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REVIEW

Weight management / Intervention

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A systematic review and qualitative synthesis of weight management interventions for people with spinal cord injury

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Summary

People with spinal cord injury (SCI) are at greater risk of developing obesity and related co-morbidities than those without SCI. The objectives of this systematic review were to examine the effectiveness of weight management interventions for people with SCI and to synthesize the experiences of people involved with SCI weight management (e.g., SCI healthcare professionals and caregivers). Five databases were searched (up to July 31, 2023) and 5,491 potentially eligible articles were identified. Following screening, 22 articles were included, comprising 562 adults. There was considerable heterogeneity in study design and weight loss interventions included behavioral nutritional and exercise education sessions, recalling food diaries, exercise interventions, and pharmaceuticals. The mean percentage change of the pooled body mass data equated to −4.0 ± 2.3%, with a range from −0.5 to −7.6%. In addition, 38% of the individuals with SCI who completed a weight loss intervention ($N = 262$) had a ≥5% reduction in body weight. Collectively, although on average the included interventions led to moderate weight loss, the finding that just over a third of individuals achieved clinically meaningful 5% weight loss suggests that available interventions for this population may need to be improved.

KEYWORDS
obesity, qualitative synthesis, spinal cord injury, systematic review

Abbreviations: AIS, American Spinal Injury Association; BM, body mass; BMI, body mass index; CASP, Critical Appraisal Skills Programme; CT, computed tomography; DXA, dual-energy X-ray absorptiometry; ES, effect size; HCP, healthcare professional; MRI, magnetic resonance imaging; NHS, National Health Service; NIHR, National Institute for Health and Care Research; NS, non-significant; PARA, paraplegia; PP, pre- to post-interventions; RCT, randomized controlled trial; ROB2, Cochrane Risk of Bias Tool v2; SCI, spinal cord injury; SD, standard deviation; TETRA, tetraplegia.

Registration review protocol: CRD42023412261 (PROSPERO).

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1 | INTRODUCTION

There are currently over 50,000 people in the United Kingdom living with a spinal cord injury (SCI), and it is estimated that a further 2500 persons acquire an SCI each year.[1] People with SCI are at a heightened risk of increased adiposity and obesity.[2] This is partly due to a reduced capacity for and engagement in physical activity, which is typically ~40% less than reported in those without SCI.[3] Further, disuse of paralyzed limbs leads to muscle atrophy, with a loss of up to 55% within the first 6 months post-injury and a subsequent reduction in resting metabolic rate of 14%–27%.[4–6] Therefore, a reduction in total daily energy expenditure is a well-established cause of weight gain in people living with SCI. People with SCI may also experience barriers to maintaining a healthy body composition, which include a lack of access to exercise facilities and accessible transportation.[7] Moreover, SCI medicine requires specialized training and expertise, and it is commonplace for many practitioners to lack the background knowledge to provide appropriate exercise or nutrition guidelines that are tailored to persons with SCI.[7,8] Consequently, people with SCI possess an elevated risk for obesity-related long-term conditions such as type 2 diabetes, metabolic associated steatotic liver disease, and cardiovascular disease.[9] Using SCI-specific cutoffs, it is estimated that nearly 70% of adults with SCI have obesity[10] and are at two-to-three times higher risk for developing type 2 diabetes and cardiovascular disease.[11,12]

Evidence-based guidance for successful weight management is urgently needed to prevent obesity-related complications in persons living with SCI. Previously, only one study has systematically appraised weight loss strategies in the SCI population, including bariatric surgery, neuromuscular electrical stimulation, aerobic exercise, and nutritional interventions.[12] However, this review included only case studies with quantitative findings. The synthesis of qualitative evidence would have enabled a more holistic understanding of the perceptions of persons with lived experience of SCI and healthcare practitioners (HCPs) about weight management interventions. For example, LaVela and co-workers[13] indicated that many SCI HCPs were unaware of population-specific evidence-based weight loss interventions, highlighting the limited professional weight loss guidance that persons with SCI often receive. Further, additional research with a pharmaceutical component[14] has been reported in the weight management field since this review was published and so an updated synthesis of the literature is necessary.

The current research aimed to bridge the research gaps identified above by examining the evidence for weight management in persons with SCI. Specifically, this review focuses on weight gain prevention strategies in the acute phase of SCI and weight loss interventions in the chronic phase of SCI. We also explored qualitative studies surrounding weight management to better understand perceptions, attitudes, and personal experiences of weight management interventions for people with SCI and support personnel.

2 | METHODS

The systematic review was conducted according to PRISMA guidelines,[15,16] and the protocol was registered on PROSPERO (ID # CRD42023412261).

2.1 | Eligibility

Published randomized controlled trials (RCTs), quasi-randomized controlled trials (participant's allocation to trial groups is not truly random), and pre–post (PP) interventions that evaluated weight management interventions in wheelchair-dependent adults (≥18 years) with SCI (AIS A-Cs) were eligible. For weight gain prevention interventions, only participants with acute (<12 months post-injury) SCI were included. For weight loss interventions, only participants with chronic SCI (≥12 months post-injury), and those with overweight or obesity (defined as BMI ≥ 22 kg/m^2) or other weight-related measurements, based on cutoffs for people with SCI.[17] Table 1 details the full inclusion and exclusion criteria. Only the intervention arms of RCTs that compared a weight management intervention to another intervention (e.g., exercise) were included and these RCTS were treated as PP studies. In addition to the participant population described above and in Table 1, qualitative studies were included that involved SCI-related healthcare professionals, caregivers, and any other individuals who may play a role in weight management for people with SCI to better understand their experiences of weight management.

2.2 | Searches

A systematic search was conducted in Medline, SportsDiscus, CENTRAL, Embase, and Scopus to identify potentially eligible studies that were published from inception to July 31, 2023. Terms relating to SCI (e.g., "spinal cord injury," "paraplegia," and "tetraplegia") and weight management (e.g., "body weight changes" and "weight loss program") were used in the literature search (a full list of search terms is available in Supplementary File 1). The following search limitations were also used in addition to the search terms: human participants, participants 18 years of age, and originally written in English. Reference lists of previous reviews and included trials were hand-searched to check for any additional studies not identified by the main searches.

2.3 | Data extraction

Results were uploaded to Covidence,[18] and duplicates were removed. Two independent reviewers screened study titles, abstracts, and full texts (from among JF, CM, CT, HG, JK, VT, and NK). Disagreements were discussed and resolved by a third reviewer who was not involved in the original decision. All decisions were recorded in Covidence, and

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TABLE 1 Study inclusion and exclusion criteria.

	Inclusion	Exclusion
Study aim	Weight loss or weight gain prevention	• Treatment of cardiovascular disease • Treatment of cancer
Population	Adults (18 + years) with traumatic and non-traumatic SCI AISA scores A-C. For weight gain prevention interventions, only participants with acute (<12 months post-injury) SCI will be included. For weight loss interventions, only participants with chronic (≥12 months post-injury), and those with overweight or obesity (defined as BMI ≥ 22 kg/m^2 or other weight-related measurement) will be included.	Studies limited to: • Syndromic and monogenic obesity disorder • Any physical chronic disease (e.g., cancer) • Severe mental illness • Taking steroid medications, • Pregnancy
Setting	Studies conducted in primary care and delivered by a staff member of the primary care health team within the practice. Primary care is defined as the first point of contact, based in the community, can offer ongoing and comprehensive healthcare.	
Interventions	• Interventions with the aim of weight gain prevention and weight loss. • Interventions may be delivered via face-to-face, telephone, video conferencing software, print materials, or technology (e.g., computer-based and text messages). • Can be delivered by numerous potential interventionists, including but not limited to physicians, nurses, exercise specialists, dietitians, nutritionists, and behavioral health specialists.	• Interventions which are <4 weeks in duration • Weight loss supplements • Alternative or complementary therapies (e.g., acupuncture and massage)
Comparisons	• No treatment (e.g., wait-list control, usual care) • Attention control (e.g., similar format and intensity to intervention but different content area) • Minimal intervention comparable to usual care (including the use of generic printed/electronic communications)	None
Outcomes	Weight outcomes: Measured weight, e.g., kg and lb	• Waist circumference and bioelectrical impedance analysis (if these are the only outcomes measured). • Studies that only report regional changes in body composition (e.g., leg, arm, and trunk). Studies that "explore" changes in body composition without explicitly stating the study aimed to achieve weight loss/weight management/weight gain prevention.

reviewers were blinded to each other's decisions. Data about study characteristics and weight data were extracted by two independent authors (from among CM, NK, and CT) (Supplementary Table S1a and S1b). Five authors were contacted for further information.[19–23] All study authors responded but only one with all the requested data[23] and one with only some of the requested data.[22]

2.4 | Outcomes, summary measures, and synthesis of results

The primary quantitative outcome was a change in body weight from baseline to program end (defined as the last contact point with participants). This was calculated as the mean difference in weight from pre- to post-intervention. Only one study used intention-to-treat analysis[24]; therefore, we only present the completers' analysis. Measures of body fat, including dual-energy X-ray absorptiometry (DXA), magnetic resonance imaging (MRI), computed tomography (CT), or skinfold thickness were also included as secondary measures. Qualitative data outcomes included perceptions, attitudes, and personal experiences of weight management from patients, healthcare professionals, and caregivers.

2.5 | Qualitative data

Thematic analysis was used to synthesize findings. Participant quotations and text, where available, were entered verbatim into NVIVO (QSR International, Release 1.3).[25] One reviewer (CM) performed line-by-line coding of the primary studies and concepts of people's perspectives on weight management. Translation of concepts across studies was grouped into similar concepts. Three authors (SH, CT, and CM) reviewed the themes and subthemes utilizing a peer debriefing approach to create a framework of analysis.

2.6 | Risk of bias/quality of studies

Two authors (CT and NK) independently assessed the risk of bias for each randomized controlled trial, using the Cochrane Risk of Bias Tool

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v2 (ROB2) for randomized controlled trials.[26] For incomplete outcome data a high risk of bias was defined as ≥20% attrition. We resolved disagreements by discussing or consulting a third author (CM). ROBINS-I was used by two review authors (CT and HG) to independently assess the risk of bias for the non-randomized studies.[27] All papers with qualitative data were rated for quality using the Critical Appraisal Skills Programme (CASP).[28]

2.7 | Patient and public involvement

The idea and rationale for the study were discussed with people living with SCI and healthcare professionals working within SCI settings (HCP). These individuals also provided feedback about study outcomes and results dissemination.

3 | RESULTS

The search identified 5491 unique study titles/abstracts after duplicates were removed (Figure 1). After screening, 133 full-text articles were assessed for eligibility, and 21 studies were eligible based on the inclusion criteria. One additional study[23] was found through hand-searching the reference lists of relevant resources, making a total of 22 articles.[13,14,23,24,29–45]

3.1 | Study characteristics

Included studies (Supplementary Table S1a and S1b) were individual RCTs ($n = 2$) (14.37), an RCT with a case series ($n = 1$),[40] PP studies ($n = 8$),[23,24,30,38,39,41–43] and qualitative studies ($n = 11$)[13,29,31–36,44,45] with one combined pre/post and qualitative design,[30] making a total of 22 studies. Eight studies focused on weight gain prevention (all qualitative studies except for a combined qualitative and pre–post design), and one study focused on weight loss.[30] Most studies were conducted in the United States ($n = 19$), and one study each, from the United Kingdom, Netherlands, and Iran. The total number of participants across studies was 562 comprising 347 persons with SCI and 215 HCPs (working within SCI settings or the home). In the RCT and PP studies the sample size ranged from 8 to 57 (median = 16), comprising a percentage range of 13%–67% identifying as female (where reported), with 54 participants dropping out of the interventions. For the HCPs in the qualitative studies, there was a much higher representation of females (median = 86%).

The age range of participants with a SCI was 21 to 66 years (group mean of 50 years). The age range of HCPs was 26 to 65 years (with one >65 years old). Average BM (SD) and BMI (SD) at baseline for the quantitative studies for the persons with SCI was 95.3 (11.1) kg (mean range, 79.1–116.8 kg) and 32.9 (3.7) kg/m^2 (mean range, 27.4–39.9 kg/m^2, respectively). Participants with SCI had heterogeneous AIS scores and represented both TETRA and PARA. Time since injury in the weight loss studies ranged from 7 months to 29 years.

3.2 | Quantitative study characteristics

The interventions (involving 247 participants with SCI) lasted between 12 weeks and 52 weeks (median 14 weeks). The follow-up period ranged from 12 weeks to 52 weeks (median 22 weeks), with some additional follow-up time points occurring up to 14 weeks after the intervention. Studies excluded participants if there were medical contraindications for changing diet or physical activity or if participants had cognitive impairment or severe mental illness. There were eight studies that included behavioral components that focused on changing diet and physical activity behaviors. This involved both individual sessions and group sessions. One study focused on exercise for weight loss using arm crank ergometry[42] and one study focused on nutrition counseling only.[43] One study explored the use of semaglutide once per week from a pharmacist. The study that focused on weight gain prevention had one initial consultation face to face and participants were directed to the app, which focused on dietary and physical activity behaviors.[30]

3.3 | Progress in weight loss

The mean weight change in the RCTs was −3.5 kg (absolute range of −0.7 to −6.0 kg) following the intervention and +0.9 kg (absolute range of −0.6 to +3.3 kg) for the comparator groups (Supplementary Table S2a). As a mean percentage (%) change of body mass, this equated to −3.6 ± 2.1%, which varied as an absolute change of −0.8 to −5.8%, for the RCTs. The mean weight change in the pre- and post-interventions ($n = 10$) was −4.0 ± 2.7 kg (absolute range −0.4 to −8.9 kg) (Supplementary Table S2b). As a mean percentage (%) change of body mass, this equated to −4.0 ± 2.3%, which varied as an absolute change of −0.5 to −7.6%. The pooled results from all studies found that only 38% of people with SCI (from 262), lost at least 5% of their body weight following a weight loss intervention.

3.4 | Progress of BMI, % body fat, and total fat mass measures changes

The mean difference in BMI for the pre- and post-intervention studies was −1.6 ± 0.8 kg/m^2, with an absolute range of −0.6 to −3.2 kg/m^2 ($n = 5$ studies). The mean difference in % body fat for the pre- and post-intervention studies was −3.1 ± 1.9%, with an absolute range of −1.7 to −5.8% ($n = 4$ studies). One study reported a reduction of −2.9 ± 4.6 kg and −2.2 ± 1.8 kg in total fat mass 12 and 24 weeks, respectively, post-intervention. Figure 2 illustrates the relationship between the initial BMI and the change in percentage body mass following the intervention. This relation for experimental design (RCT

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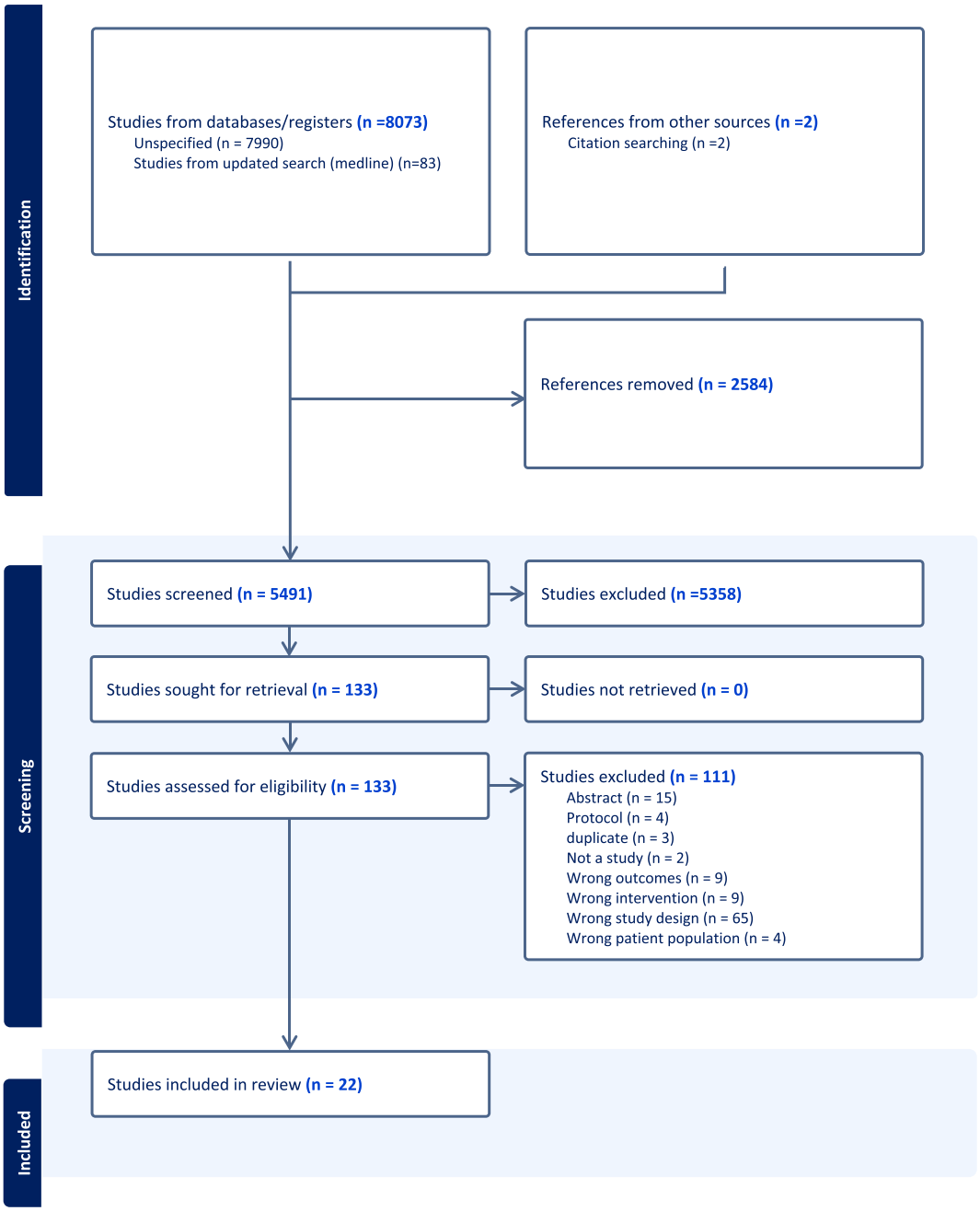

FIGURE 1 Prisma diagram.

and PP) suggested that the magnitude of weight loss intervention was associated with greater BMI initial values ($r = 0.72$ and 0.59, for the RCT and PP, respectively).

3.5 | Qualitative data characteristics

Eleven studies (involving 315 participants) were eligible for qualitative analysis. The percentage of female participants with a SCI ranged from 4% to 67%. Most of the healthcare practitioners were female (range, 83%–88%) Only one study collected data using focus groups,[29] with others collecting data using semi-structured interviews. The focus of studies was largely understanding the opinions of weight management of HCPs only (HCPs) ($n = 4$), with one study focusing on the opinions of HCPs and patients, and studies each exploring those views of caregivers ($n = 3$) and persons with SCI ($n = 3$). Finally, one study[30] specifically explored the use of an app to help people with SCI to manage their weight. All but one[30] of the studies were conducted in the United States, and eight of the studies were from the same university research team (LaVela et al).

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Study ID	D1	D2	D3	D4	D5	Overall
Sabour, 2016	!	+	+	+	!	!
Cirnigliaro, 2023	!	+	+	+	!	!

FIGURE 2 Risk of bias for randomized controlled trial.

Key:

+	Low risk
!	Some concerns
D1	Randomisation process
D2	Deviations from the intended interventions
D3	Missing outcome data
D4	Measurement of the outcome
D5	Selection of the reported result

3.6 | Qualitative data overview

There were eight themes that were under the following headings HCP, HCP and patient experience, and caregiver experience. The eight themes included prioritizing weight management, lack of information/evidence about weight management, recognizing obesity as a problem, barriers to weight management, experience of caregivers including both positive experience and burdensome, and that involving the caregiver was essential to help people with weight management (Supplementary Table S3).

3.6.1 | Healthcare professionals

Theme 1: Prioritizing weight management

Some HCPs recognized the importance of helping patients with SCI manage their weight and ensured they prioritized this: "Since a lot of other things ensue from obesity, I think it's one of the top five issues that we have to at least manage or somehow grapple with or be able to grapple with" HCP.[31] HCPs suggested there were other health problems that need prioritizing and did not see why they should focus on weight management: "so low on the list of issues that we're dealing with that it falls by the wayside."[32] There was also a belief that people with SCI could not change their behavior to lose weight.

Theme 2: Lack of information/evidence

As shown in quantitative analysis findings, there is a lack of evidence about what/how people with SCI are guided to manage their weight and HCPs reiterated this: "I haven't seen any specific things that are out there that discussed whether and what weight management efforts work in SCI."[31] This lack of knowledge made HCPs reluctant to discuss weight management or know what support to offer. Most evidence/information about weight management in people with SCI they used comes from the general population: "What I've seen is through my own reading. It's not really specific to the SCI population. So, it's mainly due to just the population in general."[31]

3.6.2 | Healthcare professionals and patients experience

Theme 3: Monitoring weight

Healthcare professionals reported that it was important to monitor changes in weight to ensure that treatment could be offered if needed: "We kind of keep an eye on the trends with their weight … to look at trends and see if patients have lost, gained, or maintained weight over time and then intervene if need be."[33] However, HCPs also recognized that it was difficult to monitor weight for people with SCI, and specialist equipment or additional staff were needed: "Healthcare providers often obtained weight through measurement rather than patients' self-report or medical records. However, clinics did not always have necessary scales, or timely replacements for broken equipment ("[scale] … hasn't been replaced in 20 years."[32] Due to

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these barriers some HCPs used visual methods that are less accurate to assess whether weight had increased such as: "truncal adiposity, longitudinal weight trends, or inadequate wheelchair fit due to excess weight, noting 'their wheelchair keeps breaking'."[32]

In addition, HCPs mentioned that defining obesity for people with SCI is problematic as BMI cutoffs for the general population were not relevant. They also questioned whether the lower BMI cutoffs proposed were accurate enough: "there's currently no standard or [BMI] cutoffs set for [SCI] populations"[32] and were uncertain if standard thresholds applied. Some HCP providers were aware of literature suggesting a BMI of 22 to classify obesity in SCI populations but questioned if lower thresholds were flawed or unachievable."[32]

Most patients wanted to be weighed as they wanted to check their progress towards achieving/maintaining a healthy weight: "I prefer to go on a scale, so I have an actual idea. I'm trying to lose weight."[32] However, the lack of availability of scales suitable to weigh people with an SCI was a barrier. "A problem for the spinal cord population is not a lot of places [have a] wheelchair scale, they can just go somewhere and be weighed."[34] Some participants also mentioned that it was uncomfortable to stand or be weighed when there was a lack of accessible scales for wheelchairs.[32]

One person with SCI mentioned that weight was a sensitive topic for them: "I would say it's kind of a sensitive topic for me. I don't really enjoy discussing my weight." This should be considered when raising the issue of weight management as some people may feel discomfort.[32]

Theme 4: Recognizing obesity as a problem

HCPs spoke about obesity being more common in patients with an SCI "It's a huge problem. So, I would say in my population of two or three hundred, well, let us say three hundred guys, at least 80% of them are overweight."[31] There was also a sense that problems with obesity were greater in the SCI population than the general population: "The hazards of overweight and immobility are clear to health care professionals but even more so in the spinal cord injury person who really has most, if not all, their mobility reduced."[31] As well as obesity leading to chronic illnesses there were also practical considerations such as heavier people being more difficult to transfer: "If it's somebody who requires a lift transfer, obviously, but then also themselves if they are able to transfer themselves via slide board or another mechanism. That increased weight affects those. It would also affect the type of equipment i.e., wheelchairs that they could use."[31]

HCPs also mentioned they made their patients aware of the hazards of obesity to help motivate them to change their behavior: "We are able to present some of the hazards of immobility that come with issues with weight gain; a lot of patients will become conscious of that and try to engage and stay kind of strict with their regimen and with their diet."[33]

Theme 5: Barriers to weight management

Individuals with SCI and HCPs identified several barriers to weight management. One of the most common barriers reported was the ability to take part in physical activity. This was a barrier in terms of accessing the facilities or exercises they could take part in: "Unfortunately for patients with higher injuries, so cervical level injuries, their opportunities for exercise are really limited." [HP01, Occupational therapist].[34] Staff at a veteran's center noted that "Veterans with SCI were hesitant to use facility level programs, because of non-specific SCI relevant information and discomfort attending sessions with general Veterans."[29] Additionally, physiologically it was recognized that arm muscles were used for movement and therefore fatigue could easily occur and limited energy expenditure: "they're already overusing their arms. sometimes in certain SCI when they have different types of lesions where there's just nothing going on in the legs, it's much more difficult for them to burn calories once you take out the leg muscles. You're then having to burn the calories with your upper body. You're exercising with your upper body." [HP20, Psychologist][34]

There were also barriers to accessing healthy foods and preparing meals was recognized as particularly difficult: "They're not able to go out to a grocery store and like do their own grocery shopping, so they're doing microwave meals or whatever is convenient for them. A lot of times those more convenient options aren't healthy." [HP08, Occupational therapist][34] HCPs also felt there was a lack of knowledge about what individuals with SCI should be eating which affected weight management: "Lack of education. A lot of patients, they don't know how to manage their diet. They don't know what a serving is of meat or a serving of vegetables."[34]

HCPs were also reluctant to discuss changing dietary habits because it might affect how people with SCI felt: "They have their injury itself, and then you're telling them to stop the most enjoyable thing in their life, so that's … the hardest thing to do."[29] HCPs suggested "A lot of patients use food as their only form of pleasure because they've lost other forms of pleasure and sensation of their body. Even us as human beings that don't have something that traumatic, we turn to food as a comfort. Food is so much more than just nutrition. There's so many more things involved, so when that's something that you get instant gratification from when so many other things have gone bad in your life, I think that's a big barrier."[34]

HCPs also found it difficult to discuss and motivate people with SCI if they were not interested in their health before their injury: "I mean there's no point pursuing weight management goals if the SCI person is not willing to do it or not."[34] This was also found in a study of caregiver's successful experience of weight management in that individuals with a healthy lifestyle before their injury carried on with the same behaviors: "Kind of the nutritional values he had beforehand have still carried over, like it was not like he was a really unhealthy individual beforehand So, he definitely still has that palate for healthier food."[35]

Other factors that were mentioned, but less frequently across the studies, was a recognition that the type of medications taken may affect weight gain and that, although in the initial stages of an SCI weight loss occurs, encouraging patients to eat lots when they are losing muscle mass may lead to obesity and should be considered:

"The problem is they've lost a lot of muscle, and they're not educated on that. So, they lost a ton of muscle. They probably lost also

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fat, but their body is not moving, lost a lot of muscle, and then we just tell them eat, eat, eat, eat, eat, eat, and they're not using energy and not building muscle. So it's a fine line. I get it. But at the same time, I've seen too many patients then go and flip, and they just start eating everything, and then all of a sudden, they like don't fit into their power chair when they go to leave, or they come back and they need a new chair because they've gained 50 pounds".[34]

3.6.3 | Caregivers and weight management

Theme 6: Positive experience

Caregivers found weight management to be a positive experience in that if the person with SCI lost weight it made it easier for the caregiver to complete tasks such as pushing the wheelchair, helping the person transfer, or placing the sleep apnea mask (with weight gain the mask did not fit): "Plus pushing him, I mean my knee has been acting up … so that would help me if he's lighter [CG02; spouse; 66 years old; caregiver for 23 years]."[36] Caregivers also recognized the importance of weight loss for the individual: "His sleep apnea is like so much better. He had sleep apnea before when he had gained weight. With less [weight], it's just, it's a lot better. Because there's nothing worse than trying to put a mask on somebody that can't keep it, it's leaking all the time, you can't fix it. It's terrible. So, it's been, so sleep apnea is better [CG13; spouse; 62 years old; caregiver for 4 years]."[36]

Theme 7: Burdensome

Weight management was sometimes perceived as a burden to caregivers as it meant there was another factor that they had to consider whilst meeting other caring duties: "Burden was attributed to the endless (24/7) and competing responsibilities required of caregivers, including household chores, employment, transportation, and the added burden of the planning needs for meals and exercise."[36] This was both for physical activity and healthy eating. For healthy eating, caregivers had to prepare all the meals and consider the portion sizes and what was healthy. For physical activity, caregivers had to identify opportunities for the person to be active, which were often limited. People who cared for individuals with SCI who were successful at weight management n mentioned that the person with SCI had more independence and was able to go to the grocery store, cook their own meals, and have accessible homes that did not rely on the caregiver. This reduced the burden: "He is responsible for himself and his daily activities for the most part." (CG08) "And he will cook healthy. He'll do the shopping, or he'll tell us what to go buy… So, he will cook for me and his dad. And he will cook healthy."[35]

Theme 8: Involving caregivers

HCPs stressed the importance of involving caregivers and that the team approach was beneficial for individuals with SCI to help them manage their weight: "It's not just the person with SCI going home and reporting what the dietitian said, but rather including the caregiver or family as team members when those different consultations are occurring."[33] HCPs also recognized that it is likely that the carers would be the ones who would buy the grocery shopping and prepare the foods so they are important: "caregivers are the ones who are doing the grocery shopping and preparing the meals, so just letting them know this is really what your son or daughter needs right now, and this is what you need to continue doing over time".[33]

3.7 | Risk of bias

Risk of bias was assessed (Figure 3) in two[14,37] of the three RCTs included in this review. The third study[22] was only an abstract with outcome data supplied by the author, thus there was not enough information to assess the risk of bias. The study by Sabour raised some concerns about the risk of bias due to the randomization process and reporting of outcomes. ROBINS-1 was used to assess the risk of bias in all nine non-randomized controlled studies. All studies had a serious risk of bias due to at least one known important domain being not appropriately measured or controlled for. There were 11 studies that included qualitative data, and none met the full CASP checklist, due to the lack of provided information to assess the checklist (see Tables S4 and S5).

4 | DISCUSSION

4.1 | Statement of principal findings

This review provides new evidence related to nutritional education and weight management programs focusing on behavioral and pharmacological interventions to induce weight loss in adults with SCI. Additionally, it is the first summary and appraisal of qualitative evidence of the experiences of weight management practices of those with an SCI and those HCPs supporting the process. The review

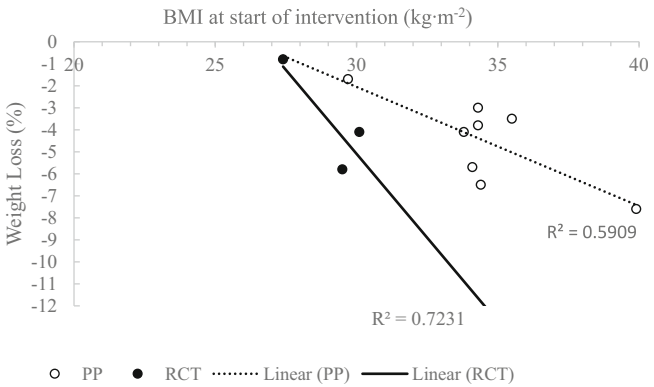

FIGURE 3 Relationship between initial BMI and percentage change in body mass following the intervention. Data from ($n = 3$, RCT and $n = 8$, PP, where BMI was reported).

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included 22 studies with 562 participants, conducted in the United States ($n = 19$), UK ($n = 1$), Netherlands ($n = 1$), and Iran ($n = 1$). The pooled results of pre-to-post interventions indicated that only 38% of people with SCI in weight loss interventions (out of 262) had a body weight reduction of ≥5%, whereas greater weight loss was typically noted in those with a higher initial BMI. Of the three RCTs identified, two were designed to be fully remotely accessible by using online interventions within a home-based environment.[22,37] Interestingly, both had contrasting results on weight loss efficacy (−0.7 kg (NS) (over 28 weeks)[37] vs. −3.7 kg (large ES) (over 16 weeks)[22] Surprisingly, the longer intervention that incorporated individualized diet advice was found least effective. The most recent RCT was a clinical trial involving the administration of obesity pharmacotherapy within a hospital setting, yielding a 5.8% reduction in body weight over 26 weeks.[14] For the PP studies ($n = 10$) a mean reduction of 4.0 ± 2.3% in body weight was reported, with six interventions (60%) resulting in significant weight loss (e.g., up to −8.9 kg with a corresponding −7.6% of body weight loss). The main findings of the qualitative analysis were that there is a perceived lack of evidence for weight management in people with SCI, meaning HCPs are not confident about what to advise. Monitoring progress in terms of weight change is also perceived as problematic and a need to overcome this was reported by HCPs. It was also recognized that involving caregivers is important but may be burdensome and should be considered when working as a team to help people with SCI manage their weight.

4.2 | Appraisal of quantitative studies

Although we were not able to statistically synthesize weight loss outcomes in this review, a simplistic pooling of data from PP studies documented an average weight loss of ∼4 kg (4%). Most interventions included in the pooled data focused on changing diet and PA. Therefore, our findings corroborate the results of another systemic review which found interventions that included combinations of physical exercise and diet therapy produced weight and BMI reductions.[12] The weight loss of 4 kg (4%) in our review is similar to what has recently been documented in meta-analyses of RCTs in primary care-led interventions (−3.7 kg, pre-to-post intervention), although studies within this review were typically several months shorter and longer term efficacy remains uncertain.[46] Nonetheless, over a similar timespan, weight loss responses in this review were comparable to that reported for the NHS online weight management tool and a commercially led weight management program.[47] Interestingly, the reported magnitude of weight change is less than frequently cited clinical targets (5%–10%) with 5% weight loss generally recognized as a lower end threshold for clinically significant health benefits.[48] Indeed, 38% of the participants who completed a weight loss intervention experienced clinically relevant weight loss of 5% following their weight loss intervention. Synthesis of the available literature investigating non-disabled individuals indicates that weight loss of 2.5%–5% is likely to incur benefits for glycemic indices, whereas weight loss of ≥5% appears needed for improvements in the lipid profile and blood pressure.[48] In the general background population, up to 60% of individuals achieve weight loss of ≥5% following a weight management intervention.[49] The apparent lower effectiveness of weight loss interventions in persons with SCI may be related to the reduced daily energy expenditure in this population, making it more challenging to attain a substantial caloric deficit.

The variation between studies in achieved weight loss may also be related to the components included in the interventions. For example, Ramage et al[43] showed that the most successful non-pharmacological weight loss interventions all included dietary advice with specific energy intake targets, physical activity as well as behavior change techniques. The current review tentatively supports these findings, as the PP studies that found the largest weight loss (6.5%–7.6%) also included these three components.[24,38] In line with Ramage et al,[50] studies in which the focus of the intervention was placed on healthy eating rather than a specific caloric deficit reported a smaller magnitude of weight loss (1.7%–3.8%).[23,30,39] Furthermore, although the heterogeneity of studies and limited evidence-base within this review makes it difficult to make conclusive statements about factors associated with weight loss efficacy, we did find that pre-trial BMI was inversely associated with weight loss. In support, the study with one of the highest initial BMI values (39.9 [10.6] kg/m^{-2}) demonstrated a more pronounced weight loss (−7.6%).[24] This is an interesting observation because a recent systematic review in non-disabled individuals concluded that initial BMI does not predict weight loss following lifestyle interventions.[51] The reason for this discrepancy is unclear, but it underscores the unique considerations in the SCI population.

The moderate weight loss found in the current study highlights the need for alternative or improved weight management interventions. In this light, the recent development and approval of incretin-based drugs for weight loss may also hold promise for persons with SCI. In able-bodied individuals, agents such as semaglutide, tirzepatide, and retatrutide have been shown to induce weight loss between ∼15% and 25% following 26 weeks[52–54] substantially larger than the average 4% reported in the current study. A small pilot trial by Cirnigliaro et al[14] showed that in the three individuals allocated to once-weekly semaglutide at the dose prescribed for diabetes (which is lower than that described for weight loss), the drug was well tolerated and led to a reduction in body weight of 5.8% after 26 weeks. This is lower than the weight loss reported in non-disabled individuals with and without type II diabetes,[52] which may be related to the lower dose used (i.e., escalated up to 1 mg) or potential alterations in the physiological responses to this class of drugs in persons with SCI. For instance, persons with SCI already experience a prolonged gastric emptying time compared with non-disabled individuals,[55] while insulin secretion and appetite suppression in response to the incretin hormones GLP-1 and GIP may be affected by the autonomic dysfunction found in this population.[54] More conclusive clinical trials are clearly needed to support the use of incretin-based treatments for weight loss in this population.

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4.3 | Synthesis of qualitative studies

The synthesis of perceptions around weight management by both HCPs and people with SCI has highlighted the difficulty in achieving and maintaining a healthy weight in this population. It was appreciated by the HCPs that weight management is harder for people with SCI than able-bodied individuals, further hampered by the limited SCI-specific recommendations[32] HCPs did not feel confident in supporting or advising their patients regarding weight management. Examples of reported issues include the fact that weight management programs for able-bodied populations require regular weigh-ins.[29] It can be challenging for people with SCI to weigh themselves at home, making it difficult to directly transpose these programs to the SCI population.

Additional problems identified include reduced physical activity levels and lack of access to suitable exercise equipment.[34] This was considered particularly problematic for people with a cervical SCI. Aside from the lack of knowledge on healthy nutrition as a potential barrier, the inability to get to the shops to do their shopping also contributed, meaning persons with SCI felt they were often looking for convenience foods or relying on others to buy their food for them.[34]

Importantly and relevant when trying to implement weight management strategies within the context of clinical practice, many of the HCPs felt that weight management was not a priority for people who had sustained an SCI, citing bladder, bowel, and mobility aspects as more pressing.[32] Furthermore, considering all the other changes that people are trying to overcome following their injury, HCPs reported finding it difficult to have the conversation about adjusting dietary habits at a time when food might be one of the few pleasures in life.[34] Considering the high prevalence of obesity and chronic diseases such as Type 2 diabetes in this population, these comments suggest that there may be a need for awareness creation during clinical training as well as effective science communication with the HCP community.[56]

Finally, while different BMI cutoffs have been suggested in the literature and consensus appears to have shifted to a 22-kg/m^2 cutoff for overweight/obesity,[57] HCPs felt there is a lack of evidence-based guidance on SCI-specific BMI cutoffs. HCPs reported that this left them unable to feel confident to provide appropriate guidance on suitable body weight targets and when to intervene with weight loss interventions. Thus, consolidating SCI-specific BMI cutoffs followed by effective knowledge translation for HCPs may be one of the research priorities going forward.

4.3.1 | Practical implications

This systematic review highlights the limited number of high-quality studies available to inform weight management strategies for persons with SCI. As such, rather than having the potential to form the direct basis for dietary guidelines, the current findings help to identify avenues for future research, in which quantitative as well as qualitative studies are needed to work towards SCI-specific dietary guidelines. Examples of quantitative studies are appropriately powered RCTs to investigate dietary and pharmacological regimens. This systematic review tentatively suggests that intervention duration and contact time may not have a substantial effect on weight loss. On the other hand, the two most effective interventions both included specific energy intake targets, physical activity as well as behavior change techniques; forming a promising combination for further investigations through larger-scale RCTs. To overcome the ever-present challenge of obtaining a sufficient sample size in studying this population, multi-center initiatives may be encouraged. While the present study has elucidated barriers, facilitators, and attitudes toward healthy eating and weight management, future qualitative studies could further explore the specific weight management support needs among people with SCI, while more emphasis may also be placed on their caregivers.[13]

4.4 | Strengths and limitations of this review

To our knowledge, this is the first systematic review and qualitative synthesis exploring weight management interventions and experiences in people with SCI. The search criteria were inclusive and involved HCPs, carers, and individuals with SCI to ensure a representative viewpoint was ascertained. We also involved several clinical and community stakeholders in designing this review to ensure that the findings could be translated into the healthcare community. There were some limitations that should be considered in interpreting the results. Firstly, in the quantitative synthesis, the number of available intervention studies was relatively small with study designs displaying significant heterogeneity (which prevented a meta-analysis). In particular, few RCTs are apparent, and the sample sizes within intervention studies are generally small. It should also be noted that most studies were conducted in the United States, several within the same institution, and findings may not generalize more widely. In the qualitative analysis, it was not possible to fully stratify the opinions by HCP role (e.g., physician, nurse, and dietitian), which would have been useful to help with developing bespoke clinical training programs and future service provision. Finally, it is important to note that, unlike other reports,[49] we only included studies if they specifically stated that the aim was for weight management or to reduce obesity; therefore, some relevant studies, such as exercise interventions, may have been excluded.

5 | CONCLUSIONS

This systematic review highlights the limited number of high-quality weight management studies conducted in persons with SCI. Based on the available evidence, it appears that weight loss interventions in this population can lead to moderate weight loss. However, the finding that just over a third of individuals achieved clinically meaningful 5% weight loss suggests that available interventions for this population may need to be improved. Furthermore, the synthesis of the qualitative studies underscored the difficulty of successful weight

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management in practice, both for the person with lived experience of SCI and the HCPs. Moreover, many HCPs did not consider weight management a priority in clinical SCI care, suggesting a possible need for awareness creation during clinical training as well as effective communication of future research outcomes to the HCP community.

AUTHOR CONTRIBUTIONS

V.L. Goosey-Tolfrey, J.A. King, and S. P. Hoekstra conceived the study, with support from C. Taylor. J.M. Fenton and H.E. Graham conducted the search with support from C.D. Madigan. C.D. Madigan, J.M. Fenton, H.E. Graham, C. Taylor, and N. Kirk completed the screening and full-text identification. C.D. Madigan, C. Taylor, H.E. Graham, and N. Kirk completed the risk of bias assessment. C.D. Madigan, N. Kirk, C. Taylor, and V.L. Goosey-Tolfrey extracted data for the primary outcome and study characteristics. C.D. Madigan and V.L. Goosey-Tolfrey analyzed the data and drafted the paper. All authors provided comments on the paper. C.D. Madigan and V.L. Goosey-Tolfrey act as guarantors. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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SUPPORTING INFORMATION

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