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ORIGINAL ARTICLE

Perceptions of exercise mastery in persons with complete and incomplete spinal cord injury

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Study design: Cross-sectional study.
Objective: To compare exercise-related self-perceptions in persons with complete and incomplete spinal cord injury (SCI) and to identify factors that explain the variance of perceived exercise mastery in the study population.
Setting: Sunnaas Rehabilitation Hospital and the Norwegian School of Sport Sciences, Norway.
Methods: A total of 116 respondents (47 persons with complete and 69 persons with incomplete SCI) answered a questionnaire measuring self-rated physical exercise habits and self-perceptions in exercise. Respondents with complete SCI performed a max test on an arm ergometer.
Results: Exercisers with complete SCI reported a significantly higher perceived exercise mastery ($P=0.002$) and exercisers with incomplete SCI reported a significantly lower perceived exercise mastery ($P=0.012$) than nonexercisers. Exercisers in both groups reported a higher perceived fitness (complete SCI, $P=0.016$; incomplete SCI, $P=0.004$) than nonexercisers. A regression analysis showed that exercising versus nonexercising (exercise status) was the only variable that contributed to the variance in perceived exercise mastery for persons with complete SCI ($P<0.001$). For persons with incomplete injury, exercise status and exercise hours per week contributed to the variance in perceived exercise mastery.
Conclusion: Although perceived fitness is associated with exercise in the whole SCI population, perception of exercise mastery is negatively related to exercise in persons with incomplete SCI, in contrast to those with complete lesions.
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Keywords: incomplete spinal cord injury; exercise status; perceived exercise mastery; perceived exercise fitness

Introduction

Long-term survival of persons with spinal cord injury (SCI) has increased. Thus, for this group, as for the general population, a healthy life with a subjective feeling of well-being has become an ultimate goal.[1] The positive connection between exercise and health condition in persons with SCI was established in a clinical context by Sir Ludwig Guttman more than 60 years ago. Sport activities positively influenced physiological, psychological and social rehabilitation, and Guttman therefore integrated sport activities in the rehabilitation program at Stoke Mandeville Hospital.[2]

Research on physical exercise in persons with SCI has primarily focused on physiological benefits. However, there are reports on quality of life and well-being as outcomes in relation to a physically active lifestyle.[3] Few studies have looked at incomplete lesions specifically. We therefore investigated life satisfaction related to physical exercise in persons with incomplete SCI.[4] As expected, those who exercised regularly experienced significantly higher life satisfaction and higher perceived physical fitness than persons who did not exercise regularly. However, a puzzling result in contrast to previous research on able-bodied persons was that the participants who exercised demonstrated a lower perceived exercise mastery than their inactive peers.[5] Perception of exercise mastery is defined as perceived competence in the execution of physical exercise.[6] We did not know whether the same tendency applied to those with complete SCI. Therefore, a comparison of perceived exercise mastery of persons with complete and incomplete SCI was called for. Potentially, different approaches to exercise or more appropriate goal setting or expectations may be needed, which thus influence how therapists should set up and individualize exercise programs.

The purpose of this study was to compare exercise-related self-perceptions between persons with complete and incomplete SCI, and to identify factors that might explain the possible variance in perceived exercise mastery in the

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two populations. For those with an incomplete lesion, the end point for functional level is not predictable. The end point of functional level for persons with complete SCI is well documented,[7,8] as it is for the able-bodied. As to expectations, those with complete lesions are more similar to able-bodied persons. We therefore hypothesized that persons with complete lesions who exercise regularly have a similar positive perception of exercise mastery and fitness as seen in an able-bodied population.

Methods

The design of the study was cross-sectional. Data were collected by a questionnaire that measured exercise status and exercise-related self-perceptions. Background information was gathered from medical records. AIS (ASIA Impairment Scale) scores were used.[9] As a control to the self-reported exercise status, aerobic work capacity was tested on an arm ergometer in participants with motor complete SCI (AIS A–B). For persons with incomplete SCI (AIS D, a subgroup of incomplete lesions), either arm or leg cranking was used for testing, making the data incomparable.

Subjects

Invitations to participate were sent to 47 persons with SCI AIS A–B and to 100 persons with SCI AIS D. The first group (AIS A-B) was recruited from a study on long-standing SCI, in which persons injured between 1961 and 1982 with SCI AIS A–E participated.[10] To minimize bias from general age variations, persons above 60 years of age at injury were excluded, as well as persons with inability to respond to the questionnaire. To measure aerobic work capacity, the participants had to be able to perform a max test on an arm ergometer. The second group consisted of 69 persons (out of 100 invited) with SCI AIS D (incomplete) rehabilitated at Sunnaas Rehabilitation Hospital before 1992.[4] These groups may be characterized as samples of convenience, which calls for caution regarding the generalization of findings.

Measures

Exercise. Participants reported the number of exercise hours per week. In addition, they reported the frequency of exercise in 19 defined exercise activities. Those who exercised less than once a week were classified as nonexercisers, and those who exercised once a week or more were classified as exercisers (exercise status). To check the accuracy of the self-reported exercise status, a correlation test between self-reported exercise status and physiological data (peak VO_2 max $ml\,kg^{-1}\,min^{-1}$) was carried out. We used data from participants with paraplegia AIS A–B ($n = 34$), because it is well documented that exercise is associated with higher VO_2 in this group.[11,12] Aerobic work capacity was measured by arm-cranking. The participants, sitting in their own wheelchair, using an adapted ergometer for arm cycling (Ergometrics 800; Ergoline MgbH, Bitz, Germany), performed a stepwise, graded exercise test until exhaustion. Expiratory volume and gas concentrations were measured continuously. Minute ventilation and oxygen uptake (VO_2) were calculated every 15 s (Sensor Medics Vmax 229).

The Self-Perception in Exercise questionnaire. Sørensen[6] constructed a scale to measure self-concept variables that are related to exercise, the Self-Perception in Exercise Questionnaire (SPEQ). SPEQ consists of four separate subscales. We used two of the subscales in this study, namely, perceived exercise mastery (SPEQ mastery, five items) and perceived fitness (SPEQ fitness, three items), Appendix 1. A mean score for each subscale was computed. Reliability and validity have been documented previously in a Norwegian able-bodied population.[6]

Procedure

The study was approved by the Regional Medical Research Ethics Committee, Eastern Norway. Respondents gave their written consent. Background information regarding injury level and severity, as well as regarding additional injuries and complications, was collected by reviewing medical records.

Statistical methods

Descriptive statistics were used to characterize samples. Independent sample *t*-tests and Pearson's χ^2-tests were used where appropriate. First, we compared data to expose differences between the subgroups, that is, time since injury (AIS D), on age, gender, injury level, exercise hours per week, exercise status, mean scores on SPEQ mastery and SPEQ fitness. We compared data on SPEQ mastery and SPEQ fitness for exercisers and nonexercisers. Associations between exercise hours and physiological parameters were studied using Spearman's correlation test. Linear regression analysis was used to study the relationship between SPEQ mastery and a set of covariates. The covariates included gender, age, time since injury, injury level, exercise status, exercise hours per week and perceived fitness. Statistical analyses were conducted by using SPSS version 15.0 for Windows.

Results

Descriptives

The characteristics of participants are given in Table 1. The mean time since injury was 29 years (s.d. 5.3) for persons with complete SCI versus 18 years (s.d. 8.1) for persons with incomplete SCI. However, we found no significant differences related to time since injury (injured before 1982 versus between 1982 and 1992) in persons with SCI AIS D concerning age, gender, injury level, exercise hours per week, exercise status, mean scores on perceived exercise mastery or on perceived exercise fitness in either of the analyses. There were no differences in gender distribution, injury level or age between exercisers and nonexercisers in the samples.

Accuracy check of the self-reported exercise status

All exercisers with AIS A–B demonstrated higher levels of peak VO_2 max $ml\,kg^{-1}\,min^{-1}$ and workload than did nonexercisers (Figure 1). For persons with paraplegia AIS A–B, there was a statistically significant correlation ($r_s = 0.605$, $P < 0.01$) between their self-reported exercise status and the measured peak VO_2 max. The association between exercise

Table 1 Descriptives of the populations with SCI AIS A–B and SCI AIS D

	Total sample (AIS A–B), n = *47*	*Exercisers (AIS A–B),* n = *33*	*Nonexercisers (AIS A–B),* n = *14*	*Total sample (AIS D),* n = *69*	*Exercisers (AIS D),* n = *47*	*Nonexercisers (AIS D),* n = *22*
Tetraplegia	13	8	5	35	26	9
Paraplegia	34	25	9	34	21	13
Age, mean (s.d.)	48 (8.2)	48 (8.6)	49 (7.5)	48 (13.7)	48 (13.4)	47 (14.6)
Gender						
Male	41	29	12	56	36	20
Female	6	4	2	13	11	2
Time since injury, mean (s.d.)	29 (5.3)	28 (4.4)	29 (7.0)	18 (8.1)	18 (8.7)	19 (7.3)
Exercise hours per week, median (range)						
Total Sample	2 (0–15)	4 (1–15)	0	1.5 (0–12)	2.3 (1–12)	0
Tetraplegia	3 (0–14)	5 (2–14)	0	1.8 (0–10)	2.7 (1–10)	0
Paraplegia	2 (0–15)	3.5 (1–15)	0	1 (0–12)	1.5 (1–12)	0

Abbreviations: AIS, ASIA Impairment Scale; SCI, spinal cord injury; s.d., standard deviation.

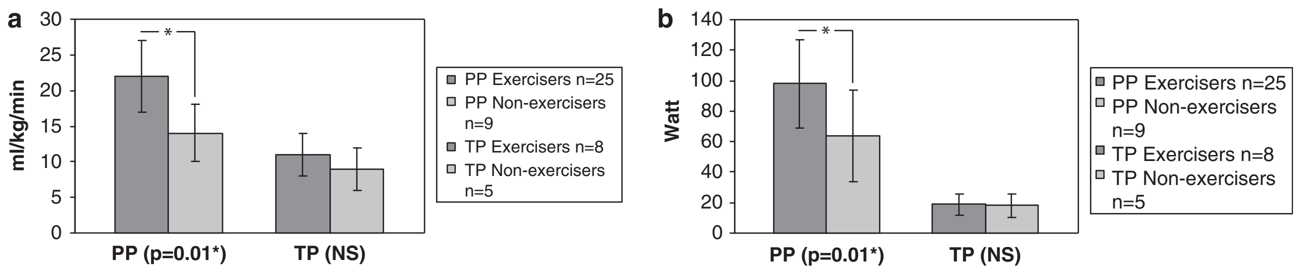

Figure 1 (**a**) Peak aerobic capacity in motor complete SCI (AIS A–B) PP and TP. (**b**) Max work load (Watt) in motor complete SC! (AIS A–B) PP and TP. All exercisers with AIS A–B ($n = 33$) demonstrated higher levels of peak VO_2 max ml kg^{-1} min^{-1} and workload than did nonexercisers ($n = 14$). Only the results for persons with paraplegia AIS A–B were statistically significant. Peak VO_2 max (s.d.) for exercisers versus nonexercisers was 22 (5) versus 14 (4) ml kg^{-1} min^{-1} for persons with paraplegia ($P = 0.01$), and 11 (3) versus 9 (3) ml kg^{-1} min^{-1} for persons with tetraplegia (NS). For exercisers versus nonexercisers, the max work load (s.d.) was 98 (29) versus 64 (30) watt ($P = 0.01$), for persons with paraplegia versus tetraplegia, 19 (7) versus 18 (8) watt (NS). Abbreviations: SCI, spinal cord injury; PP, paraplegia; TP, tetraplegia; NS, not significant; s.d., standard deviation. **P*-values from independent sample *t*-tests. Significance level: $P < 0.05$.

Table 2 Comparisons of self-perceptions in exercise between exercisers and nonexercisers with SCI AIS A–B and AIS D

	Exercisers (AIS A–B), n = *33*	*Nonexercisers (AIS A–B),* n = *14*	P*	*Mean difference (AIS A–B)*	*Exercisers (AIS D),* n = *47*	*Nonexercisers (AIS D),* n = *22*	P*	*Mean difference (AIS D)*
SPEQ mastery (s.d.) (95% CI)	2.6 (0.4)	2.0 (0.6)	0.002	0.6 (0.3, 1.0)	2.4 (0.6)	2.9 (0.6)	0.012	−0.3 (−0.7, 0.0)
SPEQ fitness (s.d.) (95% CI)	2.5 (0.9)	1.9 (0.7)	0.016	0.6 (0.1, 1.1)	2.3 (0.9)	1.6 (0.8)	0.004	0.5 (0.1, 0.9)

Abbreviations: AIS, ASIA Impairment Scale; SCI, spinal cord injury; s.d., standard deviation; CI, confidence interval.
**P*-values from independent sample *t*-tests.

hours per week and peak VO_2 max ml kg^{-1} min^{-1} demonstrated a statistically significant correlation ($r_s = 0.773$, $P < 0.01$). This supports the fact that the self-reported exercise status provides a meaningful difference for these populations.

SPEQ mastery
The results are presented in Table 2. Exercisers with complete and incomplete SCI demonstrated significant differences in SPEQ mastery compared with their nonexercising peers ($P = 0.002$ and 0.012, respectively). Exercisers with complete lesions reported more positive exercise mastery, and persons with incomplete lesions reported more negative exercise mastery than did their nonexercising peers.

SPEQ fitness
SPEQ fitness was significantly higher for exercisers versus nonexercisers in both samples ($P = 0.016$ and 0.004 for complete and incomplete SCI, respectively).

Associations with SPEQ mastery
To identify factors that explain the variance in perceived exercise mastery for the two samples, we performed linear regression analyses separately. The dependent variable was SPEQ mastery, and the independent variables were age, gender, time since injury, exercise status, exercise hours per week and SPEQ fitness. For persons with complete SCI, the regression model was significant ($R^2_{adj} = 0.26$, F = 16,102, $P < 0.001$). However, exercise status was the only variable that contributed significantly to the equation ($P < 0.001$).

For persons with incomplete SCI, the same regression model did not reach statistical significance. In this group, a regression model with SPEQ mastery as the dependent variable, with exercise hours per week and exercise status as independent variables, was significant ($R^2_{adj} = 0.07$, F = 3,527, $P < 0.01$). For the group with incomplete SCI, both exercise status and hours per week contributed negatively to the variance in SPEQ mastery ($P = 0.007$ for exercise hours per week and $P = 0.04$ for exercise status).

Discussion

The most important observation of this study was the difference in perceived exercise mastery between exercisers with complete and incomplete SCI. For persons with complete lesions, exercise status was the variable that was most clearly associated with SPEQ mastery. This association was positive, which means that if they exercised, they reported higher perceived exercise mastery. For persons with incomplete lesions, both exercise hours per week and exercise status contributed significantly to the variance in SPEQ mastery. However, this relation was negative. Persons who exercised regularly or did more hours of exercise per week reported lower scores on the SPEQ mastery scale.

According to Haskell *et al.*,[13] exercising more hours a week is associated with better physical fitness. However, it is likely that persons with incomplete SCI struggle more in everyday life to function as independently as possible. For the same reason, they probably use less adaptive aids for mobility compared with those with complete lesions. In addition, they try to perform their weekly exercise both for fitness and to maintain their physical function. The reported low exercise mastery may indicate that this is too much in order to cope well enough to feel competent while exercising. Expectations restoring function through exercise may be higher among persons with incomplete SCI.

In persons with SCI, similar results have been reported regarding fatigue due to both physiological and psychological factors. Fawkes-Kirby *et al.*[14] reported that persons with incomplete SCI perceived more fatigue than did persons with complete lesions. As persons with incomplete lesions restore more function, they are able to be more physically active. Fawkes-Kirby *et al*. suggest that compared with those with complete lesions, persons with incomplete SCI are not only more active but they also use less equipment adaptations. The authors wrote that persons with incomplete SCI may be faced with higher expectations from others, and consequently experience more fatigue. Kemp and Thompson[15] argued that low levels of fitness may result in too little energy reserves to meet the physical demands of everyday life with SCI. Hammel *et al.*[16] did a qualitative study with focus groups on fatigue in SCI. The authors identified potentially positive and negative effects from exercise. Pain seemed to be the strongest predictor for fatigue, but the authors suggested that physical exercise might contribute to fatigue.

From our clinical experience we know that there are high expectations about what physical exercise can do to restore better function, in particular for those with incomplete lesions. This group may perceive more uncertainty regarding their future physical function than those with complete SCI.[7,8] Physical exercise becomes a method to regain independency. During the few first years after injury, many persons with incomplete SCI experience a marked improvement in strength, endurance and restored function. Their expectations of recovery are fulfilled to a certain extent. Over the years, their functional improvements diminish, and a decline in daily function may occur because of normal aging, complications or possible overuse. Consequently, they may experience a lower degree of coping, as measured by exercise mastery. To capture expectations, it is important that health professionals help with realistic goal setting, both during early rehabilitation and later, if reduction in physical functions occurs.

The physical reserve capacity for persons with incomplete SCI may be insufficient for exercise activities, in addition to physical demands in their everyday life. Additional exercise activities may lead to a feeling of exhaustion (overtraining) and eventually to a loss of motivation for further exercise (burnout), similar to overtraining and burnout in elite athletes as described by Lemyre.[17]

Persons with complete SCI reported a higher score on SPEQ mastery if they exercised. According to injury level, what can be expected of the restored functional level may be more realistic, and accordingly they use more mobility aids and other adaptations to cope with their impairment, compared with persons with incomplete lesions.

The results in this study support earlier findings showing increased SPEQ fitness in persons who exercise regularly.[4,5] Defining exercisers as those who exercise once a week or more may be debated, because this amount represents too little exercise to improve the physiological work capacity in able-bodied persons.[13] This may also be the case in people with SCI who additionally have less muscle function to move their bodies. However, we do not know how much exercise is necessary to maintain an identity or a self-concept as an exerciser, or to influence psychological responses. We only know that some psychological responses seem to be more associated with exercise of moderate intensity in the normal population.[18] The 'once a week or more' criterion seemed to classify the mean scores of perceived exercise mastery and fitness for those with complete SCI meaningfully.

It differentiated between exercisers and nonexercisers with incomplete lesions, but in a more unexpected direction. However, this result was supported by the fact that persons with incomplete SCI perceived less exercise mastery the more hours they exercised per week.

A limitation of this study was the use of self-reports on physical exercise.[19] To support the reported amount of exercise, we compared the available data on peak VO_2 max with self-reports, but only for persons with complete SCI because of available reliable data. Another weakness was the difference in time since injury between the two populations. However, analyses demonstrated that this difference had little impact on results in the incomplete group, most likely because they were all long term after injury. Furthermore, the results may be influenced by the disproportionate numbers of persons with tetraplegia in the two samples.

In conclusion, the results of this study indicate that persons with complete and incomplete SCI perceive exercise mastery differently. For persons with complete SCI, exercise status was the only variable that contributed positively to variance in perceived exercise mastery. For persons with incomplete SCI, both exercise status and exercise hours per week contributed negatively to the variance in exercise mastery. This may be because of exertion from coping with demands in everyday life or unrealistic expectations about restoration of function. To capture this, the goals of each individual should be explored and adjusted. Kennedy *et al*.[20] developed instruments and procedures for this purpose in a rehabilitation setting. It seems important that health professionals working with persons with SCI learn to understand how to use these tools. However, more research is needed in this field to understand the complexity of the above-mentioned findings.

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Appendix 1

Self- Perception in Exercise Questionnaire, subscales SPEQ mastery and SPEQ fitness

1 = Totally agree 2 = Agree to some extent			3 = Disagree to some extent 4 = Totally disagree	
SPEQ mastery				
Somehow, I show what I am good for when I participate in physical activities	1	2	3	4
Physical activity gives me, among other things, a positive feeling of attaining something	1	2	3	4
Physical activity is important to me because it makes me feel I am in control of something	1	2	3	4
I think I am good at more types of physical activities than others	1	2	3	4
I think I can get away from daily stress of life by doing physical activity	1	2	3	4
SPEQ fitness				
Generally, I am not in good shape	1	2	3	4
It worries me somewhat that I don't manage to keep in good shape	1	2	3	4
I wish I was in far better shape than I am	1	2	3	4