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Original Research

Identification of Mood and Body Mass Index as Modifiable Factors for Health Improvement in Spinal Cord Injury

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KEYWORDS
Affect;
Body mass index;
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Abstract *Objective:* To examine the link between body mass index (BMI) and positive and negative affect after spinal cord injury (SCI).
Design: Cross-sectional study.
Setting: Inpatient and outpatient services of a rehabilitation department in Delhi, India.
Participants: Individuals (N=142) with spinal cord injury participated in the study.
Interventions: None.
Main Outcome Measures: Participants were asked to rate their affect using the Positive and Negative Affect Schedule. BMI was assessed with an SCI-specific procedure. Demographic and injury-related details (eg, level, nature, chronicity) were taken.
Results: As expected, BMI negatively correlated with positive affect (r=−1.70; P=.043). Furthermore, the chances of younger individuals with SCI having a lower BMI is 3.49 times the odds of the older individuals having a low BMI (odds ratio [OR], 3.491; 95% confidence interval [CI], 1.520-8.018). The chances of men having low affect was higher than women (OR, 2.55; 95% CI, 1.08-6.04).
Conclusions: Higher BMI might be associated with lower positive affect and contribute to a higher risk of depression, specifically in women with SCI. These results might be used to enhance the regulation of physical activity (exercises) and affect experiences through therapeutic activities and proactive counselling for individuals with SCI.

List of abbreviations: BMI, body mass index; CI, confidence interval; NA, negative affect; PA, positive affect; PANAS, Positive and Negative Affect Schedule; SCI, spinal cord injury.
Study performed at the Indian Spinal Injuries Centre, Vasant Kunj, N. Delhi, India and Kusum Spine and Neuro Rehabilitation, Vasant Kunj, N. Delhi, India.
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Spinal cord injury (SCI) results in unexpected and irreversible disability and life-long implications that take a considerable toll on the individual's psychological health. SCI-induced restriction of physical activity combined with the altered nervous system (low heart rate variability) are linked with emotional disorders, specifically risk of depression.[1-3] Chronic pain and fatigue lead to overall poor mental health, specifically increasing the chances of depression,[4] stress, and anxiety.[5] These psychological effects occur early and continue in the chronic phases.[6] Studies have suggested that approximately 30% of individuals with SCI are at risk of developing depressive mood-related symptoms affecting their rehabilitation.[7-9] Although mood, which is a largely positive or negative affect that governs motivation, thinking, and behavior, affects quality of life,[10-13] and an imbalance in mood is characteristic of mood disorder, it remains underexplored in the SCI. Hence, we understand that positive and negative moods are integral to understanding depression in individuals with SCI.

In addition to mood imbalance, another factor that remains unexplored in individuals with SCI is body weight. Sudden restriction of mobility and reduced physical activity might affect body weight in individuals with SCI, and high body weight contributes to the risk of depression,[14] reflects problems in interpersonal adjustment,[15,16] and is an indication of complications such as obesity that are secondary to physical ailments,[17–20]; it is also capable of reducing the quality of life.[21,22] Apart from being associated with mood disorders,[23,24] high body weight is linked to raised blood sugar and hypertension,[25] perceived exertion, and physical discomfort.[26] The link between hormones and depressive symptoms strengthens with increasing weight.[27] High body mass index (BMI) is linked to poor compliance with exercise or significant discomfort and distress during exercise sessions,[28] as well as higher risk of developing cardiovascular disorders.[29] Chen et al[30] discussed BMI as a risk factor in SCI specifically for rehospitalization, complications, and mental health problems. Graupensperger et al[31] also found that individuals with SCI were at higher risks of having a coexistence of overweight and anxiety/depression. One study reported that the prevalence of obesity in SCI is 30% and that in overweight is 66%,[32] possibly due to postinjury mobility restriction inducing a sedentary life and a lack of physical activity. Hence, mood and weight have a bidirectional[33] and modifiable relationship.[34] Despite the dual inevitabilities involved in SCI due to (1) reduced physical activity contributing to high risk of BMI imbalance, and (2) loss of ability contributing to high risk of negative mood, the link between BMI and mood in SCI remains undocumented. Because this is important for sustaining the mental and physical efforts required for achieving rehabilitation outcomes and also for maintaining quality of life, we sought to examine this link in individuals with SCI. In this study, we use the terms 'mood' and 'affect' interchangeably.[35]

Methods

Participants

This cross-sectional study was conducted with the approval of the institutional ethics committee where the study was conducted. Informed consent was obtained from all participants, and the ethical standards of the Declaration of Helsinki were maintained. The sample was selected from 2 centers. The pool of individuals with SCI included those who attended the inpatient and outpatient services of the rehabilitation department. From first center, data were obtained during the period from October 2016 to March 2018; from the second center, data collection was continued until February 2021. Although this was done through convenience sampling, we tried to minimize recruitment bias by systematically approaching all therapists in the department and then contacting the individuals with SCI assigned to each. In total, 142 individuals with SCI agreed to give their consent to participate in the study. The inclusion criteria consisted of age older than 14 years and individuals with both acute (ie, time since injury up to a few weeks) and subacute or chronic SCI (ie, time since injury of few months to years).[36] The neurological level of injury, defined as the most caudal level below which there is a normal motor and sensory function,[37] was determined using International Standards for Neurological Classification of Spinal Cord Injury.[38] The inclusion criterion for the level of injury was not restricted. Exclusion criteria consisted of a history of head injury or any associated brain dysfunction, autonomic dysreflexia, or any diagnosed case of psychiatric disorder.

Measures and procedures

After providing informed consent, participants were screened according to the inclusion and exclusion criteria. After this, data on demographics, BMI, and mood were taken. For BMI, the length was measured in the supine position from the vertex of the head to the heel using a measuring tape.[30,39,40] The weight was measured on a wheelchair-accessible scale, with and without the individual seated on the wheelchair, and the difference was calculated to determine body weight. The participants were requested to rate themselves on the Positive and Negative Affect Schedule (PANAS) scale. The PANAS is a 20-item self-rating questionnaire comprising 10 positive and 10 negative adjectives describing positive and negative feelings.[41] Each adjective is rated on a scale from 1 (very slightly/not at all) to 5 (extremely).

Two scores are obtained: positive affect (PA) and negative affect (NA). Higher scores represent a greater affect on the respective subscale. This scale has high internal consistency and good test-retest reliability.[41] Cronbach's alpha has been found to be 0.89 and 0.85 for PA and NA, respectively, in general adults.[42,43] PANAS also has evidence to support its validity and reliability in the rehabilitation population.[42] The crosscultural use of this scale in the Indian population, both healthy individuals[44,45] and those with clinical conditions[46,47] has been established. Hence, the outcome measures for this study were affect (assessed through PANAS) and BMI. Some of the possible confounders for our study could be that caregiver support[48] and socioeconomic status[49] of the individual could have potentially affected mood. The potential effect modifiers for our study were the injury-related characteristics: level of injury (high or low),[49] mode of injury (traumatic or nontraumatic),[50] severity of injury,[51] and chronicity of the injury.[9,11] Individuals who had difficulty completing the self-report questionnaire due to paralysis or paresis of the upper extremities were accommodated. This study is a part of a larger movement-related experiment on the same sample (not included in this article), including other imagery-related variables.

Statistics

Data were analyzed in the following sequence. Analyses were started with descriptive analyses, which involved means and standard deviations for continuous variables and frequencies for categorical variables. Next, a normality test was performed (Shapiro-Wilk Test), as normality was not assumed for the variables included in the analyses (all *P* values <.05). Spearman ρ was then used to find the correlation between the continuous variables; the chi-square test was used for the nominal variable. Odds ratios were used to estimate the risk of having elevated NA or lower PA as a function of SCI and other characteristics. All calculations were based on 95% confidence interval (CI). The data analyses were performed using SPSS, version 22.[a]

Results

The age of the 142 participants ranged from 14 to 66 years (mean, 32.37y; SD, 11.91y; 95% CI, 30.39-34.34). The sample comprised 78.16% males and 21.83% females; 17.60% were acute cases and 82.39% were subacute and chronic cases. The majority of the individuals (91.54%) had a traumatic mode of injury, and 32.39% had tetraplegia; 80.28% had impaired sensations from their body. The average BMI of our sample was 24.30 (SD, 4.37; 95% CI, 23.57-25.02; range, 3.51-35.56). Further description of the data has been given in table 1. The Shapiro-Wilk test for normality was performed for the continuous variables.

Table 2 Relationship of positive and negative affect to age and BMI (N=142).

	Age	BMI	PA
BMI	0.383* (*P*=.000)	–	–
PA	−0.075 (*P*=.376)	−1.70† (*P*=.043)	–
NA	−0.094 (*P*=.268)	0.052 (*P*=.537)	−0.328* (*P*=.000)

* *P*<.01.
† *P*<.05.

Relationship between mood (data obtained from PANAS), age, and BMI

Analyses were done to find the relationship between PA and NA of PANAS, with age and BMI using Spearman ρ (table 2). Spearman ρ was used since the data were not found to be normally distributed.

The correlational analyses (table 2) showed a negative relationship between BMI and PA (r=−1.70, P=.043). These results can be explained as higher BMI being associated with being less physically active, possibly reflecting low motivation, interest, and enthusiasm. These are few of the attributes that determine the PA in the PANAS scale. Our results also show age to be positively correlated with BMI (r=0.383, P<.001). These results can be explained with the help of sample characteristics, where higher aged participants were mostly those with subacute and chronic SCI. Chronicity in SCI means a prolonged period of sedentary and inactive lifestyle, possibly contributing to lack of physical fitness. The older participants in our sample showed higher BMI, possibly owing to longer duration of physical inactivity. This has also been substantiated in the means of BMI in the acute and subacute/chronic groups (see table 1); participants with subacute or chronic SCI had slightly higher BMIs. We also found

Table 1 Description of the variables (N=142).

Variables	Age Mean ± SD, Years	BMI Mean ± SD	PA Mean ± SD	NA Mean ± SD
Sex				
Male (78.16%)	32.75±12.10	24.30±4.08	38.40±7.61	23.22±8.29
Female (21.83%)	31.00±11.32	24.28±5.37	36.55±8.88	26.9±9.59
Chronicity				
Acute (17.60%)	30.84±12.15	23.09±4.70	37.00±9.33	25.64±9.26
Chronic (82.40%)	32.69±11.89	24.56±4.27	38.21±7.60	23.68±8.56
Handedness				
Left handed (4.23%)	21.33±2.42	22.94±3.64	34.50±8.36	24.33±8.64
Right handed (95.77%)	32.85±11.93	24.36±4.40	38.15±7.88	24.01±8.72
Mode of injury				
Traumatic (91.54%)	32.11±11.89	24.34±4.40	37.95±8.10	23.65±8.62
Nontraumatic (8.46%)	35.17±12.37	23.86±4.14	38.42±5.61	28.08±8.72
Level of injury				
Tetraplegia (32.39%)	35.74±13.94	24.48±4.51	36.52±8.19	23.96±7.80
Paraplegia (67.61%)	30.75±10.51	24.21±4.32	38.70±7.71	24.05±9.12
Intactness of sensations				
Impaired sensations (80.28%)	31.61±11.86	24.37±4.32	37.97±8.00	23.51±8.53
Intact sensations (19.72%)	35.46±11.86	24.01±4.62	38.07±7.64	26.11±9.17

a negative relationship between PA and NA (r= -0.328, P<.001) (see table 2).

Association of mood (data obtained from PANAS) and BMI with age group, sex, and level of injury

For the subsequent analyses, the PA and NA of the PANAS scale were dichotomized and the standardized limit was set at a score of 30.[52] The score of 30 corresponds to the response choice of 3 (out of the response choices ranging from 1 to 5, where 1 corresponds to 'very slightly/not at all' and 5 corresponds to 'extremely') in the PANAS scale. Hence, the sample was divided into 2 groups (scores 1-3 and 4-5) for both PA and NA. The BMI was also dichotomized into 2 groups based on the cutoff specific to SCI (BMI <22.5 and ≥22.6).[53,54] The sample of 142 participants was further divided into 2 categories based on age (14-35y and 36-66y) to determine whether PA and NA vary with age in individuals with SCI. The association of mood and BMI with age group, sex, and level of injury has been shown in table 3.

The association of the dichotomized scores of PA with age was not significant (see table 3), with a chi-square value of 0.52 (P=.47) among the 142 participants, thus implying that age is independent of PA. Similarly, we also found that age had no association with NA with a chi-square value of 1.07 (P=.30) among the 142 participants. These results correspond with the results of correlational analyses found in table 2, which showed that age had no relationship with PA and NA.

Relationship between NA and sex showed a significant association, with a chi-square value of 4.75 (P=.020) (see table 3), although the strength of this association was weak (ϕ=0.185). The reason behind the weak association could be the unequal data set in the male and female groups. The odds of males with SCI having lower NA was 2.55 times the odds of females having low NA scores (odds ratio, 2.55; 95% CI, 1.08-6.04). However, no association of sex and PA was seen with a chi-square value of 1.83 (P=.17).

Next, we wanted to see if PA and NA have any association with the level of injury. It can be logically assumed that tetraplegia is more severe than paraplegia in terms of disability and would, therefore, show an association with affect. However, contrary to our assumption, we found that the level of injury (ie, tetraplegic or paraplegic) is not associated with the PA of the individual, with a chi-square value of 3.37 (P=.06) (see table 3). A similar finding also occurred with NA, with a chi-square value of 0.00 (P=.99). In other words, affect was independent of the level of injury in individuals with SCI.

Table 3 shows that BMI was not independent of the 2 age categories in individuals with SCI. We found a significant association between BMI and age with a chiq-square value of 9.239 (P=.002). These results correspond with the correlation found between age and BMI and shown in table 2. A phi value of 0.255 signifies that the strength of this association was relatively weak. The odds of younger individuals with SCI having a low BMI was found to be 3.49 times the odds of older individuals having low BMI (odds ratio, 3.491; 95% CI, 1.520-8.018). However, no significant association has been found between sex and level of injury with BMI (see table 3), thus signifying that BMI is independent of sex and level of injury. Looking at the results of association of BMI with PA and NA, we found that BMI has an association with PA at a P value of 0.057. The results in table 2 also showed a negative correlation between BMI and PA.

Discussion

This study aimed to examine the link between BMI and PA/NA/mood in SCI related to demographic and injury-related factors (age, sex, level of injury). In terms of age of individuals with SCI, the studies appear to be mixed. However, results showed that BMI increased with age, which is aligned with the findings of others.[11,55,56] With increasing age and physical limitations[57] or with SCI,[58] higher depressive symptoms have been reported, indicating age-linked dependency

Table 3 SCI participants who reported high levels of PA, NA, and BMI vs those with low levels of PA, NA, and BMI, respectively, in the age, sex and level of injury groups.

Variables	PA (1-3)	PA (4,5)	Total	NA (1-3)	NA (4,5)	Total	BMI ≤22.5	BMI >22.6	Total
Age									
14-35 years	15	79	94	69	25	94	43	52	95
36-66 years	10	38	48	39	9	48	9	38	47
Sex									
Male	17	94	121	89	22	111	39	72	111
Female	8	23	31	19	12	31	13	18	31
Level of injury									
Tetraplegia	12	34	46	35	11	46	16	30	46
Paraplegia	13	83	96	73	23	96	36	60	96
BMI									
≤22.5	5	47	52	40	12	52			
>22.5	20	70	90	68	22	90			

NOTE. **Age**: (for PA) χ^2=0.52; df=1, P=.47; (for NA) χ^2=1.07; df=1, P=.30; (for BMI) χ^2=9.23; df=1, P=.002*. OR, 3.49; 95% CI, 1.52-8.01.
Sex: (for PA) χ^2=1.83; df=1, P=.17; (for NA) χ^2=4.74; df=1, P=.02[†]; (for BMI) χ^2=0.48; df=1, P=.48.
Level of injury: (for PA) χ^2=3.37; df=1, P=.06; (for NA) χ^2=0.00; df=1, P=.99; (for BMI) χ^2= 0.09; df=1, P=.75.
BMI: (for PA) χ^2=3.61; df=1, P=.057; (for NA) χ^2=0.03; df=1, P=.85.

on others.[59] Advancing age brings increased incidences of disability, more impoverished health conditions,[17-19,60] and less activity,[61] indicating that the age of individuals with SCI might be a risk factor for BMI and mood. On the other hand, the results of Kennedy and Evans[62] showed that young individuals with SCI had higher distress than older individuals. It is possible that high positive affect in young individuals with SCI reflects better coping with SCI in young age, as well as more PA in this age group, as observed by others.[63,64] Adjustment to injury might be better in younger individuals with SCI,[4] possibly because the chances of positive adjustment, social support, and return to meaningful employment are higher.[62]

Furthermore, BMI was significantly lower in the younger age group; chances of such an occurrence are approximately 3 and half times that in older individuals with SCI (see table 3). Although increased BMI with age is seen in healthy individuals as well,[50,51] older individuals with SCI might be at a higher risk of developing higher BMI than younger individuals, possibly due to slowing metabolism. BMI increases with age[55,56] and is linked with other age-related complications such as cardiovascular problems,[29] joint pain,[65,66] diabetes,[20,67] coronary artery disease, and aberrant lipid profile.[67] Higher weight and a high risk of depression and other psychiatric disorders[14,23,68] indicate that BMI regulation might improve physical and mental health in patients with SCI. Apart from age, we examined sex as a demographic variable of interest and observed a higher positive mood in males and a higher negative mood in females (see table 1); males were approximately 3 and half times more likely to have lesser NA than females. Our results align with others showing that females with SCI might be at a higher risk for mental health problems, such as higher anxiety and depression[47,69-71] and posttraumatic stress disorder symptoms.[62]

We also examined the link between BMI and mood across injury-related factors. As expected, individuals with subacute and chronic SCI reported higher positive mood, whereas those with acute SCI reported higher negative moods. Our findings align with others who found that acute cases experienced less PA and more depressed mood.[11,49,69] Difficulties faced after the transition to community post discharge, prolonged depletion of resources,[72] and poor coping skills associated with roles within families and societies[73,74] increase with the length or chronicity of injury. The role of regulatory practices such as physical fitness and weight and mental health via mood regulation should be further explored to account for such variability in findings. The consequence of SCI might be severe for females with SCI,[11,69,75] specifically within sociocultural contexts of gender inequity in favor of males. Nontraumatic SCI is characterized by incomplete injuries[76,77] and is associated with reported extremes of positive and negative mood. Higher negative mood may be prevalent in nontraumatic SCI[50]; however, relatively higher functional independence due to incomplete injury might result in extreme moods.

Limitations

Information related to preinjury body mass and fitness-related lifestyle (including mobility and other routine activities) were unavailable. Similarly, premorbid negative personality or premorbid high BMI can already have a heightened NA in an individual; hence the current results could have been confounded toward higher NA scores on PANAS.

Conclusions

To summarize, higher BMI might be associated with low positive mood, and age and sex might affect the prevalence of negative mood in SCI, along with injury-related factors. However, these findings must be interpreted for generalization with caution, considering the lack of available data related to our sample of SCI participants' premorbid personality and the postinjury situational differences, which could affect mood. Despite some limitations, our findings have important implications for rehabilitation and are the only known account of the link between physical and mental health in individuals with SCI from a largely populated developing country with less policy and infrastructural support for individuals with a disability. We foresee that these results might be used to enhance the regulation of physical activity (exercises) and affect experiences of individuals with SCI. The use of proactive counselling and engagement in therapeutic activities might contribute to improving physical and mental health in individuals with SCI.

Supplier

a. SPSS, version 22; IBM Corp.

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