
LITERATURE REVIEW

Functional Outcomes and Health-Related Quality of Life in Traumatic Brain Injury Patients with Rehabilitative Program: A Literature Review Using GOSE and HRQoL Measures

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ABSTRACT

Background: Traumatic brain injury (TBI) resulting in long-term physical and neurobehavioral impairments leads to functional disabilities and remains a major public health challenge worldwide. Rehabilitation is the key intervention in improving functional outcomes and quality of life.

Objectives: Disparities in rehabilitation access, underrepresentation of cognitive and psychological outcomes, and inconsistent use of functional assessment tools persist.

Aim: To synthesize recent evidence regarding short and long-term impact of various method of rehabilitation in functional outcome and quality of life in patients with TBI, also identify gaps in rehabilitation service and differences in the special population.

Methods: This literature review integrates evidence from ten peer-reviewed publications between 2019 and 2024, selected through targeted searches from PubMed, ScienceDirect, and Google Scholar using keywords including “traumatic brain injury,” “rehabilitation,” “functional outcome,” “GOSE,” and “neurorehabilitation”.

Results: Rehabilitation for TBI patients is proven to enhance functional outcome and quality of life across age groups and injury levels. Improvements are not restricted to the early phases, but can continue over several months or years, particularly with structured and multidisciplinary care. Pediatric, older adult patient and complicated TBI require tailored rehabilitation strategies considering cognitive development and comorbidities.

Conclusion: Rehabilitation for TBI should be initiated early and continued after acute stage. Tailored personalized program integrating physical, cognitive and psychological therapy are needed.

Keywords: functional outcome, quality of life, rehabilitation, traumatic brain injury.

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INTRODUCTION

Physical, cognitive and emotional problems after traumatic brain injury (TBI) may cause physical, behavioral and psychosocial impairments, work disability, and an overall reduction in health-related quality of life.¹ Recent studies estimated that over 40% of patients who were hospitalized as a result of an acute moderate to severe traumatic brain injury (TBI) show long-term disability, with prevalence rates ranging from 3.2 to 5.3 million in the USA, that is, more than 1.1% of the U.S. population.^{2,3}

To date, TBI research has primarily focused on the acute pathophysiology underlying primary and secondary brain injury (i.e., life-threatening brain edema and increased intracranial pressure). Despite numerous positive results obtained with basic TBI research, no treatment has yet been successfully translated from bench to bedside. Thus, interest has also shifted to studying long-term sequelae among TBI survivors, who often experience a variety of serious chronic neurological and/or psychiatric conditions. In addition to physical and cognitive disabilities, TBI patients often suffer from psychiatric disorders—namely affective, anxiety, posttraumatic stress disorders and/or sleep disturbances. However, even though TBI survivors and their caregivers may benefit from early psychiatric diagnostics and supportive neuropsychiatric treatment—facilitating adaptation and resilience after the brain impact—these heterogeneous symptoms are not routinely assessed during neurorehabilitation, and thus have neither been the focus during early neurorehabilitation of TBI patients nor have been implemented in TBI guidelines.⁴

Neurorehabilitation of TBI is a vast, many-sided topic—ranging from early rehabilitation of patients with impaired consciousness to support and to accompany reintegration of patients in their social and professional environments.⁵ TBI rehabilitation is beneficial in that it improves patients' functional outcomes beyond those expected from spontaneous recovery.⁶ The key criteria for successful health and rehabilitation services are the inclusion of, and access to, well-coordinated multidisciplinary processes, which address the varying needs of patients with TBI.⁷ Despite this, existing studies of rehabilitation needs and the use of rehabilitation services following TBI indicate a lack of multidisciplinary rehabilitation services during acute care. Furthermore, traditional

rehabilitation services, such as physical, occupational, and speech and language therapies are far more likely to be used than psychological counselling during the first three months post-TBI or during the post-acute care after severe TBI.⁸

The Glasgow Outcome Scale-Extended (GOSE) has become one of the most widely used outcome instruments to assess global disability and recovery after traumatic brain injury. The GOSE has become widely adopted in TBI research studies. Previous TBI outcome studies have primarily assessed patients' physical status using the extended Glasgow Outcome Scale within 6 months after TBI, as about 85% of recovery occurs within this time frame. But, today it is well-known that patients recover beyond 6 months after their head impact and outcome is not only related to patient's mental and physical status, but also to their self-assessed health-related quality of life (HRQoL).^{4,9}

The Quality of Life after Brain Injury (QOLIBRI) is a health-related and disease-specific instrument for assessing quality of Life (QoL) after brain injury. It has been internationally validated in a variety of languages. The QOLIBRI was systematically related to the patient's emotional state, functional outcome, comorbidity, and generic health, which were assessed by using the Hospital Anxiety and Depression Scale, the Glasgow Outcome Scale, a health questionnaire regarding 28 comorbidities, and the Short-form health survey questionnaire, i.e. the SF-36, which is a generic instrument for measuring HRQoL; thus, the QOLIBRI is well-suited for use in measuring self-reported outcome following TBI and can be completed within 7 to 10 min.^{4,10}

This scoping review aims to synthesize recent evidence regarding short and long-term impact of various methods of rehabilitation in functional outcome and quality of life in patients with TBI, also identify gaps in rehabilitation service and differences in the special population.

METHODS

This scoping review follows the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) guidelines. Literature search strategies were developed using medical subject headings and text words related to “traumatic brain injury,” “rehabilitation,” “functional outcome,” “GOSE,” and

“neurorehabilitation”. The following databases were searched: PubMed, ScienceDirect, and Google Scholar. Searches were limited to studies conducted from 2019 to March 2024.

RESULT

The included studies comprised a mix of prospective cohorts, observational multicenter studies, narrative reviews, and long-term follow-up cohorts, reflecting both clinical trials and registry-based evidence. Populations studied ranged from children to older adults with various severe from mild to severe TBI. Sample sizes varied widely, from small prospective cohorts to large multicenter datasets.

The types of rehabilitation interventions consist of inpatient rehabilitation was most often studied in pediatric populations, demonstrating superior functional outcomes compared with non-inpatient care, multidisciplinary rehabilitation services in adults typically included physiotherapy, cognitive therapy, speech therapy, and psychological support, although the latter was underutilized and neurorehabilitation programs emphasized early initiation, high intensity, and holistic approaches targeting not only physical but also cognitive and psychosocial domains. Details of the study characteristics can be found in Table 1,2 and 3.

Table 1. Characteristics of the included studies (population)

Author, Year	Country	Type of Disease	Type of Disability	Age (years)	N
Pantelatos et al., 2024	Norway	Moderate–severe TBI	Functional disability (GOSE, DRS)	≥16 (adults)	439
Andelic et al., 2021	Europe (CENTER-TBI, multicenter)	Moderate–severe TBI	Multidomain (physical, cognitive, speech, psychological)	All adults	1206
Oberholzer & Müri, 2019	Switzerland (Review)	Moderate–severe TBI	Functional, cognitive, psychosocial	Mixed	Literature review
Marklund et al., 2019	Sweden (Review)	TBI (acute & chronic, incl. sport concussion)	Cognitive, physical, psychosocial	Mixed	Literature review
Gao et al., 2022	Multinational (US, Canada, Australia, Europe)	Severe pediatric TBI	Functional & QoL (GOS-E Peds, PedsQL)	Children	254
Akira et al., 2022	Japan (Review)	TBI	Functional, cognitive, psychosocial	Mixed	Literature review
Tyler et al., 2023	USA (TBI Model Systems)	TBI (≥60 years)	Functional independence, life satisfaction	≥60 (older adults)	1841
Howe et al., 2022	Europe (CENTER-TBI)	Mild TBI (complicated vs uncomplicated)	Functional, cognitive, QoL	All adults	1379
Buh et al., 2023	Africa (Perspective)	TBI (all severity)	Functional, cognitive, psychosocial	All	Opinion (not specific)
Rauen et al., 2020	Germany	Mild–severe TBI	HRQoL (QOLIBRI)	Adults	135

Table 2. Characteristics of the included studies (study design)

Authors, Year	Aim	Design	Population	Data Collection	Key Findings
Pantelatos et al., 2024	To report functional outcome in moderate–severe TBI between 6–12 months and predictors of improvement	Prospective cohort	439 patients, ≥16 y, moderate–severe TBI, Norway	GOSE, DRS at 6 and 12 months	Functional recovery often occurs between 6–12 months; GOSE not always sensitive
Andelic et al., 2021	To assess rehabilitation needs and service provision after TBI	Observational multicenter (CENTER-TBI)	1206 patients, moderate–severe TBI, Europe	Questionnaires (daily life, physical, cognitive, speech, psychological)	Physiotherapy most frequent; psychological counseling least frequent; unmet rehab needs common
Oberholzer & Müri, 2019	Clinical review of neurorehabilitation in TBI	Narrative review	Literature on moderate–severe TBI	Literature analysis	TBI recovery follows typical phases; requires holistic programs
Marklund et al., 2019	Review of acute & chronic TBI care including rehabilitation	Narrative review	Patients with TBI, incl. sport-related concussion	Literature review	Need for coordinated interdisciplinary rehab, esp. cognitive
Gao et al., 2022	To evaluate inpatient vs non-inpatient rehab after acute care in children with severe TBI	Multinational observational study	254 children with severe TBI	GOS-E Peds, PedsQL at 12 months	Inpatient rehab → better functional outcomes if GCS <13; no QoL difference
Akira et al., 2022	Review of outcomes, management, efficacy of TBI rehab	Review	Literature on TBI patients	PubMed & Web of Science	Timing, intensity, and rehab programs strongly influence outcomes
Tyler et al., 2023	To examine functional independence & life satisfaction over 10 years after TBI in older adults	Longitudinal cohort (TBI Model Systems)	1841 patients ≥60 y with TBI	FIM & Life Satisfaction Scale (1,2,5,10 years)	Function & life satisfaction often align; one subgroup had high function but low life satisfaction
Howe et al., 2022	To compare rehab outcomes in complicated vs uncomplicated mild TBI	Cohort study (CENTER-TBI)	1379 patients with mTBI	GOSE, RPQ, QOLIBRI-OS	Complicated mTBI had worse outcomes; received more rehab
Buh et al., 2023	To highlight need for early neurorehabilitation in Africa	Opinion/Expert perspective	TBI patients in Africa	Literature & regional perspective	Rehab should start at admission & continue to community
Rauen et al., 2020	To assess long-term QoL up to 10 years after TBI	Cross-sectional	135 patients with mild–severe TBI	QOLIBRI questionnaire	Majority had good QoL; 36% poor with psychiatric disorders; autonomy & cognition key

Table 3. Characteristics of the included studies (study intervention)

Authors, Year	Intervention	Comparator	Program Details	Type of Rehab	Result
Pantelatos et al., 2024	Standard rehabilitation	Outcome at 6 vs 12 months	Longitudinal follow-up	General/Comprehensive	62% moderate TBI vs 31% severe TBI showed good recovery; young age and higher GCS predicted improvement
Andelic et al., 2021	Multidisciplinary rehab services	Patients with vs without rehabilitation	CENTER-TBI registry	Multidisciplinary	Many needs unmet, especially psychological
Oberholzer & Müri, 2019	Neurorehabilitation (medical, neuropsychology, cognitive)	None	Evidence-based review	Holistic	Rehab must adapt to phase (medical, cognitive, behavioral)
Marklund et al., 2019	Acute & chronic rehabilitation	None	Interdisciplinary approach	Cognitive & general	Coordinated rehab improves recovery
Gao et al., 2022	Inpatient rehabilitation	Non-inpatient rehabilitation	Pediatric rehab services	Pediatric inpatient	Inpatient rehab effective for low-GCS patients
Akira et al., 2022	Intensive, comprehensive neurorehabilitation	None	Review of timing & intensity	Comprehensive	Optimal rehab improves independence & QoL
Tyler et al., 2023	TBI Model Systems rehab	Patterns across groups	Long-term follow-up	Long-term multidisciplinary	Women & minorities at higher risk of poor outcome
Howe et al., 2022	Rehab services (physical, cognitive)	Complicated vs uncomplicated mTBI	CENTER-TBI multicenter	Acute & post-acute	Rehab linked to severity, outcomes still worse
Buh et al., 2023	Early neurorehabilitation	Practices in developed countries	Proposal for African guidelines	Early & community-based	Need for African-specific guidelines
Rauen et al., 2020	Long-term neurorehabilitation	Severity-based differences	Clinical long-term follow-up	Neuropsychological & functional	Autonomy & cognition most important for QoL

Table 4. Characteristics of the included studies (based on population)

Population	Study	Rehabilitation Focus	Key Findings	Implications
Children	Gao et al., 2022	Inpatient rehab after acute care	More effective in patients with GCS <13; improved function but no QoL difference	Inpatient rehab crucial for children with low consciousness
Adults	Pantelatos et al., 2024	Long-term monitoring	Recovery continues 6–12 months; GOSE sometimes insensitive	Rehab follow-up should extend beyond 6 months
Adults	Andelic et al., 2021	Multidisciplinary service provision	Physiotherapy most common, psychological least; unmet needs frequent	Expand access esp. to psychological rehab
Adults	Oberholzer & Müri, 2019; Marklund et al., 2019; Akira et al., 2022	Holistic & multidisciplinary rehab	Recovery follows typical phases; timing, intensity, cognition important	Rehab must be phase-specific, not only physical
Adults	Howe et al., 2022	Complicated vs uncomplicated mTBI	Complicated mTBI → worse outcome, more rehab	Needs special attention and tailored rehab
Adults	Buh et al., 2023	Early neuro-rehabilitation in Africa	Rehab should begin at ICU and continue to community	Need regional guidelines for resource-limited settings
Older Adults	Tyler et al., 2023	Long-term follow-up (10 yrs)	Function & life satisfaction often align; women & minorities at higher risk	Address social and QoL aspects in elderly rehab
Older Adults	Rauen et al., 2020	HRQoL up to 10 yrs	36% poor QoL with psychiatric risk; autonomy & cognition key	Focus rehab on independence & psychiatric support

DISCUSSION

This review synthesized findings from recent studies on rehabilitation after traumatic brain injury (TBI), with a focus on functional outcomes and health-related quality of life across different populations. Overall, the evidence highlights the importance of early, intensive, and multidisciplinary rehabilitation, while also underscoring persistent gaps in service provision and methodological limitations.

Severe TBI

Rehabilitation after severe TBI shows the most consistent evidence for benefit, particularly when initiated very early. Andelic et al. demonstrated that continuous rehabilitation starting in the acute phase yielded significantly better functional outcomes at 12 months compared with delayed programs. Gao et al. extended these findings to pediatric populations, showing that inpatient rehabilitation improved

functional recovery in children with low GCS scores. Together, these studies highlight that both adults and children with severe TBI benefit substantially from structured, early, and intensive rehabilitation. Nevertheless, quality of life outcomes often lag behind functional improvements, suggesting that rehabilitation must integrate psychosocial and family-centered interventions alongside physical recovery.^{1,11}

Moderate to Severe TBI

In patients with moderate to severe injuries, recovery trajectories are prolonged and heterogeneous. Pantelatos et al. showed that functional gains frequently continue between 6 and 12 months, emphasizing the importance of sustained follow-up. Similarly, the CENTER-TBI study by Andelic et al. revealed large gaps in service provision, with physiotherapy most frequently delivered while psychological counseling remained underused. Narrative reviews (Oberholzer & Müri; Marklund et al.; Akira et al.) further support a holistic,

multidisciplinary model of rehabilitation, where timing, intensity, and cognitive engagement are key determinants of outcome. These findings collectively reinforce the need for long-term, multidisciplinary strategies in this group, with greater attention to psychological and cognitive rehabilitation.^{1,5,12,13}

Mild TBI

Even mild TBI is not homogeneous, as highlighted by Howe et al. Patients with complicated mild TBI (e.g., evidence of intracranial injury on imaging) demonstrated significantly worse outcomes compared to uncomplicated cases and required more rehabilitation services. Despite higher rehabilitation utilization, their outcomes remained suboptimal, indicating that current rehabilitation strategies may not adequately address the unique challenges of this subgroup. These findings underscore the necessity of early identification of complicated mild TBI and the development of tailored rehabilitation pathways, including cognitive and psychological support.¹⁴

Mixed Severity and Long-Term Outcomes

Studies including mixed populations across severity levels, such as Rauen et al. and Tyler et al., provide insight into long-term trajectories. Rauen et al. reported that while most survivors maintained acceptable HRQoL, a significant minority experienced poor outcomes linked to psychiatric comorbidities. Tyler et al. found that in older adults, functional independence and life satisfaction generally align, but subgroups—particularly women and minorities—remain vulnerable to poor psychosocial outcomes despite adequate functional recovery. These findings emphasize that across severity levels, rehabilitation must address both medical and psychosocial dimensions, with a special focus on vulnerable populations.^{4,15}

Key Limitation

The current body of evidence is predominantly derived from observational cohort studies and narrative reviews, with a lack of randomized controlled trials (RCTs) to establish high-level evidence. Significant heterogeneity in outcome measures, absence of standardized neurorehabilitation protocols, and substantial geographic disparities particularly in low- and middle-income countries further limit the robustness and external validity of existing findings. These methodological constraints underscore the critical need for standardized research

frameworks, population-specific outcome assessments, and equitable access to comprehensive rehabilitation services in future investigations.

CONCLUSION

Evidence demonstrates that severe TBI patients benefit substantially from very early and continuous rehabilitation, while moderate to severe injuries require prolonged, phase-specific interventions that address both physical and cognitive recovery. In mild TBI, particularly complicated cases, outcomes remain suboptimal despite greater utilization of rehabilitation services. Rehabilitation for TBI should be initiated early and continued after acute stage. Tailored personalized program integrating physical, cognitive and psychological therapy are needed.

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