social interactions, and leisure participation for students with motor disabilities. For instance, specialized access solutions, as investigated in a majority of studies, facilitate computer use and participation for students with extensive motor and communication difficulties. In addition, to improve implementation, it is crucial to promote ICT training for teachers and

parents, develop more user-friendly programs, and provide follow-up support to tailor ICT to children's evolving needs, abilities, and motivations.

Further research involving children/youth, teachers, and decision-makers is needed to shed light on ICT implementation in inclusive settings, assess the benefits for learners with mild motor disabilities and learning difficulties, and evaluate the long-term impacts on equitable learning and societal participation.

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