

Assessment of Sex Differences in Body Weight Changes Following Spinal Cord Injury Using Albino Rat Models

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Abstract: Background: Several studies have reported variable body weight changes in individuals with chronic Spinal cord injury (SCI). This study assessed the sex differences in body weight changes within the first week following SCI. **Methods:** A total of 16 adult albino rats were used. They were group into two based on their sex and their weights were recorded prior to the induction of SCI. They were then anaesthetized using ketamine 75mg/kg via intra-peritoneal injection and the spinal cord was surgically transacted below T4. After recovery, they were allowed access to food and water as before the injury. Weights were recorded again five days post SCI. Mean weight of the rats pre and post SCI were compared and $P < 0.05$ was considered as significant. **Results:** The male rats were found to have a mean weight of 265.50 ± 13.9 and 245.75 ± 12.86 pre and post SCI respectively. No difference in the pre and post SCI weights of the female rats (156.83 ± 8.29 and 156.00 ± 9.05) respectively. Mean weight loss (g) and percentage weight loss (%) were found to be significantly higher ($P < 0.05$) in the males (19.75 ± 7.66 and 7.28 ± 2.74) respectively compared to the females with mean weight loss of 0.83 ± 1.92 and percentage weight loss of 0.63 ± 1.34 . **Conclusions:** The findings indicated that Males have higher and significant weight loss compared to females in the early phase of SCI.

Key Words: Spinal Cord injury; Body Weights; Albino Rats.

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I. Introduction

Spinal cord injury (SCI), a medically complex and life disrupting ailment, has remained a terminal condition especially in developing countries where people with SCI die within few years of injury.^[1] Even in developed countries SCI and paralysis remain a significant cause of disability.^[2] It is an important public health problem requiring a lifelong treatment and high cost care which negatively affect the patient, his/her family and their community at large. Unfortunately, there is still no single accepted universal treatment for SCI to date. This is why many studies are still on going on the pathophysiological changes taking place in different tissues of the body post SCI.^[3]

Spinal cord injury causes quadriplegia or paraplegia depending on the extent as well as the level of the lesion.^[1] These cause physical in activity resulting to decrease in body lean mass, increase in body fat, dyslipidemia, and more life threatening diseases such as recurrent urinary tract infection, impaired kidney function cardiovascular diseases and metabolic syndrome which according to National Cholesterol Education Program's Adult Treatment Panel III report (ATP III) was identified as a multiplex risk factor for cardiovascular disease that is deserving of more clinical attention characterized by abdominal obesity, atherogenic dyslipidemia, raised blood pressure, Insulin resistance \pm glucose intolerance, pro-inflammatory state and pro-thrombotic state^[4] all of which further complicate the SCI.^[2,5] It is therefore important to study the early changes in the body composition that may result to these complications following SCI.

Despite the devastating effects of SCI, many researchers focus more on changes in body contents and functions months and years after the injury without targeting early pathophysiological changes taking place from few days to weeks post SCI. There is paucity of information on sex related differences associated with changes in body weight, contents and functions following SCI. This study used albino rat models to assess the sex differences in the immediate body weight changes following SCI.

II. Materials and Methods

Animals and Conditions

A total of 16, comprising of 8 males and 8 females adult albino rats, weighing 150 to 200 grams, ages \geq 120 days, were obtained from the animal house, Department of Human Physiology, Bayero University Kano. All the rats were housed in plastic cages with length, width and height of 41.5cm, 33.3 cm and 13 cm respectively, four rats per cage, with adequate ventilation and maintained at temperature of between 27°C to

32⁰C inside the animal house. They were allowed free access to standard laboratory rat chaw and tap water ad libitum throughout the length of the study. All the procedures involving the handling of the animals were performed according to the ethical guidelines for animal care and handling.^[6] Body weight (g) of each rat was recorded prior to the induction of SCI.

Spinal Cord Injury Model

The rats were allowed access to food and water until one hour prior to the anaesthesia.^[6] At the time of the procedure, the rats were anaesthetized with Ketamine 75mg/kg body weight via intra-peritoneal injection. The dorsum of each animal was then shaved and a longitudinal incision was ensured through the skin. The dorsal surface of the vertebrae was then exposed and a sharp blade was deeply inserted between the paravertebral muscles below T4 level and was used to cut the spinal cord completely at that level.^[7] After the procedure, the overlying muscles were sutured with 4 – 0 silk.

Post-Operative Care

The rats were placed in warmed and clean cages for recovery 1 rat/cage. They were given Carprofen 5mg/kg S.C 12 hourly for 48 hours.^[6] They were then monitored 2 – 3 times daily for general health, coat quality, mobility within the cage and signs of paralysis such as; hind limb paralysis, tail flaccidity and uncoordinated movements.^[8] Urinary bladder manually voided 2 - 3 times daily until recovery of function as needed.^[7] After recovery from anesthesia, the rats were allowed free access to water and food as before the procedure. Five days following SCI induction, the body weights of the rats were recorded again.

Data analysis

Data were expressed as mean \pm S.E.M and analyzed using SPSS version 20.0(SPSS Inc, Chicago, U.S.A). Mean body weights of the rats pre and post SCI were compared using paired t test. P values less than 0.05 were considered as statistically significant.

III. Results

Table 1: Body weight changes in albino rats five days after spinal cord transection (Mean \pm S.E.M.)

Parameters	Males	Females
Body Weight (g) Pre SCI	265.50 \pm 13.9	156.83 \pm 8.29
Body Weight (g) Post SCI	245.75 \pm 12.86	156.00 \pm 9.05
P value	0.08	0.68

P > 0.05

It was found that, the mean weight of the male rats pre SCI was 265.50 \pm 13.9 and five days following SCI, the mean weight reduced to 245.75 \pm 12.86. However, the difference was not statistically significant (P = 0.08)). For the female rats, the mean weights (g) before and after the SCI were found to be almost the same 156.83 \pm 8.29 and 156.00 \pm 9.05 respectively (P = 0.68).

Table 2: Weight loss (g) and percentage weight loss (%) in albino rats, five days post SCI (Mean \pm S.E.M)

Parameters	Males	Females	P value
Weight Loss (g)	19.75 \pm 7.66	0.83 \pm 1.92	0.02*
Weight loss (%)	7.28 \pm 2.74	0.63 \pm 1.34	0.04*

*= significant (P < 0.05)

The percentage weight loss is the proportion or percentage of the initial body weight that was lost within five days after complete transection of spinal cord. The results showed that the mean weight loss (g) was significantly higher (P = 0.02) in the male albino rats compared to the females (0.83 \pm 1.92). The percentage

weight loss (%) was also found to be significantly higher ($P = 0.04$) in the male rats (7.28 ± 2.74) compared to the females (0.63 ± 1.34).

IV. Discussions

There were decrease in body weights of the male albino rats five days after spinal cord injury whereas, in the female rats the mean weights before and after the injury were found to be almost the same. Five days post SCI; the amount of weight loss and the percentage weight loss (Percentage of initial body weight that is lost within five days following SCI) were significantly higher in the male rats compared to the females. It is known that muscle tissues contribute about 20% - 30% of metabolic rate and total daily energy expenditure of an individual^[9] thus the males have higher energy expenditure compared to females even at rest. In the early stages of SCI, energy intake is greatly reduced due to spinal shock, loss of appetite and other catastrophic events.^[10] Therefore, the male rats having more of muscle mass and therefore higher total daily energy expenditure compared to their female counterparts were likely more predisposed to have negative energy balance where energy input is less than energy expenditure. This will cause breakdown of energy stores in the body (fats and proteins) to meet the daily energy requirement, resulting to significant loss of body weight. On the other hand, the female rats with more of fat mass than muscle, are known to have less total daily energy expenditure (TDEE) and metabolic rate compared to their male counterparts because fats contribute only about 5% of TDEE.^[11] As a result of this, despite the low energy intake in the early phase of SCI, the females were unlikely to be predisposed to higher negative energy balance and therefore have lower rate of tissue catabolism compared to males. This might be responsible for less and non-significant body weight loss in the female albino rats. The findings agreed with three previous studies^[12,13,14] all of which reported higher weight loss in males compared to females due to their higher body lean mass (muscle mass) resulting in higher energy expenditure compared to females who have less lean mass and high fat mass about 6 - 11% higher than males.^[15] This results to less amount of energy expenditure in the females. The females are more efficient in conserving energy than males and storing it as fat. Thus, they lose less weight than males when faced with similar energy deficit.^[15] In addition to these, it is well documented that decrease in physical activity as in SCI causes decrease in the level of anabolic hormones including testosterone which is essential in maintaining muscle mass in males.^[16,17] This might also contribute to higher rate of muscle catabolism in males resulting in significant weight loss.

Our findings are in support of the fact that Spinal cord injury results to significant muscle atrophy due to increase catabolism and loss of trophic support from neurons. It is known that nerves or neurons play an important role in organogenesis, tissue growth, and repair.^[18] In bones, nerve supply is essential for bone development, remodelling and mineralization.^[18] In muscles, intact nerve supply is necessary for normal muscle growth and repair. These evidences have shown that neurons have trophic effect on the target tissues such as bones, muscles and skin.^[19,20,21] Recently, it has been reported that neurotrophins (BDNF, NGF, NT and NT4/5) are produced by neurons and are transported to the target tissues including muscle where they facilitate their growth, differentiation and development.^[18,20,21,22] Disruption of nerve supply and loss of supra-spinal facilitation as in SCI, results in decrease trophic support provided by the nerves on target tissues especially the skeletal muscles resulting in their catabolism and loss of body lean mass. This statement is supported by the fact that the levels of neurotrophins NGF, BDNF, and NT₃ in the spinal cord reduce consistently from days to weeks after the injury.^[23]

V. Conclusion

The findings indicated that Males have higher and significant weight loss compared to females in the early phase of SCI. Therefore, sex specific weight modification interventions need to be employed in the management of SCI.

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