Review Paper

A Scoping Review of Cognitive Impairment in Adults With Spinal Cord Injury: Mechanisms and Assessment Tools

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ABSTRACT

Objective: Spinal cord injury (SCI) is a life-altering condition associated with a wide range of physical and psychological consequences. Among these, cognitive dysfunction remains an under-recognized complication. This scoping review aimed to explore the prevalence of cognitive impairment, the proposed underlying mechanisms, and to identify the assessment tools used to evaluate cognitive deficits in adults with SCI without concomitant traumatic brain injury.

Methods: A comprehensive search was conducted across multiple electronic databases, including Medline, OTseeker, CINAHL, PsycINFO, Cochrane Library, Scopus, ProQuest, ScienceDirect, MagIran, and Google Scholar, covering the period from January 2013 to January 2024. Peer-reviewed articles in English or Persian with full text available and using the main keywords ("pure spinal cord injury," "adult," "cognitive disorder," "cognitive domains," "assessment," "evaluation," "test") were included.

Results: A total of 15 studies met the inclusion criteria, comprising 10 cross-sectional studies, 2 cohort studies, 1 descriptive study, 1 narrative review, and 1 systematic review, involving 771 adults with SCI. The reported prevalence of cognitive impairment ranged from 30% to 60%. Proposed mechanisms contributing to cognitive dysfunction included reduced dopamine receptor expression, chronic neuroinflammatory changes in the thalamus, hippocampus, and cerebral cortex, cardiovascular dysregulation (such as impaired autonomic control, altered inhibitory processes, hypoxia, and anoxia), autonomic dysfunction, obstructive sleep apnea, substance and medication effects, and psychological factors (including emotional distress and anxiety). The most frequently affected cognitive domains were attention, concentration, working memory, visuospatial processing, and processing speed. Commonly used cognitive assessment tools included the Beck Depression Inventory, Wechsler Adult Intelligence Scale, Mini-Mental State Examination, neuropsychiatry unit cognitive assessment tool (NUCOG), edinburgh cognitive and behavioral ALS (ECAS) screen, and stroop test.

Conclusion: Cognitive impairment following pure SCI is a multifactorial condition influenced by central nervous system (CNS) alterations, cardiovascular dysfunction, and psychological factors. Although no standardized or specialized instrument currently exists for accurately screening cognitive deficits in this population, clinicians should remain vigilant in detecting these impairments to enable timely diagnosis and the development of tailored cognitive rehabilitation strategies.

Keywords:
Spinal cord injury (SCI), Adult, Cognitive impairment, Cognitive domains, Evaluation, Assessment, Cognitive dysfunction, Neuropsychological assessment, Scoping review, Rehabilitation

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Highlights

- Cognitive impairment affects approximately 30–60% of people with pure spinal cord injury without traumatic brain injury.

- Attention, memory, executive function, and processing speed are the most frequently impaired cognitive domains after SCI.

- No specialized cognitive screening tool exists for SCI, while ECAS, NUCOG, WAIS-III, MMSE, and Stroop are commonly used.

Plain Language Summary

Spinal cord injury (SCI) is a serious condition that can affect movement, sensation, and independence in daily life. While many people are aware of the physical challenges after SCI, less attention has been given to changes in thinking and memory. This study explored how spinal cord injury may affect cognitive abilities (mental skills such as memory, attention, and problem-solving) in people who do not have a brain injury at the same time. We reviewed published studies from the last ten years to better understand how common cognitive problems are after spinal cord injury, which thinking skills are most affected, and what tests healthcare professionals use to identify these problems. Our review found that between 30% and 60% of people with spinal cord injury may experience some level of cognitive difficulty, even without a traumatic brain injury. The most commonly affected areas included attention, memory, executive function (skills used for planning and decision-making), and processing speed (how quickly the brain handles information). Researchers believe these changes may happen because of several factors, including changes in blood pressure, sleep problems, emotional distress, and changes in the nervous system after injury. These findings are important because cognitive problems can influence a person's ability to participate in rehabilitation, return to work, manage relationships, and maintain independence. Recognizing these difficulties early may help healthcare professionals provide more personalized rehabilitation and improve quality of life for people living with spinal cord injury.

Introduction

Spinal cord injury (SCI) is a devastating neurological condition resulting from traumatic or non-traumatic damage that causes bruising, compression, or disruption of neural tissue (Chay et al., 2020; Craig et al., 2017). Globally, SCI imposes a significant burden: in the United States, approximately 54 new cases per million occur annually (~17,900 cases/year) (Furlan et al., 2013), while in Iran, the prevalence is estimated at 318 per million (Jazayeri et al., 2015). Beyond its physical consequences (such as motor impairment, sensory loss, and autonomic dysfunction below the injury level), SCI is increasingly recognized as a condition with substantial cognitive sequelae (Craig et al., 2015). Emerging evidence indicates that adults with SCI (awSCI) face up to a 13-fold higher risk of cognitive impairment compared to the general population (Molina et al., 2018; Sachdeva et al., 2018), even in the absence of concomitant traumatic brain injury (TBI). Cognitive deficits in awSCI can profoundly affect daily functioning, reduce independence, and increase the risk of rehospitalization (Craig et al., 2017; Chiaravalloti et al., 2020a; Chiaravalloti et al., 2020b). Reported prevalence rates of cognitive impairment in this population vary widely—from 10% to 60%, with some studies citing rates as high as 80% (likely reflecting heterogeneity in assessment methods, sample characteristics, and definitions of impairment) (Craig et al., 2017; Chiaravalloti et al., 2020a; Chiaravalloti et al., 2020b).

Critically, however, the underlying mechanisms of cognitive dysfunction following pure SCI (i.e. without TBI or other central nervous system [CNS] insults) remain poorly understood. Moreover, it is unclear which specific cognitive domains (e.g. attention, executive function, memory, processing speed) are most consistently affected, and which assessment tools are most appropriate for detecting these deficits in awSCI. Given these uncertainties, there is a pressing need to map and synthesize the existing evidence on cognitive impairment after pure SCI. A scoping review is the optimal methodological approach for this purpose, as it allows for broad exploration of a heterogeneous and evolving evidence base, identification of key concepts, and clarification of gaps in the literature (Arksey & O'malley, 2005). Unlike a systematic review, which seeks to answer a narrowly defined clinical question with rigorous quality appraisal, a scoping review is designed to chart the scope and nature of research activity, particularly in areas where evidence is fragmented or conceptual clarity is lacking (Arksey & O'malley, 2005). This approach aligns with the Preferred Reporting Items for Systematic Reviews and meta-analyses extension for scoping reviews (PRISMA-ScR) framework, which emphasizes transparency in mapping existing knowledge and informing future research priorities (Tricco et al., 2018).

What is the reported prevalence of cognitive impairment in adults with pure SCI (i.e. no history of TBI or other brain injury)?

Which cognitive domains are most frequently and significantly affected? What assessment tools or neuropsychological batteries have been used to detect cognitive impairment in this population?

Pediatric populations were excluded due to the dynamic nature of neurocognitive development during childhood and adolescence, which may confound the interpretation of cognitive test results and limit comparability across studies. By systematically mapping the current evidence, this review seeks to inform clinical practice, guide rehabilitation strategies, and highlight priorities for future research in cognitive outcomes after SCI.

Materials and Methods

This study adopted the scoping review methodology proposed by Arksey and O'Malley (2005), which involves a five-stage framework: 1) defining the research question, 2) identifying relevant studies through electronic databases, 3) establishing inclusion and exclusion criteria, 4) charting and synthesizing data using a narrative approach, and 5) summarizing and reporting the findings.

Stage 1: Identifying the research question

This review aimed to explore the following key questions:

What is the reported prevalence of cognitive impairment among adults with pure SCI, excluding those with TBI or other cerebral lesions? Which cognitive domains are most consistently and significantly affected in this population? What assessment tools or neuropsychological batteries have been applied to evaluate cognitive impairment in adults with pure SCI?

Stage 2: Identifying relevant studies

A comprehensive search was conducted in major electronic databases (MEDLINE, ScienceDirect, OTseeker, and PEDro) chosen for their broad coverage of peer-reviewed literature in psychology, neuroscience, and rehabilitation. Additional sources, such as Google Scholar, clinical guidelines, theses, and conference proceedings, were also reviewed to capture potentially relevant studies.

The search strategy combined both keywords and MeSH terms, including SCI, pure SCI, adult, cognitive impairment, cognitive dysfunction, memory impairment, attention deficit, executive function, neuropsychological assessment, and evaluation, connected through appropriate Boolean operators.

Stage 3: Study selection

The inclusion criteria included peer-reviewed, full-text articles published in English or Persian between January 2013 and January 2024, involving adults with pure SCI and no history of TBI or other cerebral involvement. Studies were excluded if they involved animal models, targeted non-SCI populations or those with co-morbid neurological conditions, participants under 18 years of age, lacked clear cognitive definitions or measures, or were case reports or editorials without empirical data.

After database searching and manual screening, 48 articles were imported into EndNote. Following the removal of 12 duplicates, 36 titles and abstracts were independently reviewed by two authors. A total of 21 articles were excluded for the following reasons: seven studies were published in languages other than English or Persian; four were animal studies; three focused on pediatric populations; and seven investigated SCI or TBI. Ultimately, 15 studies met all inclusion criteria. Any discrepancies between the two reviewers were resolved through discussion with a third independent author. Figure 1 shows the study selection process.

Stage 4: Charting the data

Data were extracted using Microsoft Excel. Table 1 presents a synthesis of key information from the 15 included studies, such as authorship, publication year, participant characteristics, study design, prevalence of cognitive impairment, identified mechanisms, assessment tools, and the affected cognitive domains.

Table 1. Studies on mechanisms and tools used for cognitive disorders in SCI patients

Authorship (y)	Study Design	No. of Participants	Age Span (y)	Assessment Tools	Prevalence of Cognitive Impairment	Identified Mechanisms	Affected Cognitive Domains
Houldsworth et al. 2023	Cross-sectional	41 patients with SCI	20-88	ECAS	68%	Describes cognitive impairment mainly from a functional–clinical perspective, while noting that biological and pathophysiological mechanisms were not examined.	Memory, executive function, verbal fluency, visuospatial skills
Haled et al. 2022	Cross-sectional	20 participants with tSCI and 20 non-SCI	18–50	A battery of neuropsychological tests, questionnaires assessing depression and distress	-	Emotional distress	Long-term memory, short-term memory, attention
Sandalicet al. 2022a	Cohort longitudinal	62 SCI participants	46–56	NUCOG	One in five to one in 13	Describes cognitive impairment mainly from a functional–clinical perspective, while noting that biological and pathophysiological mechanisms were not examined.	Minimal cognition impairment
Sandalic et al. 2022b	Cohort Study	127 SCI participants	44.82	NUCOG	17-36%	Describes cognitive impairment mainly from a functional–clinical perspective, while noting that biological and pathophysiological mechanisms were not examined.	Attention and visual perception
Molina-Gallego et al. 2021	Cross-sectional	Fifty sub-acute stage, fifty in the chronic stage	46.82, 47.80	MMSE, DS, WMS-III, BT, TAVEC, STAI, BDI	40-60%	describes cognitive impairment mainly from a functional–clinical perspective, while noting that biological and pathophysiological mechanisms were not examined.	Attention, processing speed, visual memory, learning, memory, executive functions (symbolic recall interferences), and unrecognition.
Chiaravalloti et al. 2020	Cross-sectional	60 individuals with chronic SCI, 30 AMHC and 20 OHC	Individuals with chronic SCI: 25–48 years, AMHC: 26–49 years and OHC: 55–64 years	WAIS-III; SDMT; PASAT; DKEFS; verbal fluency subtest, CVLT-II, CMDI, STAI	As many as 60%	Describes cognitive impairment mainly from a functional–clinical perspective, while noting that biological and pathophysiological mechanisms were not examined.	Information processing speed, learning and new memory, and verbal fluency, attention and active memory.
Chiaravalloti et al. 2020	Cross-sectional	59 individuals with SCI (30 with tetraplegia, 29 with paraplegia) and 30 age-matched HC	Tetraplegia: 36.57; Paraplegia: 34.31; HC: 35.73	Neuropsychological tests	up to 60%	Describes cognitive impairment mainly from a functional–clinical perspective, while noting that biological and pathophysiological mechanisms were not examined.	Impaired in new learning memory, processing speed, verbal fluency, attention, working memory
Guadagni et al. 2019	Cross-sectional	20 patients with SCI and 20 matched healthy subjects	50.9	STAI-Y, BDI, IRI, modified version of the computerized MET	-	Describes cognitive impairment mainly from a functional–clinical perspective, while noting that biological and pathophysiological mechanisms were not examined.	Empathy
Sachdevaet al. 2019	Descriptive	-			Up to 60%	SCI cardiovascular dysfunction hypotension and autonomic dysreflexia	-

Authorship (y)	Study Design	No. of Participants	Age Span (y)	Assessment Tools	Prevalence of Cognitive Impairment	Identified Mechanisms	Affected Cognitive Domains
Molina et al. 2018	Cross-sectional	Subacute SCI=32, chronic SCI=34, able-bodied subjects=27	SCI group 45.6; Control group 44.9	Comprehensive battery of neuropsychological assessments	30–60%		Attention, processing speed, memory and learning, executive functions, and
Craig et al. 2017	Cross-sectional	SCI group: 150, able-bodied adults=45	SCI group: 46.2; control group: 48.9	NUCOG,HADS and FSS	30% -perhaps up to 60%	Depression and high anxiety creation of negative mood states	attention, language, visuo-construction
Wecht et al. 2013	Cross-sectional	-	-	MMSE, stroop color task	10-60%	Decentralized cardiovascularautonomic control of the heart, reduced resting cerebral blood flow	Impaired in memory, attention processing speed executive function
Lazzaro et al. 2013	Cross-sectional	Chronic SCI=37 Healthy controls=37	Participants with SCI: Mean age 46.5 control group: Mean age 46.4	Event-Related, potentialsand behavioral performance measures		SCI+ Shifts in inhibitory processes	Inhibitory function, primary perceptual encoding processes, subsequent executive function.

Systematic Review Article

Authorship (y)	Study Design	No. of Studies	Assessment Tools	Prevalence of Cognitive Impairment	Identified Mechanisms	Results
Alcántar-Garibay et al. 2022	Narrative review	92 articles		Up to 64%	SCI concomitant TBI or hypoxia or anoxia or autonomic dysfunction or cerebrovascular dysfunction or sleep disorders, such as obstructive sleep apnea or body temperature dysregulation or alcohol abuse, and certain drugs	Attention , concentration capacity, visuospatial perception, ability to resolve problems, processing speed, memory, Learningability..
Sachdeva et al. 2018	Systematic Review	70 articles	HCT, Neuropsychological test battery, PA–recall, Rey–recognition, VOCAB, RAVLT, FIM, LM, PA, VOCAB, NCT, SDMT and Stroop test, BNIS, HISC, HVLT, WAIS-3 DS, WAIS-3 LNS, SDMT, SCAT, CVMT, NUCOG	Up to 64%	SCI concomitant TBI or psychological or somatic complaints or decentralized cardiovascular control and sleep apnea	Comprehension, expression, social interaction, memory, Problem-solving were impaired.

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Abbreviations:BNIS: Barrow neurological institute screen; BDI: Beck depression inventory; CVMT: Continuous visual memory test; CVLT-II: California verbal learning test-II; CMDI: Chicago multiscale depression inventory; DS: Digit span; DKEFS: Delis-Kaplan executive function system; ECAS: Edinburgh cognitive and behavioral ALS screen; FIM: Functional independence measure; FSS: Fatigue severity scale; HADS: Hospital anxiety and depression scale; HCT: Halstead category test; HISC: Head injury symptom checklist; HVLT: Hopkins verbal learning test; LM: Logical memory; LNS: Letter-number sequencing; MCI: Mild cognitive impairment; NCT: Number connection test; PASAT: Paced auditory serial addition test; NUCOG: Neuropsychiatry unit cognitive assessment tool; OPS: Organic psychic syndrome; PA: Paired associates; RAVLT: Rey auditory verbal learning test; SCAT: Short category test; SDMT: Symbol digit modalities test; STAI: Strait-trait anxiety inventory; TBI: Traumatic brain injury; VOCAB: Vocabulary Subtest; WAIS: Wechsler adult intelligence scale; MET: Multifaceted empathy test; IRI: Interpersonal reactivity index; HC: Healthy controls; AMHC: Age-matched healthy controls; OHC: Older healthy controls.

Stage 5: Collating, summarizing, and reporting results

The extracted findings were systematically organized into thematic categories that directly correspond to the research objectives. A narrative synthesis approach was employed to integrate and interpret the results, with thematic priorities established based on their salience and alignment with the study's guiding research questions.

The protocol of this study was not registered in PROSPERO or any other databases.

Result

This process led to the identification of 48 articles. All findings were transferred to the EndNote software, and duplicates were eliminated (n=36). Two authors reviewed the abstracts of these 36 articles and removing 7 articles due to did not meet inclusion criteria (n=29). After checking the full text, the 14 articles were excluded (Figure 1). Finally 15 articles: A total of 10 cross-sectional studies, one descriptive study, a cohort study, a longitudinal cohort study (771 participants in total), a narrative review study and a systematic review study, were included to this review (Table 1). The first author name, type of study, number of participant and participant age or number of studies which reviewed, prevalence and mechanism of cognitive impairment, type of assessment and cognitive impairment domains were extracted from articles. According to the guidelines for a scoping review, the quality of studies did not appraise.

Discussion

Cognitive impairment after SCI is increasingly recognized as a multifaceted condition, though its underlying mechanisms remain incompletely understood. Current evidence suggests that cognitive difficulties may arise from the interplay of neurological, cardiovascular, and psychosocial factors. However, most supporting data derive from cross-sectional or observational studies, limiting causal inference. Therefore, the relationships described below should be interpreted as associations or potential contributors rather than established causal pathways.

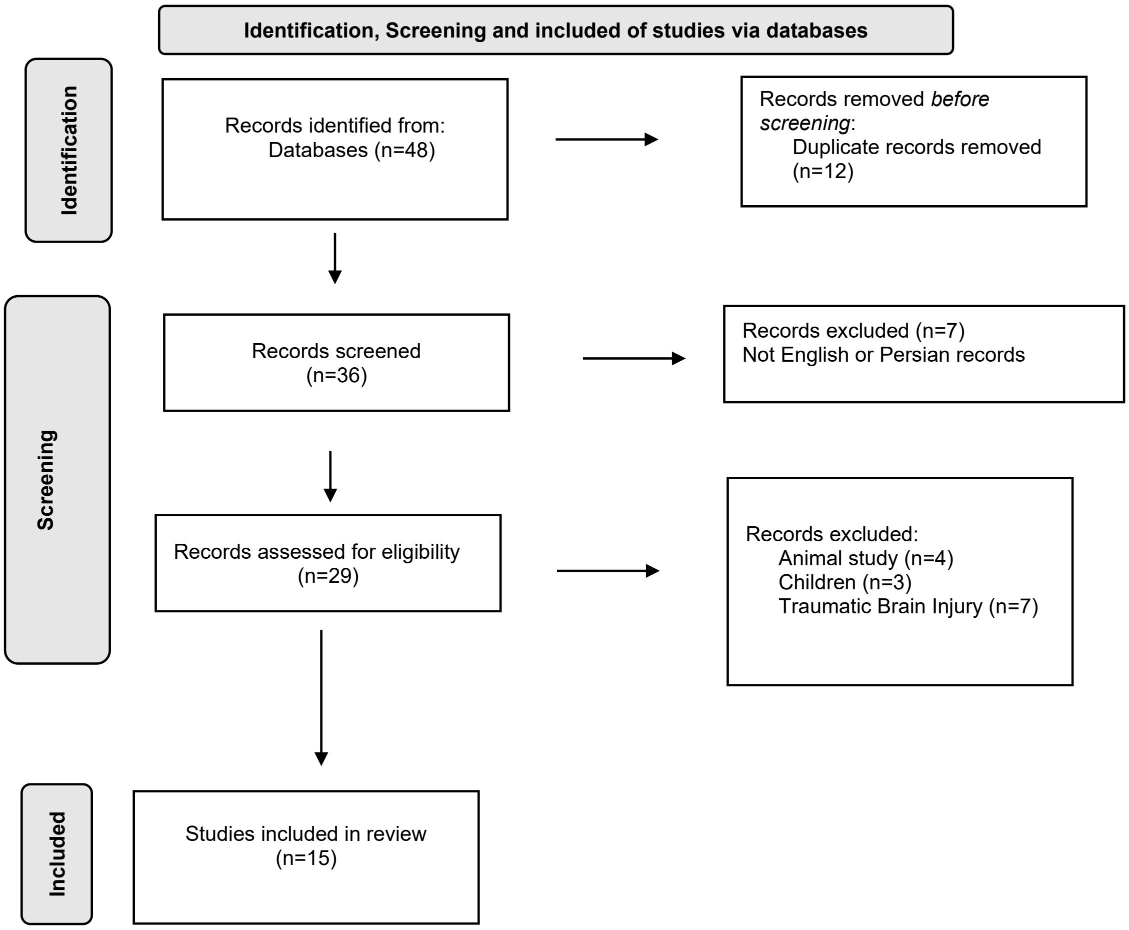

Figure 1. Flow diagram of the records selection process

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Potential contributing factors

CNS dysfunction

Individuals with SCI may exhibit cognitive deficits linked to CNS alterations, including subclinical brain injury, hypoxia secondary to respiratory compromise, autonomic dysregulation, sleep disturbances, or impaired thermoregulation (Heled et al., 2022.; Alcántar-Garib et al., 2022). Neurochemical shifts (particularly reduced dopaminergic activity) have been associated with impairments in object recognition and spatial memory in preclinical models (Kheyrkhah et al., 2020). Additionally, functional and structural changes in brain networks involved in pain processing and neural excitation/inhibition balance may indirectly influence cognition (Lazzaro et al., 2013; Wu et al., 2014). While these findings are biologically plausible, longitudinal and mechanistic studies are needed to confirm their clinical relevance in human SCI populations.

Cardiovascular alterations

Systemic blood pressure instability and reduced vascular compliance (common after high-level cervical or upper thoracic SCI) may compromise cerebral perfusion, potentially contributing to cognitive changes (Sachdeva et al., 2019; Wecht & Bauman, 2013). Although individuals with lower-level injuries may experience more subtle cardiovascular dysregulation, the long-term cognitive implications remain uncertain. Importantly, the available evidence is predominantly correlational; therefore, cardiovascular factors should be considered potential modulators rather than definitive causes of post-SCI cognitive impairment.

Psychosocial and behavioral influences

Psychological and social stressors following SCI, including depression, anxiety, reduced resilience, and disruptions in employment or social roles, are frequently reported (Wu et al., 2014; Budd et al., 2022). Maladaptive coping strategies, such as substance use, appear to exacerbate cognitive difficulties, particularly during the critical first six months of community reintegration (Craig et al., 2017). These associations highlight the importance of integrated biopsychosocial models in understanding cognitive outcomes, though directionality remains unclear (e.g. whether cognitive decline predisposes individuals to poorer coping or vice versa).

Cognitive domains affected and assessment approaches
A range of cognitive domains are reported as vulnerable after SCI, including attention, memory, executive function, processing speed, visuospatial/visuoconstructional abilities, language, learning, and problem-solving. Notably, deficits in attention and processing speed are the most consistently reported across studies (10 and 9 out of 15, respectively), whereas problem-solving impairments were documented in only one study.

This variability may reflect methodological differences in assessment sensitivity. for instance, instruments, such as the symbol digit modalities test (SDMT) and paced auditory serial addition test (PASAT), commonly used to evaluate processing speed are highly sensitive to subtle cognitive slowing and are frequently included in SCI research protocols. In contrast, higher-order functions, such as problem-solving, are less routinely assessed and may require more complex, ecologically valid tasks that are not consistently applied across studies.

Lazzaro et al. (2013) observed impairments in inhibitory control, early perceptual processing, and executive functions (e.g. contextual manipulation and working memory updating), yet found no significant associations between cognitive performance and injury level, completeness, or chronicity. This underscores the limited predictive value of traditional lesion characteristics and suggests that individual differences, such as premorbid cognitive reserve, comorbidities, or psychosocial context, may play a more substantial role than previously acknowledged.

Commonly used assessment tools include: Memory disorders occur when damage to certain parts of the brain prevents or reduces the ability to store, retain, or remember memories, which were reported in 11 of the 15 studies reviewed. The digit span, rey auditory verbal learning test (Rey AVLT), neuropsychiatry unit cognitive assessment tool (NUCOG), Wechsler Intelligence Scale-III (WAIS-III), mini-mental state examination (MMSE), and visual memory test (BMT) can evaluate different types of memory impairment following SCI (Craig et al., 2017; Molina et al., 2018; Chiaravalloti et al., 2020a; Houldsworth et al., 2023; Molina-Gallego et al. 2021; Wecht & Bauman, 2013). Deficits attention disorders are marked by an ongoing pattern of inattention that interferes with functioning, which was reported in 10 of the 15 studies reviewed. The Digit Span, Stroop Test, NUCOG, and WAIS-III tests are particularly useful in assessing attentional deficits in patients with SCI (Craig et al., 2017; Molina et al., 2018; Chiaravalloti et al., 2020a; Heled et al., 2022; Molina-Gallegoe t al. 2021).

Executive function impairment disrupts a person's ability to manage their own thoughts, emotions and actions, which were reported in 10 of the 15 studies reviewed. The NUCOG, the verbal fluency subtest of the Delis-Kaplan executive function system (D-KEFS) and the verbal learning test spain-complutense (TAVEC) are common tools for detecting executive function in patients with SCI (Craig et al., 2017; Molina et al., 2018; Chiaravalloti et al., 2020a; Houldsworth et al., 2023; Molina-Gallego et al., 2021).

Processing speed is the time it takes people to receive, understand and respond to information, which was reported in 9 of the 15 studies reviewed. The stroop test, SDMT, and the PASAT are widely utilized in clinical setting to determining deficits in processing speed (Molina et al., 2018; Chiaravalloti et al., 2020b; Heled et al., 2022; Molina-Gallego et al., 2021).

Language disorders are difficulties in communicating one's meaning through speech, writing, or even gesture, which were reported in 7 of the 15 studies reviewed. The edinburgh cognitive and behavioral ALS Screen (ECAS), NUCOG, MMSE, and Kavé naming test can help assess language disorders after SCI (Craig et al., 2017; Sachdeva et al., 2018; Heled et al., 2022; Molina-Gallego et al. 2021; Wecht & Bauman, 2013).

Visuo-spatial and visuo-constructional disorders are an inability to see an object or image as a collection of parts and then make a copy of the original from these parts, which was reported in 5 of the 15 studies reviewed. Most of the studies suggested using ECAS, NUCOG, and Rey–recognition tests to check visuospatial disorders in these individuals (Craig et al., 2017; Sachdeva et al., 2018; Houldsworth et al., 2023; Sandalic et al., 2022a; Sandalic et al., 2022b).

Learning disorders are the inability to master reading, spelling, writing, or math skills at or near the expected age and grade level, which were reported in 5 of the 15 studies reviewed. Learning disorders are evaluated using the verbal learning test spain-complutense (TAVEC) and the short category test (SCAT) (Molina et al., 2018; Chiaravalloti et al., 2020a; Molina-Gallegoet al. 2021).

Problem-solving disorder was reported in 1 out of 15 articles, which suggested using SCAT and the halstead category test (HCT) test to assessing this problem (Sachdeva et al., 2018). The heterogeneity of instruments complicates cross-study comparisons and may contribute to inconsistent prevalence estimates across domains.

Knowledge gaps and future perspectives

Several critical gaps warrant attention

Longitudinal studies are needed to track cognitive trajectories from acute to chronic phases post-SCI and to clarify temporal relationships between physiological changes (e.g. autonomic dysfunction, cerebral hypoperfusion) and cognitive outcomes. Standardized, SCI-validated cognitive screening tools should be developed and implemented to improve detection, comparability, and clinical utility. Mechanistic investigations, particularly those integrating neuroimaging, autonomic monitoring, and cerebrovascular assessments, are essential to elucidate how SCI-related physiological disruptions affect brain function. Intervention trials targeting modifiable factors (e.g. cardiovascular stability, depression, sleep quality) could inform preventive or rehabilitative strategies. Ecologically valid assessments of higher-order cognitive functions (e.g. problem-solving, real-world executive functioning) are underutilized and should be prioritized.

Conclusion

Cognitive impairment after SCI is a multidimensional phenomenon influenced by an interplay of neurological, cardiovascular, and psychosocial factors. While associations are increasingly documented, causal pathways remain speculative due to methodological constraints in the current evidence base. However, there is no specialized tool to accurately screen or detect the cognitive impairment after SCI, but ECAS, NUCOG, WAIS-III, MMSE, the Stroop test, and the BDI are the most commonly used tools. Future research must prioritize longitudinal designs, standardized assessments, and mechanistic studies to translate these insights into effective clinical interventions that enhance cognitive and functional outcomes for adults with SCI.

Limitations of the current evidence base

This synthesis is constrained by several methodological limitations in the existing literature. Most studies employ small, heterogeneous samples, limiting statistical power and generalizability. Inconsistent reporting of injury characteristics (e.g. level, completeness, time since injury) hinders subgroup analyses. Diverse assessment tools with varying psychometric properties reduce comparability across studies. The predominantly cross-sectional design of available research precludes causal inference. Language restrictions and publication bias may have excluded relevant non-English or negative findings. The absence of formal critical appraisal of study quality in many reviews further limits confidence in aggregated conclusions.

Ethical Considerations

Compliance with ethical guidelines

This article is a review study with no human or animal sample.

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Authors' contributions

Conceptualization and study design: Nazila Akbarfahimi, Elham Loni; Data collection: Mahyar Mahmoudi; Data analysis and interpretation of results: Mahyar Mahmoudi, Elham Loni; Draft manuscript preparation: Mahyar Mahmoudi, Elham Loni, Nazila Akbarfahimi, and Mohammadmasoud Mahmoudi; Final approval: All authors.

Conflict of interest

The authors declared no conflicts of interest.

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References

Alcántar-Garibay, O. V., Incontri-Abraham, D., & Ibarra, A. (2022). Spinal cord injury-induced cognitive impairment: A narrative review. *Neural Regeneration Research, 17*(12), 2649–2654. [DOI:10.4103/1673-5374.339475] [PMID]

Arksey, H., & O'malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology, 8*(1), 19-32. [DOI:10.1080/1364557032000119616]

Chay, W., & Kirshblum, S. (2020). Predicting outcomes after spinal cord injury. *Physical Medicine and Rehabilitation Clinics, 31*(3), 331-343. [DOI:10.1016/j.pmr.2020.03.003] [PMID]

Chiaravalloti, N. D., Weber, E., Wylie, G., Dyson-Hudson, T., & Wecht, J. M. (2020a). Patterns of cognitive deficits in persons with spinal cord injury as compared with both age-matched and older individuals without spinal cord injury. *The Journal of Spinal Cord Medicine, 43*(1), 88-97. [DOI:10.1080/10790268.2018.1543103] [PMID]

Chiaravalloti, N. D., Weber, E., Wylie, G., Dyson-Hudson, T., & Wecht, J. M. (2020b). The impact of level of injury on patterns of cognitive dysfunction in individuals with spinal cord injury. *The Journal of Spinal Cord Medicine, 43*(5), 633-641. [DOI:10.1080/10790268.2019.1696076] [PMID]

Craig, A., Guest, R., Tran, Y., & Middleton, J. (2017). Cognitive impairment and mood states after spinal cord injury. *Journal of Neurotrauma, 34*(6), 1156-1163. [DOI:10.1089/neu.2016.4632] [PMID]

Craig, A., Perry, K. N., Guest, R., Tran, Y., Dezarnaulds, A., & Hales, A., et al. (2015). Prospective study of the occurrence of psychological disorders and comorbidities after spinal cord injury. *Archives of Physical Medicine and Rehabilitation, 96*(8), 1426-1434. [DOI:10.1016/j.apmr.2015.02.027] [PMID]

Furlan, J. C., Sakakibara, B. M., Miller, W. C., & Krassioukov, A. V. (2013). Global incidence and prevalence of traumatic spinal cord injury. *Canadian Journal of Neurological Sciences, 40*(4), 456-464. [DOI:10.1017/S0317167100014530] [PMID]

Guadagni, V., Sarà, M., Conson, M., Carolei, A., Sacco, S., & Vadini, S., et al. (2019). Cognitive and emotional empathy in individuals with spinal cord injury. *Behavioural Neurology, 2019*(1), 1312934. [DOI:10.1155/2019/1312934] [PMID]

Heled, E., Tal, K., & Zeilig, G. (2022). Does lack of brain injury mean lack of cognitive impairment in traumatic spinal cord injury?. *The Journal of Spinal Cord Medicine, 45*(3), 373-380. [DOI:10.1080/10790268.2020.1847564] [PMID]

Houldsworth, C., Nair, K. P. S., & Hariharan, R. P. (2023). Cognition and quality of life of people with spinal cord injury. *Progress in Rehabilitation Medicine, 8*, 20230001. [DOI:10.2490/prm.20230001] [PMID]

Jazayeri, S. B., Ataeepour, M., Rabiee, H., Motevalian, S. A., Saadat, S., & Vaccaro, A. R., et al. (2015). Prevalence of spinal cord injury in Iran: A 3-source capture-recapture study. *Neuroepidemiology, 45*(1), 28-33. [DOI:10.1159/000435785] [PMID]

Kheyrkhah, H., Soltani Zangbar, H., Salimi, O., Shahabi, P., & Alaei, H. (2020). Prefrontal dopaminergic system and its role in working memory and cognition in spinal cord-injured rats. *Experimental Physiology, 105*(9), 1579-1587. [DOI:10.1113/EP088537] [PMID]

Lazzaro, I., Tran, Y., Wijesuriya, N., & Craig, A. (2013). Central correlates of impaired information processing in people with spinal cord injury. *Journal of Clinical Neurophysiology, 30*(1), 59-65. [DOI:10.1097/WNP.0b013e31827edb0c] [PMID]

Molina-Gallego, B., Gómez-Cantarino, S., Ugarte-Gurrutxaga, M. I., Molina-Gallego, L., & Mordillo-Mateos, L. (2021). Neuropsychological study in patients with spinal cord injuries. *Healthcare, 9*(3), 241. [DOI:10.3390/healthcare9030241]

Molina, B., Segura, A., Serrano, J. P., Alonso, F. J., Molina, L., & Pérez-Borrego, Y. A., et al. (2018). Cognitive performance of people with traumatic spinal cord injury: A cross-sectional study comparing people with subacute and chronic injuries. *Spinal Cord, 56*(8), 796-805. [DOI:10.1038/s41393-018-0076-0] [PMID]

Sachdeva, R., Gao, F., Chan, C. C., & Krassioukov, A. V. (2018). Cognitive function after spinal cord injury: A systematic review. *Neurology, 91*(13), 611-621 [DOI:10.1212/WNL.0000000000006244] [PMID]

Sandalic, D., Tran, Y., Arora, M., Middleton, J., McBain, C., & Myles, D., et al. (2022). Improving assessment of cognitive impairment after spinal cord injury: Methods to reduce the risk of reporting false positives. *Journal of Clinical Medicine, 12*(1), 68. [DOI:10.3390/jcm12010068]

Sandalic, D., Tran, Y., Craig, A., Arora, M., Pozzato, I., & Simpson, G., et al. (2022). The need for a specialized neurocognitive screen and consistent cognitive impairment criteria in spinal cord injury: analysis of the suitability of the neuropsychiatry unit cognitive assessment tool. *Journal of Clinical Medicine, 11*(12), 3344. [DOI:10.3390/jcm11123344] [PMID]

Sachdeva, R., Nightingale, T. E., & Krassioukov, A. V. (2019). The blood pressure pendulum following spinal cord injury: implications for vascular cognitive impairment. *International Journal of Molecular Sciences, 20*(10), 2464. [DOI:10.3390/ijms20102464] [PMID]

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., & Levac, D., et al. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Annals of Internal Medicine, 169*(7), 467-473. [DOI:10.7326/M18-0850] [PMID]

Wecht, J. M., & Bauman, W. A. (2013). Decentralized cardiovascular autonomic control and cognitive deficits in persons with spinal cord injury. *The Journal of Spinal Cord Medicine, 36*(2), 74-81. [DOI:10.1179/2045772312Y.0000000056] [PMID]

Wu, J., Zhao, Z., Sabirzhanov, B., Stoica, B. A., Kumar, A., & Luo, T., et al. (2014). Spinal cord injury causes brain inflammation associated with cognitive and affective changes: Role of cell cycle pathways. *Journal of Neuroscience, 34*(33), 10989-11006. [DOI:10.1523/JNEUROSCI.5110-13.2014] [PMID]