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Impact of Spinal Cord Injury on Body Composition and Weight

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Abstract

Weight gain is a common consequence of spinal cord injury (SCI), often resulting from decreased physical activity, metabolic alterations, and changes in body composition. This study aimed to assess post-injury weight changes among individuals with SCI. Data was obtained using a multistage random sampling method, utilizing a patient questionnaire administered to 28 individuals diagnosed with SCI. Participants' baseline weights were compared with their recorded weights at follow-up. The mean initial body weight of the participants was recorded as 64.92 kg, whereas the mean current body weight was found to be 72.11 kg. This reflects an average increase of 7.19 kg over the study period. To determine the statistical significance of this observed change, a paired t-test was conducted, which demonstrated that the increase in body weight was statistically significant ($p < 0.05$). This result indicates that individuals with spinal cord injury (SCI) are prone to substantial weight gain following the onset of their condition. Several factors may contribute to this trend, including reduced physical activity due to mobility limitations, alterations in metabolism, and changes in dietary intake. Such weight gain can exacerbate secondary complications, including cardiovascular risk, insulin resistance, and increased strain on musculoskeletal structures. These findings underscore the critical importance of implementing targeted interventions, including nutritional counseling, structured exercise programs, and ongoing monitoring, to manage weight effectively during both rehabilitation and long-term care for patients with SCI. Addressing these factors early may improve overall health outcomes and quality of life for this population.

Keywords: Body composition, metabolic changes, rehabilitation, spinal cord injury, weight gain

INTRODUCTION

According to the study of Brasil, Ministério da Saúde (2012) [1], physical disability is the outcome of interactions between health conditions and contextual factors, not merely a medical issue.

In Brazil's legal and medical context, quadriplegia and paraplegia are defined as forms of permanent physical disability resulting from spinal cord injury. Quadriplegia is paralysis of all 4 limbs due to injury to cervical cord whereas Paraplegia is paralysis of lower half of body typically affecting both lower limbs and sometimes part of lower abdomen.

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Obesity is a worldwide health problem. It is a metabolic disorder and characterized by the deposition of adipose tissue in the body [2, 3].

Neurogenic obesity is a specific type of obesity that is recognized as a contributing factor for the development of type 2 diabetes mellitus, hypertension, dyslipidemia, and cardiometabolic syndrome.

In spinal cord injury patients, there occurs a decrease in energy expenditure due to reduced

muscle mass and altered metabolic rates. This low energy expenditure often leads to deposition of adipose tissue, causing neurogenic obesity [4].

NUTRITIONAL REQUIREMENT IN SPINAL CORD INJURY PATIENTS

Neurogenic obesity results from the difference between total energy consumed and energy used by the spinal cord injury patients [5].

The Food and Agriculture Organization explained nutrition as an outcome of the individual's nutrient intake and nutrient requirements.

Dietary modification is widely known for the quality of life, maintaining healthy weight and improving Basal Metabolic Rate in several individuals [6].

To understand the dietary modification in the spinal cord injury patients, we must first evaluate the total calorie intake of the individual and calculate the percentage of carbohydrate, protein and fat derived from total calories.

Total Energy Requirement

Literature shows that total caloric intake of the spinal cord injury patients ranges from 1250 kcal to 2112 kcal/day [7].

Several studies have shown that spinal cord injury patients generally consume lesser calories than the normal population, which is around 1800 kcal to 2600 kcal per day [8].

Carbohydrate Requirement in Spinal Cord Injury Patients

A good number of studies have shown that the fruit and vegetables consumption in spinal cord injury patients is lower than the recommended quantity [9].

Farkas et al. (2019) [3] suggested that individuals with spinal cord injury consume more carbohydrates which account more than 50% of the total calories.

Gorgey et al. (2012) [4] explained that the total carbohydrates should comprise 45% of the total calorie intake in spinal cord injury patients.

Fiber Requirement

Many studies have highlighted that in spinal cord injury patients, the dietary fiber intake is low [4]. It was said that the total fiber intake in spinal cord injury patients should be 17 g per day. The Academy of Nutrition and Dietetics Evidence Analysis Library (ANDEAL) recommended a daily fiber intake of 15 g [3].

Low fiber intake in spinal cord injury patients can lead to fecal impaction, constipation, unformed stool and long transit time [6, 7].

Protein Requirement

Several studies reported that protein intake in spinal cord injury patients should be 17% to 19% of the total energy intake [3, 5, 8].

ANDEAL recommends 0.8g to 1.0 g intake of protein per kg body weight per day in acute and sub-acute phase or chronic phase in spinal cord injury patients [6].

Fat Requirement

Several studies have highlighted that the patients with spinal cord injury consume 34% to 40% fat of the total caloric intake which is more than the total recommended fat amount of 30% [8–12].

Many studies report that patients with spinal cord injury consume fat, higher than the recommended levels.

Literature suggests that saturated fat intake was higher in patients with spinal cord injury. The National Cholesterol Education Program, the American Heart Association, and the USDA each advise that saturated fats should contribute 7–10% of total daily calories [13–16].

Objective

- To assess the pattern and extent of weight gain in chronic spinal cord injury patients over a period and evaluate its statistical significance.
- Silveira et al. (2019) [10] showed that individuals with SCI/D consumed fewer whole fruits, vegetables, and whole grains each day.
- Silveira et al. (2019) [10] indicated that people with SCI/D had reduced daily consumption of whole fruits, vegetables, and whole grains.
- Silveira et al. (2019) [10] revealed that individuals with SCI/D consumed lower amounts of whole fruits, vegetables, and whole grains daily.

METHODOLOGY

Review of Literature

Literature was reviewed and it was observed that there is high chance of weight gain in spinal cord injury patients. There was not enough data on obesity in hospitalized spinal cord injury patients, hence this study.

Place of Study

The study was conducted in a Spinal cord injury center in Pune, India.

Sample Size and Selection

A multistage random sampling method was employed, resulting in a total sample of 28 participants. Informed consent was obtained from all patients prior to data collection.

Instrument (Questionnaire)

The questionnaire included 46 questions organized into six sections: general information, overall health, weight, physical activity, diet, and lifestyle (activities of daily living).

Data Collection

Data were gathered over a two-week period using a structured questionnaire, and informed consent was secured from participants beforehand [17].

Data Analysis

Data analysis was performed using MS Excel and SPSS 20.0. Descriptive statistics (mean and standard deviation) were applied to summarize overall patterns, and inferential tests (t-test and ANOVA) were used to assess group differences [18–20].

RESULT

Weight gain was checked in spinal cord injury patients after 6 months of the injury.

Table 1 highlights the age of spinal cord injury patients included in the study.

Table 1. Age bracket of spinal cord injury patients.

S.N.	Age interval	No of the patients	%
1.	26–30	10	35.71
2.	31–35	09	32.14
3.	36–40	06	21.42
4.	>40	03	10.71

Among the 28 patients, 35.71% were aged 26–30 years, 32.14% were between 31–35 years, 21.42% fell within 36–40 years, and 10.71% were older than 40. The findings indicate that most patients were relatively young, primarily within the 26–35-year age range.

In the study conducted by Bühler et al. (2011) [8], which reviewed 76 medical records from the Disability Care Center (CAD) for SCI patients in Passo Fundo, Rio Grande do Sul, the highest incidence was observed in individuals aged 18–35 years (44.89%). This was followed by those around 52 years of age (32.65%) and patients aged 53–70 years (22.44%) (Figure 1).

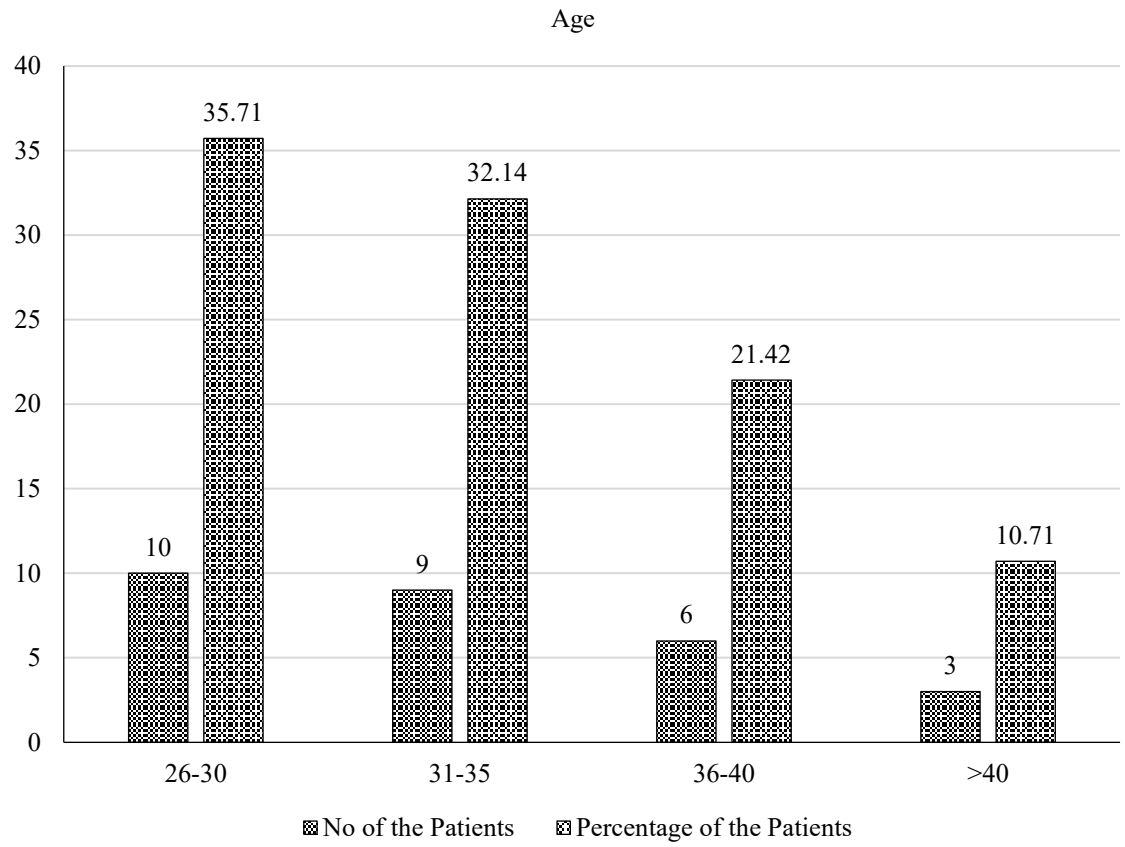

Figure 1. Age-wise distribution of spinal cord injury patients by number and percentage.

Pattern of Smoking and Alcohol Consumption in Spinal Cord Injury Patients

Out of 28 patients, 46.42% were having alcohol; no one was smoking, 46.42% were neither having alcohol nor smoking and 7.14% were having both alcohol and smoking. Our study shows that most of the patients were both smokers and consumed alcohol (Table 2).

Table 2. Outlines the smoking and alcohol consumption patterns among patients with spinal cord injuries.

S. N.	History of alcohol/smoking	Yes	%	No	%
1.	Only Alcohol	13	46.42	15	53.58
2.	Only Smoking	00	00.00	28	100.00
3.	None	13	46.42	15	53.58
4.	Both	02	07.14	26	92.86

In the study by Groah et al. (2009) [10], the ingestion of alcohol was greater for male patients, both with paraplegia and with tetraplegia (Figure 2).

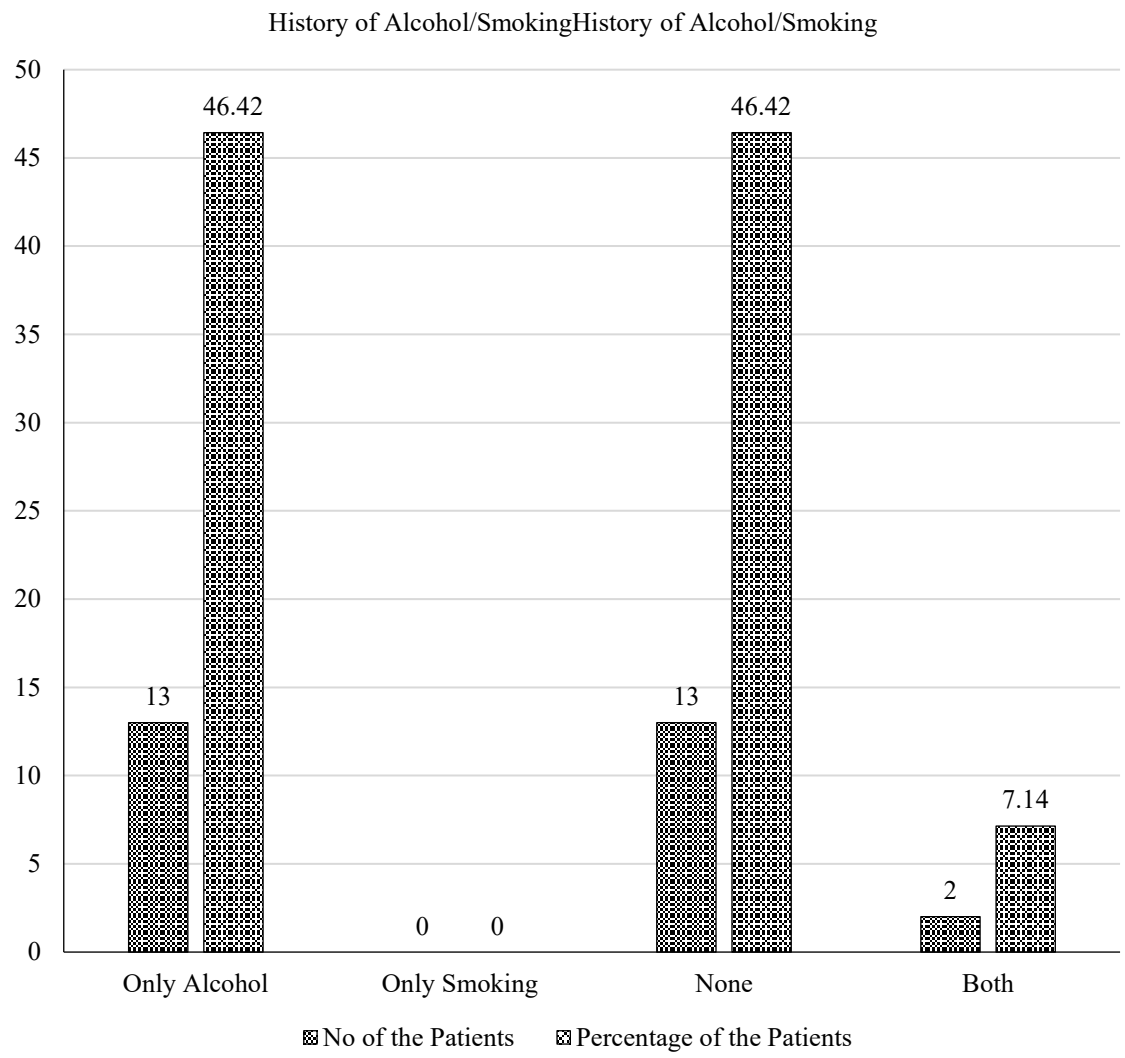

Figure 2. History of alcohol / smoking.

Body Mass Index (BMI) In Patients with Spinal Cord Injury

Table 3 highlights the distribution of spinal cord injury patients according to Body Mass Index (BMI).

Among the 28 patients, none had a BMI below 18.5. A total of 28.57% fell within the BMI range of 18.5–22.9 kg/m², while 71.42% were in the 23.0–27.9 kg/m² category, and no participants had a BMI between 28.0–32.9 kg/m². reported that people with spinal cord injuries face a higher risk of obesity due to their substantial dependence on wheelchairs for mobility.

Table 3. Distribution of spinal cord injury patients according to BMI categories.

S. N.	BMI interval (Kg/m^2)	No of the patients	%
1.	<18.5	00	00.00
2.	18.5 to 22.9	08	28.57
3.	23.0 to 27.9	20	71.42

An estimated 32% of individuals with spinal cord injuries experience an increase in BMI.

classified Body Mass Index (BMI kg/m^2**)** for spinal cord injury patients as <18.5 kg/m^2 (Underweight), 18.5 to 22 kg/m^2 (Normal weight) and >22.0 kg/m^2 (Overweight) (Figure 3).

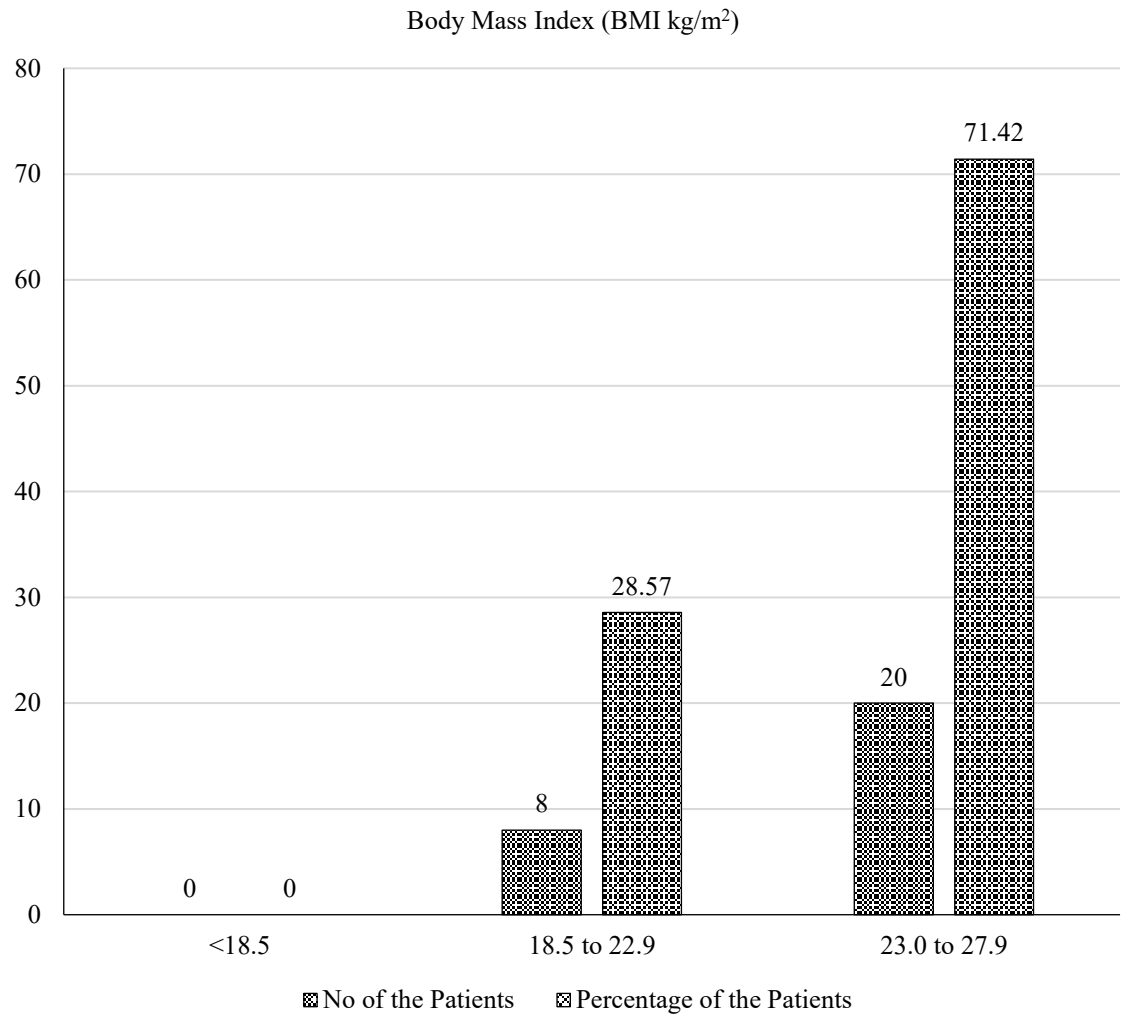

Figure 3. Body Mass index (Kg/m^2).

Distribution of the Spinal Cord Injury Patients According to Type of Injury

Table 4 highlights the distribution of spinal cord injury patients according to type of injury. Out of 28 patients, 71.42% were paraplegic, and 28.58 % were quadriplegic.

Table 4. Distribution of spinal cord injury patients based on type of injury.

S. N.	Type of injury	No of patient	%
1.	Paraplegia	20	71.42
2.	Quadriplegia	08	28.58

Gupta et al. (2006) [21] observed that the prevalence of obesity was higher in paraplegics than tetraplegics regardless of the level of injury as per American Spinal Injury Association (ASIA) classification

It was reported by Gupta et al. (2006) [21] that paradoxically, obesity appears to be more prevalent in individuals with paraplegia than in those with tetraplegia, according to studies relying on BMI rather than direct measurements of body composition.

Groah et al. (2009) [10] observed that the BMI in paraplegics was slightly greater than BMI in tetraplegics viz 25.2 kg/m^2 and 24.7 kg/m^2, respectively (Figure 4).

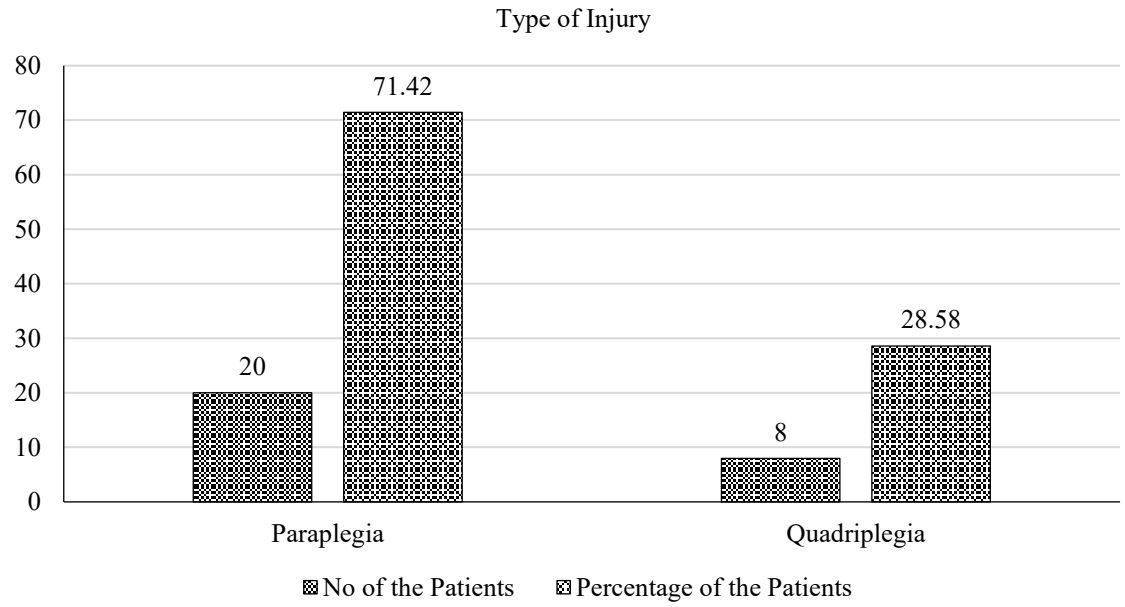

Figure 4. Type of Injury.

Distribution of Spinal Cord Injury Patients According to Duration of Hospitalization

Table 5 highlights the duration of hospitalization Out of 28 patients, 25.0% patients were admitted for <1.0 year, 39.28% were admitted for 1–2 years, 25.0% were admitted for 2–3 years, 3.57% were admitted for 3–4 years and 7.14% were admitted for >4.0 years (Figure 5).

Table 5. Duration of hospitalization among spinal cord injury patients.

S. N.	Duration of hospitalization	No of the patients	%
1.	<1.0 year	07	25.00
2.	1–2 year	11	39.28
3.	2–3 year	07	25.00
4.	3–4 year	01	03.57
5.	>4.0 years	02	07.14

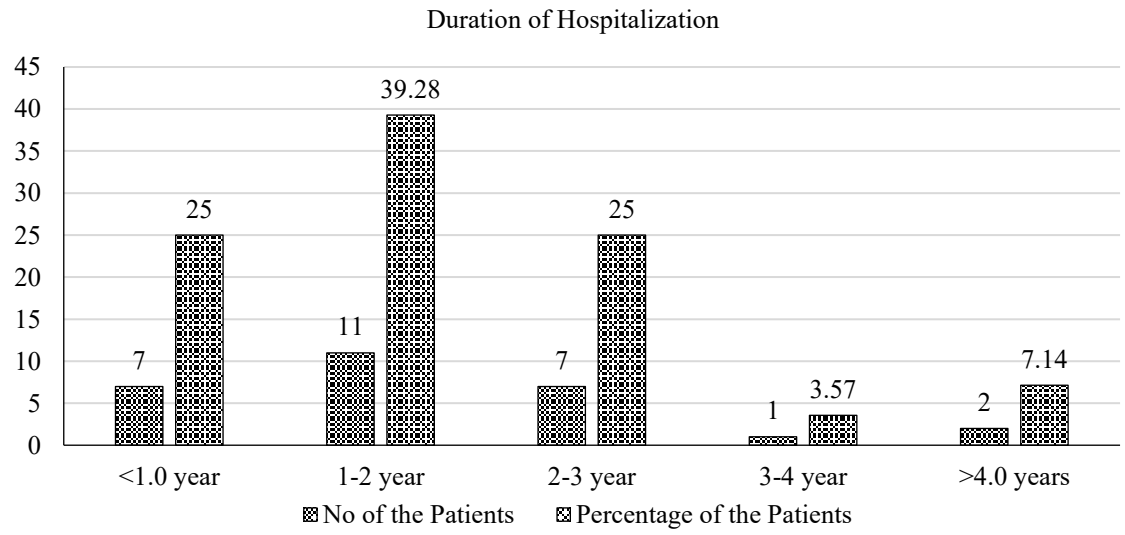

Figure 5. Duration of hospitalization.

Distribution of the Spinal Cord Injury Patients According to Muscle Training

Table 6 highlights the distribution of spinal cord injury patients according to muscle training. Out of 28 patients, 71.42% were doing walking with support where 28.57% were not doing walking with support, 92.85% were doing muscle strengthening exercises whereas 7.14% were not doing muscle strengthening exercises, 96.42% were doing assisted cycling whereas 3.57% were not doing assisted cycling, 21.42% were doing yoga whereas 78.57% were not doing yoga and 100.0% were doing other machine based movement therapy by physiotherapist. Approximately 12%–29% of the SCI population meets population-specific exercise guidelines) (Figure 6).

Table 6. Participation of spinal cord injury patients in various exercise activities.

S. N.	Exercises	Yes	%	No	%
1.	Walking with support	20	71.42	08	28.57
2.	Muscle strengthening	26	92.85	02	07.14
3.	Assisted cycling	27	96.42	01	03.57
4.	Yoga	06	21.42	22	78.57
5.	Other machine-based movement therapy by physiotherapist	28	100.00	00	00.00

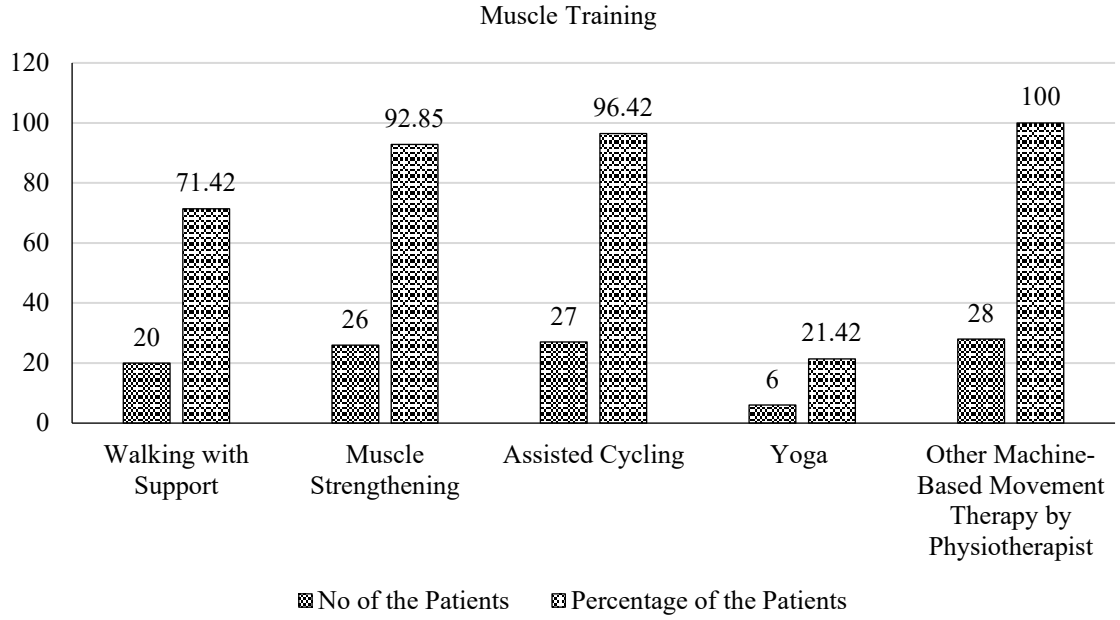

Figure 6. Muscle training.

Distribution of Spinal Cord Injury Patients According to Time Duration of Exercises

Table 7 shows the distribution of spinal cord injury patients based on their exercise timing. Among the 28 patients, none exercised for less than 60 minutes daily. A total of 7.14% exercised for 60–90 minutes, 14.28% for 91–120 minutes, and the majority, 78.57%, exercised for more than 120 minutes each day. Tweedy et al. (2017) [22] recommended that individuals with spinal cord injury engage in a minimum of 150 minutes of aerobic exercise per week. For further health benefits, adults are advised to undertake up to 300 minutes of moderate-intensity physical activity weekly (Figure 7).

Table 7. Daily exercise duration among spinal cord injury patients.

S. N.	Time duration of exercises/day	No of the patients	%
1.	60–90 min	02	07.14
2.	91–120 min	04	14.28
3.	>120 min	22	78.57

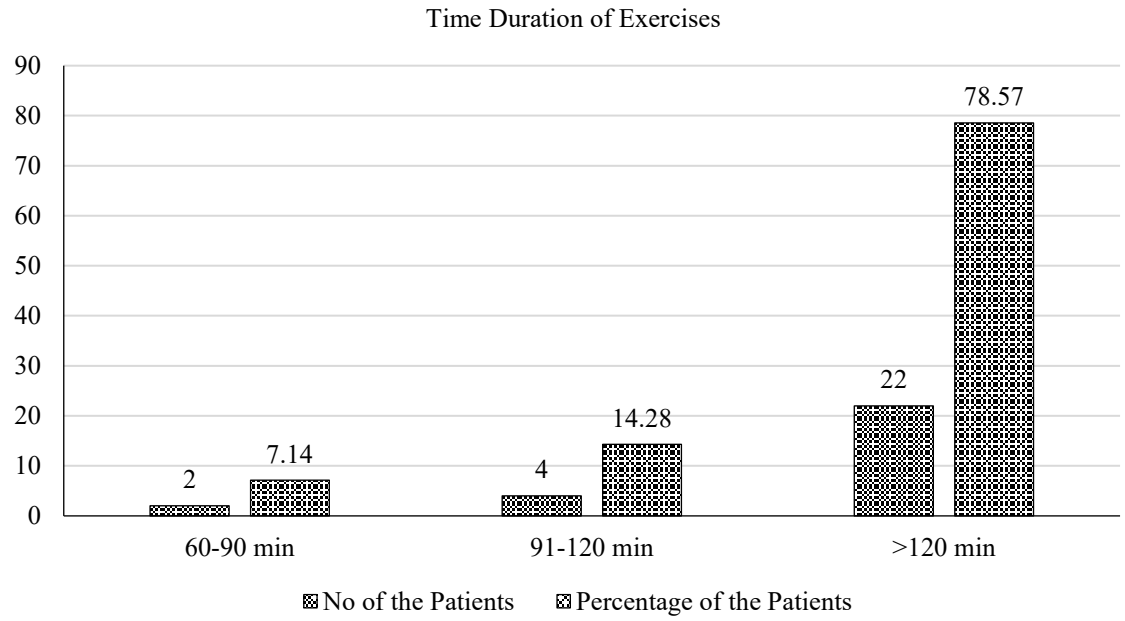

Figure 7. Time duration of exercise.

Distribution of the Spinal Cord Injury Patients According to Dietary Habit

Table 8 below illustrates how spinal cord injury patients are distributed based on their dietary habits. Out of 28 patients, 32.14% of patients were vegetarian and 67.85% patients were non-vegetarian. Numerous studies have shown a correlation between a vegetarian diet and regular exercise with lower body mass, blood pressure, and the risk of cardiovascular events than individuals who consume a non-vegetarian diet (Figure 8) [23–27].

Table 8. Dietary habits of patients with spinal cord injury

S. N.	Dietary habit	No of the patients	%
1.	Vegetarian	09	32.14
2.	Non-vegetarian	19	67.85

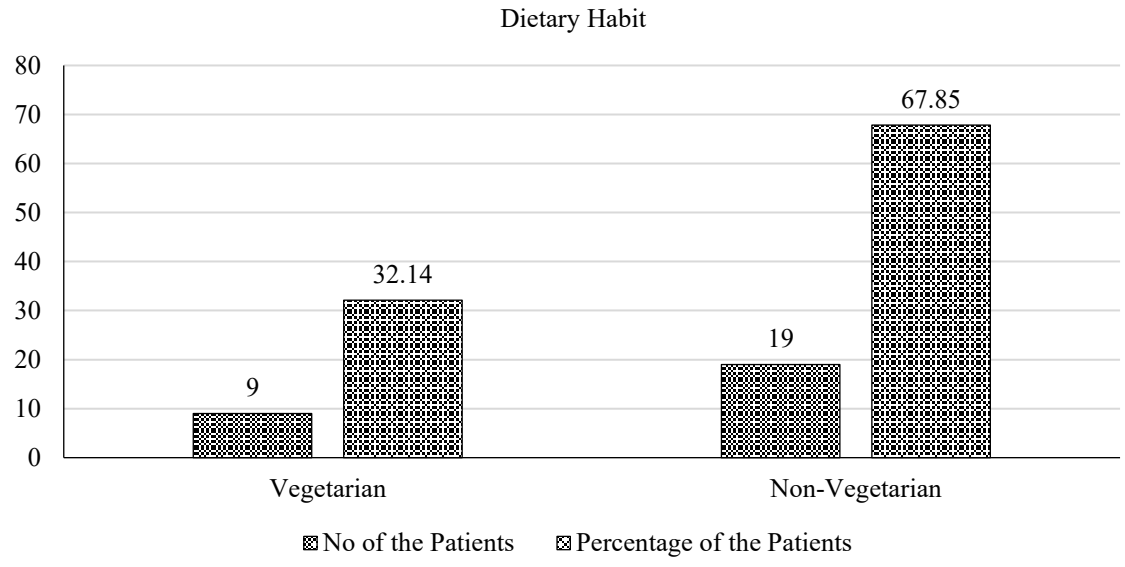

Figure 8. Dietary habit.

Distribution of the Spinal Cord Injury Patients According to Fried Food Consumption by the Patients

Table 9 highlights the distribution of spinal cord injury patients according to fried food consumption by the patients. Out of 28 patients, 21.42% of patients never had fried food, 17.85% were having them once a week, 10.71% were having them 2 times a week, 46.42% were having them 3–4 times in a week and 3.57% were having them every day (Figure 9).

Groah et al. (2009) [10] reported that, among all participants, both paraplegic and tetraplegic—intake of fats and carbohydrates exceeded the recommended levels.

Table 9. Frequency of fried food consumption among spinal cord injury patients.

S. N.	Friend food consumption by the patients	No of the patients	%
1.	Never	06	21.42
2.	1.0 time/week	05	17.85
3.	2 times/week	03	10.71
4.	3–4 times/week	13	46.42
5.	Everyday	01	03.57

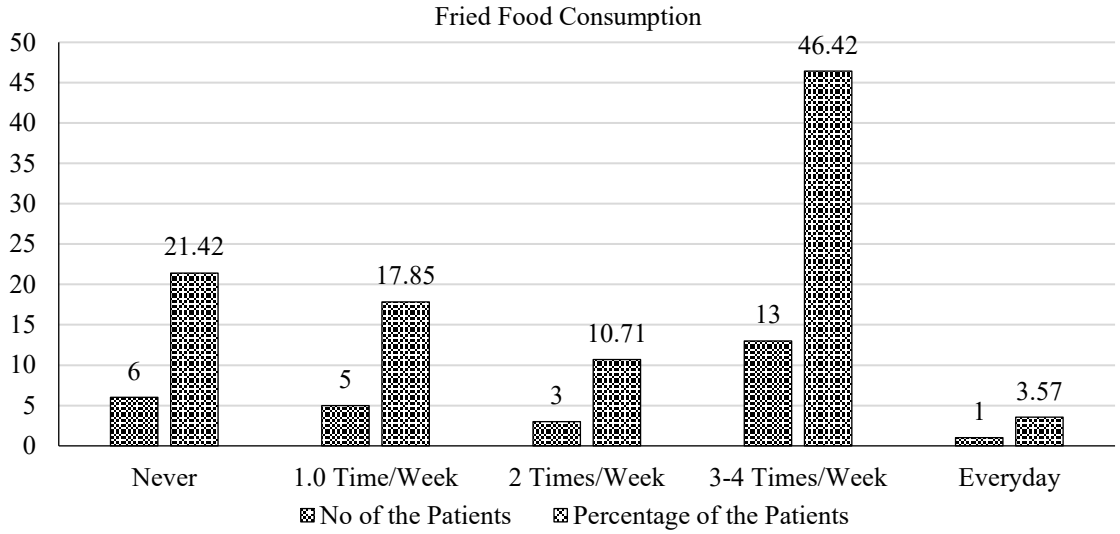

Figure 9. Fried food consumption.

Distribution of the Spinal Cord Injury Patients According to Number of Meals Consumed by the Patients

Table 10 highlights the distribution of spinal cord injury patients according to the number of meals consumed by the patients. Out of 28 patients, 28.57% were having 3 meals/day, 17.85% were having 4 meals/day, 46.42% were having 5 meals/day and 7.14% were having 6 meals/day (Figure 10).

The pieces of research of Leidy et al. (2011) and McCrory et al. (2011) [23, 24] suggest that meal frequency may be linked to weight gain, although the findings remain inconclusive.

Table 10. Hospital meal frequency among spinal cord injury patients.

S. N.	Hospital meal frequency	No of the patients	%
1.	3 meals/day	08	28.57
2.	4 meals/day	05	17.85
3.	5 meals/day	13	46.42
4.	6 meals/day	02	07.14

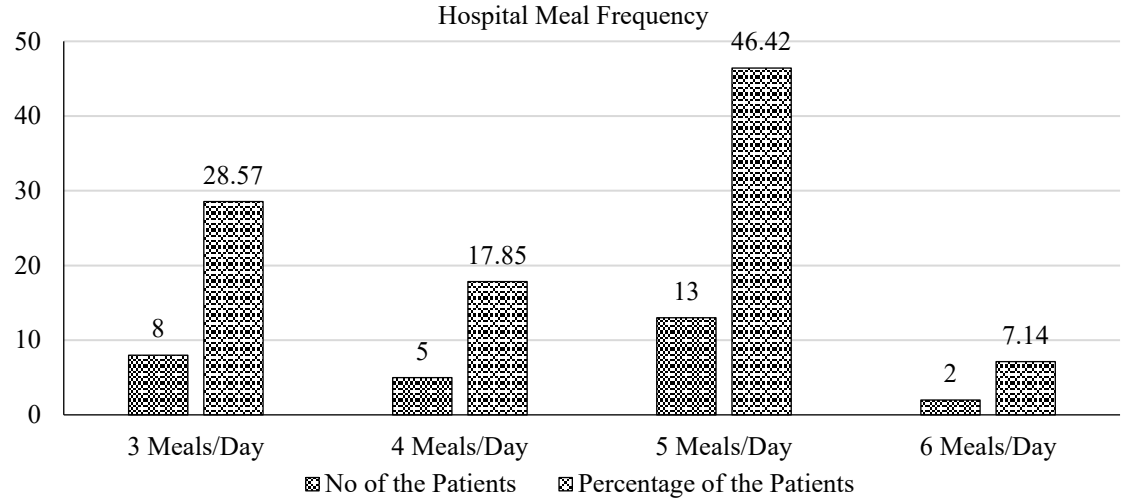

Figure 10. Hospital meal frequency.

Distribution of the Spinal Cord Injury Patients According to Frequency of Eating Outside Meals

Table 11 highlights the distribution of spinal cord injury patients according to frequency of eating outside meals. (Home cooked food or ordered from nearby Restaurant or Zomato/Swiggy) Out of 28 patients, 17.85% of patients had never eaten outside meals, 46.42% were having outside meals occasionally, 7.14% were eaten twice/week, 25.00% were eaten once/week, 3.57% were eaten alternate days and nobody was eating outside meals every day (Figure 11).

Frequent eating outside may worsen lipid profiles (Kaneko et al., 2021) [28].

Table 11. Frequency of eating meals outside among spinal cord injury patients.

S. N.	Frequency of eating outside meals	No of the patients	%
1.	Never	05	17.85
2.	Occasionally	13	46.42
3.	twice/week	02	07.14
4.	once/week	07	25.00
5.	Alternate day	01	03.57
6.	Everyday	00	00.00

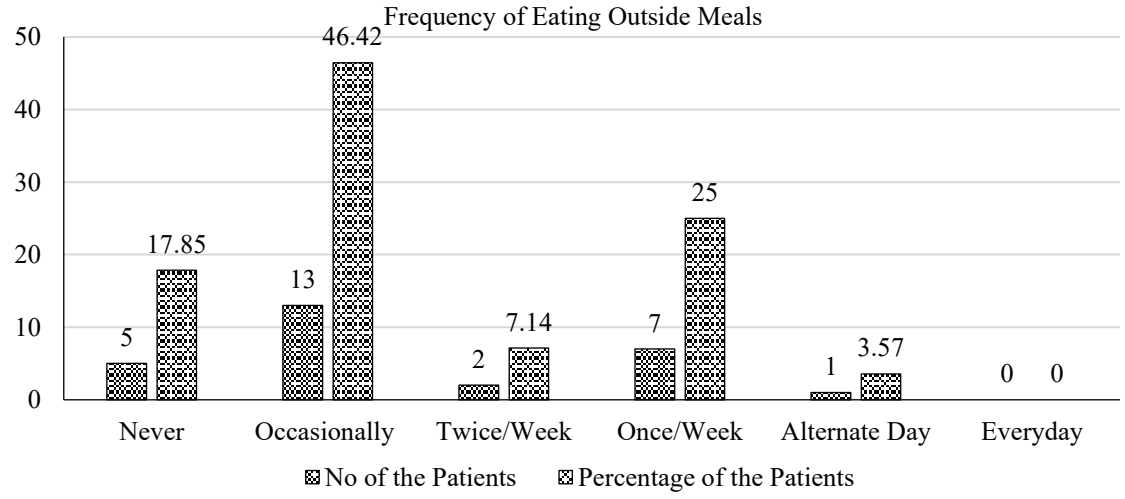

Figure 11. Frequency of eating outside meals.

Distribution of the Spinal Cord Injury Patients According to ADL Function

Table 12 highlights the distribution of spinal cord injury patients according to ADL Function. Out of 28 patients, 71.42% patients were able to bath and 28.57% were not able to bath, 53.57% were able to do dressing and 46.42% were not able to do dressing, 78.57% were able to do grooming and 21.42% were not able to do grooming, 82.14% were able to do mouth care and 17.85% were not able to do mouth care, 46.42% were able to toilet and 53.57% were not able to toilet, 25.00% were able to arrange the bed and 75.00% were not able to arrange the bed, 78.57% were able to eat by themselves and 21.42% were not able to eat by themselves, 71.42% were able to manage the medications and 28.57% were not able to manage the medication, 89.28% were able to use the mobile phones and 10.71% were not able to use the mobile phones (Figure 12).

Table 12. Activities of daily living (ADL) performance among spinal cord injury patients.

S. N.	ADL function	Yes	%	No	%
1.	Bath	20	71.42	08	28.57
2.	Dressing	15	53.57	13	46.42
3.	Grooming	22	78.57	06	21.42
4.	Mouth care	23	82.14	05	17.85
5.	Toilet	13	46.42	15	53.57
6.	Arranging bed	07	25.00	21	75.00
7.	Eating	22	78.57	06	21.42
8.	Managing medications	20	71.42	08	28.57
9.	Using phone	25	89.28	03	10.71

Patients suffering from SCI may lose parts of their body function, and their activity of daily living (ADL), such as eating and dressing, will be extremely difficult (Lynch et al., 2001) [29].

men with SCI spend more time partaking in personal care activities and less time engaged in work-related activities than men without an SCI men with SCI spend more time partaking in personal care activities and less time engaged in work-related activities than men without an SCI men with SCI spend more time partaking in personal care activities and less time engaged in work-related activities than men without an SCI

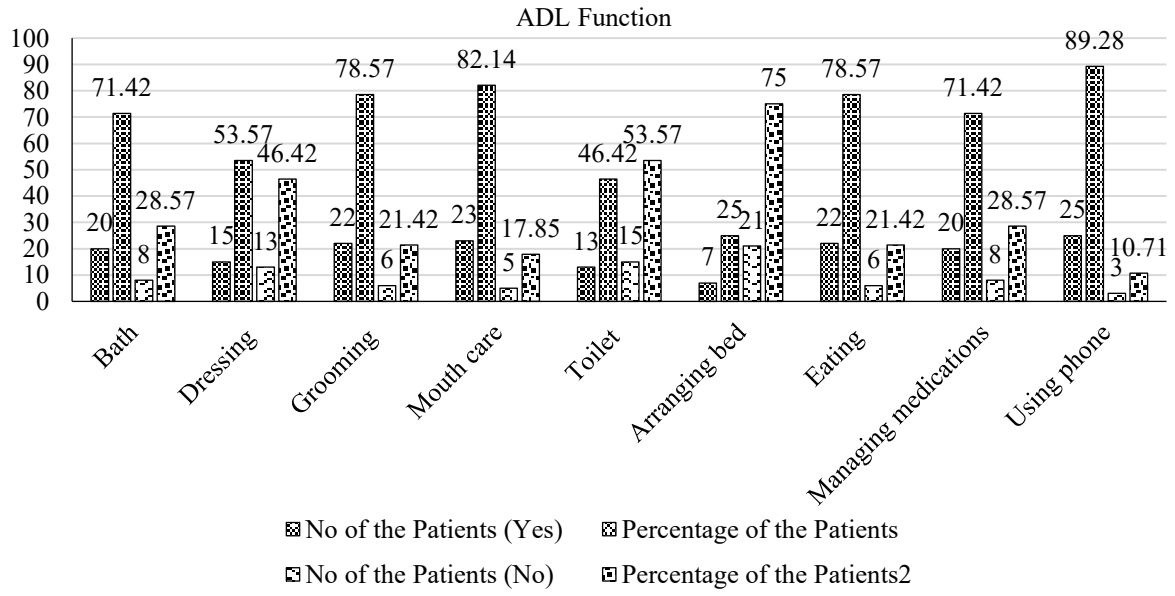

Figure 12. ADL function.

Distribution of Spinal Cord Injury Patients According to Weight Gain

Table 13 highlights the distribution of spinal cord injury patients according to weight gain. Out of 28 patients, 46.42% of patients gained weight 1 to 5 kg, 42.85% of patients gained weight 6 to 10 kg, 3.57% of patients gained weight 11 to 15 kg, no patient had gained 16 to 20 kg, and 7.14% patients had gained >20kg. It was noted that a decrease in skeletal muscle mass, even with consistent dietary habits, creates an imbalance between energy intake and expenditure, leading to fat accumulation and obesity. Remarkably, a mere 2% mismatch between energy intake and expenditure can cause a weight gain of 20–30 kg within a year.

Table 14 shows a significant increase in mean body weight after spinal cord injury, while Figure 13 highlights that most patients gained between 1 and 10 kg.

Table 13. Weight gain intervals among spinal cord injury patients.

S. N.	Weight gain interval (kg)	No of the patients	%
1.	1 to 5	13	46.42
2.	6 to 10	12	42.85
3.	11 to 15	01	03.57
4.	16 to 20	00	00.00
5.	>20	02	07.14

Table 14. Comparison of mean scores before and after injury with t-test analysis.

S. N.	Condition	Mean ± St. Deviation	t-test	p-value
1.	Before injury	64.92 ± 9.08	3.0366	0.000000030366
2.	After injury	72.11 ± 6.62		

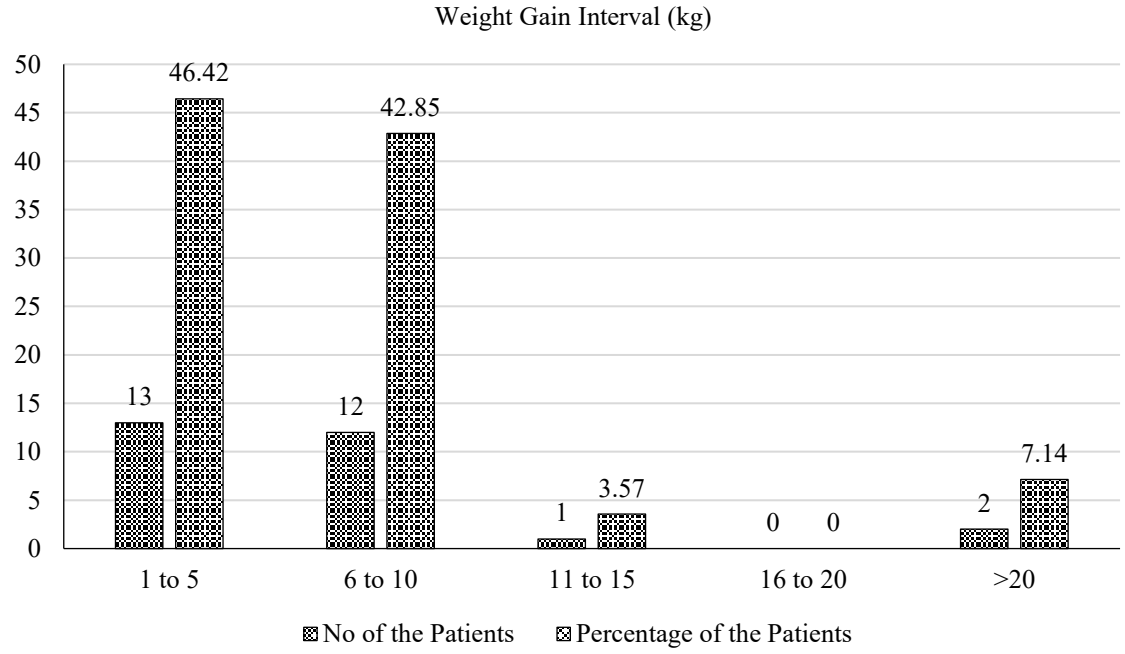

Figure 13. Weight gain interval (kg).

Interpretation

- This p-value is extremely small (<0.05).
- It means the difference in weights before and after injury is statistically significant.
- There is very strong evidence that the injury caused a change in weight.

Conclusion (if α = 0.05)

- Since p-value = 0.000000030366 < 0.05, Reject the null hypothesis.
- There is a significant difference in patient weight vs. after injury.

DISCUSSION

Rimmer et al. (2005) [30] showed that the incidence of obesity is 2 to 4 times more in individuals with disabilities, especially with mobility limitations. found that patients with spinal cord injury have higher rates of obesity.

It was observed that a reduction in muscle mass, coupled with unchanged dietary habits, disrupts the balance between energy intake and expenditure, leading to fat accumulation and obesity. Even a small 2% imbalance between energy intake and expenditure can result in a weight gain of 20–30 kg over the course of one year.

Gupta et al. (2006) [21] concluded that the prevalence of obesity was higher in paraplegic patients than tetraplegic patients. This may be contributed to the greater independence in paraplegics of feeding themselves due to preserved upper limb function.

Studies indicate that spinal cord injury patients with a BMI below 25 kg/m² are at risk of developing metabolic syndrome, which is marked by increased fat mass, low HDL, elevated LDL, insulin resistance, and impaired glucose tolerance (Gorgey et al., 2006) [31].

Buchholz et al. (2003) [32] showed that reduced energy expenditure certainly plays a role in the progression of obesity.

A strong association has been found between reduced energy expenditure, lower sympathetic activity and increase in fat mass in patients with spinal cord injury (Jeon et al., 2003) [33].

Gupta et al. (2006) [21], in their study, reveal that prevalence of obesity is higher in paraplegics than in tetraplegics.

Safdarian et al. (2023) [34] observed higher incidence of obesity in males than females with spinal cord injury.

Gorgey et al. (2014) [35] found that lower muscle mass contributes to a reduced resting energy expenditure that predisposes individuals with chronic spinal cord injury to weight gain, central adiposity, and metabolic disorders.

CONCLUSION

This study shows that weight gain is a significant concern among individuals with spinal cord injury (SCI), primarily due to reduced physical activity, altered metabolism and changes in body composition. Our findings indicate that a combination of factors – including decreased energy expenditure and psychological challenges contribute to this issue.

In this study, patients involving 28 spinal cord injuries (SCI) patients, a statistically significant increase in body weight was observed over time. The average weight before injury was 64.92 ± 9.08 and which increased to 72.11 ± 6.62 after injury. The application of a paired t-test yielded a p-value of <0.05, indicating that the weight gain was statistically significant.

These findings suggest that individuals with SCI are at a high risk of weight gain, likely due to reduced physical activity, metabolic alterations and lifestyle post injury. This weight gain can contribute

to further health complications, including cardiovascular risk, insulin resistance and decreases functional independence.

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