Correlation Between Physical Activity Level and Functional Status of Subjects with High Spinal Cord Injury

Ewa Szeliga (ewa.szeliga@gmail.com)
University of Rzeszow

Renata Borys
University of Rzeszow

Agnieszka Brzozowska-Magoń
University of Rzeszow

Andżelina Wolan-Nieroda
University of Rzeszow

Grzegorz Magoń
University of Rzeszow

Katarzyna Walicka-Cupryś
University of Rzeszow

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Abstract

Background. Spinal cord injuries are one of the main causes of disability in Poland and in the world. Quadriparesis, limitations in activities of daily living, lack of full autonomy and psycho-social problems are consequences of cervical spinal cord injury. Due to the consequences, especially motor paralysis and sedentary lifestyle resulting from spinal injuries, much attention is drawn to physical activity in subjects with this type of injuries.

Objective. The aim of the study is to assess the effect of regular physical activity on functional fitness and independent existence of subjects after high spinal cord injury.

Methods. 80 subjects with transverse injury of cervical spinal cord were enrolled in the study. The study group included men aged 20-50, in which group 40 (50%) of the subjects were qualified to the physically active group – subjects doing wheelchair sport, and 40 (50%) of the subjects were qualified to the physically inactive group – subjects taking no physical activity. The physically active men were qualified on the basis of their participation in organised activities - wheelchair rugby. Minimum participation was 90 minutes a day twice a week. Subjects from the physically inactive group had a passive lifestyle and participated in no sports activities.

Results. Highly significant differences were observed during the study between the physically active and inactive men with regard to the functionality status. The study subjects taking regular physical exercise had better results in all assessed activities. The biggest differences were observed in the field of toilet and dressing up.

Conclusions. The study confirmed that regular physical activity is correlated with better fitness. The study also showed that the subjects playing wheelchair rugby are more independent, which results in their better functional status in everyday life.

Background

Cervical spine injury with spinal cord damage is one of the most serious consequence of accidents which are often dramatic. The problems resulting from inhibition of the spinal cord function, e.g. inability to move, necessity to use a wheelchair and limited physical performance are a serious challenge for an individual.

Due to the consequences of spinal cord injury, mainly motor deficits and sedentary lifestyle, much attention is drawn to physical activity. Movement improves not only the functional status, but also the emotional status [1]. Regular physical activity taken by a person with tetraplegia results in improved movement coordination, muscle strength, endurance and fitness, as well as improved fatigue tolerance, which has a significant influence on effective movement on a wheelchair [2]. Improved movement fitness also results in improved everyday functioning, for example movement between the bed and wheelchair, tub, car [1, 2]. Regular sports activity affects the emotional condition and social life of subjects with

spinal cord injuries. Participation in sports and recreation facilitates mental adaptation to life after spinal cord injury, mitigating symptoms of depression and improving an image of oneself [2]. Participation of subjects after spinal cord injury in sports activities may be extremely beneficial with regard to social reintegration, providing opportunity to make new friends and share experience. It also develops a network of social support and reduces the feeling of being inferior. Physical activity not only allows keeping a better health state, but also plays an important role in improving physical, mental and social functioning, as well as improving the quality of life and satisfaction of a disabled person [3, 4].

Taking up regular physical activity is a very important element in the life of subjects after spinal cord injury, since it significantly affects their functional status [5]. Participation in physical activity is currently an essential element of complex rehabilitation of subjects after spinal cord injury. A special advantage of physical activity among other rehabilitation forms is the possibility to improve strength, endurance and fitness of patient, together with coordination and fatigue tolerance [6]. Aside to the motor aspect, physical activity also affects other areas of life, especially emotional state and social life [7]. Doing sport facilitates mental adaptation to life after spinal cord injury. It facilitates social integration by providing opportunities to meet people, share experience and make new friends [6]. Allowing subjects after spinal cord injury to participate in sports and recreation is especially important for reducing the consequences of disability and using their full potential. The achievements of Paralympic athletes are an ideal example of human possibilities [5].

Regular physical activity is recommended for the disabled, especially those after spinal cord injury [6, 7, 8]. Participation in various forms of physical activity is not only a condition for better well-being, but also results in improved muscular strength and faster adaptation to disability [9, 10, 11]. Regular exercise and participation in sports activities contribute to a better mental function, [12, 13] as well as to higher levels of life satisfaction and improvement in the quality of life [13, 14, 15]. Sport is a factor which may affect independence, functional abilities, well-being, as well as professional, social and family life. However, despite these well-known benefits of regular physical activity, participation of subjects after spinal cord injury in such activities is low [16, 17, 18]. Numerous researchers show that lack of movement revealed by subjects after spinal cord injuries has a great influence on the occurrence of physical and mental health problems. It is also correlated with lack of self-reliance and reduced quality of life of a disabled person [19–24].

The literature review shows no data on the differences between the functional status, health state and quality of life. Moreover, no studies are available on subjects after spinal cord injury who do not take any forms of activity, live in social isolation and do not participate in any social and professional life.

Objective

The aim of the study is to assess the effect of regular physical activity on functional fitness and independent existence of subjects after high spinal cord injury.

Methods

The study included 80 men after transverse spinal cord injury in the cervical section, mean age 33.1 with standard deviation of 7.5. The study subjects were divided into two groups: physically active and physically inactive. The physically active group included 40 subjects after spinal cord injury who played wheelchair rugby twice a week for a minimum of 90 minutes. The physically inactive group included 40 subjects after cervical spinal cord injury who did not take any individual or organised forms of physical activity.

Similar sensorimotor deficits were found in all subjects. No movement or feeling below the damage level. All test persons were able to use an active wheelchair. Most of the surveyed men needed help with the basic functions of everyday life.

The studies were conducted personally with each individual patient in central and southern Poland. All study participants had been informed about the objective of the study and had given their consent for participation before the study started. The study plan was approved by the Bioethics.

Study qualification criteria:

- Cervical spinal cord injury at C4-C7
- Minimum 12 months period since the occurrence of the injury
- Men aged between 20 and 50
- Voluntary consent of the patient to conduct the study

Study exclusion criteria:

- Spinal cord injury below the level of C7
- Spinal cord injury above the level of C4
- Time since the occurrence of injury below 1 year
- Lack of consent to take part in the study

The assessment was based on the author's questionnaire, Konstancin Functional Scale and the WHOQOL-bref questionnaire.

The WHOQLQ-BREFF questionnaire is currently the best tool to evaluate the quality of life, since it allows precise assessment of both subjective and objective indices of quality of life of subjects after spinal cord injury.

The Konstancin Functional Scale (Mazowieckie Rehabilitation Centre “STOCER” Konstancin) defines degrees of independence regarding basic functions of everyday life, i.e. ability to sign, use the computer keyboard, have meals, personal hygiene (brushing one's teeth, washing the face, washing the top and

bottom part of the body), use the toilet, dress up (putting on specific items of clothing: blouse, trousers, socks, gloves), changing position between the bed and wheelchair.

Statistical analysis was performed with the use of statistical tests: chi-square test of independence (for determination of the percentage of nominal features), t-test for independent samples (to compare average numerical characteristics), the Mann-Whitney test (for 2 independent groups) (for additional analyses of self-assessment of the health state and quality of life), Spearman's rank correlation coefficient (for analysis of correlation between two features).

Results

The majority of subjects, 22 (55%), in the physically active group were aged 30–39 years. In the physically inactive group, the highest number of subjects, 9 (22.5%), were aged 25–29 years.

The average age of the study subjects was 33.1 years. In the study population, 25% of men were not more than 27 years old, half of them were no more than 33.5 years old, and 75% were not more than 39 years old. The distribution of the study groups with regard to age is presented in Table 1.

Table 1
The distribution of the study groups with regard to age

Age [in years]	**Group (p = 0.2487)**		**Total**
	active subjects	**inactive subjects**	
20–24	5 (12.5%$_{\downarrow}$)	6 (15.0%$_{\downarrow}$)	11 (13.6%)
25–29	7 (17.5%$_{\downarrow}$)	9 (22.5%$_{\downarrow}$)	16 (20.0%)
30–34	11 (27.5%$_{\downarrow}$)	6 (15.0%$_{\downarrow}$)	17 (21.3%)
35–39	11 (27.5%$_{\downarrow}$)	6 (15.0%$_{\downarrow}$)	17 (21.3%)
40–44	5 (12.5%$_{\downarrow}$)	8 (20.0%$_{\downarrow}$)	13 (16.3%)
45–49	1 (2.5%$_{\downarrow}$)	5 (12.5%$_{\downarrow}$)	6 (7.5%)
Total	**40**	**40**	**80 (100%)**

The majority of subjects, 22 (55%), in the physically active group were aged 30–39 years. In the physically inactive group, the highest number of subjects, 9 (22.5%), were aged 25–29 years.

The average age of the study subjects was 33.1 years. In the study population, 25% of men were not more than 27 years old, half of them were no more than 33.5 years old, and 75% were not more than 39 years old.

The physically active subjects showed a higher level of self-reliance in daily activities than the physically inactive subjects. For most of the activities (washing and dressing up), the level of self-reliance was significantly higher in the group of active subjects $p < 0.0000$ (***).For such activities as: signing, holding a sandwich and moving from the bed, no statistically significant differences between the groups were observed, Table 2.

Table 2
Self-reliance in performing daily activities

Activities	**Group**				***P***
	active subjects		**inactive subjects**		
	N	**%**	***N***	**%**	
manual signing	40	100.0%	39	97.5%	0.3143
using keyboard	40	100.0%	37	92.5%	0.0775
tooth-brushing	**40**	**100.0%**	**30**	**75.0%**	**0.0007*** **
holding a sandwich	40	100.0%	38	95.0%	0.1521
drinking from a cup	39	97.5%	35	87.5%	0.0895
moving between the bed and wheelchair	31	77.5%	26	65.0%	0.2168
using the toilet	31	77.5%	23	57.5%	0.0562
washing the top part of the body	**38**	**95.0%**	**24**	**60.0%**	**0.0002*** **

The mean values for the highest results of the self-reliance study showed significant differences between the active and inactive group $p < 0.0000$ (***)Table 3.

Table 3
Distribution of the study groups with regard to assessment of self-reliance

Group	**Assessment of self-reliance (score)**				
		Me	***S***	**Min**	**Max**
active subjects	8.6	10.0	2.3	3.0	10.0
inactive subjects	5.3	5.5	2.9	0.0	10.5
P	0.0000***				

Assessment included the ability to turn over, change position from the wheelchair onto the bed and to move around without assistance. A statistically significant difference was observed in performing basic activities related to changing position between the bed and wheelchair to the benefit of the physically

active group. The biggest differences are observed in turning over $p < 0.0001$(***) and in adopting a sitting position without assistance $p < 0.0001$(***) Table 4.

Table 4
Distribution of the study groups with regard to basic activities related to changing position

Performing basic activities	Group				*P*
	active subjects		inactive subjects		
	N	%	*N*	%	
turning over	29	72.5%	5	12.5%	0.0000***
sitting on the bed	30	75.0%	10	25.0%	0.0000***
sitting with legs hanging down the bed	29	72.5%	16	40.0%	0.0034**

Subjects from the physically active group left the house without assistance a bit more often (67.5%) than the physically inactive subjects (55%). Differences between the groups were not statistically significant, Table 5.

Table 5
Distribution of the study groups with regard to leaving the house without assistance

Going out without assistance	Group		Total
	active subjects	inactive subjects	
Yes	27 (67.5%$_{\downarrow}$)	22 (55.0%$_{\downarrow}$)	49 (61.25%)
No	13 (32.5%$_{\downarrow}$)	18 (45.0%$_{\downarrow}$)	31 (38.75%)
Total	**40 (100%)**	**40 (100%)**	**80 (100%)**
	($p = 0.2512$)		

Discussion

For subjects after spinal cord injury, it is very important to achieve the best possible functional level which affects their whole life. To prepare them for active life in the society, family and at work, a very important role is played by camps and activities organised by Active Rehabilitation [25]. Participation in such activities allows achieving a high level of movement and self-reliance abilities of subjects with spinal cord injury. Instructors are usually people with the same disability. They guide the patient and inspire them with their own person having the same disability, leading active life and being a rich source of human experience, both with regard to specific skills and information about the rights, obligations and possibilities of subjects after spinal cord injury [14, 26].

Our studies revealed a significant difference in self-reliance between the physically active and inactive subjects. The biggest differences were observed in such activities as: doing up the buttons (65.0% of physically active subjects and 17.5% of physically inactive subjects), putting on gloves (92.5% of the physically active and 20.0% of the physically inactive), putting on socks (77.5% of the physically active and 22.5% of the physically inactive), putting on trousers (80.0% of the physically active and 27.5% of the physically inactive), putting on a blouse (95.0% of the physically active and 60.0% of the physically inactive), washing the bottom part of the body (80.0% of the physically active and 42.5% of the physically inactive), washing the top part of the body (95.0% of the physically active and 60.0% of the physically inactive) and other activities related to toilet and everyday functioning, with which the regularly active subjects coped better than the subjects from the physically inactive group. Similar results were achieved by Ravenek, Ginis, Smerjian, and Tasiemski and Van der Ploeg - taking regular physical activity by subjects after spinal cord injury causes a higher subject independence, and physically active subjects are to a greater extent self-reliant in their daily activities [27–30]. The studies by Ginis et al., similarly to our studies, showed improved functional independence in various daily activities and movement in the group of physically active subjects after spinal cord injury [31–33]. Also studies by Fliess-Douer confirm that physical activity significantly improves the functional status and, which is correlated with it, movement [34]. Similar results are presented by Furmaniuk, emphasising a positive influence of movement and Active Rehabilitation camps on the functional status (with regard to daily activities and movement) of subjects after cervical spinal cord injury [35]. Our own results are different from the results achieved by Kędziora, where only a slight improvement was observed in such activities as dressing up and using the toilet without assistance [26].

Regular physical activity is recommended for the disabled, especially those after spinal cord injury. [6–8]. Participation in various forms of physical activity is not only a condition for better well-being, but also results in improved muscular strength and faster adaptation to disability [9,–11]. Regular exercise and participation in sports activities contribute to a better mental function, [12, 13] as well as to higher levels of life satisfaction and improvement in the quality of life [13–15]. However, despite these well-known benefits of regular physical activity, participation of subjects after spinal cord injury in such activities is low [17–18]. Sport is a factor which determines their independence, functional abilities, well-being, as well as professional, social and family life.

People after spinal injury often encounter numerous barriers preventing, or making impossible, getting involved in physical activity and active social life. They are related to costs of travelling to the training site, sports activities and architectural barriers [36–42]. Due to these problems, persons after spinal cord injuries often resign from taking up physical activity. Studies of Tasiemski and Anneken show that as much as 50% of the population after spinal cord injury is physically inactive [20, 30]. The overlapping factors may lead to further disability, contributing to reduced mobility and fitness, as well as to reduced ability to perform activities of daily living, and finally to complete dependence on others and reduced quality of life of subjects after spinal cord injury [28, 43].

Taking up regular physical activity – in contrast to physically inactive subjects – is an important factor which has a positive effect on the life of subjects after spinal cord injury. It is very important for the broadly understood quality of life and attitude to disability. Patients working in a team with other people with the same deficit, not only sooner, but also more easily adapt to the new, difficult situation. Sport is not only a form of recreation, but also rehabilitation. Regular physical activity clearly differentiates between the groups of physically active and inactive subjects which I studied.

Conclusion

1. Functional fitness of physically active subjects is better than that of physically inactive subjects. The factors that significantly affect functional fitness include: regular physical activity and participation in FAR camps.
2. Due to their low functional fitness, physically inactive subjects remain dependent on third persons, and are unable to exist on their own.

Abbreviations

FAR - foundation for active rehabilitation

WHOQLQ-BREFF questionnaire – World Health Organization Quality of Life questionnare

Declarations

Ethics approval and consent to participate

Informed consent was obtained from all subjects or, if subjects are under 16, from a parent and/or legal guardian

Patient declaration and consent to participate in the study

My name is Ewa Szeliga, I work at the Institute of Physiotherapy at the Medical Faculty of the University of Rzeszow. In my research, I deal with the issues of the quality of life and social security of people after spinal cord injury.

Participation in the study is voluntary. The questionnaire is completely anonymous and my conduct is in line with the Personal Data Protection Act of August 29, 1997 (Journal of Laws No. 133, item 883). The results in the form of your answers will not be shared or used for purposes other than scientific.

The obtained results will be used to construct optimal therapeutic programs. It is also important that the ZUS Healthcare Institutions and other insurers are interested in the problems you encounter in your everyday life, and they will also serve to formulate postulates aimed at improving the quality of life.

I am counting on your help, I am asking for honest and uninhibited statements.

I consent to the examination

First name and last name……

All methods were carried out in accordance with relevant guidelines and regulations

Approval of the bioethics committee Uwał No. 2/06/2008 was obtained

Bioethics Committee at the University of Rzeszów, Poland

All authors consent to the publication of our article in the journal BMC Sport Science Medicine and Rehabilitation . I declare that the work has not been previously published or submitted to another editorial office.

Consent for publication - Not applicable

Availability of data and material

The datasets used and / or analyzed in the present study are available from the respective author - Ewa Szeliga upon reasonable request

Competing interests - The authors declare that they have no competing interests

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Authors' contributions:

A – prepare a manuscript, fundamental contribution to the concept and design of the work,

B - data collection and interpretation,

C - statistical analysis and preparation of test results for analysis,

D - critical review of relevant intellectual content,

E - collection of literature,

F - acceptance of the final version for publication

ES - A, B, C, E, F

RB – A, C, D

ABM – A, C

AWN – A, D

GM - A, E

KWC - E, F, A

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