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Research Article

Multimorbidity of overweight and obesity alongside anxiety and depressive disorders in individuals with spinal cord injury

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Objective: To compare the prevalence of anxiety/depression and overweight/obesity (Aim 1) and the multimorbidity of these conditions (Aim 2) in a sample of adults with and without spinal cord injury (SCI). Aim 3 was to examine whether overweight/obese individuals with SCI differ on the prevalence of anxiety/depressive disorders compared to non-overweight/obese individuals with SCI.

Design: Retrospective cohort study.

Participants: Individuals ≥ 16 years old who had patient encounters between January 1, 2011, and February 28, 2018. In total, 761,598 individuals were included, of which 3136 had SCI.

Main Outcome Measures: Individuals were identified as diagnosed with SCI, anxiety and/or depressive disorders, and overweight/obesity using the International Classification of Diseases.

Results: Age-adjusted odds ratios (ORs) were calculated using logistic regression. In contrast to non-SCI individuals, those with SCI had increased odds of anxiety disorders (OR: 3.58, 95% CI [3.29–3.90]), depressive disorders (OR: 4.33, 95% CI [3.95–4.74]), and overweight/obesity (OR: 3.08, 95% CI [2.80–3.38]). Pertaining to multimorbidity, individuals with SCI had increased odds of having overweight/obesity alongside anxiety disorders (OR: 4.30, 95% CI [3.71–4.98]) and overweight/obesity alongside depressive disorders (OR: 4.69, 95% CI [4.01–5.47]) compared to those without SCI. Individuals with SCI who were diagnosed as overweight/obese had increased odds of having anxiety disorders (OR: 2.54, 95% CI [2.06–3.13]), and depressive disorders (OR: 2.70, 95% CI [2.18–3.36]), relative to non-overweight/obese individuals with SCI.

Conclusions: This work is among the first to find evidence that individuals with SCI are at heightened odds of overweight/obesity alongside anxiety and/or depressive disorders. This early work holds clinical implications for treating these interrelated comorbidities in SCI.

Keywords: Physical disability, Mental health, Weight gain, Multimorbidity

Introduction

Advances in both acute and ambulatory care have led to an increasing number of individuals with spinal cord injury (SCI) who survive beyond the first one or two years post-injury. 1,2 Although life expectancy for those with SCI remains lower than able-bodied individuals, 3,4 the fact that individuals with SCI are living longer brings rise to associated physical and psychological health implications that may disproportionately affect this population. Although the current evidence base indicates that individuals with SCI are at heightened risk for both physiological (e.g. cardiovascular disease, diabetes, obesity) 5–9 and psychological conditions (e.g. anxiety, depression), 10–15 little work has been done to understand the co-occurrence of physical and psychological conditions that may uniquely impact individuals with SCI. These multimorbidities (i.e. the presence of co-occurring long-term disorders) are important to identify given that multimorbidity can lead to additional adverse outcomes beyond those associated with the individual diagnoses. 16 Such knowledge can inform integrated treatment approaches for patients with SCI.
which are designed to treat the whole individual rather than independently targeting individual diagnoses.

**Psychological and physical conditions related to SCI**

Meta-analyses in SCI research have estimated that the prevalence of anxiety disorders range between 15 and 32%, while the prevalence of depressive disorders range between 18.7 and 26.3%. In contrast, reported prevalence of anxiety and depressive disorders in the general population hover around 7 and 5%, respectively. On one hand, the relatively high prevalence of psychological disorders in individuals with SCI may be partially explained because SCIs often involve sudden and dramatic changes in lifestyle. For example, Lim and colleagues focused on individuals with traumatic SCIs, finding that those who had acquired more severe injuries were at increased risk of developing anxiety or depressive disorders after being discharged. On the other hand, mental health disorders may also entail a more chronic etiology in individuals with SCI — associated with chronic health conditions such as pain, bowel/bladder dysfunction, and sexual dysfunction. In either case, psychosocial conditions in those with SCI are essential to consider because they are linked to a loss of general functioning and independence that impacts the quality of life as well as community reintegration and participation.

Among individuals with SCI, anxiety and depressive disorders likely co-occur with related physical and physiological conditions. In particular, acquiring an SCI puts individuals at risk for weight gain and obesity. Using body mass index (BMI) to indicate weight status, over half of those with SCI are considered overweight or obese. Within a few weeks of sustaining an SCI, patients begin to experience a loss of lean muscle mass, especially in the lower limbs, that is subsequently replaced by increased fat mass, which is primarily due to physical inactivity and hormonal changes (e.g., decreased anabolic hormone and increased leptin). Although researchers have evinced a link between SCI and psychological disorders, as well as between SCI and overweight/obesity, relatively few studies have examined the potential for these two comorbidities to be interconnected.

**Co-occurrence of weight gain and psychological disorders**

The link between overweight/obesity and mental health disorders has been well established in various populations, with indications that the association is bidirectional. That is, people with various psychological disorders are disproportionately affected by obesity, and obesity can increase the risk for various psychological disorders. Considering paths beginning from overweight status, inflammation is one explanatory mechanism for increased anxiety and depression because overweight/obesity activates inflammatory pathways that are subsequently associated with mental health disorders. There are also numerous psychological pathways featuring similar directionality. For example, being overweight increases psychological distress, increases body dissatisfaction, and decreases self-esteem, which are all known to increase the risk for mental health disorders. On the other hand, depression and anxiety may lead to individuals becoming overweight or obese. As one example, depression and anxiety are among numerous mental health problems that cause dysregulation in the hypothalamic-pituitary-adrenal axis, which plays a key role in the development of overweight and obesity. The symptoms of these mental health disorders may also contribute to increased appetite and stimulation of cravings for high-sugar and high-fat foods that may contribute to the development of overweight/obesity. Furthermore, many medications used to treat mental health disorders carry the possibility of weight gain as a side effect. Despite the understanding in non-SCI groups, much less is known about the link between overweight/obesity and mental health disorders in individuals with SCI.

Weight gain and mental health disorders are both risks for SCI patients that occur in a similar timeline (i.e., after acquiring injury) and emerge through similar underlying causes such as physical inactivity. Indeed, multimorbidity is associated with a range of adverse outcomes that extend beyond the complications of the individual diagnoses. For example, as individuals with SCI develop secondary health conditions such as gaining excessive weight, their health care utilization dramatically increases and caretaking needs may become increasingly difficult (e.g., bathing and dressing), which contribute to decreased quality of life. Similar work outside of SCI has found that those who live with multimorbid chronic conditions have decreased quality of life and increased mortality compared to those with one condition or the other. Although there is early evidence that overweight/obese individuals with physical disabilities self-report lower levels of subjective well-being and health-related quality of life, there remains a critical gap in knowledge of whether overweight/obesity co-occurs alongside psychological disorders with greater prevalence in individuals with SCI than able-bodied individuals.
The current study sought to address this knowledge gap by utilizing a large database of deidentified patient electronic medical records to (1) estimate the odds of anxiety disorders, depressive disorders, and overweight/obesity to compare SCI and non-SCI populations; (2) estimate the odds of having diagnoses of both overweight/obesity and anxiety or depressive disorders (i.e. multimorbidity) in individuals with SCI to compare these odds to non-SCI individuals; and (3) estimate the odds of anxiety disorders and/or depressive disorders for those individuals with SCI who are overweight/obese to compare these odds to non-overweight/obese individuals with SCI. In addition to providing evidence regarding multimorbidity, using electronic records from a large population of patients based on the diagnoses of licensed clinicians builds upon the self-report survey data that form much of the evidence base regarding anxiety and depression in those with SCI.14,17,21

Hypotheses
(H1) Based on existing epidemiological and cohort studies,21 the expectations for the current study were that individuals with SCI – compared to a general sample of patients without SCI – would be at a relatively greater odds of all three conditions (i.e. overweight/obese, anxiety disorders, depressive disorders). Exploratory hypotheses were that (H2) the odds of having multimorbidity of overweight/obese alongside psychological disorder would be relatively greater among those with SCI, compared to a comparison sample of patients without SCI, and (H3) that the odds of anxiety and depressive disorders would be higher among overweight/obese individuals with SCI, compared to individuals with SCI who were non-overweight/obese.

Method
Data source
We performed a retrospective cohort study using data obtained from deidentified medical records stored within the National Institutes of Health-supported Informatics for Integrating Biology and the Bedside (i2b2) database and query tool.44 Beginning in 2011, medical records for all patients treated at the Penn State Milton S. Hershey Medical Center2 have been included within this database, which is updated monthly and contains data for over one million unique patients. These data are recorded during every visit or appointment to any facility that is associated with the Hershey Medical Center (i.e. inpatient and outpatient) and are submitted by certified coders based on observations, diagnoses, and treatments of physicians/clinicians during the course of care. Although various forms of individualized data are stored in the database (i.e. demographics, procedures, visit types, lab tests), cohort-based studies often leverage International Classification of Disease (ICD) procedure and diagnostic codes that are provided as unique patient “counts.” ICD codes are particularly useful because they are standardized and closely following for medical record and billing purposes. Patient counts are searchable using a “query” designated by the researcher, and a patient is counted once if he/she ever met the criteria requested by the query.

In the current study, we extracted data pertaining to participants’ clinician-assigned diagnoses, as identified using ICD code, for all individuals over the age of 16 that had patient encounters from January 1, 2011, to February 28, 2018. It is prudent to consider that the i2b2 database includes information regarding patients’ medical history in terms of having ever been given a particular diagnosis, rather than when they were diagnosed. Given that the data were deidentified, the Institutional Review Board at the Pennsylvania State University considered this study exempt.

Study sample
Patients with SCI were identified by having one or more of the following ICD versions 9 and 10 codes: 806, 907.2, 336, 952, S12, S14, S24, S34, and G95 (full description of the included ICD codes is available in the supplemental material). We opted to exclude codes 344 (“other paralytic syndromes”) or G82 (“paraplegia or quadriplegia”) from our search queries as these conditions may not be directly associated with SCI (e.g. cerebral palsy) and may lead to an overestimation of SCI.45 Anxiety disorders were identified using the patient diagnosis codes 300, 309.2–309.4, 309.81, and F40–F48, while depressive disorders were identified using codes 296, 300.4, 309.0, 309.1, 311, and F30–F39. As providers assign an ICD code for a mental health disorder when it is diagnosed and/or treated, ICD coding for mental health requires diagnosis or treatment for these conditions as defined by the Diagnostic and Statistical Manual of Mental Disorders.46 Indeed, using ICD codes is a valuable method as it indicates that patients were diagnosed and/or treated by a licensed healthcare practitioner. Lastly, overweight/obesity diagnoses were identified using codes 278.0 and E66. These diagnosis codes are derived from the clinician’s appraisal rather than exclusively BMI calculations and are assigned to patients

The Hershey Medical Center (located in Hershey, PA) is a 548-bed hospital that averages over one million outpatient visits and nearly 75,000 emergency visits per year.
both when conditions related to overweight/obesity are treated, and as a patient descriptor. Experts in this domain argue that, because individuals with SCI lose substantial muscle mass, BMI-based classifications are systematically inaccurate and should not be used to classify individuals with SCI. Given that using BMI alone as an index of overweight/obesity holds limitations, we argue that the professional assessment by patients’ clinicians – indicated by ICD code – is a valid method for identifying overweight and obese patients. Comparison samples for each of the analyses were age- and sex-matched patients who had not been diagnosed with aforementioned SCI condition ICD codes.

**Analytical procedures**

**Confounds**

We stratified the samples by sex, given that women are more likely to be diagnosed with anxiety, depression, and obesity than men within clinical samples, and that men are more likely than women to acquire SCI. Because the prevalence of SCI is higher in older populations (i.e. people acquire SCI as they age), we also statistically adjusted our analyses to control for age.

**Statistical analyses**

To test hypothesis 1, logistic regressions were used to determine separate odds ratios (OR) of the associations between having SCI and having diagnoses pertaining to anxiety disorder, depressive disorder, and overweight/obesity – compared to a non-SCI comparison sample. To test hypothesis 2, logistic regressions were conducted to examine multimorbidity of overweight/obesity alongside anxiety and depressive disorders in individuals with SCI compared to non-SCI patients. Regressions were conducted to consider associations with anxiety and depressive disorders separately. To test hypothesis 3, we explored only the subset of individuals with SCI using logistic regression to determine the association between overweight/obese and having anxiety or depressive disorders. All associations were determined using ORs with corresponding 95% confidence intervals (CI). ORs were adjusted for age and were stratified by sex. We presently interpret ORs as indices of effect size that are considered small ($d = .2$; OR = 1.5), moderate ($d = .5$; OR = 2.7), and large ($d = .8$; OR = 4.6).

**Results**

**Demographics**

The present study included 761 598 unique patients, of which 3136 received an SCI diagnosis and 758 462 consisted of the non-SCI comparison sample for a total SCI prevalence of 0.4%. Patient age and sex are described in Table 1 using 15-year increments. Statistical contrasts were not made in relation to differences within strata, provided the low cell counts within specific strata (e.g. only 26 SCI patients aged 16–30 were classified as overweight/obese). Nevertheless, taking a descriptive view of the data, the prevalence of overweight/obesity was higher for individuals with SCI than non-SCI individuals for both sexes and all ages. Women also appeared to have a higher prevalence of overweight/obesity than men in both samples, other than at ages 76+. Although the demographic details in Table 1 are stratified by age, all further analyses involved statistical adjustment to account for age as a confounder.

**Odds of anxiety, depression, and overweight/obesity among those with SCI**

As displayed in Table 2, compared to non-SCI patients, individuals diagnosed with SCI were at increased odds of having a clinical diagnosis of anxiety disorders (OR: 3.58, 95% CI [3.29–3.90]) and depressive disorders (OR: 4.33, 95% CI [3.95–4.74]), while also being more likely to be classified as overweight/obese (OR: 3.08, 95% CI [2.80–3.38]).

**Odds of multimorbidity: Overweight/obesity with anxiety or depression**

Table 3 contains the ORs for multimorbidities of overweight/obese alongside anxiety and depression, respectively, contrasting individuals with SCI to those without. Compared to the 1% of non-SCI patients with diagnoses for both overweight/obesity and anxiety, the 6% of individuals with SCI having multimorbidity is significantly greater (OR: 4.30, 95% CI [3.71–4.98]). Similarly, the odds of multimorbidity of overweight/obesity and depression was significantly greater for individuals with SCI (i.e. 7%) than in non-SCI individuals (i.e. 2%; OR: 4.69, 95% CI [4.01–5.47]).

**Odds of overweight/obesity and psychological morbidity in SCI sample**

In addition to multimorbidity, planned analyses probed the odds for overweight or obese individuals with SCI being diagnosed with anxiety or depressive disorders, focusing exclusively on the subset of 3136 individuals with SCI diagnoses (see Table 4). Compared to non-overweight/obese individuals with SCI, those with diagnoses of overweight or obesity were at increased odds of being diagnosed with anxiety disorders (OR: 2.54, 95% CI [2.06–3.13]) and depressive disorders (OR: 2.70, 95% CI [2.18–3.36]).
Table 1 Prevalence of anxiety disorder, depressive disorder, and overweight/obesity stratified by age and sex.

<table>
<thead>
<tr>
<th>Age/Sex</th>
<th>Total N</th>
<th>Anxiety disorder</th>
<th>Depressive disorder</th>
<th>Overweight/Obese</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SCI</td>
<td>Non-SCI</td>
<td>SCI</td>
<td>Non-SCI</td>
</tr>
<tr>
<td>All ages</td>
<td>3136</td>
<td>758462</td>
<td>704 (22%)</td>
<td>57036 (8%)</td>
</tr>
<tr>
<td>M</td>
<td>1744</td>
<td>336888</td>
<td>310 (18%)</td>
<td>18658 (6%)</td>
</tr>
<tr>
<td>F</td>
<td>1392</td>
<td>420722</td>
<td>394 (28%)</td>
<td>38378 (9%)</td>
</tr>
<tr>
<td>16–30</td>
<td>499</td>
<td>189066</td>
<td>108 (22%)</td>
<td>13466 (7%)</td>
</tr>
<tr>
<td>M</td>
<td>264</td>
<td>85027</td>
<td>40 (15%)</td>
<td>4280 (5%)</td>
</tr>
<tr>
<td>F</td>
<td>235</td>
<td>104021</td>
<td>68 (29%)</td>
<td>9186 (9%)</td>
</tr>
<tr>
<td>31–45</td>
<td>520</td>
<td>143859</td>
<td>136 (26%)</td>
<td>13596 (9%)</td>
</tr>
<tr>
<td>M</td>
<td>277</td>
<td>58511</td>
<td>60 (22%)</td>
<td>4182 (7%)</td>
</tr>
<tr>
<td>F</td>
<td>243</td>
<td>85326</td>
<td>76 (31%)</td>
<td>9414 (11%)</td>
</tr>
<tr>
<td>46–60</td>
<td>854</td>
<td>169910</td>
<td>223 (26%)</td>
<td>14262 (8%)</td>
</tr>
<tr>
<td>M</td>
<td>467</td>
<td>74875</td>
<td>102 (22%)</td>
<td>4744 (6%)</td>
</tr>
<tr>
<td>F</td>
<td>387</td>
<td>95017</td>
<td>121 (31%)</td>
<td>9518 (10%)</td>
</tr>
<tr>
<td>61–75</td>
<td>872</td>
<td>156736</td>
<td>169 (19%)</td>
<td>10661 (7%)</td>
</tr>
<tr>
<td>M</td>
<td>534</td>
<td>74399</td>
<td>77 (14%)</td>
<td>3909 (5%)</td>
</tr>
<tr>
<td>F</td>
<td>338</td>
<td>82321</td>
<td>92 (27%)</td>
<td>6752 (8%)</td>
</tr>
<tr>
<td>75+</td>
<td>391</td>
<td>98897</td>
<td>68 (17%)</td>
<td>5052 (5%)</td>
</tr>
<tr>
<td>M</td>
<td>202</td>
<td>44076</td>
<td>31 (15%)</td>
<td>1543 (4%)</td>
</tr>
<tr>
<td>F</td>
<td>189</td>
<td>54037</td>
<td>37 (20%)</td>
<td>3509 (6%)</td>
</tr>
</tbody>
</table>

M, male; F, female.

Discussion
In the present study, we utilized a large database of de-identified medical records to advance the understanding of the association between SCI and overweight/obesity, anxiety, and depressive disorders. A central goal was to investigate the odds of having multimorbidities that entailed classification as overweight/obese alongside anxiety or depressive disorders for individuals with SCI compared to a non-SCI matched sample. Results focused on each condition independently were consistent with existing literature9,10,15,17,21,24 and supported our hypothesis that those with SCI were at greater odds for being clinically diagnosed with overweight/obesity, anxiety disorders, and depressive disorders. The results also supported our second hypothesis in that individuals with SCI had roughly four times greater odds of having multimorbidity of overweight/obesity alongside anxiety or depressive disorders than those without SCI. Lastly, our third hypothesis was supported as individuals with SCI who were overweight or obese were at increased odds of having an anxiety or depression diagnosis. These findings provide an initial demonstration that individuals with SCI may face greater odds for physical morbidities co-occurring alongside, or in conjunction with, mental health conditions.

We found evidence that the odds of multimorbidity (i.e. overweight/obese alongside anxiety/depressive disorder) in individuals with SCI are roughly four times greater than the odds of these multimorbidities for non-SCI patients. To our knowledge, this is the first study to investigate both overweight/obesity and psychological morbidity in terms of how these diagnoses are interlinked in SCI. Although the absolute magnitude of these forms of multimorbidity in the SCI sample (6–7%) represents a minority, the large effect size identified in these comparisons holds substantial public health implications. Notably, multimorbidity leads to decreased functioning, decreased quality of life, and greater healthcare utilization, above and beyond the

Table 2 Logistic regressions to assess the association between SCI and anxiety disorder, depressive disorder, and overweight/obesity.

<table>
<thead>
<tr>
<th></th>
<th>Anxiety</th>
<th>Depression</th>
<th>Overweight/Obese</th>
</tr>
</thead>
<tbody>
<tr>
<td>All SCI</td>
<td>3.58</td>
<td>4.33</td>
<td>3.08 [2.80–3.38]</td>
</tr>
<tr>
<td>Male</td>
<td>3.66</td>
<td>4.75</td>
<td>3.10 [2.72–3.54]</td>
</tr>
<tr>
<td>Female</td>
<td>3.98</td>
<td>4.47</td>
<td>3.26 [2.74–3.63]</td>
</tr>
</tbody>
</table>

Regressions are age-adjusted and ORs are contrasted with non-SCI comparison sample. Brackets contain 95% CI.

Table 3 Logistic regressions to assess the association between SCI and both overweight/obesity and psychological morbidity (i.e. anxiety and depressive disorders).

<table>
<thead>
<tr>
<th></th>
<th>Overweight/Obese + Anxiety</th>
<th>Overweight/Obese + Depression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>5.27 [4.24–6.55]</td>
<td>5.76 [4.56–5.72]</td>
</tr>
<tr>
<td>Female</td>
<td>4.17 [3.41–5.09]</td>
<td>4.64 [3.77–5.71]</td>
</tr>
</tbody>
</table>

Regressions are age-adjusted and ORs are contrasted with non-SCI comparison sample. Brackets contain 95% CI.
The current findings revealed an important link between weight and mental health in individuals with SCI. Specifically, although individuals with SCI are already at heightened risk for anxiety and depression, these odds were amplified among overweight and obese individuals with SCI. Although the link between overweight/obesity and psychological morbidity is evident in non-SCI samples, the current study is among the first to provide evidence for the strength of this association in a sufficiently large SCI sample. With respect to magnitude, these associations were generally moderate in size and similar across sex. As such, the present findings provide evidence that the well-established association between overweight/obesity and mental health disorders is also present in individuals with SCI. Nevertheless, it is prudent that future work examines directionality of this association given that overweight/obesity can lead to mental health disorders through mechanisms such as inflammation, while mental health disorders can alternatively lead to overweight/obesity through mechanisms such as hypothalamic–pituitary–adrenal axis dysregulation. It is also worth noting that the association between secondary health conditions may be somewhat dependent on individual circumstances such as anatomical level or severity of injury and amount of social support or presence of a spouse. In any case, knowledge of directionality is critical for early prevention efforts that may seek to address the precursory condition as a means of not only decreasing its occurrence but also to prevent parallel secondary health conditions that are influenced by the initial condition.

Focusing on the integration of prevention and treatment approaches for mental health and weight status, it is prudent to consider existing approaches that benefit both conditions. One especially promising rehabilitation route may entail physical activity promotion. Although there are inherent challenges to maintaining healthy weight in individuals with SCI, the physiological health benefits of exercise and recreational physical activity are well reported. There is also a burgeoning body of literature indicating that physical activity may partially alay depression symptoms in individuals with SCI and that greater time spent in leisure-time physical activity is positively correlated with satisfaction with life. Furthermore, physical activity has been shown to buffer the negative effects of multimorbidity on patients’ quality of life in general samples. Physical activity holds additional benefits of providing an avenue to rely on existing community programs and groups, as opposed to relying on medical systems. Although this literature provides early indication that physical activity may be an effective means of managing the multimorbidity of overweight/obesity and mental health disorders, research is required to strengthen clinicians’ willingness to prescribe exercise and physical activity to individuals with SCI, and inform best practices when doing so (e.g. optimal programming, recommended amount of physical activity, referral to community programs).

Despite the strengths of the current study, such as accessing a large sample of individuals with SCI, there are limitations worth noting that may inform future studies. Although the I2b2 database provided access to data that would be exceedingly difficult to collect prospectively, the data source in itself introduced limitations. Pertaining to generalizability, all patients were treated at the same hospital in Central Pennsylvania and all individuals within the comparison sample received some form of treatment to be included in the database. As such, the current sample is neither representative nor is the comparison sample a “healthy” comparison sample. This constrains the generalizability of the current study considering that healthy individuals or individuals that do not regularly visit medical facilities were not included. As a related point, the prevalence of SCI in the sample (i.e. around 0.4%) was higher than most United States national estimates (i.e. around 0.1%). but in line with several other SCI epidemiological study...
samples (i.e. around 0.5%).\(^5,6\) Despite these limitations in generalizability, we expect that these comparisons will correspond with other clinical samples – especially comparisons within the all-SCI sample – yet, we concede that additional representative work is prudent.

A second limitation is that ICD codes used to identify individuals with SCI do not indicate injury severity (i.e. completeness), etiology (i.e. traumatic or non-traumatic), or time since injury, which reduces the opportunity to consider how these features may moderate the findings herein. Similarly, the associations described in the current study may depend on the anatomical level of SCI, especially considering that those with incomplete lower-level injuries may be able to engage in more physical activity and live more independent lives, which can protect against mental health concerns as well as weight gain.\(^{60,61}\) For example, based on evidence that pain and comorbid depression varies by anatomical level, injury completeness, and time since injury,\(^{64,65}\) we anticipate that the associations found in the current study would be moderated by these factors.\(^{66}\) Being able to explore time since injury may furthermore generate an understanding of whether one morbidity precedes the other temporally. These limitations are noteworthy given that clinicians' and rehabilitation specialists' treatment plans for the multimorbidity of overweight/obesity and mental health disorders in individuals with SCI may largely depend on these factors that we were currently unable to account for.

Another limitation is that researchers employing ICD codes should consider the relative shortcomings that specific codes may present.\(^{67}\) In the current study, clinician-reported ICD codes for overweight and obesity should be interpreted cautiously, especially as they tend to be underreported.\(^{68}\) There is nevertheless contrasting evidence that, even though ICD code processes underdiagnose overweight and obesity, they are reliable and accurate. We also argue SCI and non-SCI samples should both be equally subject to this bias, so the comparisons between samples should be consistent. For example, recent reports based on BMI indicate that roughly 53% of individuals with SCI and nearly 40% of all American adults are overweight or obese,\(^{26,69}\) whereas overweight/obese rates were systematically lower based on the ICD diagnosis indices applied in the current study at roughly 17% for SCI and 6% for non-SCI. With all of this in mind, we encourage readers to interpret our results descriptively and to use this research as a foundation for deeper investigations. Moreover, this limitation further demonstrates the need for the field to develop consistent and accurate coding guidelines for overweight and obese individuals with SCI.

Pertaining to future directions, we encourage researchers to build on these preliminary findings to conduct prospective studies that will overcome the limitations of this design. First, a prospective study could recruit patients with SCI shortly after injury to account for temporal precedence with regard to onset of overweight/obesity in relation to the development of anxiety or depressive disorders. Such knowledge would inform clinical treatment in terms of deciding whether to intervene on weight gain or mental health in an initial step. Additionally, although a strength of the current study was investigating clinically diagnosed cases of anxiety and depressive disorders (i.e. as opposed to self-report), future work would be prudent to clearly and objectively measure overweight and obesity, especially as it pertains to individuals with SCI.\(^{47}\) Lastly, given that the retrospective use of the medical records provides limited information regarding potential confounding factors, prospective studies could examine or control for variables that relate to mental health and/or overweight, such as education level, socioeconomic status, and employment, that are known to be lower in individuals with SCI.\(^{12,15,21,37}\)

**Conclusion**

In contrast to the able-bodied population, individuals with SCI have greater odds of obesity/overweight and for developing mental health concerns related to anxiety and depressive disorders. The current findings extend this literature by indicating that, compared to persons without SCI, individuals with SCI may have much higher odds for multimorbidity of unhealthy weight alongside mental health disorders. The current study also revealed that overweight or obese individuals with SCI have even greater odds for mental health disorders – demonstrating the importance of weight management beyond the physiological repercussions of unhealthy weight. Although the present research should be replicated in broader populations and further unpacked in prospective and primary studies, the current results hold clinical implications in that healthcare professionals should seek to consider these comorbidities directly through interventions or treatments that approach SCI from a holistic perspective, rather than one morbidity at a time.

**Disclaimer statements**

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Declaration of interest None.

Conflicts of interest Authors have no conflict of interests to declare.

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