Remote digital health interventions to support physical, functional and/or psychological rehabilitation of adult patients with major traumatic injuries: Protocol for a systematic review of randomised controlled trials

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Abstract

Background: Digital health (DH) interventions have increased across the past two decades, providing patients with alternative remote pathways to receiving healthcare services. Patients with major trauma frequently require long-term access to healthcare services to support their mental and physical health and their overall quality of life. DH interventions could help patients stay connected to rehabilitation services to enhance their health condition and regain their independence to enable them to return to the workplace and/or regain a role in society. There is a need to explore existing evidence on the effectiveness of DH interventions in improving health-related outcomes of patients with major trauma.

Objective: This review aims to identify DH interventions that support physical and/or mental rehabilitation of patients who have been subject to major physical trauma.

Methods: This review targets randomised controlled trials. Eligibility criteria include studies investigating DH interventions in adult patients with major traumatic physical injuries as end users of the intervention. Digital interventions that are delivered remotely and studies that report the impact of DH interventions on patients' health-related outcomes will be included. The search strategy will be limited to time (since year 2000 to date) and to peer reviewed journals. No language restriction will be used, and articles that are not written in English will be translated. The search will be conducted in MEDLINE, EMBASE, AMED, CINAHL Plus, and PsycInfo. Grey literature, bibliographies of included studies and of relevant reviews will also be searched for potentially relevant articles. A minimum of two reviewers will independently screen retrieved references. Data extraction will be conducted by one reviewer and independently checked by another reviewer. Quality assessment of included studies will be conducted using the Cochrane RoB-2 tool. Any disagreements arising at any stage of the review will be resolved through discussion or by consulting a third reviewer where needed. A meta-analysis will be performed where possible, and a descriptive analysis of included studies will be reported.

Results: Results will be available on completion of the review.

Conclusions: The review findings will help identify existing evidence regarding DH interventions used to support physical and/or mental rehabilitation needs of patients with major trauma. This would help guide practitioners and policy makers to implement effective interventions to better support patient outcomes. The evidence synthesised from this review will also identify existing gaps and direct future research. Clinical Trial: Systematic review protocol is registered at PROSPERO International Prospective Register of Systematic Reviews (registration reference CRD42023485748).

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Abstract

Background

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Results will be available on completion of the review.

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The review findings will help identify existing evidence regarding DH interventions used to support physical, functional and/or psychological rehabilitation needs of patients with major trauma. This would help guide practitioners and policy makers to implement effective interventions to better support patient outcomes. The evidence synthesised from this review will also identify existing gaps and direct future research.

Trial registration
Systematic review protocol is registered at PROSPERO International Prospective Register of Systematic Reviews (registration reference CRD42023485748).

Keywords
digital health; mHealth; mobile health application; mobile health; telemedicine; rehabilitation, physical trauma, major trauma, major injury.

Introduction

The last two decades witnessed a significant development in information technology to the point that it became widely available in almost all aspects of modern life [1]. This has been greatly influenced by the innovative development of devices; the widespread implementation of various performing networks, e.g. Microsoft Teams; and more recently, by the rising needs for remote delivery associated with the COVID-19 pandemic [2, 3]. This strongly contributed to driving improvements in the use of technology in healthcare, introducing new concepts in healthcare delivery, through the use of digital health (DH) [1, 4, 5].

DH plays a significant role in healthcare, and it can be seen in many medical specialties [6, 7]. Several definitions exist for DH [5], often with different terms used interchangeably, including DH care [1, 4], telehealth [1, 5, 8], telemedicine [6, 8-11], or telecare [12]. However, DH is the umbrella that encompasses all other terms [13-15].

DH tools can be delivered anywhere; in different healthcare settings, with both the healthcare professional (HCP) and patient present at the setting, or at the patient's own residence, where the patient can use a digital tool to track, document and monitor their health with an opportunity to communicate with the HCP [6]. Thus, DH provides a wider scope of care and interventions that aim to reduce associated pressure on healthcare systems [8].

Traumatic injuries represent a significant cause of early death and morbidity, especially among the working population [16, 17]. Globally, traumatic injuries are reported to cause around five to six million deaths each year [17, 18], with around 40 million people and 100 million people left with permanent or transient impairment respectively [19-22], with rising needs for prolonged rehabilitation care to adjust to post-injury life. Rehabilitation is described as *"a process of assessment, treatment and management with ongoing evaluation by which the individual (and their family/carers) are supported to achieve their maximum potential for physical, cognitive, social and psychological function, participation in society and quality of living"* [23]. Whilst there has been a recognition that more lives are being saved, rehabilitation following trauma is woefully behind, with global estimates of at least one in every three people needing rehabilitation services at some point throughout their injury [24]. Many people who have had major trauma are left with disability, medical dependency, family disruption and ongoing psychosocial issues [17, 25]. There is additionally a financial burden associated with supporting the rehabilitation needs of patients post major trauma [26, 27].

A traumatic injury is defined as any injury that requires admission to hospital at the time of injury [16]. According to the National Institute for Health and Care Excellence (NICE), a major trauma/injury is also

defined as an injury or a combination of injuries that are life-threatening and/or life changing and that could result in long-term disability [28, 29]. This includes musculoskeletal injuries, traumatic brain injuries (TBIs), spinal cord injuries (SCIs), multiple fractures, and traumatic amputation [30].

Traumatic injuries have negative consequences, both physically and mentally [16]. SCIs, for example, hinder the patient's ability to access healthcare, affecting their mobility and transportation [31, 32], thus disrupting the patient's quality of life (QoL) [33, 34]; whereas TBIs affect memory, executive functions, and cognitive skills associated with planning and decision making [35, 36], leading to long lasting activity limiting impairment [37], disability [38, 39] and changed healthcare needs [40]. These injuries are usually associated with psychological consequences that require equal attention [30].

Mild injuries are usually treated at home with minimal time spent in the hospital when needed [30]. However, major injuries usually require more intensive or specialised care to properly manage the patient's condition [30]. Following traumatic injuries, patients still need rehabilitation support to help them regain their optimum function and independence [16]. However, several challenges are encountered with providing continuous services at the healthcare setting, including the lack of available beds in rehabilitation facilities, a dwindling workers in these facilities, the location of the rehabilitation facility far from a person's home and family (e.g., people living in rural areas), and the difficulty for people with different injuries to travel to the healthcare setting to receive rehabilitation support [41-44]. There is therefore a need to continue delivering services using alternative, remote pathways to keep patients connected to the rehabilitation and healthcare services [42].

DH is a cost-effective solution that is increasingly used to support people with different traumatic injuries [45-48].

Similar results were reported when services are delivered face-to-face or in a virtual remote environment [49]. Over the past decade, the advancement and wide availability of information and communication technology has been associated with an increased and expanded use of remote approaches to deliver medical and rehabilitation services [36, 50, 51]. Several digital health interventions have been designed across the past decades to support people with different types of traumatic injuries. This review aims to identify DH interventions that are specific to support patients' physical, functional and/or psychological rehabilitation following major physical traumatic injuries and the impact of these interventions on health-related outcomes.

Aim and objectives:

This review aims to identify DH interventions that support physical, functional and/or psychological

rehabilitation of adult patients who have sustained major high impact physical traumatic injuries, and the impact of these interventions on health-related outcomes.

The review objectives are to identify:

- What types of DH interventions are being used
- Which healthcare conditions are currently supported by DH interventions
- What the impact of DH interventions are on patient health related outcomes

Methods

Criteria for considering studies for this review

Type of studies

For this systematic review, randomised controlled trials (RCTs) with associated patient-reported health-related outcome measures (PROMs) will be considered eligible for inclusion. Completed studies that are published in peer reviewed journals will be included. Other study designs such as case reports, case studies, qualitative studies, and reviews will be excluded. All languages will be considered, and studies that are written in a language other than English that are eligible for inclusion will be translated using the onlinedoctranslator website to confirm their eligibility. Furthermore, corresponding authors will be contacted to confirm the accuracy of data extracted from the translated studies that will be included in the review.

Participants

The review will target studies that are conducted with adult patients (aged 18 years and over) who report to have had major physical high impact trauma/injury, who have received a period of inpatient hospitalisation due to their injury, and who have received remote rehabilitation support through a DH tool. This review will focus on high impact injuries that are usually treated in major trauma units/services (e.g., TBIs, SCIs, road traffic accidents) [52-54]. Other types of traumas will not be included as they follow a different treatment pathway to the high impact injuries (e.g., fractured neck of femur linked to fragility, or injuries that can be the result of low velocity trauma e.g. fall from standing as opposed to a fall from a high-speed motor vehicle collision). The level of severity of the traumatic injury will depend on how this is described by included studies, which may include measuring the Injury Severity Score (ISS) or other measures [55].

Interventions

Studies that include DH interventions to improve physical, functional and/or psychological rehabilitation that are remotely delivered/utilised by patients will be considered for inclusion. Rehabilitation interventions would include treating, assessing, managing and/or evaluating individuals for the purpose of improving their health-

related outcomes [23]. DH interventions that are only delivered in the healthcare setting e.g. hospital or clinic, will not be included in this review. Additionally, DH interventions that are directed to HCPs, students, family members, parents or carers; and blended interventions where the impact of the targeted DH intervention on patients cannot be identified/distinguished will be excluded. No restriction will be imposed on the type of control group to be included in this review in comparison to the HD intervention group.

Outcomes measured

This review will only include studies that report patient health-related outcomes to the use of DH interventions. This will help in identifying the impact of the DH intervention on these outcomes and therefore allow drawing conclusions on its potential usefulness in supporting the care of patients with major traumatic injuries. Based on the focus of this review, reported outcomes will primarily focus on the physical (e.g., improving activity/movement/ physical function), and/or psychological patient outcomes (e.g., improve cognition, reduce depression/ improve mental function). Studies that only report outcomes that are not health-related (e.g., intervention satisfaction and/or acceptability, or feasibility to delivering the intervention) will not be included. The review will also report the tools used in measuring reported outcomes (if any).

Search methods for identification of studies

Electronic searches

A search will be conducted systematically by the main researcher using the following electronic databases: Medline, EMBASE, AMED (via Ovid), and CINAHL Plus, PsycInfo (via Ebsco). Preliminary searches were initially conducted using these databases to identify the relevant keywords, and the final search strategy was then developed in consultation with an Information Specialist with expertise in developing search strategies for systematic reviews, to identify published relevant studies focusing on DH interventions, rehabilitation, and major trauma.

Table-1 provides the keywords that will be used in searching the databases to identify eligible studies. Search results will be limited by publication date since the millennium (2000), a time period which was associated with a wide range of technological innovations that allowed patients and service users to gain easier access to the world of medicine [56-58]. Example of the full search strategy is provided in Appendix 1.

Table 1 Search keywords

Keyword heading	Keywords

Digital health	telemedicine or "e?health" or "electronic health" or "m?health" or "mobile health" or "e?medicine" or e?therapy or "health technolog?" or "information technolog*" or "communication technolog*" or "mobile technolog*" or tele?care or tele?communication or tele?monitoring or "remote monitor*" or "remote consult*" or telephone or phone or smart?phone or wearable or smart?watch or internet or web?based or e?mail or "electronic mail" or online or wireless or "mobile app*" or app* or "digital health" or "digital health?care" or tele?health or "remote health*" or internet?based or computer?based or e?learning or electronic?health or electronic?learning or video?gam* or gaming or "game-based" or gamification or "Virtual Reality" or "augmented reality" or "artificial intelligence" or "Internet of Things" or technology or virtual or teletherapy or "medical technology" or "mobile application" or teleconsultation or "virtual medicine" or "video consultation" or telepsychiatry or telepsychology or telerehabilitation or tele?therapy
	AND
Rehabilitation	Rehabilitation or "Exercise Therapy" or "exercise rehabilitation" or physiotherapy or "physical therapy" or "physical rehabilitation" or "cognitive rehabilitation" or "cognitive therapy" or "psychological rehabilitation" or "psychological therapy" or "mental rehabilitation" or "mental therapy" or "musculoskeletal rehabilitation" or "physical therapy modalities" or "occupational therapy" or "post?trauma rehabilitation" or "occupational rehabilitation" or "post?traumatic rehabilitation" or "rehabilitation exercise" or "vocational rehabilitation" or kinesiotherapy or "neurologic rehabilitation" or "neurological therapy" or "recreation therapy" or "recreation rehabilitation"
	AND
Trauma/injury	"traumatic injur*" or "musculoskeletal trauma*" or "complex fracture" or fracture* or "traumatic brain injur*" or "spinal cord injur*" or "traumatic amputation" or "major trauma" or "brain injur*" or "brain trauma*" or "musculoskeletal injury" or "posttraumatic stress disorder" or "PTSD" or "acquired brain injur*" or "physical injur*" or "physical trauma*" or injur* or trauma* or "multiple trauma" or "multiple injur*" or "soft tissue injur*" or "soft tissue trauma*" or "nervous system injur*" or "nervous system trauma*" or "athletic injur*" or "athletic trauma*"

Searching other resources

Reference searching

The reference lists of all studies included for final analysis and of relevant reviews will be inspected to identify previously conducted studies that might be relevant to this review.

Author contact

Authors will be contacted for any missing data. Studies will not be included if there is ambiguity, and authors could not be contacted for clarification.

Grey literature search

A grey literature search will be considered using the same search strategy to identify additional studies that might be useful for this review. This will be conducted using the OpenGrey website (www.opengrey.eu).

Inclusion and exclusion criteria

Study inclusion criteria

1. Research that is focused on a digital health intervention(s) to support physical, functional and/or psychological rehabilitation of patients with major physical trauma
2. Primary end user of the digital health intervention is an adult patient (aged 18 years and above)
3. DH interventions with potential for direct interaction with an HCP
4. Any form of digital-based intervention/treatment delivered by any digital means (e.g., website or app) over any time frame
5. Interventions delivered remotely at the patient's own residence (no need to be in office/clinic/HC setting)
6. Research that reports patient health-related outcome(s) (any reported HC outcome)
7. Study design: RCT with comparison/control group
8. Original research (article/journal article)

Studies that do not meet one or more of the above criteria or that meet any of the following exclusion criteria will be excluded from the review:

1. DH interventions that are not focused on physical, functional and/or psychological rehabilitation of patients
2. Research that includes patients with minor or low impact trauma/injury
3. Research focused on healthy people/public members
4. DH Interventions that are only delivered at hospital/healthcare setting
5. Studies where the researcher or HCP need to do home visits to deliver the intervention
6. DH intervention end user is a patient carer/caregiver, family member, HCP or a student (e.g., medical or nursing student)
7. Studies that include caregivers/family members however with reported outcomes that cannot be distinguished from patient reported outcomes
8. Studies with no reported outcomes or that only reports outcomes that are not health-related (e.g., feasibility, acceptability, satisfaction, or economic evaluation)
9. Studies that include mixed patient cohorts with several underlying conditions with no specific links to reported outcomes
10. Studies where the underlying cause of injury is mixed (e.g., traumatic and non-traumatic spinal cord injuries)
11. Studies that focus on stroke/post stroke, burns, concussion, stress after ICU discharge

12. Studies that focus on psychological health rehabilitation that is not secondary to physical traumatic injury
13. Studies that predict the occurrence of an outcome(s) or where the digital intervention is used as a screening tool.
14. Digital intervention validation studies.
15. Study design that is not considered an RCT, e.g., quasi-experimental designs, pre-test/post-test cohort studies, qualitative research, observational studies, cross-sectional studies, and review articles.

Data Collection and Analysis

Study selection

Search results obtained from all databases will be exported into the reference manager EndNote 9.3.3 for reference management and removal of duplicates. A double review process by two reviewers will be independently carried out at all screening stages to check the eligibility of all retrieved records against the inclusion criteria. Screening will be conducted using Covidence software [59]. Any arising discrepancies will be resolved by discussion between the reviewers and, where necessary by consulting a third reviewer. Inter-rater agreement will be measured using Cohen's kappa coefficient.

The search results and final findings will be presented in a PRISMA flow chart, including summaries of the numbers of studies included/removed throughout the screening process, with reasons for exclusion provided for the full text screening.

Data Extraction

A data extraction template using Excel sheet will be designed to extract relevant data from each eligible study, where possible. Table 2 displays the data that will be extracted from included studies.

Table 2 Data to be extracted from included studies

Data category	Details to be extracted
1. General characteristics	Study title, authors, publication year, study design, and country
2. Characteristics of included Participants	Sample size of patient participants, demographic of recruited patient participants, type of traumatic injury under investigation, and people

		involved in delivering the digital health intervention (e.g., healthcare professionals)
3.	Characteristics of the Intervention	Type of digital health intervention, duration and mode of intervention delivery, control group, outcomes, outcome measures, and impact/effect

- Data from each eligible study will be independently extracted by one reviewer and checked by a second reviewer to verify accuracy and completeness of all data extracted. Disagreements will be resolved by discussion and consensus, or by consulting a third reviewer where necessary.

Assessment of risk of bias in included studies

The need for quality assessment of identified studies will be determined once data extraction begins. Two reviewers will independently assess the risk of bias in included studies using the Risk of Bias 2 (RoB 2) tool [60, 61]. This tool assesses the risk of bias in five domains in RCTs: randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result. Any arising disagreement will be resolved by discussion or if needed by consulting a third reviewer.

Strategy for data synthesis

The results of the search from all databases will be fully reported in the final document and presented in a PRISMA flowchart. A description of all included studies will be provided in tables to summarise extracted data. Study participant characteristics and intervention specifications will be presented, as reported in the original articles, to enable comparisons across studies. The quality rating of included studies will also be presented.

We will undertake a meta-analysis if the participants, interventions, comparisons, and outcomes are judged to be sufficiently similar to be combined to arrive at an answer that is clinically meaningful. Results will be pooled from trials using fixed-effect or random-effects models, considering issues of trial methodological and clinical heterogeneity, and reported diagrammatically using forest plots. Where issues of trial methodological and clinical heterogeneity appear to exist, we will also consider strategies including not pooling data and conducting subgroup analyses or sensitivity analyses. Where data cannot be pooled due to high heterogeneity, we will still provide descriptive analysis of trial results and report them in the text of the review.

Where meta-analyses are possible, for continuous outcomes, we will use the inverse variance method for fixed-effect models, and the DerSimionian and Laird variant of the inverse variance methods for random-effects models. For dichotomous outcomes, we will use the Mantel-Haenszel method for fixed-effect models, and the DerSimionian and Laird method for random-effects models. A 0.5 zero-cell correction will be applied in the event of zero frequencies.
For studies with multiple treatment groups, we will aim to combine treatment groups to facilitate a single pairwise comparison following methods recommended by Cochrane [62].

We will base our analyses on change scores where all necessary data including baseline and follow-up scores and correlations are provided; otherwise, we will use follow-up scores. Where not provided directly, we will calculate standard deviations from reported standard errors or confidence intervals; or estimate from other statistics such as IQR or from graphical representations. We will conduct sensitivity analyses to assess the influence of individual studies and represent on influence plots. We will consider representing small-scale effects using funnel plots following methods recommended by Cochrane [62] and subject to a minimum of 10 included studies.
We will use Stata statistical software for all meta-analyses (Stata 2017) and/or SPSS.

Subgroup analysis and investigation of heterogeneity
None planned.

Ethical Considerations
No ethical approval is deemed necessary for this review as the review will be conducted by searching available evidence that does not report any personal information about individual participants.

Results
As of January 2025, the systematic review is in the data extraction stage. Seven studies have been identified for analysis. Following data extraction, the included studies will undergo assessment of risk of bias. The findings are expected to be published in a peer-reviewed journal by December 2025. The review is registered on PROSPERO (registration number CRD42023485748).

Discussion
Principal Findings

This review is designed to identify published RCTs that investigate the use of remotely delivered DH interventions and their impact on supporting physical, functional and/or psychological rehabilitation of adult patients with major physical high impact traumatic injuries. Identifying this would add more information to current knowledge on the use of DH interventions in rehabilitation care and would establish the extent of the use of these interventions and their potential impact to improving patient outcomes.

Major traumatic injuries can drive problems with the patient's mobility and access to healthcare service, and depending on the type of injury, other associated symptoms may include affecting breathing, swallowing, drinking and cognitive functioning; and causing depression and anxiety [16]. Major trauma thus puts patients at risk for chronic health conditions that can become life-threatening if not adequately managed [63]. Major trauma is a common cause of death in adults younger than 40 years old. Various traumatic injuries demand different rehabilitation support [16]. Therefore, there is a need to address rehabilitation care needs of individual patients. Patients discharged home following the acute inpatient care for their major traumatic injuries are usually still in need for continuous long term rehabilitation support. Through this review, identified effective DH interventions are expected to benefit these patients in support their needs and in improving their health-related outcomes and overall independence.

[64-67]

Comparison to Prior Work

DH has undergone a great development in terms of its application, growth, and its widespread. The number of DH interventions is increasing worldwide, as evidenced by the growing number of scientific publications, which has been greatly influenced by the COVID-19 pandemic [1]. There is additionally a growing development of DH interventions in managing patients with traumatic injuries [64-67]. A wide range of DH tools have been described by previous studies in rehabilitation services, including the use of remote communication pathways such as emails, text messages, and video conferencing [68, 69]. Positive outcomes were also reported by previous studies on the impact of telerehabilitation in improving patient outcomes [70, 71]. ~~Associated with this tremendous increase in technological development is a need to identify existing evidence, which could then support drawing conclusions to inform policymakers and guide HCPs to implement effective interventions in practice to better support patient outcomes.~~ Therefore, there are promising expectations for the use and impact of DH interventions in patients with major trauma.

Strengths and Limitations

DH interventions provide an avenue to support the rehabilitation needs of patients, especially using remote pathways when challenges exist to providing face-to-face support. The findings of this review will help identify the interventions currently available to support patients with major traumatic injuries, the types of major injuries being targeted by the DH intervention, the impact these interventions drive on patient health-related outcomes, and prioritising resources for rehabilitation interventions towards those that are most effective and/or have the biggest evidence base. This review has several strengths. To the best of authors' knowledge, this is the first review to investigate the use of DH interventions in supporting people with major traumatic injuries. The findings of the review are expected to address, inform, and minimise gaps in DH rehabilitation specific to this patient population. The review is adhering to PRISMA-ScR guidelines related to conducting systematic reviews [72] and is using a rigorous strategy including searching related databases and the plans to check the bibliography of finally included studies and relevant reviews to identify additional relevant studies. Furthermore, no language restriction will be used in the search strategy to reduce the risk of missing studies that might be relevant to this review. Moreover, to reduce the risk of selection bias, the screening of retrieved studies and quality assessment of included studies will be conducted by two reviewers, and data extraction will be checked aby another reviewer, with disagreements resolved via discussion or by consulting a third reviewer where appropriate.

The review has some limitations. The review is only focusing on studies that include patients with major traumatic injuries, thus, studies with mixed cohort of patients with various degrees of injury severity will be rejected. This may therefore lead to missing the identification of useful interventions. However, if distinction is made between the impact of the DH intervention on the various injury levels of the included cohort sample, these studies will be included. Another limitation is related to the focus of the review that is not investigating a specific DH intervention nor outcome measures. This might therefore identify studies with a wide range of different DH interventions and outcomes, reducing therefore the possibility for conducting meta-analysis to included studies. Upon completion of this review, further strengths and limitations might be identified and summarized.

[73]

Future Directions

DH interventions provide an avenue to support the rehabilitation needs of patients, especially using remote pathways when challenges exist to providing face-to-face support. The findings of this review will help identify the interventions currently available to support patients with major traumatic injuries, the types of major injuries being targeted by the DH intervention, the impact these interventions drive on patient health-related outcomes,

and prioritising resources for rehabilitation interventions towards those that are most effective and/or have the biggest evidence base. Additionally, by identifying existing evidence, this could support drawing conclusions to inform policymakers and guide HCPs to implement effective interventions in practice to better support patient outcomes.

Dissemination plan

The findings of this systematic review will be disseminated through various channels to share it with the wider academic, professional and research communities. These channels will include publishing the findings in a peer-reviewed journal and presenting the work at relevant scientific conferences. Additionally, links to conference presentations/posters and published peer reviewed work will be shared on professional social medial platforms such as LinkedIn.

Conclusions

The findings of the review will highlight the available evidence on DH interventions to support physical, functional and/or psychological rehabilitation in patients with major trauma, and the associated impacts on patient health-related outcomes. The review results will provide directions on the available interventions that could be implemented in practice. The findings will also help identify existing gaps that warrants further research and investigation.

Acknowledgments

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Data Availability

Data sharing is not applicable at this stage, as no data were generated and presented in this protocol.

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Authors' Contributions

HA, ES, EH, JS, and TH participated in conceptualization and designing of the protocol. HA drafted the manuscript. All authors reviewed and approved the final version of the manuscript.

Conflicts of Interest

None declared.

Multimedia Appendix 1: Search strategy using Ovid Medline database

References

1. Giansanti D, editor. Ten Years of TeleHealth and Digital Healthcare: Where Are We? Healthcare; 2023: MDPI.
2. Peek N, Sujan M, Scott P. Digital health and care in pandemic times: impact of COVID-19. BMJ Health & Care Informatics. 2020;27(1).
3. Awad A, Trenfield SJ, Pollard TD, Ong JJ, Elbadawi M, McCoubrey LE, et al. Connected healthcare: Improving patient care using digital health technologies. Advanced Drug Delivery Reviews. 2021;178:113958.
4. Digital Health. Digital Health. Digital Health Europe; 2023 [20th July 2023]; Available from: https://digitalhealtheurope.eu/glossary/digital-health/.
5. Fatehi F, Samadbeik M, Kazemi A. What is digital health? Review of definitions. Integrated Citizen Centered Digital Health and Social Care: IOS Press; 2020. p. 67-71.
6. Hersh WR, Helfand M, Wallace J, Kraemer D, Patterson P, Shapiro S, et al. Clinical outcomes resulting from telemedicine interventions: a systematic review. BMC Medical Informatics and Decision Making. 2001;1:1-8.
7. Howarth A, Quesada J, Silva J, Judycki S, Mills PR. The impact of digital health interventions on health-related outcomes in the workplace: a systematic review. Digital health. 2018;4:2055207618770861.
8. El-Miedany Y. Telehealth and telemedicine: how the digital era is changing standard health care. Smart Homecare Technology and Telehealth. 2017:43-51.
9. Telehealth. Telehealth. NIBIB.2023 [20th July 2023]; Available from: https://www.nibib.nih.gov/science-education/science-topics/telehealth.
10. Mechanic OJ, Persaud Y, Kimball AB. TeleHealth Systems. National Library of Medicine; 2022 [cited 20th July 2023]; Available from: https://www.ncbi.nlm.nih.gov/books/NBK459384/.
11. Telehealth. Telehealth: Defining 21st Century Care. 2023 [cited 20th Julyt 2023]; Available from: https://www.americantelemed.org/resource/why-telemedicine/.
12. Federal Communications Commission. Telehealth, Telemedicine, and Telecare: What's What? 2023 [18th July 2023]; Available from: https://www.fcc.gov/general/telehealth-telemedicine-and-telecare-whats-what.
13. FDA. What is Digital Health? 2020 [20th July 2023]; Available from: https://www.fda.gov/medical-devices/digital-health-center-excellence/what-digital-health.
14. Bernstein C. digital health (digital healthcare). 2023 [19th july 2023]; Available from: https://www.techtarget.com/searchhealthit/definition/digital-health-digital-healthcare#:~:text=Under%20its%20umbrella%2C%20digital%20health,as%20well%20as%20personalized%20medicine.
15. Maier E, Reimer U, Wickramasinghe N. Digital healthcare services. Electronic Markets. 2021:1-4.
16. NICE. Rehabilitation after traumatic injury. 2022.
17. Miclau T. Rehabilitation after musculoskeletal trauma: global systems. LWW; 2024. p. e312.
18. Dewan MC, Rattani A, Gupta S, Baticulon RE, Hung Y-C, Punchak M, et al. Estimating the global incidence of traumatic brain injury. Journal of neurosurgery. 2018;130(4):1080-97.
19. Joshipura M. Global alliance for care of the injured. BMJ Publishing Group Ltd; 2012.
20. Rossiter ND. Trauma—the forgotten pandemic? International orthopaedics. 2022;46(1):3-11.
21. Debas HT, Donkor P, Gawande A, Jamison DT, Kruk ME, Mock CN. Essential surgery: disease control priorities, (volume 1). 2015.
22. Wesson HKH, Boikhutso N, Bachani AM, Hofman KJ, Hyder AA. The cost of injury and trauma care in low-and middle-income countries: a review of economic evidence. Health policy and

planning. 2014;29(6):795-808.
23. National Institute for Health and Care Excellence. Rehabilitation after traumatic injury. 2022 [cited 2025 14th January]; Available from: https://cks.nice.org.uk/topics/rehabilitation-after-traumatic-injury/#:~:text=Rehabilitation%20is%20a%20process%20of,society%20and%20quality%20of%20living.
24. Cieza A, Causey K, Kamenov K, Hanson SW, Chatterji S, Vos T. Global estimates of the need for rehabilitation based on the Global Burden of Disease study 2019: a systematic analysis for the Global Burden of Disease Study 2019. The Lancet. 2020;396(10267):2006-17.
25. Olive P, Hives L, Ashton A, O'Brien MC, Taylor A, Mercer G, et al. Psychological and psychosocial aspects of major trauma care: A survey of current practice across UK and Ireland. Trauma. 2024;26(2):124-33.
26. van der Vlegel M, Haagsma JA, Havermans RJM, de Munter L, de Jongh MAC, Polinder S. Long-term medical and productivity costs of severe trauma: Results from a prospective cohort study. PLoS One. 2021;16(6):e0252673.
27. Malekzadeh H, Golpayegani M, Ghodsi Z, Sadeghi-Naini M, Asgardoon M, Baigi V, et al. Direct cost of illness for spinal cord injury: a systematic review. Global spine journal. 2022;12(6):1267-81.
28. NICE. Rehabilitation after traumatic injury. 2022 [cited 2023 10th November]; Available from: https://www.nice.org.uk/guidance/ng211/chapter/Context.
29. Kanani AN, Hartshorn S. NICE clinical guideline NG39: Major trauma: assessment and initial management. Archives of Disease in Childhood-Education and Practice. 2017;102(1):20-3.
30. Thunder Basin Orthopedics. What Is Considered A Traumatic Injury? 2021 [cited 2024 1st October]; Available from: https://thunderbasinortho.com/what-is-considered-a-traumatic-injury/.
31. Iezzoni LI, Killeen MB, O'Day BL. Rural residents with disabilities confront substantial barriers to obtaining primary care. Health services research. 2006;41(4p1):1258-75.
32. Lawthers AG, Pransky GS, Peterson LE, Himmelstein JH. Rethinking quality in the context of persons with disability. International Journal for Quality in Health Care. 2003;15(4):287-99.
33. Ahuja CS, Wilson JR, Nori S, Kotter M, Druschel C, Curt A, et al. Traumatic spinal cord injury. Nature reviews Disease primers. 2017;3(1):1-21.
34. Fougeyrollas P, Noreau L. Long-term consequences of spinal cord injury on social participation: the occurrence of handicap situations. Disability and rehabilitation. 2000;22(4):170-80.
35. Cicerone K, Levin H, Malec J, Stuss D, Whyte J. Cognitive rehabilitation interventions for executive function: moving from bench to bedside in patients with traumatic brain injury. Journal of cognitive neuroscience. 2006;18(7):1212-22.
36. Bergquist T, Gehl C, Mandrekar J, Lepore S, Hanna S, Osten A, et al. The effect of Internet-based cognitive rehabilitation in persons with memory impairments after severe traumatic brain injury. Brain Injury. 2009;23(10):790-9. PMID: 105417720. Language: English. Entry Date: 20091023. Revision Date: 20200708. Publication Type: Journal Article. doi: 10.1080/02699050903196688.
37. Brown AW, Moessner AM, Mandrekar J, Diehl NN, Leibson CL, Malec JF. A survey of very-long-term outcomes after traumatic brain injury among members of a population-based incident cohort. Journal of neurotrauma. 2011;28(2):167-76.
38. Selassie AW, Zaloshnja E, Langlois JA, Miller T, Jones P, Steiner C. Incidence of long-term disability following traumatic brain injury hospitalization, United States, 2003. The Journal of head trauma rehabilitation. 2008;23(2):123-31.
39. Zaloshnja E, Miller T, Langlois JA, Selassie AW. Prevalence of long-term disability from traumatic brain injury in the civilian population of the United States, 2005. The Journal of head

trauma rehabilitation. 2008;23(6):394-400.
40. Masel BE, DeWitt DS. Traumatic brain injury: a disease process, not an event. Journal of neurotrauma. 2010;27(8):1529-40.
41. National Academies of Sciences E, Medicine. Traumatic brain injury: A roadmap for accelerating progress2022. ISBN: 030949043X.
42. Bergquist TF, Moessner AM, Brown AW. THE CONNECT TRIAL: Remotely connecting Traumatic brain injury experts with Those Who Need Them. Brain Injury Professional. 2017;14(1):14-6. PMID: 125228541. Language: English. Entry Date: 20171010. Revision Date: 20190212. Publication Type: Journal Article.
43. Lowe R. Rehabilitation 2030 – 2.4 billion people are in need of rehabilitation services. 2019.
44. The Chartered Society of Physiotherapy. NHS must seize upon growth in physiotherapist numbers. Integrated Care Journal. 2023.
45. Smith MW, Hill ML, Hopkins KL, Kiratli BJ, Cronkite RC. A modeled analysis of telehealth methods for treating pressure ulcers after spinal cord injury. International Journal of Telemedicine and Applications. 2012;2012(1):729492.
46. Dorstyn D, Mathias J, Denson L. Applications of telecounselling in spinal cord injury rehabilitation: a systematic review with effect sizes. Clinical Rehabilitation. 2013;27(12):1072-83. PMID: 23823709.
47. Molina-Garcia P, Mora-Traverso M, Prieto-Moreno R, Díaz-Vásquez A, Antony B, Ariza-Vega P. Effectiveness and cost-effectiveness of telerehabilitation for musculoskeletal disorders: A systematic review and meta-analysis. Annals of Physical and Rehabilitation Medicine. 2024;67(1):101791.
48. Suero-Pineda A, Oliva-Pascual-Vaca Á, Durán MR-P, Sánchez-Laulhé PR, García-Frasquet MÁ, Blanquero J. Effectiveness of a Telerehabilitation Evidence-Based Tablet App for Rehabilitation in Traumatic Bone and Soft Tissue Injuries of the Hand, Wrist, and Fingers. Archives of Physical Medicine & Rehabilitation. 2023;104(6):932-41. PMID: 164109727. Language: English. Entry Date: 20230614. Revision Date: 20230615. Publication Type: Journal Article. doi: 10.1016/j.apmr.2023.01.016.
49. Cason J. Telehealth: A rapidly developing service delivery model for occupational therapy. International journal of telerehabilitation. 2014;6(1):29.
50. Forducey PG, Ruwe WD, Dawson SJ, Scheideman-Miller C, McDonald NB, Hantla MR. Using telerehabilitation to promote TBI recovery and transfer of knowledge. NeuroRehabilitation. 2003;18(2):103-11.
51. Turkstra LS, Quinn-Padron M, Johnson JE, Workinger MS, Antoniotti N. In-person versus telehealth assessment of discourse ability in adults with traumatic brain injury. Journal of Head Trauma Rehabilitation. 2012;27(6):424-32. PMID: 22190010.
52. Thompson L, Hill M, Shaw G. Defining major trauma: a literature review. British paramedic journal. 2019;4(1):22-30.
53. Thompson L, Hill M, McMeekin P, Shaw G. Defining major trauma: a pre-hospital perspective using focus groups. British paramedic journal. 2019;4(3):16-23.
54. Thompson L, Hill M, Lecky F, Shaw G. Defining major trauma: a Delphi study. Scandinavian journal of trauma, resuscitation and emergency medicine. 2021;29(1):63.
55. The Trauma Audit and Research Network. The Trauma Audit & Research Network Procedures manual
56. Narayanan K, Bakshi A. History and future of digital health. Itihaasa Research and Digital. chromeextension ...; 2021.
57. Kuszko J. Milestones Of Digital Health: Infographic About Its Timeline. 2020 [cited 2023 10th November]; Available from: https://medicalfuturist.com/milestones-of-digital-health-infographic-

about-its-timeline/.
58. Mahya FZ. A Brief History of Digital Health. 2021 [cited 2023 10th November]; Available from: https://medium.com/that-medic-network/a-brief-history-of-digital-health-b238f1f5883c.
59. Covidence. The World's #1 Systematic Review Tool. 2024 [cited 2024]; Available from: https://www.covidence.org/.
60. Higgins JPT, Savović J, Page MJ, Elbers RG, Sterne JAC. Assessing risk of bias in a randomized trial. Cochrane handbook for systematic reviews of interventions. 2019:205-28.
61. Cochrane. Risk of Bias 2 (RoB 2) tool. 2021 [cited 2024 1st Octiber]; Available from: https://methods.cochrane.org/risk-bias-2.
62. Borenstein M, Hedges LV, Higgins JPT, Rothstein HR. Introduction to meta-analysis: John Wiley & Sons; 2021. ISBN: 1119558387.
63. Houlihan BV, Brody M, Everhart-Skeels S, Pernigotti D, Burnett S, Zazula J, et al. Randomized Trial of a Peer-Led, Telephone-Based Empowerment Intervention for Persons With Chronic Spinal Cord Injury Improves Health Self-Management. Archives of Physical Medicine & Rehabilitation. 2017;98(6):1067-76.e1. PMID: 123215555. Language: English. Entry Date: 20170526. Revision Date: 20170526. Publication Type: Journal Article. doi: 10.1016/j.apmr.2017.02.005.
64. Juengst SB, Hart T, Sander AM, Nalder EJ, Pappadis MR. Mobile health interventions for traumatic brain injuries. Current Physical Medicine and Rehabilitation Reports. 2019;7:341-56.
65. Christopher E, Alsaffarini KW, Jamjoom AA. Mobile health for traumatic brain injury: a systematic review of the literature and mobile application market. Cureus. 2019;11(7).
66. Luisa C, Pawel K, Martina G, Francesca B, Sara F, Andrea T, et al. Telerehabilitation for people with aphasia: A systematic review and meta-analysis. Journal of Communication Disorders. 2021;92. PMID: 2021-58321-001. doi: 10.1016/j.jcomdis.2021.106111.
67. Karvandi E, Barrett L, Newcombe V, Hutchinson P, Helmy A. Digital health interventions for remote follow-up after mild traumatic brain injury. British journal of neurosurgery. 2024:1-7.
68. World Health Organization. Rehabilitation. 2024 [cited 2022 25 November]; Available from: https://www.who.int/news-room/fact-sheets/detail/rehabilitation.
69. Nussbaum RP, Dicianno B, Parmanto B, Quinby EJ. Systematic review of mobile health applications in rehabilitation. PM and R. 2019 November;11(Supplement 2):S11. PMID: 631855067.
70. Betts S, Feichter L, Kleinig Z, O'Connell-Debais A, Thai H, Wong C, et al. Telerehabilitation Versus Standard Care for Improving Cognitive Function and Quality of Life for Adults with Traumatic Brain Injury: a Systematic Review. Internet Journal of Allied Health Sciences & Practice. 2018;16(3):1-16. PMID: 130595056. Language: English. Entry Date: 20180714. Revision Date: 20180717. Publication Type: Journal Article.
71. Ownsworth T, Arnautovska U, Beadle E, Shum DHK, Moyle W. Efficacy of telerehabilitation for adults with traumatic brain injury: A systematic review. The Journal of Head Trauma Rehabilitation. 2018;33(4):E33-E46. PMID: 2018-42829-013.
72. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. Annals of internal medicine. 2018;169(7):467-73.

Supplementary Files

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