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Narrative Review

Nutrition care in adults with spinal cord injuries and disorders with pressure injuries: A systematic review of clinical practice guidelines

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SUMMARY

Pressure injuries (PIs) are a common and costly complication in adults with spinal cord injuries and disorders (SCI/D), with a global prevalence of 32 % and a lifetime risk exceeding 85 % in Australia. Nutrition is a key factor in the prevention and management of PIs, supporting wound healing, immune function, and overall recovery. This systematic review evaluated the quality, scope, and methodological rigour of 17 international clinical practice guidelines (CPGs) published since 2010 that included nutrition recommendations for PIs in adults with SCI/D. Using the AGREE II and the AGREE-REX tools, this review assessed overall guideline quality and nutrition-specific recommendations mapped to the Nutrition Care Process domains. Seven CPGs were rated high quality with AGREE II, and three with AGREE-REX. While most guidelines focussed on nutrition interventions, limited detail was provided on assessment and monitoring. Considerable variation was found in the rigour and specificity of recommendations. These findings underscore a need for high-quality, SCI/D-specific guidelines that offer consistent, evidence-based, actionable nutrition guidance, particularly in the under-represented areas of assessment and monitoring, to better support PI prevention and treatment in this vulnerable population.

1. Introduction

Pressure injuries (PIs) are among the most common and expensive secondary complications affecting adults with spinal cord injuries and disorders (SCI/D) [1,2]. Globally, approximately 32.4 % (95 % CI: 28.2–36.5 %) of individuals with SCI/D develop PIs [3]. In Australia, over 85 % of individuals with SCI/D are expected to develop a PI during their lifetime [4], with more than 30 % experiencing an active PI at any given time leading to prolonged hospital stays, **decreased** infection risk, diminished quality of life, and substantial economic burden.

Nutrition plays a critical yet often underemphasised role in both the prevention and treatment of PIs [5–7]. Individuals with SCI/D face a paradoxical risk of both malnutrition through deficiency (undernutrition) and malnutrition through excess (overnutrition), and obesity due to reduced energy expenditure, changes in body composition, suboptimal dietary practices, and increased metabolic demands [8,9]. Neurogenic obesity, present in over 75 % of individuals with SCI/D, leads to increased adipose tissue accumulation, which releases pro-inflammatory cytokines that perpetuate systemic inflammation and elevate PI risk [8,10–12]. Conversely, malnutrition through deficiency, driven by factors such as dysphagia, gastrointestinal dysfunction, and poor dietary intake undermines skin integrity, impairs wound healing, and increases susceptibility to infection [13]. Antioxidant depletion caused by systemic inflammation in people with SCI/D, particularly of nutrients like vitamin C, further exacerbates oxidative stress and hinders tissue repair [14,15]. If inadequately

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addressed, PIs can progress to infection, sepsis, multi-organ failure, and ultimately death [16–18].

Given the critical role of nutrition in modulating both the risk and healing trajectory of PIs, it is essential that **Clinicl** Practice Guidelines (CPGs) incorporate clear, evidence-based nutritional recommendations tailored to the unique needs of individuals with SCI/D. CPGs are systematically developed statements intended to assist clinician and patient decisions about appropriate healthcare for specific clinical circumstances [19]. While previous reviews have assessed the quality and applicability of general PI-related CPGs [20,21], there remains a gap in evaluating how well these guidelines address nutrition-specific care in the SCI/D population. This systematic review therefore aimed to synthesise current ev-idence on nutritional care for preventing and treating pressure injuries in adults with SCI/D by examining the quality, scope, and consistency of nutrition-related recommendations in existing CPGs.

2. Materials and methods

This systematic review was conducted according to a registered protocol with the International Prospective Register of Systematic Reviews (https://www.crd.york.ac.uk/PROSPERO/view/CRD42025 1016189). The methodology was informed by Johnston et al., [22], using the Participants, Intervention, Control/Comparator, Attributes, and Recommendations (PICAR) framework to guide inclusion criteria (Table 1). Reporting followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and flow diagram [23].

2.1. Search strategy

An initial exploratory search in MEDLINE (via Ovid) was conducted by one research team member (PI) to identify relevant keywords and index terms. The finalised search strategy was peer-reviewed by the research panel (MF, YW & ML), guided by the librarian and then adapted for other databases, including Cochrane Library, Embase, and CINAHL with studies limited to English language (resource limitations) and those published in the last 15 years (for currency). Five guideline repositories were also searched: the National Institute for Health and Care Excellence (NICE), Scottish Intercollegiate Guidelines Network (SIGN), Agency for Healthcare Research and Quality (AHRQ), TRIP Medical Database, and the **Supernatural** Journal of Australia. Additionally, predefined websites such as Practice-based Evidence in Nutrition, the Agency for Clinical Innovation, and Wounds Australia were searched for relevant CPGs. A supplementary Google search (first 10 pages of results) was performed using these keywords: *clinical practice guidelines, nutrition guidelines, and pressure injury in spinal cord injury'*. Reference lists of guidelines included were also manually screened by two independent reviewers (YW & ML) to identify any additional eligible documents. The complete search strategy for one database is available in Supplement 1.

Table 1
Eligibility criteria using PICAR framework.

P: Population, clinical indication(s), and condition(s)	Population: Adults with SCI/D in any setting Clinical indications: Prevention & treatment; Nutrition care and intervention Condition: Pressure injuries
I: Interventions	Nutrition focussed interventions
C: Comparator(s), comparison(s), and (key) content	Comparator: Any or none Key content: CPG with reference to adults with SCI (main focus or included reference group in the CPG); focus on nutrition and related recommendations
A: Attributes of CPG	Publication year: Last 15 years (2010 to present date) Language of publications: English Publishing organisations: Endorsed publications by local, national or international authorities/organisations/ associations will only be considered. Scope: Prevention or treatment of PI in adults with SCI/D; published CPG; national or international; covers nutrition care/ recommendations Version: Most current version which is active and not rescinded will be considered. Format: Consensus guidelines or evidence-based guidelines Quality: Not a criterion for inclusion in the review but will be used in addressing the second research question.
R: Recommendation characteristics and "other" considerations	Nutrition focussed recommendations must be included.

2.2. Study selection

All citations from the database searches were imported into EndNote 21 (Clarivate Analytics, PA, USA) for automated and manual deduplication, then transferred to Covidence (Veritas Health Innovation Ltd, Melbourne, Australia) for further screening. Two independent reviewers (YW & ML) screened all titles and abstracts or summary text in Covidence. CPGs were rated with 'yes', 'maybe' or 'no' with clear reasons for exclusion. Full texts of "yes" and "maybe" articles were retrieved to complete the next round of screening. Primary supervisor (PI) randomly audited a small percentage of both included and excluded CPGs for quality assurance. Discrepancies between the two reviewers were resolved through discussion (YW & ML) and unresolved cases were referred to a third reviewer (PI) and/or other members of the research team (MF, KD, AN). Reasons for exclusions were recorded and presented in the PRISMA flow diagram, Fig. 1 [23].

2.3. Data extraction

Data extraction was carried out using a customised, predefined form based on Johnston et al., [22], covering key concepts guided by the PICAR framework (Table 1). The form was pilot tested and refined iteratively to ensure it captured all relevant data required to address the research questions. Two independent reviewers (YW and ML) completed the data extraction, with disagreements resolved by consensus or, if needed, through consultation with a third reviewer (PI) or additional team members (MF, AN, KD).

2.4. Risk of bias assessment

Two reviewers (YW and ML) independently appraised the quality of the included CPGs using the AGREE II (Appraisal of Guidelines for Research and Evaluation, version 2) and AGREE-REX (Recommendation Excellence) tools [24,25]. Discrepancies were resolved through discussion or adjudication by a third reviewer (PI).

The AGREE II tool consists of 23 items grouped into six do-mains: Scope and Purpose, Stakeholder Involvement, Rigour of Development, Clarity of Presentation, Applicability, and Editorial Independence. Scores were calculated using AGREE PLUS software by scaling raw domain scores to percentages. Although AGREE II does not provide specific cut-off values for guideline quality, CPGs were considered higher quality if they achieved ≥50 % in three key domains: Stakeholder Involvement (Domain 2), Rigour of

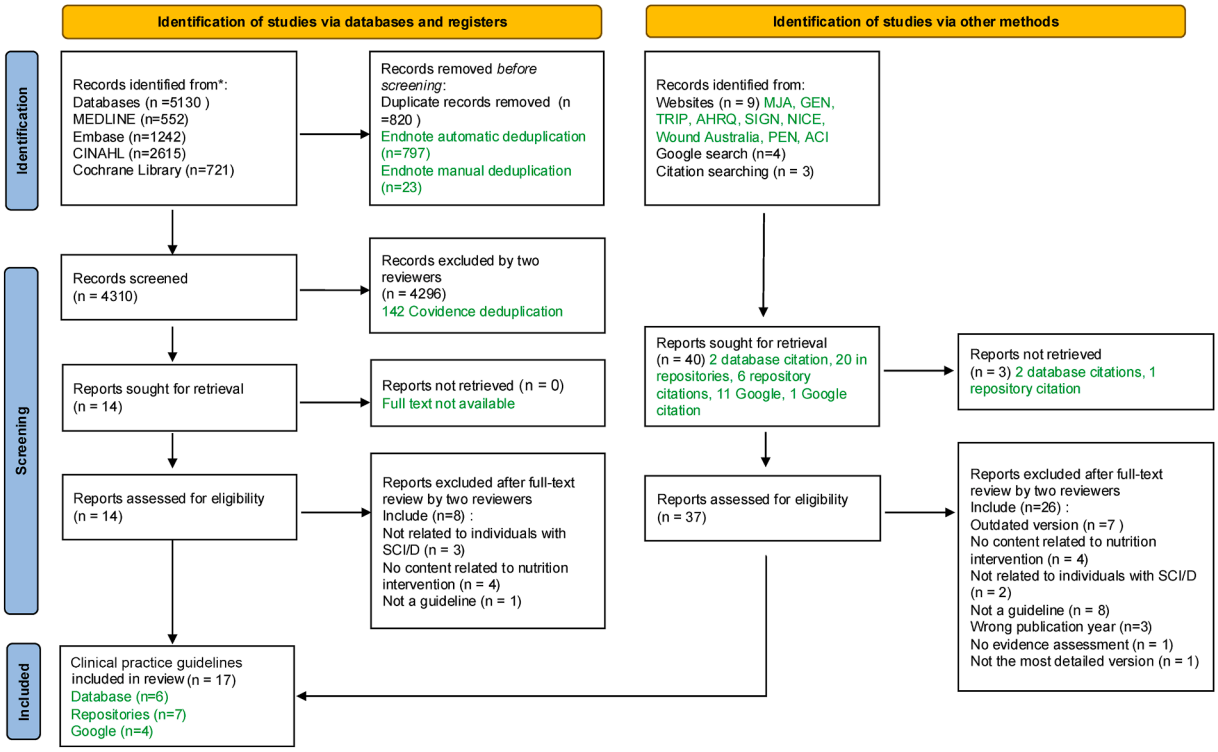

Fig. 1. PRISMA flow diagram.

Development (Domain 3), and Editorial Independence (Domain 6) [26,27].

AGREE-REX included nine items across three domains: Clinical Applicability, Values and Preferences, and Implementability. The optional context-specific assessment component was not utilised, due to variability in guideline settings. Scores were calculated in Microsoft Excel according to the AGREE-REX user manual. Based on thresholds used in previous literature, CPGs were classified as: >70 % high quality, 30 %–70 % moderate quality, and <30 % poor quality [28–30].

2.5. Data synthesis

Data were analysed in the IBM SPSS Statistics (Version 29.0), with means and standard deviations (SDs) calculated for all items and domain scores. Inter-rater reliability was assessed using two-way random effects intraclass correlation coefficients (ICCs), classified as poor (<0.40), fair (0.40–0.59), good (0.60–0.74), or excellent (0.75–1.00) [31].

2.6. Categorisation and quantification of nutrition recommendations

Nutrition-related recommendations were categorised using the Nutrition Care Process (NCP) model [32], which includes: Nutrition Assessment, Diagnosis, Intervention, Monitoring and Evaluation. Two reviewers (YW and ML) performed the categorisation independently, with consensus used to resolve differences. Discrepancies that could not be resolved were referred to a third reviewer (PI) and/or team members (MF, AN, KD). Recommendations were quantified by assigning each to the appropriate NCP domain. If a single recommendation contained multiple components or sub-recommendations, each distinct directive was counted individually. Two reviewers (YW and ML) conducted this process collaboratively, with discrepancies resolved through discussion or referral to a third reviewer (PI).

2.7. Ethics

As this study was a systematic review ethical approval was not required. All data have been transparently reported and are available from the review paper and its supplementary material.

3. Results

The initial search across databases, repositories, and grey literature sources yielded 5170 potentially relevant records. After removing 962 duplicates, 4208 titles and abstracts were screened. Of these, 54 full-text records were assessed for eligibility. Three records were excluded due to unavailable full texts, and 34 did not meet the inclusion criteria. A total of 17 CPGs met the eligibility criteria and were included in the final analysis [33–49]. The detailed CPG selection process is outlined in Fig. 1.

3.1. Characteristics of included clinical practice guidelines

The 17 included CPGs were published between 2010 and 2025 (Supplement 2). The majority were developed in the United States (n = 5) [34,35,38,39,47] and Canada (n = 4) [40,42,48,49], followed by Belgium (n = 2) [43,44], Australia (n = 1) [41], Germany (n = 1) [33], Japan (n = 1) [37], and international collaborations (n = 2) [36,45]. One Canadian CPG [49] was a *living guideline*, designed for ongoing updates to reflect emerging evidence.

All included CPGs were developed based on systematic evidence reviews and/or expert consensus. All but one guideline [41] reported an appraisal of evidence quality supporting their recommendations. Most (n = 11) evaluated both the level of evidence and the strength of recommendations [33–37,42–47], while five

assessed only the level of evidence [38–40,48,49]. Six CPGs used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach for evidence appraisal [42–47,50], while others used alternative grading systems [33–40]. Eleven CPGs explicitly incorporated SCI/D-specific evidence into their nutritional guidance [33–35,39–41,45–49], while six did not [34,37,38,41–43].

In terms of focus, 12 CPGs addressed both prevention and treatment of pressure injuries [33,36–41,45–49], three focussed exclusively on prevention [34,42,43], and two on treatment only [35,44]. Four guidelines targeted adults exclusively [34,35,47,49] while 13 addressed both adult and paediatric populations [33,36–46,50]. Only recommendations relevant to adults (aged ≥18 years) were included in this review.

3.2. Characteristics of nutrition recommendations

The nutrition recommendations included in the CPGs were mapped to the three main NCP domains, namely "Nutrition Assessment and Diagnosis", "Nutrition Intervention", and "Nutrition Monitoring and Evaluation". The number of nutrition recommendations in each domain is depicted in Fig. 2.

3.3. Scope and consistency of nutrition recommendations

Supplement 3 provides a summary of the nutrition recommendations in the CPGs. Of the 166 total nutrition recommendations identified, the majority (n = 87) were related to Nutrition Intervention, followed by Nutrition Assessment and Diagnosis (n = 64), and Nutrition Monitoring and Evaluation (n = 15). Differences in emphasis were observed between prevention and treatment-focussed recommendations. Recommendations for prevention primarily emphasised assessment and diagnosis, whereas those for treatment focussed more on interventions. Both categories consistently lacked detailed guidance on monitoring and evaluation.

While the overarching themes within each NCP domain were broadly similar across CPGs, inconsistencies were noted in the specific tools, parameters, and thresholds recommended. For example:

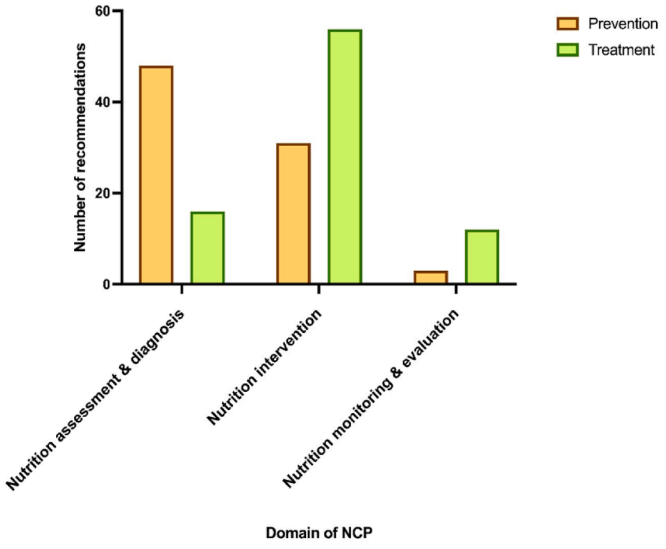

Fig. 2. Nutrition recommendations categorised using NCP domains.

- For Nutrition Assessment and Diagnosis, tools ranged from the Subjective Global Assessment (SGA) to the Mini Nutritional Assessment (MNA), with varied criteria for identifying malnutrition risk.
- For Nutrition Intervention, oral nutritional supplementation was commonly recommended, yet specific targets for energy and protein intake differed, as did supplementation protocols.
- For Nutrition Monitoring and Evaluation, while regular monitoring of nutritional status was advised, the frequency and methods of reassessment were inconsistently defined.

Of the 17 included CPGs, only three guidelines were specifically developed for adults with SCI/D [47–49]. The remaining 14 were intended for broader populations, with SCI/D related considerations addressed to varying extents within the content.

3.4. Methodological and recommendation quality appraisal of clinical practice guidelines

3.4.1. AGREE II results

Table 2 presents domain and overall AGREE II scores. Among the six domains, CPGs performed best in Domain 1 - Scope and Purpose, with a mean score of 79 % ± 24 %, and weakest in Domain 5 - Applicability, with a mean of 50 % ± 21 %. Based on pre-defined quality thresholds, seven CPGs [34–36,42,43,45,46] were rated as high quality, having scored ≥50 % in the three key domains: Domain 2 - Stakeholder Involvement; Domain 3 - Rigour of Development; Domain 6 - Editorial Independence. The remaining ten guidelines did not meet the criteria in at least one domain and were categorised as low quality [33,37–43,45,46].

3.5. AGREE-REX results

AGREE-REX appraisal outcomes are summarised in Table 3. The highest-performing domain was Clinical Applicability (mean score = 64 % ± 20 %), while Values and Preferences scored the lowest (mean = 38 % ± 18 %). Overall, three guidelines were rated as high quality (AGREE-REX score >70 %) [42,45,46]. Thirteen guidelines fell within the moderate quality range (30–70 %) [33–41,43,44,47,48]. One guideline, Praxis/SCIRE/KITE [49], was rated as low quality with an AGREE-REX score below 30 %.

Inter-rater reliability between the two appraisers (YW and ML) was consistently high. Intraclass correlation coefficients (ICC) for all AGREE II and AGREE-REX domains across the 17 CPGs [33–49] exceeded 0.75, indicating excellent agreement. ICC values for each domain are detailed in Tables 4 and 5.

4. Discussion

This systematic review synthesised the nutritional recommendations within CPGs aimed at preventing and treating PIs in adults with SCI/D. Across the 17 included CPGs [33–49], nutrition recommendations were predominantly clustered within the NCP domain of "Nutrition Intervention" (n = 87), with comparatively fewer recommendations focussing on "Nutrition Assessment" (n = 64), and even fewer addressing "Nutrition Monitoring and Evaluation" (n = 15). Notably, most evidence underpinning CPGs were developed for the general population, with only a limited subset specifically targeting adults with SCI/D. While this finding underscores a gap in SCI/D-specific nutrition guidance, it is more likely attributed to limitations in the available evidence base rather than a shortcoming in guideline development itself. Methodological quality, assessed by the AGREE II tool showed variable results. While many CPGs scored highly on "scope and

Table 2
Domain scores and quality of clinical practice guidelines according to AGREE II instrument (n = 17).

Guidelines	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Domain 6	Average score (%)	Quality
	Scope and purpose (%)	Stakeholder Involvement (%)	Rigour of Development (%)	Clarity of Presentation (%)	Applicability (%)	Editorial Independence (%)		
DMGP	69	64	42	19	13	75	47 ± 27	Low
ACP-risk assessment and prevention	97	89	61	72	52	71	74 ± 17	High
ACP-treatment	97	94	64	75	40	71	74 ± 21	High
AWMA	86	94	80	97	56	100	86 ± 16	High
JDA	75	33	45	89	65	67	62 ± 20	Low
WHS	17	44	38	75	42	79	49 ± 24	Low
AAWC	64	69	49	83	81	46	65 ± 16	Low
Wounds Canada	69	69	58	72	69	0	56 ± 28	Low
ACI	100	56	48	75	17	0	49 ± 37	Low
RNAO	100	100	98	64	83	100	91 ± 15	High
KCE-prevention	100	53	99	97	40	25	69 ± 34	Low
KCE-treatment	100	56	100	97	44	96	82 ± 25	High
EPUAP/NPIAP/PPPIA	100	94	91	81	52	63	80 ± 19	High
NICE	97	83	93	86	71	75	84 ± 10	High
PVA	50	58	63	78	44	25	53 ± 18	Low
ONF/RHI	56	86	58	89	54	21	61 ± 25	Low
Praxis/SCIRE/KITE	58	78	46	61	19	75	56 ± 22	Low
Mean ± SD	79 ± 24	72 ± 20	67 ± 22	77 ± 18	50 ± 21	58 ± 33		

Note: Guidelines in this table are named according to their developing or endorsing organisations to ensure clarity and consistency. When multiple guidelines originate from the same organisation, they are distinguished by their primary focus (e.g., prevention, treatment).
Abbreviations: AAWC, Association for the Advancement of Wound Care; ACI, NSW Agency for Clinical Innovation; ACP, The American College of Physicians; AGREE, Appraisal of Guidelines for Research & Evaluation; AWMA, Australian Wound Management Association (now known as Wounds Australia); DMGP, German-speaking Medical Society for Paraplegiology; EPUAP/NPIAP/PPPIA, European Pressure Ulcer Advisory Panel/National Pressure Injury Advisory Panel/Pan Pacific Pressure Injury Alliance; JDA, Japanese Dermatological Association; KCE, Belgian Health Care Knowledge Centre; NICE, National Institute for Health and Care Excellence; ONF/RHI, Ontario Neurotrauma Foundation/Rick Hansen Institute; Praxis/SCIRE/KITE, Praxis Spinal Cord Institute/Spinal Cord Injury Research Evidence/Toronto Rehabilitation Institute; PVA, Paralyzed Veterans of America; RNAO, Registered Nurses Association of Ontario; WHS, Wound Healing Society.

Table 3
Domain scores and quality of clinical practice guidelines according to AGREE-REX instrument (n = 17).

Guidelines	Domain 1	Domain 2	Domain 3	Average score (%)	Quality
	Clinical Applicability (%)	Values and Preferences (%)	Implementability (%)		
DMGP	53	25	33	37 ± 14	Moderate
ACP-risk assessment and prevention	75	21	50	49 ± 27	Moderate
ACP-treatment	72	10	50	44 ± 31	Moderate
AWMA	81	44	79	68 ± 21	Moderate
JDA	47	25	38	37 ± 11	Moderate
WHS	56	25	21	34 ± 19	Moderate
AAWC	42	35	54	44 ± 10	Moderate
Wounds Canada	47	58	67	57 ± 10	Moderate
ACI	36	48	58	47 ± 11	Moderate
RNAO	89	56	83	76 ± 18	High
KCE-prevention	78	29	50	52 ± 25	Moderate
KCE-treatment	75	35	31	47 ± 24	Moderate
EPUAP/NPIAP/PPPIA	92	69	75	79 ± 12	High
NICE	92	71	58	74 ± 17	High
PVA	61	35	21	39 ± 20	Moderate
ONF/RHI	56	40	71	56 ± 16	Moderate
Praxis/SCIRE/KITE	28	13	21	21 ± 8	Low
Mean ± SD	64 ± 20	38 ± 18	51 ± 21		

Note: Guidelines in this table are named according to their developing or endorsing organizations to ensure clarity and consistency. When multiple guidelines originate from the same organization, they are distinguished by their primary focus (e.g., prevention, treatment).
Abbreviations: AAWC, Association for the Advancement of Wound Care; ACI, NSW Agency for Clinical Innovation; ACP, The American College of Physicians; AGREE-REX, Appraisal of Guidelines Research and Evaluation-Recommendations Excellence; AWMA, Australian Wound Management Association (now known as Wounds Australia); DMGP, German-speaking Medical Society for Paraplegiology; EPUAP/NPIAP/PPPIA, European Pressure Ulcer Advisory Panel/National Pressure Injury Advisory Panel/Pan Pacific Pressure Injury Alliance; JDA, Japanese Dermatological Association; KCE, Belgian Health Care Knowledge Centre; NICE, National Institute for Health and Care Excellence; ONF/RHI, Ontario Neurotrauma Foundation/Rick Hansen Institute; Praxis/SCIRE/KITE, Praxis Spinal Cord Institute/Spinal Cord Injury Research Evidence/Toronto Rehabilitation Institute; PVA, Paralyzed Veterans of America; RNAO, Registered Nurses Association of Ontario; WHS, Wound Healing Society.

purpose," lower scores in "clinical applicability" suggest challenges in translating recommendations into practice. The AGREE-REX tool, evaluating individual nutrition recommendations, identified only three CPGs as high quality [42,45,46].

Overall, the nutrition recommendations in these CPGs were predominantly of moderate quality (13 out of 17) [33–41,43,44,47,48]. The lowest scores were observed in the domains of 'Values and Preferences' (Domain 2) and

Table 4
Inter-rater reliability for AGREE II domain and overall scores.

AGREE II	Domain 1. Scope and Purpose	Domain 2. Stakeholder Involvement	Domain 3. Rigour of Development	Domain 4. Clarity of Presentation	Domain 5. Applicability	Domain 6. Editorial Independence
Intraclass correlation coefficient (ICC)	0.974	0.954	0.967	0.956	0.963	0.982
95 % confidence interval	[0.955, 0.985]	[0.919, 0.974]	[0.954, 0.977]	[0.922, 0.975]	[0.940, 0.977]	[0.965, 0.991]

Abbreviation: AGREE, Appraisal of Guidelines Research and Evaluation; ICC, intraclass correlation coefficient.

Table 5
Inter-rater reliability for AGREE-REX domain and overall scores.

AGREE-REX	Domain 1. Clinical Applicability	Domain 2. Values and Preferences	Domain 3. Implementability
Intraclass correlation coefficient (ICC)	0.936	0.912	0.912
95 % confidence interval	[0.888, 0.964]	[0.858, 0.946]	[0.825, 0.956]

Abbreviation: AGREE-REX, Appraisal of Guidelines Research and Evaluation-Recommendations Excellence; ICC, intraclass correlation coefficient.

'Implementability' (Domain 3). This reflects a common shortcoming across existing CPGs, consistent with findings from multiple systematic reviews, regardless of focus area [20,29,51,52]. The low Domain 2 scores stem from inadequate consideration of the values and preferences of target users, populations, guideline developers, and policymakers during recommendation development. Integrating these perspectives is fundamental to evidence-based nutrition practice [53]. Failure to incorporate these inputs often results in recommendations that misalign with the needs and priorities of end users, undermining implementation [54]. Interestingly, our appraisal paradoxically revealed the overall score for 'stakeholder involvement' (AGREE II Domain 2) was relatively high, yet the 'values and preferences' domain (AGREE-REX) scored poorly. This discrepancy is likely attributed to many CPGs reporting stakeholder involvement but lacking transparency about processes and details regarding stakeholder input. Previous reviews have documented this widespread issue [55], though it remains unclear if it is due to poor reporting or methodological flaws [56]. The NICE guidelines [46] were a notable exception, rated high quality for values and preferences and overall methodological rigour. This is attributed to adherence to the 'NICE Guidelines Manual,' which explicitly guides the integration of stakeholder contributions and values during guideline development [57]. However, a standardised approach specifically focussed on embedding values and preferences remains absent [55]. Future CPG development should prioritise comprehensive integration and transparent reporting of stakeholder values and preferences, alongside establishing standard methods to address this gap.

Implementability (Domain 3) is another critical factor influencing the overall quality and clinical utility of recommendations. Among the five CPGs scoring lowest in this domain [33,38,44,47,49], poor performance was driven mainly by 'Local Application and Adoption' (item 9). This aligns with previous literature [54] and reflects a recurring issue whereby many nutritional recommendations inadequately address applicability in diverse clinical contexts. Factors such as economic constraints, availability of equipment, human resources, and staff expertise are often overlooked, with few strategies proposed to overcome barriers. For example, five CPGs recommended blood testing to assess nutritional status [33,39,40,47,49] but failed to acknowledge that some regions may lack laboratory infrastructure and trained personnel [58,59]. This omission reduces the feasibility and equity of guideline implementation, turning recommendations into theoretical ideals rather than practical tools [28,54,60]. One reason may be the limited inclusion of diverse target users and policymakers in guideline development [30]. Additionally, all included CPGs originated from high-resource settings, with over 70 % focussing at the national level, which likely contributed to neglecting resource variability across regions. This mirrors findings from a previous systematic review [28] that suggests international collaboration and representation in guideline development as a potential solution. The EPUAP/NPIAP/PPPIA guideline [45], an internationally representative CPG, acknowledges challenges in implementation across varying resources and settings but lacks detailed guidance or strategies to address these challenges. Though this is understandable given the vast heterogeneity between countries, it limits health equity. This lack of consideration for regional and resource variability extends beyond nutritional recommendations to the AGREE II 'Applicability' domain (Domain 5), which scored the lowest among all domains in the included CPGs. Furthermore, many nutrition recommendations lacked specific details, such as type and dosage of nutritional supplements making implementation challenging. However, it is worth noting that as clinical questions become more specific, such as optimal supplement doses for SCI/D, the supporting evidence may become scarcer which may limit guideline recommendations. Such challenges are not unique in SCI/D but reflects a broader issue across guideline development in the general population [61]. Additionally, most nutrition recommendations were derived from evidence in the general population, with only limited SCI/D-specific data, further limiting relevance and reliability for this population [25].

The NCP is a globally recognised framework linking Nutrition Assessment and Diagnosis, Nutrition Intervention, and Nutrition Monitoring and Evaluation to provide standardised nutrition care [32]. Nearly all included CPGs emphasised nutrition assessment as the first step, which involves systematic data collection across multiple dimensions anthropometry, biochemical data, clinical condition, dietary intake, and social/environmental factors [62,63]. However, related recommendations were often fragmented or incomplete, potentially impairing accurate nutritional status identification and complicating clinical implementation [63,64]. Five guidelines consistently recommended validated nutrition assessment tools [33,36,39–41], such as the SGA and MNA, which are validated in the general population to identify malnutrition [62,65] but not in persons with SCI/D. The Spinal Nutrition Screening Tool (SNST) is the only tool validated in SCI/D [66,67], which has been referred to within only one CPG [33] although failing to clearly indicate that the SNST is a screening tool and not an assessment tool. Some guidelines also used screening and assessment interchangeably, failing to distinguish between the two which may lead to confusion in clinical application [62]. Only five guidelines explicitly noted that nutrition assessments should be conducted by nutrition professionals [37,40,46,48,49]. While this is an important aspect for ensuring appropriate

interpretation and intervention, it was not consistently emphasised. It is however important to contextualise the role of nutrition assessment within the broader scope of PI prevention and management. Although nutrition is a relevant factor in PI prevention and treatment, more directly implicated causes such as mechanical loading may re-assign focus for the CPGs which is worth noting to guide interpretation.

Nutrition intervention, the second NCP step, aims to implement targeted strategies based on assessment outcomes [32]. Most nutrition intervention recommendations focussed on meeting nutritional needs through supplementation when dietary intake was insufficient. However, there was significant variability, especially in protein requirements, ranging from 1.0 to 2.0 g/kg/day in some guidelines [48,49] to 1.25–1.50 g/kg/day in others [38]. Few guidelines [45] were distinctive in recommending protein requirements adapted to SCI/D metabolic changes, which aligned with multiple studies [68–70]. They suggested 1.2–2.0 g/kg actual body weight/day, with adjusted targets for individuals with obesity (BMI 30–40: 2.0 g/kg ideal body weight; BMI >40: 2.5 g/kg) [45]. Nonetheless, this guideline insufficiently addressed the needs of SCI/D individuals with obesity, a population at high risk of neurogenic obesity and pressure injuries [8]. Excessive protein intake during high-demand phases is generally not advised (>2.0 g/kg/day) [71,72]. Similarly, many CPGs frequently recommend a daily energy intake of 30–35 kcal/kg [38,47–49] for individuals with SCI/D which needs to be interpreted with caution given the significantly reduced energy needs in people with SCI/D [11,73,74]. One CPG [36] clearly outlines this by specifying different needs in people with paraplegia requiring approximately 29.8 $\pm$ 1.2 kcal/kg/day, while those with tetraplegia require only 24.3 $\pm$ 1.1 kcal/kg/day. This suggests that the blanket recommendation of 30–35 kcal/kg a day may overestimate actual energy needs. The use of indirect calorimetry has been highlighted by a few CPGs [48,49] to determine energy expenditure more precisely to avoid overfeeding and related consequences. The importance of individualised assessment is further reinforced in one CPG [48] which recommends considering concurrent diagnoses and patient-specific factors while estimating energy needs. Tailoring these macronutrient recommendations using indirect calorimetry if available and SCI specific information is essential to ensure appropriate nutritional support and optimal clinical outcomes.

Treatment-focussed nutrition intervention recommendations exceeded prevention, possibly explained by a reactive clinical focus with its management in real-world practice and a lack of specific high-quality evidence to direct prevention measures in this population. As a result, the treatment-centric approach in many guidelines, potentially neglects the importance and benefits of prevention. Without follow-up interventions, nutrition assessments risk being ineffective. Nutrition monitoring and evaluation, the final NCP step, was underrepresented in both prevention and treatment contexts which remained common across CPGs [75,76]. Although continuous monitoring is acknowledged as important, many guidelines offered vague recommendations lacking details on testing types and frequency, which limits clinical application. Given recurrent or worsening PIs are a key driver of high hospital readmission rates among people with SCI/D, adequate and timely monitoring is critical [77,78].

Furthermore, the NCP framework emphasises continuity. As each step informs the next, monitoring is essential because it triggers reassessment if outcomes are suboptimal [32]. The uneven distribution of nutrition recommendations across the NCP domains, especially monitoring, suggests fragmented guidance that undermines coherence and implementation. The imbalance with fewer recommendations in assessment but many in nutrition intervention, and limited monitoring recommendations reflects an overall but common focus on treatment while overlooking prevention [79–82]. Future CPG development should align nutrition recommendations with the NCP, equally emphasising prevention and treatment to provide comprehensive, and effective nutrition care for individuals with SCI/D.

While CPGs serve as essential tools for ensuring evidence-based care, their relevance depends heavily on regular updates to reflect emerging research and evolving clinical standards. However, a notable limitation among the guidelines reviewed is that not all specify a regular review cycle or update schedule. This lack of transparency around CPG maintenance can pose challenges for clinicians seeking to apply the most current evidence. Without a clearly defined review period, there's a risk that recommendations particularly those related to energy needs and nutritional support may become outdated or misaligned with newer research findings, including those specific to SCI/D.

4.1. Strengths and limitations

The strengths of this review include its novelty as the first to systematically synthesise nutrition-related recommendations in SCI/D-focussed PI guidelines, as well as its rigorous methodological appraisal using validated tools (AGREE II and AGREE-REX) [24,25] with excellent inter-rater reliability [26,27]. The comprehensive search strategy minimised the risk of missing relevant guidelines, and the focus on nutrition ensured detailed evaluation of this important aspect of PI management. Nonetheless, some limitations must be acknowledged. The review was restricted to English-language publications, possibly omitting high-quality guidelines in other languages. The AGREE tools, while widely used and validated, inherently involve subjective judgments, which we mitigated by using independent reviewers and consensus discussions. Also, since AGREE-REX was applied solely to nutrition recommendations rather than all guideline content, the appraisal does not reflect the overall quality of CPGs. Detailed considerations of methodological quality of studies underpinning the key recommendations and other elements within NCP such as specific lab values, wound assessment scores, and wound dimensions are worth exploring in future research. Finally, the paucity of high-quality, SCI/D-specific evidence in nutrition research constrained the robustness of the recommendations evaluated.

5. Conclusions

This systematic review reveals substantial gaps and inconsistencies in the nutrition recommendations within CPGs for preventing and treating PIs in adults with SCI/D. While most nutrition recommendations were concentrated in the “Nutrition Intervention” domain of the NCP, fewer addressed “Nutrition Assessment”, while focus on “Nutrition Monitoring and Evaluation” was broadly lacking. Critically, most of the evidence underpinning these guidelines was derived from the general population, with limited SCI/D-specific data. This undermines the relevance and applicability of recommendations for individuals with SCI/D, whose unique metabolic and physiological profiles demand tailored guidance. Methodological appraisal using AGREE II and AGREE-REX tools revealed low to moderate overall quality, with only three guidelines [42,45,46] rated as high quality. Notably, recommendations failed to consider resource variability, limiting feasibility and equity, particularly in low-resource settings. Additionally, general population nutrition assessment tools were frequently recommended without adaptation, and there was a lack of differentiation between screening versus assessment tools. The absence of regular updates across most CPGs raises concerns about

currency and relevance. Future guideline development must prioritise high-quality, SCI/D-specific evidence, transparent stakeholder engagement, and context-specific implementable strategies to enhance the quality, equity, and impact of nutrition recommendations in this population.

Author contributions

Yiwen Wang and Man Ching Lo: Data Collection; Formal analysis; Investigation; Validation; Visualisation; Writing - original draft. **Priya Iyer:** Conceptualisation; Data curation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualisation; Writing - review & editing. **Murray Fisher:** Methodology; Supervision; Validation; Writing - review & editing. **Kate Desneves:** Methodology; Validation; Writing - review & editing. **Amy Nevin:** Methodology; Validation; Writing - review & editing.

Data sharing statement

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Statement of ethics

Ethical approval was not required for this systematic review as it involved only publicly available literature, and no human or animal participants were involved.

Declarations

No one eligible for authorship has been excluded from the list of authors.

No generative AI or AI-assisted technologies were used in the writing processes.

Conflict of interest

Authors have no conflict of interest to declare.

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Appendix A. Supplementary data

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