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Review

Digital Health Technology for Stroke Rehabilitation in Canada: A Scoping Review

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Abstract: (1) Background: Digital Health Technology (DHT) is an emerging method for stroke rehabilitation that could potentially be very effective in solving different problems in the therapeutic process. This study aims to explore the use of DHT for stroke rehabilitation in Canada, providing insights into how current technologies have been implemented and identifying gaps to inform future decision-making in clinical, research, and policy settings in the Canadian setting. (2) Methods: We followed the Arksey and O'Malley framework for scoping reviews. The original search was created in Medline (Ovid) and translated to PsycINFO (Ovid), Scopus, and CINAHL with Full Text (EBSCOhost). To locate grey literature, we searched Canadian Theses and Google. The search yielded 163 articles, of which we included 14 (8.6%) in the review. (3) Results: Fourteen studies published between 2010 and 2022 in Canada varied in design: 4 qualitative (28.6%), 4 randomized clinical trials (RCTs) (28.6%), 2 mixed methods (14.3%), and other types. The main goals included assessing intervention effectiveness (35.7%), client (28.6%) and clinician (28.6%) perceptions of technology, and feasibility (21.5%). Most studies focused on upper extremity (UE) function (85.71%), with some addressing walking speed (7.1%) and sitting balance (7.1%). Research mainly targeted the chronic phase of stroke (64.3%). Studies were conducted in home (50%) and institutional settings (42.9%). Technologies included sensors (50%), virtual reality (VR) (42.9%), games (28.6%), telerehabilitation (28.6%), and robots (14.3%). (4) Conclusions: This scoping review offers key insights into the use of DHTs for stroke rehabilitation in Canada, highlighting the types of technologies, their effectiveness, and the facilitators and barriers to adoption. These technologies show promise in improving patient outcomes, and their integration into Canadian healthcare systems presents a significant opportunity to enhance stroke rehabilitation.

Keywords: digital health technology; stroke rehabilitation; Canada

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1. Introduction

Digital Health Technologies (DHTs) refer to the integration of information technology, communication networks, and healthcare systems to improve health outcomes [1]. This broad and evolving field includes innovations such as telemedicine, mobile health (m-health), electronic health (e-health), wearable devices, sensors, and artificial intelligence (AI) [2–4]. DHTs have become increasingly embedded in modern healthcare, facilitating not only clinical diagnosis and treatment, but also long-term patient monitoring, data-driven decision-making, and remote research collaboration [1,2]. The COVID-19 pandemic significantly accelerated the adoption of DHTs, reshaping healthcare delivery worldwide [5,6]. In response to social distancing protocols, DHTs enabled remote patient care and ensured continuity of healthcare services during crisis periods [7].

One of the key advantages of DHTs is their ability to provide timely and accessible healthcare, particularly in underserved or remote regions. The effectiveness of these technologies has been well-documented, with numerous studies highlighting their role in improving patient outcomes, enhancing care coordination, and streamlining healthcare delivery [2,8]. Consequently, DHTs have become integral to modern healthcare, contributing to both efficiency and accessibility [9]. Blackman et al. (2024) found out that DHTs could help improve communication, coordination, and information sharing between clinicians and patients during transition periods and recommended that further research be needed to assess the effectiveness of DHTs on patient outcomes [10]. Furthermore, current implementation methods in the field are inadequate. Digital interventions need well-planned, tailored implementation for successful adoption in rehabilitation [11].

Several researchers looked at the effectiveness of DHTs to support post-stroke recovery. A recent systematic review and meta-analysis examined the effectiveness of digital home rehabilitation for stroke survivors, finding that it has similar benefits to traditional home training or clinic-based services and could potentially replace them [12].

The implementation of DHTs varies globally, with both high-income and low- to middle-income countries adopting similar technologies for patient care and public health management [13]. However, research indicates that the application of digital health in stroke rehabilitation requires context-based approaches tailored to different countries and cultures [14].

Stroke is a major health issue in Canada, affecting approximately 405,000 individuals in 2013 with a prevalence rate of 1.15% [15], making effective rehabilitation critical for preventing further disability and enhancing participation in daily activities [16]. DHTs hold significant promise for improving stroke rehabilitation services, particularly by enhancing access to care in rural, remote, and Indigenous communities that face ongoing challenges in obtaining specialized services [17,18]. Given the significant burden of stroke on individuals and healthcare systems [19], research focused on DHT use in stroke rehabilitation is crucial for the Canadian context.

However, despite the potential benefits, Canada's unique healthcare landscape presents distinct implementation challenges not fully addressed in global studies [20]. Disparities in access and continuity of stroke rehabilitation services between urban and rural areas persist, and integration of advanced technologies into routine practice remains inconsistent [16,21,22]. Furthermore, a national survey by McIntyre et al. (2023) reported low adoption rates of evidence based DHT interventions among Canadian therapists, primarily due to limited infrastructure, training, and institutional support [20]. These context-specific barriers highlight the need for a focused investigation within Canada.

Therefore, this scoping review seeks to answer the following research questions:

- How are DHTs used in stroke rehabilitation across Canada?
- What key gaps exist in the current use of DHTs for stroke rehabilitation in this context?
- How can findings from Canadian research inform funding decisions, resource allocation, and clinical improvements in stroke rehabilitation?

Focusing on Canadian research ensures that the results are accessible and practical for implementation, supporting clinicians, hospital administrators, and funders in making informed decisions about future investments.

2. Materials and Methods

2.1. Design

This scoping review followed the framework outlined by Arksey and O'Malley, which includes identifying research questions, selecting relevant studies, charting data, and collating, summarizing, and reporting results [23]. The review was conducted in line with the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) checklist [24]. The review protocol was registered on the Open Science Framework (OSF) and is publicly available at https://doi.org/10.17605/OSF.IO/NSY29.

2.2. Search Strategy

The search was developed by a health sciences librarian (CM) in consultation with the team. Using a combination of controlled vocabulary (i.e., MeSH) and keywords, we created 4 search concepts (stroke, digital technology, rehabilitation, and Canada) and combined them to retrieve the final set of results. The digital technology search concept was purposefully broad to include a wide range of technologies including artificial intelligence; virtual reality; wearable technology; smartphones; and touch perception. Other MeSH terms selected include stroke, physical therapy modalities, and Canada. We limited the results to English. The original search was created in Medline (Ovid) (Appendix A) in January 2023 and translated to PsycINFO (Ovid), Scopus, and CINAHL with Full Text (EBSCOhost). To locate grey literature, we searched Canadian Theses and Google. All records were exported and deduplicated, using Endnote (Clarivate, Philadelphia, PA, USA). The screening was conducted using Covidence (Veritas Health Innovation, Melbourne, VIC, Australia). All search strategies are available in Appendix A.

2.3. Inclusion & Exclusion Criteria

Key inclusion criteria are studies involving individuals who have experienced a stroke and use digital technologies for rehabilitation, such as AI, virtual reality, wearable devices, smartphones, or touch-based tools. Only studies conducted in Canada and published in English were considered.

Studies were excluded if they were outside the scope of the review, review articles, research proposals, study protocols, not conducted in Canada, did not involve digital health technologies, or were not focused on stroke rehabilitation.

2.4. Study Selection Process

Study selection was performed using Covidence by three researchers based on the eligibility criteria. The search yielded 163 articles, with 161 (98.8%) remaining after duplicates were removed. After screening titles and abstracts, 120 (74.5%) articles were retained and read in full text to determine eligibility. As a result, 106 (65.4%) articles were excluded for various reasons. Thus, of the initial 163 articles, 14 (8.6%) were finally included in this scoping review (Figure 1).

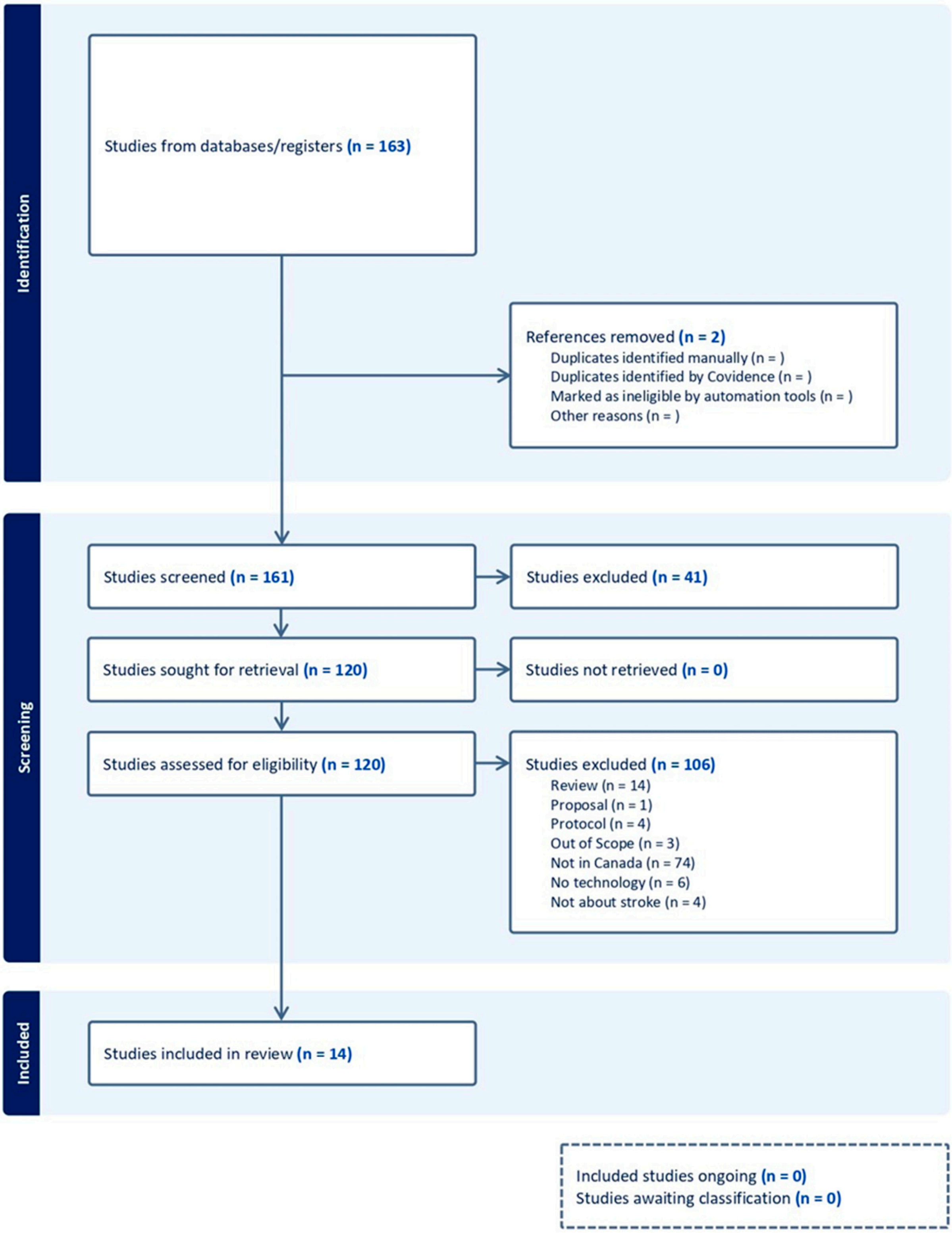

Figure 1. Study selection process.

2.5. Data Extraction and Analysis

Two authors (SA and JB) were responsible for screening the studies. Data were extracted from the included studies using charting forms developed by the research team. Data extraction was carried out by a trained occupational therapist with an MSc degree (PS) and over 15 years of experience in neurorehabilitation and was reviewed by a postdoctoral researcher (MK) and an associate professor specializing in digital health technologies in neurorehabilitation (AC). Any ambiguities or disagreements were resolved through consensus, with final decisions guided by the supervisor and corresponding author (AC) to ensure consistency and rigor. The following information was gathered and charted: title, author, year of publication, objectives, study type, protocol, population, outcomes, and results. MK was responsible for summarizing, interpreting, and reporting the results. The findings of this scoping review were reported based on study type, main goal, outcomes focus, stroke phase, setting, and type of technology.

3. Results

The scoping review included 14 studies published between 2010 and 2022, exploring various use of DHTs for stroke rehabilitation specifically in Canada (Table 1). The studies encompassed multiple study designs. Of the 14 studies, 4 (28.6%) were qualitative studies [25–28], 4 (28.6%) were RCTs [29–32], 2 (14.3%) were mixed methods [33,34], 1 (7.2%) was a pilot RCT [35], 1 (7.2%) was a feasibility clinical trial [36], 1 (7.2%) was a multiple case study design [37], and 1 (7.2%) was a pre-post double baseline repeated measures design [38].

The studies included in this review varied in sample size, which can be categorized as 8 studies with small sample studies (1–10 participants) [25–28,32,34,37,38], 3 studies with medium sample studies (11–50 participants) [29,33,36] and 3 studies large sample studies (>50 participants) [30,31,35].

10 studies focused on chronic stroke phase [25–27,29,30,32–34,36,37], while acute phase was explored in 2 studies [31,35]. One study considered both phase [38] and one not specified the phase of stroke [28].

Twelve studies focused on UE function [25–30,32,34–38], while one study examined sitting balance [31], and another study focused on walking speed [33].

Studies were conducted in various settings, including 7 studies performed home-based [27,32–34,36–38], 6 studies was in institutional settings [26,28–31,35], and one study considered both home and institution [25].

Study main goals varied, with 3 studies assessing feasibility [34,36,38], while 5 studies investigated intervention effectiveness [29–32,35]. 6 studies explored clinician and client perception about technology [25–28,33,37].

The types of technologies including 6 studies focus on VR [29,31,34–37], 3 study on VR called her work as telerehabilitation [34,36,37] 2 studies on robotic devices [25,30], 4 studies on gaming systems [27,28,32,35], and 3 studies on mobile and sensor-based training [26,33,38]. This categorization groups technologies based on their applications, with relevant studies supporting each category.

3.1. VR and Telerehabilitation

VR and telerehabilitation have been explored for home-based stroke rehabilitation. The VirTele system was found to be feasible and effective in promoting UE rehabilitation, with high engagement and motivation among participants [34,36,37]. Additionally, VR-based serious gaming was shown to be as effective as traditional home exercise programs, with greater improvements in participants who engaged more frequently [29]. Low-cost VR training was also found to improve sitting balance in stroke rehabilitation inpatients [31]. Furthermore, a pilot RCT demonstrated that VR using Wii gaming technology is a feasible and safe adjunct to conventional rehabilitation, showing potential to improve motor function in patients with mild to moderate stroke [35].

Table 1. Summary of Included Articles.

	Author	Study Type	Goals			Participants			Stroke Phase	Setting	Type of Technology	Main Findings
			Description	Main Goal	Outcome Focus	N	Age	Male/Female				
1	Dorra Rakia Allegue (2022) [37]	Multiple Case Study Design	Identify behavioral and motivational techniques used by clinicians during the virtele intervention. Explore indicators of empowerment among stroke survivors. Investigate the determinants of VirTele use among stroke survivors and clinicians.	Client Perception, Clinician Perception	UE	3	Mean Age of 58.8 (SD 19.4)	F (2) M (1)	Chronic	Home	VR and Telerehabilitation	5 major determinants of virtele use emerged from the qualitative analyses: • Technology performance (usefulness and perception of exergames) • Effort (ease of use) • Family support (encouragement) • Facilitators (considerations of the stroke survivors' safety as well as trust and understanding of instructions) • Challenges (miscommunication and exergame limits). During the virtele intervention, both clinicians used motivational and behavioural techniques to support autonomy, competence, and connectivity, all reflected as empowerment indicators in the stroke survivors.
2	Dorra Rakia Allegue (2022) [36]	Feasibility Clinical Trial	Determine the feasibility of using virtele in survivors of chronic stroke at home and explore the impact of VirTele on UE motor function, quantity and quality of use, quality of life, and motivation in survivors of chronic stroke compared with conventional therapy.	Feasibility	UE	11	Mean Age 57.8	Both Genders	Chronic	Home	VR and Telerehabilitation	The VirTele intervention constitutes another therapeutic alternative, in addition to the GRASP, to deliver an intense personalized rehabilitation program to survivors of chronic stroke (at least 8 years since the stroke) with UE deficits. The highest scores for autonomous motivation were achieved in the experimental group, which achieved a high frequency of use of the exergames and a very high number of repetitions.

Table 1. *Cont.*

	Author	Study Type	Goals			Participants			Stroke Phase	Setting	Type of Technology	Main Findings
			Description	Main Goal	Outcome Focus	N	Age	Male/Female				
3	Nancy M. Salbach (2022) [33]	Quantitative (Case Study) & Qualitative	Describe how authors used a process model, a determinant framework, and two classic theories to guide the design and process evaluation of the implementation of the iWalk toolkit.	Clinician Perception	Walking Speed	Pre-Intervention: 49 Post-Intervention: 37 Focus Group: 33	Pre-Intervention: Mean Age of 38.7 Post-Intervention: Mean Age of 38.1 Focus Group: Mean Age of 38.5	Pre-Intervention: F (45) M (4) Post-Intervention: F (33) M (4) Focus Group: F (29) M (4)	Chronic	Home	Mobile and Sensor Based Training	Self-efficacy ratings for recommended practices increased and were significant for the 10 mwt. Theory-based toolkit features and implementation strategies likely facilitated engagement with toolkit components, contributing to observed improvements in pts' knowledge, attitudes, skill, self-efficacy, and clinical practice.
4	Alejandro Hernandez (2022) [29]	RCT	(Determine the extent to which a 1-month intervention using a VR-based serious game is effective in improving UE function compared with an evidence-based home exercise program. Assess the feasibility of implementing the intervention for chronic stroke rehabilitation in participants' homes.	Intervention Effectiveness	UE	51	Treatment: Mean Age 59.8 (Sd 13.1) Standard Care: Mean Age 56.7 (Sd 11.2)	F (14) M (37)	Chronic	Institution	Vr and Telerehabilitation	UE training for chronic stroke survivors using virtual rehabilitation in their home may be as effective as a gold standard home exercise program and those who used the system the most achieved the greatest improvement in UE function, indicating its relevance to being included as part of ongoing rehabilitation services
5	Dorra Rakia Allegue (2021) [34]	Mix Method Case Study	To determine the feasibility of VirTele for remote UE rehabilitation in a chronic stroke survivor Explore the preliminary efficacy of virtele on UE motor function, the amount and quality of UE use, and impact on quality of life and motivation Explore the determinants of behavioral intention and use behavior of VirTele along with indicators of empowerment.	Feasibility	UE	1	63	Male	Chronic	Home	Vr and Telerehabilitation	Results suggest that the virtele intervention and the study protocol could be feasible for stroke survivors.

Table 1. *Cont.*

	Author	Study Type	Goals			Participants			Stroke Phase	Setting	Type of Technology	Main Findings
			Description	Main Goal	Outcome Focus	N	Age	Male/Female				
6	Brontë Vollebregt (2019) [26]	Qualitative	Determine the perceived benefits of the participants in a hand training program using a haptic indirect-feedback hand function device (HIFHFD)	Client Perception	UE	8	55–82 (M = 69.38)	F (3) M (5)	Chronic	Institution	Mobile and Sensor-Based Training	This study provided insight into the response of stroke survivors to a community-based hand training program using this novel HIFHFD and examined its impact on their QOL. In addition to functional improvements, participants experienced a sense of community, companionship, and motivation.
7	Lisa A. Simpson (2019) [38]	Pre-Post Double Baseline Repeated Measures Design	Investigate the feasibility of a phone-monitored home exercise program for the UE following stroke.	Feasibility	UE	8	Mean 66.4	Female 4 Male 4	>2 Months and <12 Months Post-Stroke	home	Mobile and Sensor Based Training	The H-GRASP was feasible for participants when they were sufficiently challenged by the exercise program. Participants showed sustainable improvements in UE function, UE use, grip strength and occupational performance following the H-GRASP program.
8	Ahmed Elnady (2018) [25]	Qualitative	Describe users' perceptions about existing wearable robotic devices for the ue education and information technologies Identify if there is a need to develop new devices for the ue and the desired features Explore obstacles that would influence the utilization of these new devices.	Client Perception, Clinician Perception	UE	10	50–60 (13%) 61–70 (62%) >70 (25%)	F (13%) M (87%)	Chronic	Home and Institution	Robotic Devices	"They exist, but. . ." A. Existing devices and technologies B. Cost-effectiveness C. Doubts on efficiency D. Compromise the independence Indeed, we need more. Can we have it all? A. Assistance vs. rehabilitation B. Distal vs. proximal C. Portability vs. complexity D. Activation and motivation Bumps on the road A. Single solution is challenging B. Ensure accessibility C. Setup time and learning curve

Table 1. *Cont.*

	Author	Study Type	Goals			Participants			Stroke Phase	Setting	Type of Technology	Main Findings
			Description	Main Goal	Outcome Focus	N	Age	Male/Female				
9	Amy E. Bouchard (2017) [30]	RCT	The goal of the study was to evaluate the impact of a single session of haptic guidance (HG) and error amplification (EA) robotic training interventions on the improvement of post-stroke timing accuracy.	Intervention Effectiveness	UE	34	Haptic Guidance Group: 67 ± 7, Error Amplification Group: 67 ± 6	NA	Chronic	Institution	Robotic Devices	The results of this innovative study have demonstrated that HG robotic training helps improve the immediate timing accuracy of Survivors' post-chronic stroke, and that the side of the stroke lesion can influence timing accuracy following EA training. Knowing that Timing deficits can have a detrimental impact on the performance of daily activities
10	Kate Paquin (2016) [27]	Qualitative	Gather end-user data from chronic stroke participants who engaged with an off-the-shelf CG device in a community-level rehabilitation setting.	Client Perception	UE	10	Mean Age 72.1	Male (10)	Chronic	Home	Gaming Systems	Participants illustrated the positive impact that VR training had on their functional abilities as well as their confidence towards completing activities of daily living (ADL). Participants also expressed the need for increased rehabilitation opportunities within the community.
11	L. Sheehy (2016) [31]	RCT	Determine if supplemental VRT-based sitting balance exercises improve sitting balance ability and function in stroke rehabilitation inpatients.	Intervention Effectiveness	Sitting Balance	76	NA	NA	Acute	Institution	VR and Telerehabilitation	Provide important evidence for the use of low-cost, accessible VRT as an adjunct intervention to increase sitting balance in lower-functioning patients receiving inpatient rehabilitation. The motivating and enjoyable attributes of VRT may increase exercise dosage, leading to improved function and optimal results from rehabilitation.
12	Kate Paquin (2015) [32]	RCT	Investigate the effectiveness of commercial gaming as an intervention for fine motor recovery in chronic stroke.	Intervention Effectiveness	UE	10	Mean Age 72.1	M (10)	Chronic	Home	Gaming Systems	Illustrating an increase in fine motor ability as well as an increase in the participants' perceived ability to complete ADL.

Table 1. *Cont.*

	Author	Study Type	Goals			Participants			Stroke Phase	Setting	Type of Technology	Main Findings
			Description	Main Goal	Outcome Focus	N	Age	Male/Female				
13	Sandy K Tatla (2015) [28]	Qualitative	Explore clinicians' perceptions of how young people and adults with hemiplegia use gaming and social media technologies in daily life and rehabilitation Identify barriers to using these technologies in rehabilitation.	Clinician Perception	UE	10	20–34 Years Old: 5 (50%) 35–49 Years Old: 4 (40%) 50–64 Years Old: 1 (10%)	F (8) M (2)	NA	Institution	Gaming Systems	Therapists were using technology in a limited capacity. They identified barriers to using social media and gaming technology with their clients, including a lack of age appropriateness, privacy issues with social media, limited transfer of training, and a lack of accessibility of current systems. Therapists also questioned their role in the context of technology-based interventions. The opportunity for social interaction was perceived as a major benefit of integrated gaming and social media
14	G. Saposnik (2010) [35]	Pilot RCT	ComparE VRWII versus recreational therapy in patients receiving standard rehabilitation within six months of stroke with a motor deficit of $\geq$3 on the Chedoke-McMaster Scale (arm)	Effectiveness of the Intervention	UE	21	Mean Age: 61 [41–83] Years	NA	Acute	Institution	Gaming Systems	The results of secondary endpoints will serve to calculate the necessary sample size for a potentially larger multicentre trial. The initial step in understanding of the potential benefit of interactive rehabilitation using Wii gaming technology post-stroke with potential implications for daily patient care.

3.2. Robotic Devices

Robotic-assisted interventions have demonstrated benefits for functional recovery, but accessibility barriers remain a challenge [25,30]. Concerns about cost-effectiveness, independence, and complexity contribute to skepticism surrounding these technologies [25]. Haptic guidance robotic training has been found to improve timing accuracy in post-stroke survivors [30].

3.3. Gaming Systems

Interactive rehabilitation tools, including gaming-based systems, have been reported to enhance fine motor function, engagement, and self-confidence [27,28,32,35]. Commercial gaming platforms, such as Wii-based rehabilitation, have demonstrated potential benefits in improving motor skills and increasing confidence in performing daily activities [35]. However, accessibility and clinician involvement remain key barriers to adoption [28].

3.4. Mobile and Sensor-Based Training

Sensor-based rehabilitation technologies have shown feasibility and effectiveness, particularly for home-based training [26,38]. The phone-monitored home exercise program (H-GRASP) was found to be feasible and effective when participants were sufficiently challenged [38]. Additionally, a haptic-feedback hand function device was reported to improve motivation and social engagement, beyond functional gains [26]. A mobile toolkit for gait training was also found to enhance self-efficacy among users [33].

4. Discussion

Stroke rehabilitation is critical for functional recovery, yet access to services in Canada is inconsistent, particularly for rural and underserved populations [39]. Emerging DHTs such as telerehabilitation, VR, exergames, and wearable robotic devices offer the potential to overcome geographic barriers and deliver personalized, intensive, and engaging rehabilitation programs remotely [40–42]. This scoping review aimed to explore how DHTs are currently used in Canadian stroke rehabilitation, identifies key gaps in the existing research, and provides insights to guide future funding decisions, resource allocation, and clinical practice improvements. We reviewed the studies published between 2010 and 2022 in Canada.

4.1. Interpretations of Study Characteristics on the Use of DHTs in Stroke Rehabilitation in Canada

The studies reviewed had varied goals, including assessing intervention effectiveness, exploring client and clinician perceptions, and evaluating feasibility. These findings indicate that Canadian researchers are investigating these technologies comprehensively, reflecting the complex and multifaceted nature of technology use in stroke rehabilitation.

Additionally, most studies in this review were qualitative research articles and RCTs. Qualitative studies provided in-depth insights into client and clinician experiences. Since healthcare providers and patients may have different perspectives, understanding these perceptions is crucial for successful implementation alongside standardized assessments of feasibility and effectiveness. However, the limited number of RCTs highlights a gap in rigorous interventional research. Conducting ideal RCTs in rehabilitation is challenging due to potential biases, which can impact effect estimates. While RCTs offer valuable evidence, a diverse methodological approach is essential for advancing the field, reinforcing the need for varied study designs in research [43]. Future research in Canada could strengthen the body of knowledge by conducting more high-quality RCTs to discover and validate new methods for stroke rehabilitation. In addition, it is important to continue using qualitative studies that capture the perspectives of culturally diverse populations, including

Indigenous peoples and immigrants, whose experiences and needs may differ from those of the general population.

Various technologies are currently being explored in Canadian stroke rehabilitation research, including VR, robotic devices, gaming systems, sensors, and mobile apps. These findings suggest that technological advancements have already made their way into research, highlighting their potential for broader clinical adoption. As Canada continues to invest in digital health and innovation, expanding the use of available, evidence-based technologies presents a significant opportunity to improve patient outcomes. Integrating these tools into the healthcare system will ensure that stroke survivors have timely access to effective rehabilitation solutions and will promote the translation of research into clinical practice, ultimately enhancing the quality of care.

Regarding clinical outcomes, the majority of studies focused on UE function. While UE rehabilitation is undoubtedly important, the narrow focus on UE function overlooks other critical areas where stroke survivors face challenges, such as walking, transferring, balance, cognition, and activities of daily living (ADLs). likely due to the prevalence of UE impairments in stroke survivors and their significant impact on daily activities and independence [44]. However, recent studies propose hypotheses suggesting potentially faster lower extremity (LE) recovery. One key factor that may explain this difference is the frequency of use or intensity of the rehabilitation intervention. The LE is used more frequently in daily activities, and when limbs are used frequently, it results in use-dependent plasticity and eventual recovery. Consequently, rehabilitation techniques that involve high-repetition task practice, such as robotic rehabilitation, Wii gaming, and constraint-induced movement therapy, should be incorporated into UE rehabilitation to facilitate recovery [45] However, many studies outside Canada exist that use technologies for non-upper extremity purposes. Multiple studies have demonstrated that VR-based rehabilitation can enhance walking speed, balance, and mobility compared to standard rehabilitation [46]. In addition, recent research highlights the potential of technology in enhancing cognitive rehabilitation for stroke patients. Various studies review neurotechnology, including computerized cognitive training and brain-computer interfaces, noting their promise but emphasizing the need for further research to integrate these tools into clinical practice [47,48]. It appears that Canadian research places comparatively less emphasis on non-upper extremity outcomes than international studies, highlighting a need to align more closely with global efforts that address LE function, cognition, and ADLs. Broadening the range of targeted outcomes would support a more comprehensive approach to stroke rehabilitation and significantly enhance the overall quality of life for stroke survivors.

We also examined the contribution of DHTs at each phase of stroke. As expected, most studies focused on the chronic phase, where technology is primarily used for remote rehabilitation. However, while remote rehabilitation is more feasible in the chronic stage, its role remains somewhat niche. In the acute stage, rehabilitation should begin as soon as the patient is clinically stable, with a focus on preventing secondary complications such as pneumonia, pressure ulcers, and contractures through early mobilization and functional training. During this phase, in-person intervention is generally recommended over remote rehabilitation [49,50]. As patients stabilize, more intensive therapies can be introduced, including new technologies such as functional electrical stimulation, robot-assisted therapy, and VR-based cognitive therapy [51]. While the effectiveness of rehabilitation in the acute stage of stroke is well established, further research is needed to evaluate the role of technology in this phase [52]. In line with international developments, future Canadian research could prioritize the use of rehabilitation technologies not only during the chronic phase but also in the early stages of stroke recovery. Focusing on the acute and subacute phases—critical periods for rehabilitation—could better support patients during the transition from hospital to home and enhance early rehabilitation outcomes. Addressing these earlier phases may also help prevent further disability and promote improved long-term recovery [49].

As this review highlighted, most studies on rehabilitation technology for stroke patients in Canada focus on home-based interventions. This aligns with another research, which indicates that telerehabilitation for stroke patients has gained traction in Canada, offering a promising alternative to traditional face-to-face rehabilitation [53]. Furthermore, as previously discussed, technology-based stroke rehabilitation is more commonly implemented during the chronic stage, typically delivered in a home setting. However, since some global studies have begun focusing on the use of telerehabilitation during the acute phase, this could represent an emerging area of research for Canada.

4.2. Findings on the Feasibility and Effectiveness of Technology Use in Stroke Rehabilitation in Canada

Technologies such as VirTele [29], VR exergames [34,36,37], and H-GRASP [38] demonstrated high feasibility and adherence, particularly when training was personalized and user support was provided. These technologies helped patients feel more independent when exercising at home and motivated them to use their UE, which in turn improved UE strength, using the affected limb, and overall function [34,36,38]. The authors recommended that therapists provide behavioral support and motivation to ensure feasibility, as well as encourage family involvement [31,36]. Additionally, it is important to raise awareness and provide information to patients about the technology being used, ensuring they are actively engaged in their therapy process [25]. Making the technology easy to use and prioritizing safety are also key considerations [25,37,38]. Personalized care enhances feasibility; therapists should tailor the technology to each patient's abilities, motivation, and autonomy [29].

These results in Canada align with recent studies worldwide that have explored the feasibility and acceptability of technology-based interventions in stroke rehabilitation [53]. Both internationally and in Canada, highly intensive technology-assisted training has shown promise for inpatients and outpatients in the subacute and chronic phases of stroke, leading to improvements in functional performance and efficiency [54]. In particular, VR-enabled telerehabilitation programs have been found feasible for rural stroke survivors in Canada, although some technological challenges were noted, especially regarding participants' hand function and comfort with the technology [55]. Additionally, technology-based mental health interventions have demonstrated low refusal rates and high levels of satisfaction and adherence among stroke patients globally; however, Canadian research has paid comparatively less attention to mental health interventions for stroke survivors [56].

Studies have demonstrated that DHTs improve motor function and increase the use of the affected limb in daily activities, showing good to high efficacy in supporting improvements for stroke rehabilitation [29,31,34,36–38]. For example, the VirTele program led to meaningful improvements in the FMA-UE scores, maintained for months after intervention [37]. Similarly, H-GRASP participants surpassed clinically meaningful thresholds in motor performance and grip strength [38]. Gaming-based interventions, including commercial gaming systems [27] and VR-based interactive rehabilitation using Wii technology [35], have also demonstrated efficacy in improving UE function and overall motor recovery post-stroke. The included studies found that participants who engaged with gaming-based rehabilitation showed increased fine motor ability and confidence in performing activities of daily living [27] and highlighted the potential of interactive gaming (e.g., Wii) in stroke rehabilitation, suggesting that such systems could enhance engagement and motivation, leading to improved patient outcomes [35]. Some studies show a significant increase in self-efficacy, occupational performance, improvement in activities of daily living, and enhanced quality of life after incorporating technology into rehabilitation plans [26,32,33]. Given the demonstrated effectiveness of DHTs in stroke rehabilitation, the next logical step is their integration into clinical practice. Hospital decision-makers and clinicians should prioritize the adoption of these technologies to ensure that rehabilitation services remain current and evidence-based. Consistent with global research, DHTs provide engaging and interactive environments that have the potential to transform traditional rehabilitation approaches [12]. Emerging evidence suggests that DHTs may complement or even replace conventional methods; however, further research is necessary to refine their application and facilitate their widespread implementation in clinical settings [12,57,58].

4.3. Determinants of DHT Adoption for Stroke Rehabilitation

Understanding user experience is essential when implementing DHTS, as it can be context dependent. In Canada, several facilitators have supported the adoption of DHTs for stroke rehabilitation, including user motivation [31,34,37,38], clinician support [31,34,37,38], and technology performance [34,37,38]. Findings from the included studies revealed that motivation was enhanced through engaging activities, goal-setting, and social support. Programs that promoted autonomy and competence, such as exergames offering real-time feedback, helped improve adherence. Participants who observed progress were more likely to continue using the affected limb after the intervention [34,37,40]. Clinician support was also crucial, as therapists played a vital role in encouraging adoption and ensuring proper use of the technology [38]. On the other hand, barriers to adoption included technical challenges [25,37], user inexperience [25,28], and limited portability of devices [25,28]. These challenges encompassed issues such as poor connectivity, interoperability, and limited computer literacy, all of which hindered uptake. Usability concerns were also highlighted, with participants stressing the importance of simple, easy-to-don devices for better adoption [25]. Miscommunication, particularly in cases of aphasia, further reduced motivation and engagement, diminishing the overall effectiveness of the program [37]. Therapists also faced barriers when incorporating social media and gaming technologies, such as concerns about age appropriateness, privacy issues, limited transfer of training, and accessibility to current systems [28]. Many of these factors are consistent with findings from other countries. Globally, ease of use, access to technologies, awareness of available options, and evidence of effectiveness are commonly reported facilitators [59]. Similarly, stakeholders, particularly therapists, have been recognized internationally as playing a crucial role in introducing and supporting the adoption of new rehabilitation technologies [60]. Furthermore, the Technology Acceptance Model highlights that computer self-efficacy and anxiety are key predictors of users' willingness to engage with telerehabilitation, a finding that aligns with observations in the Canadian context as well [61].

4.4. Strengths and Limitations of This Review

A notable strength of this review lies in its examination of the current landscape of DHTs for stroke rehabilitation, with a specific focus on Canada. This insight offers a solid foundation for researchers to explore existing gaps in evidence or build upon the current body of knowledge, as well as for Canadian clinicians to utilize evidence-based technologies in their practice. However, given that this is an emerging field, the review is based on only 14 studies, which limits the strength and generalizability of the conclusions. Additionally, the literature search was restricted to studies published in English, which may have limited the inclusion of relevant studies published in other languages. Moreover, the wide range of applications and the variability in study designs make it challenging to provide detailed recommendations or propose a targeted systematic review on a particular area.

5. Conclusions and Future Directions

Canadian research, like global findings, demonstrates the feasibility and effectiveness of using DHTs in stroke rehabilitation. Most Canadian studies have focused on UE rehabilitation and home-based telerehabilitation during the chronic phase, with less attention to cognition, LE, ADLs, and mental health. Key facilitators include user motivation, clinician support, and technology performance, while major barriers involve technical challenges, user inexperience, limited device portability, poor connectivity, interoperability issues, and limited computer literacy.

To advance the integration of DHTs into clinical practice, future Canadian research should prioritize conducting high-quality RCTs, expanding the scope of targeted outcomes beyond UE function, and addressing critical areas such as cognition, LE function, ADLs, and mental health. More research is also needed on the use of DHTs during the acute and subacute phases of stroke recovery to optimize early rehabilitation outcomes. Policymakers should support innovative research through dedicated funding for underexplored areas, while hospital decision-makers and clinicians must facilitate knowledge translation efforts to integrate proven technologies into routine practice. Additionally, future work should consider the unique needs of culturally diverse and rural populations to ensure equitable access and relevance of digital health interventions across Canada.

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Abbreviations

The following abbreviations are used in this manuscript:

ADLs	Activities of Daily Living
AI	Artificial Intelligence
DHT	Digital Health Technology
EMG	Electromyogram
FMA-UE	Fugl-Meyer Assessment for Upper Extremity
H-GRASP	Home-Graded Repetitive Arm Supplementary Program
UE	Upper Extremity
LE	Lower Extremity
RCT	Randomized Controlled Trial
VR	Virtual Reality
PRISMA-ScR	Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews

Appendix A

Medline (Ovid) Search; 1946–26 January 2023

1. exp stroke/
2. exp Cerebral Hemorrhage/
3. (stroke or strokes or cva* or poststroke* or apoplexy).tw,kw.
4. ((cerebro* or brain or brainstem or cerebral*) adj3 (infarct* or accident*)).tw,kf.
5. brain attack*.tw,kw.
6. exp artificial intelligence/
7. exp Monitoring, Physiologic/
8. exp Monitoring, Ambulatory/
9. Biofeedback, psychology/
10. Self-Help Devices/
11. exp Man-Machine Systems/
12. automation/
13. exp Computer Simulation/
14. exp Video Games/
15. exp wearable electronic devices/
16. exp Cell Phone/ or Mobile Applications/ or Computers, Handheld/
17. Electronic Mail/
18. exp Touch Perception/
19. wireless technology/
20. (artificial intelligen* or AI or neural network* or (automat* adj2 recogni*) or machine learning).tw,kf.
21. robot*.tw,kw.
22. (video gam* or videogam* or exergam* or exer gam*).tw,kw.
23. ambient assisted living.tw,kw.
24. ambient intelligen*.tw,kw.
25. (assistive adj3 (device* or technolog* or self-help)).tw,kf.
26. ((ambient or smart or intelligent) adj2 (environment* or home* or house*)).tw,kf.
27. (intelligent adj2 system*).tw,kf.
28. ((technolog* or comput*) adj5 (ambient or non-wearable* or nonwearable* or unobtrusiv* or non-intrusive or nonintrusive or pervasive or ubiquitous or non-contact or noncontact or smart or intelligen* or passive)).tw,kf.
29. (home adj2 (automation or device or module)).tw,kw.
30. (digital technolog* or smart technolog*).tw,kw.
31. ((monitor* or track*) adj2 (biomedical or medical or personal or home* or patient* or health or activit* or ambulat* or physiolog*)).tw,kf.
32. (robot* or automat* or computer aided or computer assisted or power assist*).tw,kw.
33. (virtual realit* or VR or simulat*).tw,kw.
34. ((interactiv* or virtual) adj2 (environment or technolog*)).tw,kf.
35. augmented realit*.tw,kw.
36. (smartphone or smart-phone*).tw,kw.
37. ((mobile or cell or smart or handheld) adj2 (device or phone*)).tw,kf.
38. (iphone* or android* or ipad*).tw,kw.
39. (personal digital assistant* or handheld computer* or handheld device*).tw,kw.
40. mobile app*.tw,kw.
41. haptic*.tw,kw.
42. biofeedback.tw,kw.
43. ((force or tactile or touch or tactual or electr*) adj2 (feedback or perception)).tw,kf.
44. sensory substitution.tw,kw.

45. piezoelectric*.tw,kw.
46. (vibrotactile or vibration).tw,kw.
47. wearable*.tw,kw.
48. sensory aids/
49. ((intelligent or smart) adj1 (home* or technolog* or sensor? or environment)).tw,kw.
50. (rehabilitat* or rehab or "occupational therap*" or physiotherap* or "physical therap*").tw,kw.
51. rehabilitation/ or "activities of daily living"/ or neurological rehabilitation/ or stroke rehabilitation/ or telerehabilitation/
52. exp Physical Therapy Modalities/
53. Occupational Therapy/
54. or/1–5 [Stroke Search]
55. or/6–49 [Digital Technology Search]
56. or/50–53 [Rehab Search]
57. exp Canada/ or canada.cp. or canad*.tw,kw.
58. 54 and 55 and 56 and 57 (129)
59. limit 58 to english (128)

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