

Comparison of Therapeutic Interventions for Gait Rehabilitation in Incomplete Spinal Cord Injury – A Scoping Review Protocol

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Abstract

Introduction: Globally, 250,000–500,000 people sustain a spinal cord injury (SCI) each year, with approximately 2,000 new cases reported annually in Germany. Demographic shifts increasingly challenge treatment centres: Whereas affected individuals were historically younger male trauma patients without comorbidities, most patients today are older than 60 years and frequently multimorbid. The proportion of incomplete SCIs is also rising. Rehabilitation aims to achieve the highest possible level of independence, with restoration of walking ability becoming a central goal in individuals with incomplete SCI. Long-term outcomes depend on neurological recovery, medical and therapeutic interventions, and social participation, highlighting the importance of gait rehabilitation for independence and quality of life. Therapeutic approaches for gait recovery, however, are highly heterogeneous, and no standardized protocol exists. This variability limits comparability and underscores the need for a structured overview of current interventions. A scoping review can systematically map available evidence and identify key concepts, methodological limitations, and existing knowledge gaps to support evidence-based practice in this evolving field.

Methods and analysis: This scoping review will systematically search electronic databases and follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines.

Ethics and dissemination: Ethical approval is not required, as this review draws on publicly accessible primary studies. Findings will be published in peer-reviewed journals and presented at national and international conferences.

Keywords: Spinal Cord Injury, Walking ability, Rehabilitation, Physiotherapy

Introduction

Worldwide, 250,000–500,000 people sustain a spinal cord injury (SCI) each year (Galeoto et al., 2024). While in Germany the annual number is approximately 2,000 cases (Nehiba & Kutzenberger, 2015). Demographic change presents new challenges for treatment centres: Whereas in the past, affected individuals were predominantly young male trauma patients without comorbidities, today most patients are over 60 years old at the onset of paralysis and are multimorbid (Wirz, 2013). In addition, the number of incomplete spinal cord injuries is increasing (Curt, 2005). The primary goal of rehabilitation is to achieve the greatest possible independence in daily life, depending on the level of injury and supported by appropriate assistive devices (Harder et al., 2023). In cases of incomplete lesions, the restoration of walking ability may become a central rehabilitation objective (DGUV, 2020). Following an SCI, long-term functional outcomes arise from a combination of acute neurological recovery, medical interventions, rehabilitation measures, and social participation (Galeoto et al., 2024). Gait recovery is a fundamental goal in patients with incomplete spinal cord injury to attain quality of life (La Rosa et al., 2023).

Relevance of a Scoping Review

The therapeutic interventions aimed at restoring walking ability after spinal cord injury (SCI) are highly heterogeneous, and no standardized treatment protocol currently exists. A wide range of rehabilitation strategies, physical therapy techniques, assistive devices, and technological innovations continues to be explored and developed to improve the likelihood of regaining ambulation and enhancing overall quality of life for individuals with SCI (Hernandez-Navarro et al., 2025). However, recent evidence regarding the effectiveness of gait rehabilitation for individuals with incomplete SCI remains inconclusive (Patathong et al., 2023). This lack of standardization complicates the comparison of therapeutic approaches and underscores the need for a structured overview of existing methods. A scoping review is particularly suitable for systematically mapping the current state of research and identifying key concepts, theoretical frameworks, sources, and knowledge gaps (Tricco et al., 2018). Such an overview is especially valuable in this rapidly evolving field, where therapeutic strategies continue to progress. For clinical practice, a scoping review offers a structured synthesis that supports clinicians in making well-informed decisions throughout the rehabilitation process.

Study Objectives and Guiding Questions

The objectives of this review are to characterize rehabilitation interventions delivered in inpatient and outpatient settings following the onset of an incomplete spinal cord injury, to describe their effects on patients' walking ability and gait mobility, and to identify methodological and conceptual research gaps to provide recommendations for future research initiatives.

The research project is specified through the following two guiding research questions:

- *Which physiotherapeutic interventions are applied in inpatient and outpatient settings to rehabilitate walking ability and gait mobility in patients with incomplete spinal cord injury?*

- *What effects do the various physiotherapeutic interventions have on improving walking ability and gait mobility in patients with incomplete spinal cord injury during inpatient and outpatient phases of rehabilitation?"*

Methods

Protocol

This protocol was developed in accordance with the 'Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews' (PRISMA-ScR) checklist (Tricco et al., 2018).

Study Design

The methodological structure of this scoping study is based on the following five stages of the scoping review process (Tricco et al., 2018):

Stage 1: Identifying the research question

Stage 2: Identifying relevant studies

Stage 3: Study selection

Stage 4: Charting the data

Stage 5: Collating, summarizing, and reporting the results

Search Strategy and Eligibility Criteria

The search will be conducted in electronic, bibliographic databases. The following databases will be searched:

- Medical Literature Analysis and Retrieval System Online (MEDLINE)
- Elsevier Science Direct

For this review, date restrictions will be applied, and search results published before the year 2000 will be excluded due to a lack of contemporary relevance. The search terms will include filters for human subjects, adult patients, and language. Studies published in either German or English will be considered. Articles will be included if they address any type of rehabilitation aimed at improving walking ability in patients with incomplete spinal cord injury. The use of the following search terms is planned:

- Spinal Cord Injury; incomplete; Rehabilitation; Physiotherapy; Therapy; Intervention; Walking; Walking Ability; Gait

A pilot test of the planned search strategy was conducted. The following filters were applied: Books and Documents, Clinical Trial, Randomized Controlled Trial, English, Humans, from 2000 – 2025. The following table 1 presents the pilot testing of the search, including the search terms used on PubMed.

Table 1 Search strategy - PubMed (MEDLINE); 07.07.2025

| Search | Searchterms | Results |
|--------|--|------------|
| # 1 | ((("incomplete spinal cord injury"[Title/Abstract] OR "incomplete spinal cord lesion"[Title/Abstract] OR "incomplete spinal cord lesions"[Title/Abstract] OR "incomplete spinal cord injury patients"[Title/Abstract] OR "incomplete spinal cord syndrome"[Title/Abstract] OR "incomplete spinal cord injuries"[Title/Abstract] OR "incomplete spinal cord syndromes"[Title/Abstract] OR "incomplete spinal injuries"[Title/Abstract] OR "incomplete spinal injury"[Title/Abstract] OR "incomplete spinal cord injured"[Title/Abstract] OR "incomplete spinal cord"[Title/Abstract] OR "incomplete spinal cord injured patients"[Title/Abstract]) AND ("walking"[Title/Abstract] OR "walking abilities"[Title/Abstract] OR "walking ability"[Title/Abstract] OR "walking ability recovery"[Title/Abstract] OR "walking activities"[Title/Abstract] OR "walking activity"[Title/Abstract])) AND ("rehabilitation"[Title/Abstract] OR "rehabilitation activities"[Title/Abstract] OR "rehabilitation actions"[Title/Abstract]) | 43 results |

Study Selection

The documents will be screened in two phases. First, two authors will independently assess the titles and abstracts of the documents identified by literature through the search based on the inclusion and exclusion criteria. Subsequently, a full-text screening will be conducted for the articles deemed potentially eligible for final inclusion. In cases of disagreement regarding the suitability of a study, discrepancies will be resolved through discussion between the two authors or by consulting a third reviewer. The reference management software Zotero will be used to organize and document the study selection process. Reference lists for all documents considered eligible for the review will also be generated within Zotero. All steps of the literature research process, including reasons for exclusion and search results, will be reported in detail in the final manuscript and illustrated in a PRISMA flow diagram.

Data Extraction

Using the Rayyan data-processing software, data will be independently extracted by two authors. The results obtained by both authors will be cross-checked. Any discrepancies arising during the data extraction process will be resolved by consultation with a third reviewer. For each study, the following information will be extracted:

- Title of the study
- Year of publication
- First author
- Country in which the study was conducted
- Type of study
- All outcomes relevant to the conceptual framework of the review.

The process of data extraction will be referred to as “charting the results”. The authors will maintain detailed documentation to ensure the clear identification of each study.

Collating, Analyzing, and Reporting the Results

Quantitative results will be captured in the form of frequency counts for concepts and outcomes. Table 2 will provide a descriptive and logical summary of the results reported in the included studies.

Table 2 – Summary of the Results

| | |
|---|---|
| Study | First author; year of publication; country of study; study design |
| | <i>If reported:</i> |
| Participants/Demographic Information / Clinical Data | <ul style="list-style-type: none">- Mean age- Sex- Classification of injury (AIS type)- Cause of injury (disease-related / trauma-related)- Inclusion and exclusion criteria |
| Interventions | Characteristics of gait-rehabilitation interventions (if available). <ul style="list-style-type: none">- Design of the rehabilitation program:- Involved healthcare providers- Timing of the intervention- Number of intervention sessions |
| Outcomes | Primary and secondary outcomes, if specified. |

No quality appraisal of the included studies will be conducted. For qualitative studies, a descriptive qualitative content analysis will be performed using the Rayyan software.

Data Availability Statement

The datasets and analytical procedures generated during this study, including preprocessing steps, are available from the author upon reasonable request

Ethics and Dissemination

This paper does not require ethical approval, as its content is derived from publicly accessible primary studies. The findings of this evaluation will be published in peer-reviewed journals and disseminated through presentations at national and international conferences.

Conclusion

This scoping review will identify the available literature on all therapeutic interventions aimed at rehabilitating walking ability in individuals with incomplete spinal cord injury. Through its broad inclusion criteria, the review aims to systematically map the effects of various rehabilitative interventions on walking function and to highlight existing limitations within the current body of research. The insights gained are intended to support improvements in the care of individuals with incomplete spinal cord injury and to inform future research as well as clinical practice.

Fundings

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