Comparison of Quality of Life, Physical and Respiratory Parameters in Players and Non Players with Spinal Cord Injury

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ABSTRACT

Introduction: Spinal cord injury is a devastating condition making most of the affected population wheelchair-bound. Moreover, affecting cardio-respiratory functioning and the overall life quality of an individual. Sports has been an evident and widely accepted means to strengthen all body systems.

Materials & Methods: A comparative cross-sectional study with two groups of sports players and non-players with Spinal cord injury [sample size (n) = 34, for each group] with a mean age of 28.5 ± 3.956 in players groups and 31.24 ± 5.217 in non-players group, were selected. Quality of life was measured using the WHOQOL BREF questionnaire (including 4 domains i.e. Physical health, Psychological health, Environmental health and social relationships). Physical health parameters included Resting heart rate, Physiological cost index and Muscular endurance. Respiratory parameters (FEV1%, FVC% and MVV %) were recorded using a computerized spirometer (minister model).

Results: In the independent t-test, the Quality of life domains showed a statistically significant difference in the Physical health domain ($p=0.007$), Psychological health domain ($p=0.00$) and Environmental domain ($p=0.021$) while not in the Social relationships domain ($p=0.889$). Among respiratory parameters; FEV1% ($p=0.022$), FVC % (0.04) showed statistically significant differences while no significant difference in MVV% was predicted. Among Physical health parameters, the Physiological cost index ($p=0.00$), Resting heart rate ($p=0.01$) and Muscular endurance ($p=0.01$) showed significant differences.

Conclusion: The present study concluded that the overall Quality of life of sports players with spinal cord injury (paraplegic) is improved. Due to participation in sports and training; muscular endurance improved, the Physiological cost index of wheelchair propulsion and Baseline heart is decreased.

Key Words: Baseline heart rate, Muscular endurance, Physiological cost index, Spinal cord injury, Quality of life, Wheelchair sports

INTRODUCTION

The term 'spinal cord injury refers to damage to the spinal cord resulting from trauma (e.g. a car crash) or disease or degeneration (e.g. cancer). Symptoms of spinal cord injury depend on the severity of the injury and its location on the spinal cord. Symptoms may include partial or complete loss of sensory function or motor control of arms, legs and/or body depending on the level of injury to the spinal cord.¹

The consequences of sustaining a spinal cord injury (SCI) can be overwhelming and can impact many areas of one's life.² There is a huge impact of SCI on employment and social participation.² Diminishing the negative impact of impairments, and ultimately increasing the well-being of individuals with an SCI is the goal of clinicians and researchers.

Indeed, well-being or quality of life (QoL) has become an important outcome in SCI research.³

Physical de-conditioning is a state of diminished strength, stamina, and capacity to perform physical activity. A decline in strength, endurance and functional capacity are major health concerns for the individual living with SCI. Sedentary behaviour and inactivity are major risk factors for the development of cardiovascular disease and metabolic disorders and have been linked to decreased muscular strength, reduced aerobic capacity, and increased disability.^{4,5} Time since injury was found to be associated with decreases in all lung volumes.⁴

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A decline in cardiovascular function has also been observed in SCI and can significantly contribute to de-conditioning and reduced functional capacity following the injury. This dysfunction ultimately leads to an inability to challenge the cardiovascular system to the extent required to achieve health and fitness benefits.^{6,7,8}

Evidence indicates that strategies to promote exercise and improve the components of fitness positively affect the overall health of individuals with SCI and can reduce the risk of secondary health complications associated with chronic disability. (ACSM's resource manual for guidelines for exercise testing and prescription). There are five health-related components of physical fitness (body composition, cardiovascular endurance, muscular strength, and muscular endurance, flexibility). The absence of health-related fitness attributes have been more closely associated with increased morbidity and mortality in SCI.⁹⁻¹³

Individuals with SCI also often have to cope with altered social roles and psychiatric co-morbidities including reactive depression and anxiety disorders. These issues represent major challenges to living with SCI.¹⁴

A wheelchair is an efficient means of locomotion with optimal independence for a Patient with paraplegia. Estimation of the energy cost of ambulation provides functional efficiency of the user, locomotor efficiency of the wheelchair and potential benefit of the propulsion system.

Sports has always been established as a source of physical and mental fitness, also fits true for Patients with spinal cord injury (SCI) and has shown a decrease in anxiety and depression among sports participants following SCI.¹⁵

There are established studies showing the positive impact of sports on the life of SCI patients in terms of quality of life, respiratory functions and cardiac functioning, but none of them compared the physical, physiological and psychological parameters in players and non-players with spinal cord injury.¹⁶

AIMS AND OBJECTIVES OF THE STUDY

Aim: To compare the quality of life, physical and respiratory parameters between players and non-players following spinal cord injury patients.

OBJECTIVES

- To compare the psychological, physical health, environmental and social domains of QOL between players and non-players with SCI
- To compare the Physiological cost index of wheelchair propulsion between players and non-players with SCI
- To compare muscular endurance between players and non-players with SCI
- To compare Resting heart rate between players and non-players with SCI

- To compare % predicted respiratory parameters(FEV1, FVC, MVV) between players and non-players with SCI

Inclusion Criteria

- More than 3 months of spinal cord injury at thoracic/lumbar level, both genders, Able to propel wheelchair 100 meters without rest, at least one month after completion of the initial phase of rehabilitation, Able to follow commands, Sports active group of patients must be involved in any sport for greater than 6 months

Exclusion Criteria

- Patients with orthostatic hypotension, Pressure sores, Recent fractures and pulmonary infection (less than 3 months), Cognitive problems & mental retardation, Recent pulmonary infection, Cardiac problems, history of Pulmonary Tuberculosis

Instrumentation

1. **Safety pin and whip of cotton** - To test the neurological level of injury
2. **World health organization-quality of life (WHO-QOL-BREF):** Comprises 26 items, which measure the following broad domains: physical health, psychological health, social relationships, and environment. It is possible to derive four domain scores. The four domain scores denote an individual's perception of quality of life in each particular domain. Domain scores are scaled in a positive direction (i.e. higher scores denote the higher quality of life).¹⁷
3. **Spirometer**
 - Minispir model
 - PC based USB spirometer
 - FDA approved, ATS standard, ISO 9001-2000 certified, ISO 13485
 - Measurement parameters FVC, FEV1, MVV.(% predicted)
4. Stopwatch

PROCEDURE

68 Spinal cord injury patients were taken non randomly and were divided into two groups; players(n=34) and non-players (n=34). Participants were recruited from the department of physiotherapy in SVNIRTAR based on the fulfilment of inclusion criteria and exclusion criteria, through informed consent and assessment Performa. The entire procedure of the measurement was explained to them. They were given verbal instructions for the study.

Quality of life of the participants was measured by WHOQOL-BREF scale which included 4 domains viz Physical health domain, Psychological health domain, Social relationships and Environmental domain, which was self-administered by the patients. The scores of all 4 domains were calculated separately.

Physical parameters include Muscular endurance, Physiological cost index and resting heart rate. Muscular endurance was calculated by counting the no. of push-ups at one time while seated in a wheelchair. Physiological cost index (beats/minute) was calculated by using the formula given by Mac Gregor in 1979 i.e. $PCI = \frac{\text{exercise heart rate} - \text{resting heart rate}}{\text{speed of wheelchair propulsion}}$. Resting heart rate and exercise heart rate (100 mts wheelchair run) were taken from the right radial artery in a sitting position before and after the completion of the 100 meters wheelchair run on a level surface. Time taken (in minutes) to complete 100 meters wheelchair run was noted from a stopwatch. Speed of wheelchair propulsion was calculated by dividing 100 mt (distance travelled) by the time taken to travel 100 mts (min).

Respiratory parameters (FVC%, FEV1%, MVV%) were measured by Spirometry testing using the computerized Minispir spirometer. Subjects carried out FVC and MVV tests while seated with their wheelchair without any type of abdominal binding support. All tests were carried out following American thoracic society guidelines for respiratory measurement.¹⁸ Test report was generated in the system.

DATA ANALYSIS

- Statistical analysis was performed using SPSS version 23.0
- The individual domain scores in WHOQOL- BREF (physical health, psychological health, social relationships and environmental constraints) between two groups were analysed using an independent t-test using a 0.05 level of significance.
- The % predicted respiratory parameters (FEV1, FVC, MVV) taken by spirometry were analysed using an independent t-test between two groups using a 0.05 level of significance.
- Physiological cost index, muscular endurance and resting heart rate were analysed using an Independent t-test between two groups using a 0.05 Level of significance.

RESULTS

Comparison of Quality of Life between Players and Non Players with SCI

A significant difference on independent t test in three domains of QOL was found viz physical health [$t(66)=8.057$, $p=0.007$] (TABLE 1.1), psychological quality of life [$t(66)=10.89$, $p=0.00$] (TABLE 1.2) and environmental constrain [$t(66)=10.21$, $p=0.021$] (TABLE 1.4) Whereas in the domain on social relationships [$t(66)=7.37$, $p=0.889$] (TABLE 1.3) the difference was not statistically significant.

Comparison of Respiratory Parameters between Players and Non Players with Sci

Independent t test was done. Statistically significant difference were found in FEV1(%predicted) [$t(66) = 6.165$, $p=0.022$] (TABLE 2.2) and FVC(% predicted) [$t(66) = 6.32$, $p=0.04$] (TABLE 2.1) while no statistically significant difference in MVV(% predicted) [$t(66) = 8.76$, $p=0.17$] (TABLE 2.3) was found between both the groups.

Comparison of Physical Parameters between Players and Non-Players with Sci

Independent t test was done. Statistically significant difference between two groups in Physiological cost index of wheelchair propulsion [$t(66) = -8.524$, $p=0.00$] (TABLE 3.1), Resting heart rate [$t(66) = -13.26$, $p=0.01$] (TABLE 3.3) and Muscular endurance [$t(66) = 10.203$, $p=0.004$] (TABLE 3.2) was found.

DISCUSSION

Quality of Life

In the present study, results of the independent t-test show significant QOL difference in players in the physical health domain ($p=0.007$) with a mean difference of 9.17, which could be possibly explained by the physiology which says that Physical activity and exercise are stressors on the body and stress is the body's response to a stressor, that interferes with normal physiology. The body resists the stress, so when stress becomes chronic, as with regular exercise, the body finds ways to resist it. Stress resistance is accomplished with physiological changes within the systems. These changes are referred to as "physiological adaptations". Training adaptations, including better efficiency, resulting in an increased ability to perform physical activity. In addition, exercise's adaptations strengthen the body's systems making them more resistant to illness and disease, resulting in a lower risk for many diseases and better general overall health.¹⁹

The subjects in the player group in our study were involved in different types of sports (wheelchair basketball, swimming, wheelchair rugby etc) for more than 6 months of period with variable levels of training, with various physiological adaptations the physical health in terms of ADLs, energy and fatigue, mobility, pain and discomfort, sleep and rest, and work capacity (WHOQOL-BREF questionnaire) must have improved.

T-test results show the statistically significant difference in the psychological health domain ($p=0.00$) with a mean difference of 21.05. The possible reason for the improvement in psychological health in players group could be predicted from various theories, one of which tells that exercise increases the level of brain norepinephrine and serotonin and that the release of endogenous opioids from the pituitary glands acts as a mood

enhancer and anti-depressant. Another hypothesis is the thermogenic theory, which suggests that an increase in body temperature has a tranquilizing effect.

T-test results show the statistically significant difference in environmental constraints ($p=0.021$) having a mean difference of 31.44. The possible reason for the improvement in the environmental domain includes questions related to financial resources, freedom, physical safety and security, health and social care, home environment, participation in and opportunities for recreation/leisure activities, the physical environment and transport could be that as found in the interview with the participants, after getting involved in sports they started traveling alone to different places for participation in various events at national and international level made them more confident to live independently in any environment and also received opportunities to earn which even more boosted them to stay engaged in sports and opt it as a career.

While social relationships domain of QOL ($p=0.889$) was not found to have a significant difference in the independent t-test. The possible reason for the down score in social relationships could be that there were three questions within this domain about personal relationships, sex life, and support from friends (Q 20-22 in WHOQOL-brief questionnaire-Appendix III). Out of which one question regarding sex life has not been answered by most of the subjects and results were made by averaging the answers obtained from the other two. Also, there were fewer questions in this domain as compared to the other, so the chances of variability among groups decreases. The other possible reason could be that in a study it was found that all domains showed good internal consistency in SCI (Cronbach range .74 –.78), except for the social relationships domain.²⁰ But overall Social relations are enhanced through the involvement in sports as isolation is decreased, sharing with others with common disability experiences are enhanced, and emotional connections with others increase self-confidence.²¹

Increased capacity in the physical domain allows ease of navigation and satisfaction of the environmental domain. Thus involvement in any form of sports has a significant role in improving physical health perception and overall outlook towards various life aspects in subjects with spinal cord injury and in promoting better socialization and community participation.

RESPIRATORY FUNCTIONS (FEV1, FVC AND MVV)

In the present study, in the independent t-test significant difference is found in FEV1 ($p=0.022$) and FVC ($p=0.04$) between the two groups with a mean difference of 13.52 and 11.96 respectively. Although no statistically significant difference in MVV ($p=0.17$) between the two groups but the clinical difference was seen.

The increase in FVC and FEV1 (% predicted) could be possi-

ble that as the muscular exercise increases the rate and depth of respiration to improve FVC, the consumption of oxygen and the rate of diffusion.²² A functional connection of the corticospinal tract fibres, from the motor cortex to the spinal motor circuitry of the respiratory and accessory respiratory muscles, has also been shown.²³

The increase in FVC and FEV1 post-exercise might be related to the enhanced strength of respiratory muscles following training, reduction in air trapping, improvement in lung compliance, reduced airway resistance, reduced blood lactate concentration and improved lactate uptake by these trained muscles (as fuel for their activity) along with a motivation which enforces the subject to take deep inspiration and fill all air passages after training.²²

The possible reason for the increase in MVV in sports players with SCI could be that the difference in effect size between the sports player group (1.84) and non-player group (2.60) was found to be 0.76 (Cohen's d) i.e. moderate. The physiology behind the increase in MVV could be the combined and perhaps simultaneous effects of several chemical and neural stimuli that initiate and modulate exercise alveolar ventilation.²⁴

PHYSIOLOGICAL COST INDEX

A significant mean difference of -1.97 ($p=0.00$) has been found in PCI between the player's groups and non-players groups with SCI. In the present study, it is established that a lower PCI is required for players as compared to the player group in moving around for about 100 meters at their own pace.

The possible reason for this could be as people become more skilled at performing an exercise, the energy demands during exercise at a given pace are reduced. In a sense, people become more economical.

A study established that the PCI was the least at the preferred speed of walking and increased when the subjects either walked slower or faster than the preferred speed.²⁵

This exercise economy effect of sports could be reciprocated in the regular rehabilitation programs to benefit the patients with SCI to perform their ADLs and locomotion effortlessly and at a lower energy cost.

RESTING HEART RATE

A statistically significant mean difference of -9.25 ($p=0.01$) has been found in the independent t-test between the two groups. Regarding the Possible mechanisms of the decreasing Heart Rate by the effect of Sports and Physical Activity by Bahrainy et al. the effect may be due to a decrease in the intrinsic heart rate via mechanisms that have not yet been fully understood.²⁶

Endurance training creates an imbalance between sympathetic accelerator and parasympathetic depressor activity to

favour greater vagal parasympathetic dominance.²⁷the effect occurs primarily from increased parasympathetic activity, with some decrease in sympathetic discharge. Training may also decrease the SA node's intrinsic firing rate. These adaptations account for the bradycardia frequently observed among highly conditioned endurance athletes and sedentary individuals who undertake aerobic training.²⁸

In a study by Reimers et al., it was found that all sports types resulted in a decrease in the RHR. The higher the initial RHR, the more the RHR decreased due to exercise. The effect occurs after only a few months-on averages, three months with three training sessions per week.²⁹

MUSCULAR ENDURANCE

In the independent t-test, a statistically significant mean difference of 50.5 ($p=0.004$) was found between the player's group and the non-players group with SCI. The possible reason for the increase in muscular endurance in the player's group could be justified by the fact that physical conditions improve when it is sufficiently stimulated.³⁰Also due to adaptive changes in the muscles around the shoulder girdle [anterior deltoid, pectoralis major, supraspinatus, infraspinatus, middle trapezius, triceps] involved in the wheelchair propulsion as a result of prolonged time being spent moving around on wheelchair.³¹

CONCLUSION

The present study concluded that psychological, physical health, environmental domains of quality of life of sports players with spinal cord injury (paraplegic) are improved. Due to participation in sports and training muscular endurance improved, physiological cost index and baseline heart decreased.

LIMITATION

The study could not establish the effect of individual sports on the parameters.

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Data collection.- Aditi Shah

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Table 1.1: Independent t test for physical health domain of WHOQOL BREF

		Independent Samples Test								
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
PHYSICAL HEALTH DOMAIN	Equal variances assumed	7.881	.007	8.057	66	.000	9.17647	1.13897	6.90243	11.45051
	Equal variances not assumed			8.057	48.845	.000	9.17647	1.13897	6.88743	11.46551

Table 1.2: The Independent t-test for the psychological health domain of WHOQOL BREF

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
PSYCHOLOGICAL DOMAIN	Equal variances assumed	38.411	.000	10.896	66	.000	21.05882	1.93268	17.20011	24.91754
	Equal variances not assumed			10.896	52.168	.000	21.05882	1.93268	17.18092	24.93673

Table 1.3: Independent t test between two groups for social relationship domain of WHOQOL BREF

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
SOCIAL RELATIONS DOMAIN	Equal variances assumed	.019	.889	7.378	66	.000	18.38235	2.49143	13.40805	23.35665
	Equal variances not assumed			7.378	65.8529	.000	18.38235	2.49143	13.40781	23.35689

Table 1.4: Independent t-test between two groups for environmental health domain of WHOQOL BREF

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ENVIRONMENT DOMAIN	Equal variances assumed	5.550	.021	10.219	66	.000	31.44118	3.07675	25.29824	37.58412
	Equal variances not assumed			10.219	49.928	.000	31.44118	3.07675	25.26111	37.62124

2. RESPIRATORY PARAMETERS ANALYSIS

Table 2.1: Independent t-test for FVC% predicted

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
FVC%	Equal variances assumed	4.383	.040	6.320	66	.000	11.96147	1.89251	8.18296	15.73999
	Equal variances not assumed			6.320	49.236	.000	11.96147	1.89251	8.15879	15.76415

Table 2.2: Independent t-test for FEV1% predicted

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
FEV1%	Equal variances assumed	5.546	.022	6.165	66	.000	13.52176	2.19316	9.14299	17.90054
	Equal variances not assumed			6.165	47.831	.000	13.52176	2.19316	9.11172	17.93180

Table 2.3: Independent t-test for MVV% predicted

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
MVV%	Equal variances assumed	1.924	.170	8.767	66	.000	15.70529	1.79147	12.12850	19.28208
	Equal variances not assumed			8.767	59.457	.000	15.70529	1.79147	12.12114	19.28944

3. PHYSICAL HEALTH PARAMETERS

Table 3.1: Independent t-test between two groups for physiological cost index

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
PHYSIOLOGICAL COST INDEX	Equal variances assumed	39.187	.000	-8.524	66	.000	-1.79794	.21093	-2.21909	-1.37680
	Equal variances not assumed			-8.524	34.282	.000	-1.79794	.21093	-2.22648	-1.36940

Table 3.2: Independent t-test for muscular endurance

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Muscular endurance	Equal variances assumed	8.990	.004	10.203	66	.000	50.50000	4.94932	40.61836	60.38164
	Equal variances not assumed			10.203	52.062	.000	50.50000	4.94932	40.56874	60.43126

Table 3.3: Independent t-test for resting heart rate

Independent Samples Test		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESTING HEART RATE	Equal variances assumed	7.000	.010	-13.269	66	.000	-9.85294	.74253	-11.33545	-8.37043
	Equal variances not assumed			-13.269	59.230	.000	-9.85294	.74253	-11.33862	-8.36726