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PHYSICAL ACTIVITY IN PEOPLE WITH SPINAL CORD INJURY IN SWITZERLAND

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Alexandra Rauch

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Berichterstatter:	Prof. Dr. Alarcos Cieza, MPH
Mitberichterstatter:	PD Dr. Martin Weigl
Mitbetreuung durch den promovierten Mitarbeiter:	-
Dekan:	Prof. Dr. med. dent. Reinhard Hickel
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1. List of abbreviations

ACH-WHO-REC	Achievement of World Health Organizations' recommendations on physical activity
ICF	International Classification of Functioning, Disability and Health
KA	Körperliche Aktivität
LTPA	Leisure time physical activity
LTPAQ-SCI	Leisure Time Physical Activity Questionnaire for People with Spinal Cord Injury
MET	Metabolic equivalent
PA	Physical activity
PARA-SCI	Physical Activity Recall Assessment for People with Spinal Cord Injury
PASIPD	Physical Activity Scale for Individuals with Physical Disabilities
PiS	Participation in sport
RMV	Rückenmarksverletzung
SCI	Spinal cord injury
SCIM	Spinal Cord Independence Measure
SR-SCIM	Self-reported Spinal Cord Independence Measure
SwiSCI	Swiss spinal cord injury cohort study
WHO	World Health Organization

2. List of publications

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3. INTRODUCTION

3.1. SPINAL CORD INJURY – EPIDEMIOLOGY, PATHOPHYSIOLOGY AND DISABILITY

A spinal cord injury (SCI) describes damage of the spinal cord due to a sudden, traumatic event, such as an accident, or related to a non-traumatic disorder, such as degenerative diseases of the spine, neoplasms or vascular diseases. Typically, about 80% of people suffering from traumatic SCIs are male; about 50% are aged from 16-30, and the most frequent causes for traumatic SCIs are motor-vehicle accidents.[1] In contrast, about 50% of those suffering from non-traumatic SCIs are female, about 60 years of age, and the most frequent cause is tumors.[2] Although traumatic SCIs still represent the majority of cases, the number of non-traumatic SCIs is increasing. This relates to the increasing life expectancy, especially in high-income countries,[3] as the prevalence of diseases that might cause non-traumatic SCIs increases with age.

Knowledge about the nature of the spinal cord lesion is important to understand the consequences of impaired functions and resulting levels of disability. Depending on the level and severity of the SCI, affected people suffer not only from impairments in muscle and sensory functions, but also from impairments in bowel, bladder, sexual and respiratory functions, dysregulation of the heart rate, blood pressure and thermoregulation, and frequently neuropathic pain. A lesion below the cervical spine causes paraplegia, where the trunk and legs are affected, and a lesion at the level of the cervical spine causes tetraplegia, where the arms are also affected. The severity of the SCI describes whether the lesion is complete (complete loss of motor and sensory functions) or incomplete (partially preserved motor and/or sensory functions).[3] Both, the level and severity of a SCI are classified in the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI).[4]

The multitude of impairments in body functions related to spinal cord lesions leads to limitations in many activities and restrictions in different domains of participation.[5,6] While people with tetraplegia have a higher risk of experiencing limitations in activities and participation than people with paraplegia, the environment has a huge impact on functioning regardless of the severity of the SCI.[7]

3.2. LIFE EXPECTANCY, CAUSES OF DEATH AND HEALTH RISKS IN PEOPLE WITH SPINAL CORD INJURY

Life expectancy in people with SCI is still below that of the general population, although people with SCI living in high-income countries have become older during the last decades.[1]

In general, life expectancy depends on the level and severity of the SCI, whereas people with tetraplegia die earlier than those suffering from paraplegia.[8]

The reduced life expectancy in people with SCI is associated with the increased risk of developing secondary conditions. Undiagnosed and untreated wound complications, urinary-tract infections and respiratory diseases have been the leading causes of death for a long time, but, due to improved healthcare in industrialized nations, there has been a shift to other causes of death.[9] Cardiovascular diseases have become one of the leading causes of death[3], and the risk of suffering from heart disease or stroke is significantly increased in people with SCI.[10] The risk factors contributing to cardiovascular disease (lifestyle factors, metabolic changes) are similar to those in people without disabilities. People with SCIs suffer from decreased physical capacity (defined as the combined capacity of cardiovascular, respiratory and muscular functions),[11] which, in combination with physical inactivity, results in reduced energy expenditure, particularly in those with complete spinal cord lesions.[12] This combination increases the risk of developing a metabolic syndrome, which is characterized by obesity, elevated levels of cholesterol, glucose and triglycerides and high blood pressure.[13] With increasing age, the number of people with SCIs affected by the metabolic syndrome increases, which also increases the risk of developing cardiovascular conditions and diabetes.[14]

Aside from physical disorders, people with SCIs also have increased risks of developing mental disorders.[15] Depressive disorders and symptoms were found in about 30% of people with SCIs during inpatient rehabilitation and in up to 60% in the later phase of the disease. Anxiety disorders are prevalent in up to 30%.[16] Suicide is among the leading causes of death in people with SCIs,[3] as it is frequently associated with depressive disorders.[17]

3.3. PHYSICAL ACTIVITY AND ITS IMPACT ON THE HEALTH OF PEOPLE WITH SPINAL CORD INJURY

Regular physical activity (PA) and participation in sports can contribute to better health in people with SCI and reduce health risks.[18] The following paragraphs focus on the existing evidence regarding the beneficial effects of PA on mental and physical health of individuals with SCI.

MENTAL HEALTH BENEFITS

Depressive and anxiety disorders were found less often in people with SCI who participated in sports or any other type of PA than in the physically inactive reference groups.[19,20] People with SCI participating in sports or regular physical activities reported a better quality of life and life satisfaction[20-24] than the physically inactive. Taking into account that people with SCI suffer more often from mental disorders and show lower quality of life and life satisfaction than people without disabilities, PA could play a decisive role in improving mental health in the SCI population.

PHYSICAL HEALTH BENEFITS

Regular PA, in particular specific types of sporting activities and exercises, can improve physical fitness (physical capacity and muscle strength)[25-28] and reduce risks of secondary conditions related to physical inactivity.[26,29,30] More specifically, arm or wheelchair ergometry and treadmill training (for those with motor incomplete SCI) can improve cardiovascular endurance.[23,31-34] The above and different types of resistance training (e.g. weight lifting) can also increase muscle strength.[23,31,34] Unfortunately, the quality of the existing research is evaluated as rather low.[25,27]

3.4. DEFINITION AND MEASUREMENT OF PHYSICAL ACTIVITY IN PEOPLE WITH SPINAL CORD INJURY

"Physical activity" must first be precisely defined to better understand the concept of PA and different approaches to measuring it.

DEFINITION OF PHYSICAL ACTIVITY

PA is generally understood as 'any bodily movement produced by skeletal muscles that requires energy expenditure'.[35] PA can be subdivided into different types of activity, as illustrated in Figure 1.

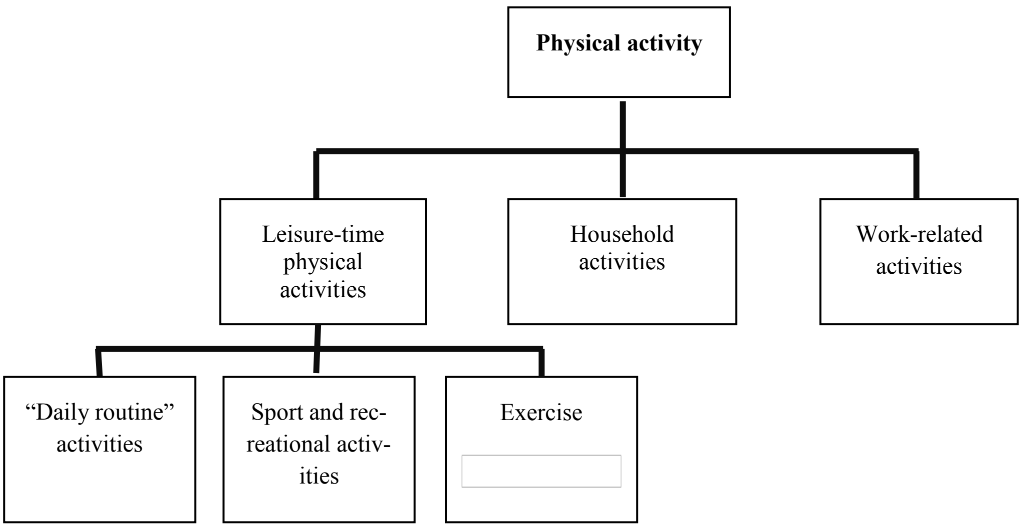

Figure 1: Definition of subcategories of physical activity

Household activities and work-related activities

Various activities during work or housekeeping, such as sweeping or vacuuming floors, cleaning windows or doing home repairs, require physical activity and increase energy expenditure. PA during work also contributes a significant proportion of energy expenditure.

Leisure-time PA (LTPA)

LTPA is defined as a PA performed by an individual that is not required as an essential activity of daily living and is performed at the discretion of the individual. Such activities include sports participation, exercise conditioning or training and recreational activities, such as going for a walk, dancing and gardening.[35]

Sport is a sub-category of LTPA and covers a range of activities. Doing sports typically includes a set of rules and can be performed competitively. Sporting activities can be carried out as team-sports or individual sports. Sports are usually supported by an institutional framework, such as a sporting club.[36] Sports can also be performed as an individual activity without any support from an institutional framework, without following specific rules and without following exercise recommendations, e.g. cycling, running or walking for fun.

Exercise represents another subcategory of LTPA. Specific exercises are planned, structured, repetitive and purposeful and aim to improve or maintain physical fitness, physical performance and health. "Exercise" and "exercise training" can be used interchangeably.[36]

Daily routine activities include PAs that are not performed for health purposes, such as walking, wheeling or cycling to work or to a supermarket or climbing stairs.

MEASUREMENT OF PHYSICAL ACTIVITY IN PEOPLE WITH SPINAL CORD INJURY

To date, no standard for measuring PA in people with SCI exists. Both interviewer administered, self-reported instruments and objective instruments are available. Depending on the study design and research question, all types have advantages and disadvantages regarding reliability and practicability. The following presents an overview of existing measuring instruments developed for people with physical disabilities and specifically developed for people with SCI, which were applied or discussed in this research.

Self-reported measuring instruments

Self-reported measuring instruments assess PA from the perspective of the responder. Three measures will be presented here.

Physical Activity Scale in Individuals with Physical Disabilities (PASIPD)[37]

The PASIPD is a questionnaire that was developed and tested in 2002 to provide an assessment for physical activity in people with physical disabilities that can be applied in epidemiological research. For the development, people with various physical disabilities (of which 20% had paraplegia or tetraplegia) were included in the study.

The PASIPD can be administered as a self-report or as an interview-guided assessment. The questionnaire consists of 13 items, which refer to LTPAs, household activities and work-related activities with two questions each. The minutes per week can be calculated from the answers for each activity. The total PASIPD score is then calculated with a given algorithm. This score itself represents a metabolic equivalent (MET), which shows whether the achieved PA is sufficient to reduce health risks related to physical inactivity.

The given algorithm does not differ among different types of physical disabilities, i. e., the MET for a person with, for example, an amputated leg is equivalent to the MET of a person with tetraplegia. The PASIPD has been criticized[38] for this reason, and the METs should be used with caution, although the calculated time spent on PAs provides useful information.

Physical Activity Recall Assessment for People with Spinal Cord Injury (PARA-SCI)[38]

The PARA-SCI was developed and tested in 2005. The PARA-SCI was specifically developed for people with SCI using a wheelchair as the primary means of locomotion.

The PARA-SCI is usually assessed per telephone by an interviewer who asks open questions on the type, frequency, intensity and duration of LTPAs or lifestyle activities during the preceding three days. The number of minutes for each specific activity is recorded and coded either as a LTPA or lifestyle activity. The total minutes per day for the different types of PAs can be calculated from the answers by averaging the sum of all activities across the three days.

Leisure-Time Physical Activity Questionnaire in People with Spinal Cord Injury (LTPAQ-SCI)[39]

The LTPAQ-SCI was developed and tested in 2012 and represents a self-report measuring instrument that assesses the minutes spent on mild, moderate and high-intensity LTPAs during the previous seven days.

The LTPAQ-SCI consists of only two questions for each of the intensities; the responder is requested to name the number of days on which s/he performed that type of LTPA and the average number of minutes spent on it on these days. The answers enable the total time spent on PAs of different intensities to be calculated and summed up into the total number of PAs over the preceding week.

Objective measuring instruments

Activity monitors measure movements based on signals sent by accelerometers attached to the body,[40,41] and the wheelchair[42] or only to the wheelchair.[43] Using activity monitors can overcome the limitations resulting from subjective measures, where people with SCI tend to overestimate the time spend on PAs.[44] Activity monitors are valid instruments to measure the time spent on PAs and also the type of movement,[45] but have limited suitability to measure the intensity of the movement. This presents some problems when aiming to assess energy expenditure for the PAs.

3.5. RECOMMENDATIONS ON PHYSICAL ACTIVITY

PA recommendations on physical activity suggest distinct levels of PA that are required to achieve a desired goal. Different recommendations focus on the achievement of better health and fitness and prevention in particular of noncommunicable diseases, i.e. secondary conditions related to physical inactivity. Evidence is still lacking whether recommendations for the general population can be applied to people with SCI due to the different levels of physical capacity. Recommendations for both target groups are presented below.

General WHO recommendations on physical activity

In 2010, the World Health Organization (WHO) published the “Global recommendations on physical activity for health” to provide policy-makers with guidance on the frequency, duration, intensities and types of PAs that are required to prevent non-communicable diseases in populations worldwide.[36] The recommendations differ for different age groups (5-17, 18-64, 65 years and older). For each age group it is emphasized that the given recommendations “should be met by children, can be applied by adults and older adults with disabilities, even if they need to be adjusted to each individual, based on their exercise capacity and specific health risk or limitations”.

For people aged 18-64 and 65 and older, the recommendations suggest to “do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week or at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week or an equivalent combination of moderate- and vigorous intensity activity”. As well, “muscle-strengthening activities should be done involving major muscle groups on 2 or more days a week.”

Specific recommendations for people with spinal cord injury

In 2004, Jacobs PL et al.[18] published exercise recommendations for individuals with SCI for the first time. The recommendations suggest performing "three to five times a week for about 20-60 minutes endurance trainings (arm cranking, wheelchair propulsion, swimming, etc) with 50-80% of the maximum performance". Muscle-resistance training is recommended with "8-12 repetitions per exercise in two sessions per week".

In 2005 Myslinksi[46] published exercise prescriptions based on a review of evidence for aerobic and anaerobic training. These recommendations are similar to those provided by the WHO, and suggest performing aerobic training with "40-80% of the maximum heart rate for at least 30 minutes on 2-3 days per week". Anaerobic training (muscle-strengthening exercises) should also be performed "two times per week with 2-3 sets of 10 repetitions".

The most recent PA guidelines for people with SCI published in 2011 by Martin Ginis et al.[47] recommend levels of aerobic exercises with only "20 minutes of moderate to vigorous intensity aerobic activity two times weekly". The recommendations for muscle-strengthening exercises suggest to perform "strength training exercises two times per week, consisting of three sets of 8-10 repetitions of each exercise for each major muscle group." First testing of these guidelines have shown that the recommended levels are sufficient to increase fitness parameters,[48] but seem to be insufficient to reduce the risks of vascular diseases.[49]

3.6. PHYSICAL ACTIVITY LEVELS, CORRELATIONS WITH AND DETERMINANTS OF PHYSICAL ACTIVITY IN PEOPLE WITH SPINAL CORD INJURY

Evidence on PA levels in people with SCI is still rather meager, but has been increasing during the last decade. Correlations with and determinants of PA have been investigated, but a comprehensive understanding of why people with SCI are physically active or not is still lacking. Evidence in both areas is essential for the development and implementation of interventions to improve PA. For Switzerland, evidence on both PA levels and their correlates is lacking. This doctoral thesis was conducted to produce such evidence for Switzerland.

The common finding in the existing evidence is that PA levels in people with SCI are rather low. A small Canadian sample (n=27) in which PA levels were measured in terms of energy expenditure, found limited activity levels according to a WHO definition.[12] A large study in the UK (n=985) found that 52% did not engage in any kind of sport.[50] Similarly, 50.1% of participants in a Canadian study (n=695) reported performing no LTPA at all[51], while those who were active spent a mean of 55.2 minutes/day on PAs.[52] A German study (n=277) found comparable results; 48.5% of the study sample reported not engaging in any sport, but no figures on time spent on sports in the active population were presented.[53] The results of a Korean sample (n=79) showed that only 3.8% of the participants reported not engaging in any LTPA, and those who were active spent a mean of 3.1 hours/day on LTPAs.[54] Only two studies investigated the change in PA levels after the onset of a SCI. In an English SCI population (n=45), participation in sports and PA significantly decreased after discharge from rehabilitation.[55] A similar decrease was found in a Dutch SCI population (n=36) shortly after discharge from in-patient rehabilitation. PA levels increased again after one year, but remained below those of the able-bodied population.[56]

To better understand the PA levels, it is necessary to investigate their correlates and determinants. Since PA levels can depend on a variety of factors related to the severity of the SCI, the environment in which a person lives and factors related to the individual himself, a comprehensive perspective of potential cofactors is required. The International Classification of Functioning, Disability and Health (ICF)[57], a universally accepted conceptual framework, can provide this. The ICF provides an overview of the dynamic interactions among its different components (body functions, body structures, activities and participation, environmental and personal factors) with its model of functioning, disability and health (Fig. 2).

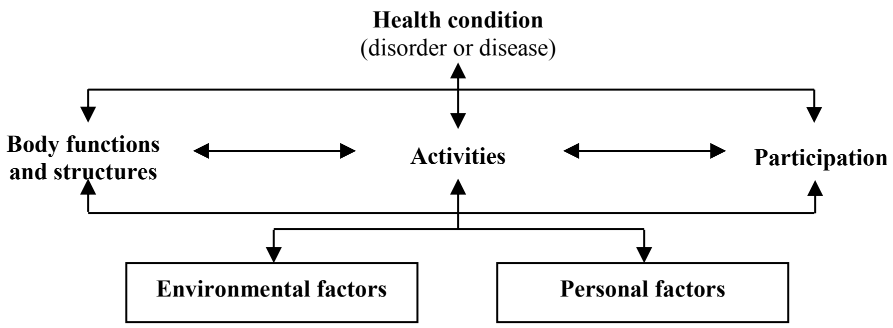

Figure 2: The model of functioning and disability

According to the ICF, "body functions are the physiological functions of the body system, body structures are anatomical parts of the body, activities are the execution of tasks or actions, participation is involvement in a life situation, environmental factors make up the physical, social and attitudinal environment in which people live and conduct their lives, and personal factors are the particular background of an individual's life and living and comprises features of the individual that are not part of a health condition or health state".[57] Based on this model, the extent to which PA (which is among 'activities') is performed is the result of the interaction of all ICF components. The classification provides a standardized categorization and description of the components of the ICF (except for personal factors). The classification facilitates assigning already identified correlates to categories in the components of the model or selecting variables from these components when investigating factors associated with PA. Using the ICF in research on PA can contribute to a comprehensive perspective of PA and to a better comparability of the findings on factors associated with PA.

A systematic review published in 2012 summarized the findings from the existing research published from 1980 to 2011.[58] Studies found that PA in people with SCI is more strongly influenced by the environment than by "classical" socio-demographic factors, as is also true in the able-bodied population. By applying the ICF framework in this review it could be shown that body functions and structures and activities and participation have rarely been considered when investigating factors associated with PA. The ICF framework was also applied in a Canadian study to assess predictors for LTPA among people with SCI in 2012.[59] In this study, personal factors and aspects referring to activities and participation were identified as important predictors. The ICF also proved helpful in identifying key factors relevant to PA in people with SCI.[59]

The ICF was applied for the first time in a qualitative study on PA in people with SCI in Switzerland.[60] This study identified factors associated with PA across all components of functioning and in many domains of these ICF components. Gender differences could also be identified in a number of these associated factors. These findings have not been validated with quantitative research yet.

3.7. OBJECTIVES OF THIS RESEARCH

The overall objective of this research was to describe PA levels and their correlates in people with SCI in Switzerland for the first time. This presents relevant information to potential stakeholders responsible for the development and implementation of programs to promote PA in people with SCI in Switzerland. It comprises the following three objectives:

1) To describe PA levels by investigating participation in sports and exercise levels and to identify potential differences among distinct subgroups,
2) to investigate whether PA recommendations are achieved and to identify potential differences among distinct subgroups and
3) to identify factors associated with being physically active and the achievement of PA recommendations by applying the comprehensive framework of the ICF.

I performed three studies conducting secondary analysis of existing data with the following specific aims:

1) For the first study, I used the data from a survey on work integration. The specific aims were (1) to present figures on the frequency of participation in sports in persons with SCI in Switzerland and (2) to identify factors associated with the levels of participation in sports.

2) For the second study, I used the data from the community survey of the Swiss Spinal Cord Cohort Study (SwiSCI). The specific aims were (1) to quantify the time spent on different types and intensities of PA in people with SCI, (2) to report proportions of those who are completely physically inactive, who carry out muscle-strengthening exercises and who achieve the WHO recommendations on PA and (3) to investigate sociodemographic and SCI-related characteristics associated with the latter three PA categories.

3) The third study was also based on data from the community survey of the Swiss Spinal Cord Cohort Study (SwiSCI). The specific aim was to identify those aspects that potentially explain the outcomes of study II (being physically active and achieving the WHO recommendations on PA). The ICF framework was applied to take into account and address aspects referring to body functions, body structures, activities and participation and environmental and personal factors.

3.8. Study results

Study I: Participation in sport in persons with spinal cord injury in Switzerland

This study demonstrated that about 60% of the study sample (n=505) participated in sports at least once a week. However, PiS decreased significantly from the time before the onset of SCI to the time of the survey ($P<.001$). Sports levels were significantly lower in women than men at the time of the survey ($P<.001$), whereas no difference was observed before onset of SCI ($P=.446$). Persons with tetraplegia participated significantly less often in sports than persons with paraplegia ($P<.001$). Lesion level, active membership in a sports club, frequency of PiS before the onset of SCI and the subjective evaluation of the importance of sports correlate with PiS. When controlling for gender differences, only the subjective importance of sports for persons with SCI determines PiS, particularly among women.

Study II: Do people with spinal cord injury meet WHO recommendations on physical activity?

This study demonstrated that participants (n=485) carried out PA a total of 6.0 hours/week (median), whereas most time was spent performing PAs of only light intensity (median: 2.2 hours/week). 18.6% were physically inactive, 50.3% performed muscle-strengthening exercises, and 48.9% fulfilled the WHO recommendations. It was also found that women, people aged 71+ and people with complete tetraplegia had significantly lower odds of fulfilling the WHO recommendations than participants in the respective reference category (men, ages 17-30, incomplete paraplegia).

Study III: Associations with being physically active and the achievement of WHO recommendations on physical activity in people with spinal cord injury

The specific aim of this study was to identify those aspects that potentially explain being physically active and achieving the WHO recommendations on PA (ACH-WHO-REC) in people with SCI. It could be shown that higher levels of social support and self-efficacy significantly increased the odds of being physically active. For ACH-WHO-REC, the use of an intermittent catheter increased, whereas being dependent on self-care mobility and coping with emotions by focusing on and venting them decreased the respective odds. Experiencing hindrances in accessibility was associated with increased odds for ACH-WHO-REC. Older age decreased, and being a manual wheelchair user increased the odds to achieve both PA outcomes.

3.9. GENERAL DISCUSSION

The findings from the conducted studies present relevant preliminary information to address subgroups with low PA levels and to plan targeted interventions.

Study I investigated the frequency of participation in sports (performed for at least 30 minutes). This outcome was assessed with a single-item question which did not specify the time, intensity or type of sport. Study II investigated the frequency, time and intensity of different types of sports and exercise based on four standardized questions included in the PASIPD. Both studies described the proportion of subjects who were rather physically inactive (study I) or completely physically inactive (study II). 33% of the subjects in study I reported participating in sports fewer than several times per month; 18.6% in study II never performed any sports or exercises. The proportional difference in the two studies may relate to the different measuring instruments. In study I, it was not possible to identify those who were completely physically inactive due to the response option offered. Among the identified 33% with the lowest PA levels there were probably also persons who performed sports rather irregularly (fewer than several times a month). Therefore, the proportion of the physically inactive in the two studies might be rather similar. Despite the use of the different measuring instruments, the proportion of rather or completely inactive people with SCI in both studies was lower compared to findings from studies from other countries, where 37% to 50% were reported to be physically inactive.[51,53,61]

This finding is in line with results for the total amount of PAs performed by people with SCI. People with SCI in Switzerland spent more time on PAs than people with SCI in other countries, where the mean time for PA varied from 45 to 55 minutes/day.[44,51,52] In study I, nearly 60% participated in sports at least once and about 40% at least several times a week. In study II, 50% of the study sample performed at least 6 hours of the different types (sports of mild to strenuous intensity and muscle exercises) of PAs per week (mean: 9.1 hours/week). However, it has to be taken into account that the study participants probably overestimated their PA levels in the questionnaire-based surveys – a phenomenon that was identified in previous research.[62]

Study I showed that women and people with tetraplegia participated significantly less frequently in sports. In study II, although the difference in the total time spent on PAs did not significantly differ for gender and severity of SCI, women and people with tetraplegia spent significantly less time on moderate and strenuous PAs. This finding is reported for the first time. A previous qualitative study on factors associated with PA in people with SCI in Switzerland found that women reported less interest in competitive sports.[60] This could explain the lower levels of more strenuous types of sports.

Age did not explain PiS in study I; in study II it was found that people older than 70 years spent a significantly lower total time on PAs and also on strenuous PAs and muscle-strengthening exercises. This confirms existing evidence.[51,56] People with more severe SCIs, such as tetraplegia, showed lower PA levels; the difference was significant for the frequency of PiS (study I) and for the time spent on moderate and strenuous types of PAs (study II). Existing evidence agrees that people with tetraplegia are less physically active,[51,53,56,63] whereas study II revealed that the intensity might play an important role. The fact that the elderly and people with tetraplegia are among those with the lowest PA levels is understandable, as both probably have decreased physical capacity. This may prevent them from being physically active, particularly in strenuous PAs.

Study II also revealed that the type of locomotion is associated with PA levels. People using a manual wheelchair for locomotion (for more than 100m) spent the most total time on PAs. They also spent significantly more time on the more strenuous PAs compared to all other types of locomotion (pedestrians without devices, pedestrians with devices or assistance, electric wheelchairs). The association between the type of locomotion and PA has hitherto rarely been investigated. Only one study presented results with the same finding,[51] and only one study investigated potential reasons for this.[64] For Switzerland, this finding requires further research. It can presently only be assumed that sports and exercise programs for people with SCI focus mainly on wheelchair sports and probably are not appropriate for people with gait limitations.

Study II was the first study to investigate whether people with SCI achieve PA recommendations – more specifically, the WHO recommendations for PA.[36] The achievement of the PA recommendations may be associated with the achievement of health benefits, although evidence for this in people with SCI is still lacking. 48.9% of the total sample achieved the WHO recommendations on PA (aerobic activities). Due to the response options provided for the question on the frequency spent on muscle exercises, it was not possible to investigate the achievement of WHO recommendations on muscle-strengthening exercises precisely. However, it could be shown that about 50% perform muscle-strengthening exercises on at least 1 to 2 days per week. The finding that the proportion of people with SCI who achieve the WHO recommendations is higher than in the general Swiss population was unexpected.

Women, people older than 71 years of age and people with tetraplegia showed significantly lower odds for ACH-WHO-REC. Women and people with tetraplegia did not spend significantly less total time on PAs in general, but spent less time on the moderate and strenuous types of PA which are required in ACH-WHO-REC. In study I, women and people with tetraplegia participated significantly less in sports. The question used in study I, which specifically asked about sports participation without providing any examples, was probably associated with PAs with rather strenuous intensities by the participants.

The third objective of this research (*to identify factors associated with PA levels*) was addressed in both study I and study III. In study I, the number of suitable covariables was limited due to the different objectives of the primary study. Only the 'importance of sport' at the time of the survey was found to be associated with participation in sports in the final model, particularly among women. In study III, comprehensive models could be applied due to the ICF-based data collection within the SwiSCI community survey.[65] Study III benefitted from this comprehensive data pool by selecting covariables from all components of the ICF that were considered to be potentially associated with PA and the ACH-WHO-REC. This was only the second quantitative study to apply models based on the ICF framework. The first was conducted in 2012 in Canada.[59] In both studies, the use of the ICF was evaluated as helpful to gain a comprehensive understanding of PA. Both studies showed that body functions do not explain PA. They also demonstrated that categories from all other ICF components explain PA. The categories associated with PA differed, which may be related to the different independent variables, the different dependent variable presenting the PA level and also to the different study designs (cross-sectional vs. longitudinal study). In study III, except for age and type of locomotion, different associated factors were identified to explain being physically active and to ACH-WHO-REC. This finding suggests focusing on different interventions when aiming to encourage people with SCI to become physically active and to perform types of PA of at least moderate intensity to achieve the WHO recommendations on PA.

Methodological considerations and consequences for future research

Some methodological considerations have to be taken into account to evaluate the results of this research. First, all three studies presented secondary data analyses of cross-sectional studies. Secondary data analyses are limited regarding the selection of variables that can be included in the analyses. Furthermore, causal relationships between the identified associated factors and the investigated outcomes cannot be demonstrated because the primary studies were conducted as cross-sectional studies.

Second, the results from the three studies derive from data collected using self-reported measurements where people with SCI tend to overestimate their PA levels. This was specifically found for the use of the PASIPD,[44,66] which was administered in the SwiSCI community survey. SCI-specific questionnaires, in particular the PARA-SCI, have been found to correlate better with energy expenditure.[66] The use of objective measurements, such as activity monitors, should at least be applied in a sub-sample to validate the findings from self-reported instruments.

Studies II and III investigated the achievement of the WHO recommendations on PA.[36] Although the WHO recommendations explicitly suggest that they can be applied in people with disabilities,[36] it has never been investigated whether people with SCI gain health benefits when following the recommendations.

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4. SUMMARY

Spinal cord injury (SCI) is a devastating health condition by leading to the deterioration or loss of a number of functions depending on an intact spinal cord and consequently to limitations and restrictions in a variety of activities and domains of participation. Due to the decrease of physical capacity, people with SCI have increased risks to develop secondary conditions, which again possibly contribute to premature death. Accordingly, people with SCI still have a shorter life expectancy compared to the general population. Among the leading causes of death in SCI are cardiovascular diseases for which physical inactivity represents a significant risk factor.

In general, physical activity (PA) can improve both mental and physical health in people with SCI. People participating in sport or other PAs show lower levels of mental disorders. Furthermore, regular leisure time PA and specific exercises can improve fitness and reduce the risks for secondary conditions. However, to achieve physical health benefits recommendations on PA suggest regular specific endurance and muscle strengthening training with a defined minimum of intensity and duration.

In a number of studies in different countries it could be shown that PA levels are rather low, in particular for some subgroups. Since it is likely that PA behavior depends on the culture and context in which people are living, PA levels may vary in different countries. Associates and determinants with PA levels have been investigated and identified mainly environmental factors to associate with participation in PAs. However, a comprehensive understanding of the associations with PA rarely exists yet due to the lack of a comprehensive model explaining PA in people with SCI. For the development and implementation of programs to promote PA country specific information is essential to target the programs to the specific needs of the SCI population. For Switzerland, no data on PA levels and according associations with PA levels for people with SCI exist to date.

The general objective of this doctoral thesis is to describe PA levels and their associates in people with SCI in Switzerland for the first time. Specifically, it aims to describe LTPA (sport and exercise) levels and the achievement of recommendations on PA in the Swiss SCI population and to identify associations with PA levels by applying comprehensive models. The results should provide stakeholders responsible for the development of programs promoting PA in people with SCI in Switzerland with relevant information.

The first study aimed to describe the frequency of participation in sport (PiS) and to identify correlates for PiS in persons with SCI in Switzerland. It could be shown that about 60% of the study sample (n=505) participated in sport at least once a week. However, PiS decreased significantly from the time before the onset of SCI to the time of the survey (P<.001). Sport levels were significantly lower in women than men for the time of the survey (P<.001), whereas no difference was observed before onset of SCI (P=.446). Persons with tetraplegia participated significantly less often in sport than persons with paraplegia (P<.001). Lesion level, active membership in a club, frequency of PiS before the onset of SCI, and the subjective evaluation of the importance of sport correlate with PiS. When controlling for gender differences, only the subjective importance of sport for persons with SCI determines PiS, particularly among women.

The objective of the second study was to describe physical activity (PA) levels by considering distinct types and intensities and the achievement of the World Health Organization (WHO) recommendations on PA in persons with SCI and to investigate associated factors. In this study it could be shown that participants (n=485) carried out PA a total of 6.0 hours/week (median) whereas most time was spent to carry out PAs with only light intensity (median 2.2 hours/week). 18.6% were physically inactive, 50.3% carried out muscle-strengthening exercises, and 48.9% fulfilled the WHO recommendations. Furthermore, it was found that women, people aged 71+, and people with complete tetraplegia had significantly lower odds of fulfilling the WHO recommendations than participants in the respective reference category (men, ages 17-30, incomplete paraplegia).

The third study aimed to explore associations with PA levels by applying a comprehensive model based on the ICF framework. The specific aim was to identify those aspects that potentially explain being physically active and the achievement of the WHO recommendations on PA (ACH-WHO-REC) in people with SCI. This study showed that higher levels of social support and self-efficacy significantly increased the odds of being physically active. For ACH-WHO-REC, the use of an intermittent catheter increased, whereas being dependent in self-care mobility and coping with emotions by focusing on and venting of emotions decreased the respective odds. Furthermore, experiencing hindrances due to accessibility is associated with increased odds for ACH-WHO-REC. For both PA outcomes, older age decreased, but being a manual wheelchair user increased the odds to achieve the outcome.

General discussion

The overall objective of this doctoral thesis was to describe PA levels and their associates in people with SCI in Switzerland for the first time.

Study I and study II showed that PA levels in people with SCI in Switzerland are rather high compared to results from studies in other countries. However, it has to be taken into account that the participants in both studies have likely overestimated their PA levels in the questionnaire-based surveys. The subgroups with lower PA levels (total time, respectively less time for more strenuous types of PA) in women, the elderly, and in people with tetraplegia should receive specific consideration for intervention planning. The fact that manual wheelchair users show significantly higher PA levels than people not using a wheelchair was rarely investigated to date. It can be only assumed that sport and exercise programs for people with SCI focuses on wheelchair sport and thus, do probably not fit to people with gait limitations not using a wheelchair. To overcome the problem of potential overestimation of PA levels, the selection of assessment instrument with better correlation with energy expenditure and the use of objective measurements, such as activity monitors, should be considered.

To investigation of the achievement of PA recommendations in study II showed that with 48.9% that fulfilled the WHO recommendations this proportion is rather high. The finding that women, people older than 71 years, people with tetraplegia showed significantly lower odds for ACH-WHO-REC contributes again to the identification of specific target groups for intervention planning. Interestingly, women and people with tetraplegia did not have significantly lower total time of PAs but spent less time for the moderate and strenuous types of PA that are required for the ACH-WHO-REC. Interventions should focus on how to empower these subgroups to perform the more strenuous types of PAs. Furthermore, future research should investigate whether recommendations on PA lead to health benefits in people with SCI, respectively which PA levels are required to gain heath benefits.

The use of the ICF framework to explore associations with being PA and ACH-WHO-REC in study III contributes to a comprehensive understanding of PA behavior. Except for age and the type of locomotion, different associations were identified to explain being PA and to ACH-WHO-REC. This suggests focusing on different interventions when aiming to empower people with SCI to become PA at all and when empowering people to perform at least moderate intensity types of PA to achieve the WHO recommendations on PA. Future research, however, should apply longitudinal study designs to identify causal relationships for being PA or not and for ACH-WHO-REC.

5. Zusammenfassung

Rückenmarksverletzungen (RMV) stellen schwerwiegende Gesundheitsstörungen dar, die zur Verminderung bis hin zum Verlust von Funktionen, die von der Unversehrtheit des Rückenmarks abhängen, führen. Das kann zu Beeinträchtigungen einer Vielzahl von Aktivitäten und Bereichen der Teilhabe beitragen. Aufgrund der reduzierten physischen Kapazität bei Personen mit RMVen ist das Risiko für die Entstehung von Sekundärerkrankungen erhöht. Diese tragen wiederum zu einer erhöhten Mortalität in jener Personengruppe bei, wodurch die Lebenserwartung bei Menschen mit RMVen im Vergleich zur Gesamtbevölkerung immer noch reduziert ist. Unter den führenden Todesursachen befinden sich kardiovaskuläre Erkrankungen. Körperliche Inaktivität trägt zu einer Erhöhung des Risikos für das Auftreten von kardiovaskulären Erkrankungen bei.

Regelmäßige körperliche Aktivität (KA) kann sowohl die mentale als auch körperliche Gesundheit bei Personen mit RMVen verbessern. So treten bei Personen, die Sport oder andere Formen der KA betreiben, weniger psychische Erkrankungen auf. Außerdem verbessert regelmäßige KA und spezifisches Training die körperlichen Fitness und reduziert das Risiko für das Auftreten von Sekundärerkrankungen. Um dies zu erreichen, muss jedoch, entsprechend existierender Empfehlungen zur KA, ein regelmäßiges und spezifisches Ausdauer- und Krafttraining durchgeführt werden.

In Studien in unterschiedlichen Ländern konnte gezeigt werden, dass Personen mit RMVen eher wenig körperlich aktiv sind, insbesondere in bestimmten Untergruppen. Da angenommen werden kann, dass das Bewegungsverhalten auch von kulturellen und kontextspezifischen Aspekten abhängt, kann sich das Ausmaß der KA in verschiedenen Ländern unterscheiden. Zusammenhänge mit dem Ausmaß der KA wurden bisher ebenfalls untersucht, dabei wurden vor allem Umweltfaktoren als Einflussfaktoren identifiziert. Allerdings existiert bis heute kein umfassendes Verständnis zu genannten Einflussfaktoren, da kaum umfassende Erklärungsversuche zur KA bei Personen mit RMV unternommen wurden. Für die Entwicklung und Implementierung von Programmen zur Förderung der KA sind solche länderspezifischen Informationen essentiell, um die Programme auf die besonderen Bedürfnisse der Personen mit RMV zuschneiden zu können. Für die Schweiz gibt es jedoch bis heute keine Daten zum Ausmaß der KA und zu möglichen Zusammenhängen mit diesem Ausmaß bei Personen mit RMV.

Das übergeordnete Ziel dieser Doktorarbeit ist es somit, zum ersten Mal das Ausmaß der KA und damit im Zusammenhang stehende Faktoren bei Personen mit RMV in der Schweiz zu untersuchen. Die spezifischen Ziele umfassen die Beschreibung des Ausmaßes der KA in der Freizeit (Sport und Training) und des Erreichens der Empfehlungen zur KA in der Schweizer Bevölkerung mit RMV und die Identifizierung von Zusammenhängen mit diesen Aspekten. Hierfür sollen umfassende Modelle angewandt werden. Die Ergebnisse sollen den Organisationen, die für die Entwicklung von Programmen zur Förderung der KA bei Menschen mit Rückenmarksverletzungen zuständig sind, relevante Informationen zur Verfügung stellen.

Die erste Studie verfolgte das Ziel, die Häufigkeit der Durchführung sportlicher Aktivitäten bei Menschen mit RMV in der Schweiz zu beschreiben, und damit im Zusammenhang stehende Aspekte zu identifizieren. Etwa 60% der Studienteilnehmer (n=505) übten zum Zeitpunkt der Erhebung mindestens einmal die Woche Sport aus. Allerdings kam es zu einer signifikanten Abnahme im Vergleich zum Zeitpunkt vor Beginn der RMV ($P<.001$). Frauen waren zum Zeitpunkt der Erhebung signifikant weniger sportlich aktiv als Männer ($P<.001$). Zum Zeitpunkt vor Beginn der RMV konnte kein Unterschied festgestellt werden ($P=.446$). Ebenso trieben Personen mit einer Tetraplegie signifikant seltener Sport als Personen mit einer Paraplegie ($P<.001$). Die Läsionshöhe, die aktive Mitgliedschaft in einem Verein, die Häufigkeit sportlicher Aktivität vor dem Beginn der RMV und die subjektive Einschätzung der Bedeutung von Sport korrelierten mit der Häufigkeit sportlicher Aktivität zum Zeitpunkt der Erhebung. Nach Kontrolle des Einflusses des Geschlechts erklärte nur noch die subjektive Einschätzung der Bedeutung von Sport die Häufigkeit sportlicher Aktivität, und dies signifikant stärker bei den Frauen.

Das Ziel der zweiten Studie war es, das Ausmaß der KA hinsichtlich unterschiedlicher Arten und Intensitäten und den Anteil der Personen, welche die Empfehlungen der Weltgesundheitsorganisation (WHO) zur KA erreichen, zu beschreiben, und damit im Zusammenhang stehende Faktoren zu identifizieren. Die Studienteilnehmer (n=485) waren insgesamt 6,0 Stunden/Woche (Median) körperlich aktiv, wobei sie die meiste Zeit KAen mit nur leichter Intensität (Median 2,2 Stunden/Woche) betrieben. 18,6% waren körperlich inaktiv, 50,3% führten regelmäßig Übungen zur Muskelkräftigung aus und 48,9% erreichten die WHO-Empfehlungen. Darüber hinaus zeigte sich, dass Frauen, Personen 71 Jahre und älter und Personen mit einer kompletten Tetraplegie im Vergleich zu ihrer Referenzpopulation (Männer, Personen 17-30 Jahre alt, inkomplette Paraplegie) eine signifikant niedrigere Wahrscheinlichkeit haben, die WHO-Empfehlungen zu erreichen.

In der dritten Studie sollten Aspekte, die mit der KA assoziiert sind, aufgedeckt werden. Hierfür werden umfassende Modelle, basierend auf dem Rahmenkonzept der ICF, angewandt. Das spezifische Ziel ist es, diejenigen Aspekte zu identifizieren, die erklären, ob Personen mit einer RMV überhaupt körperlich aktiv sind und ob sie die Empfehlungen der WHO zur KA erreichen. Die Ergebnisse dieser Studie zeigen, dass ein größeres Ausmaß an sozialer Unterstützung und Selbstwirksamkeit die Wahrscheinlichkeit erhöht, körperlich aktiv zu sein. Die Benutzung eines intermittierenden Katheters erhöht die Wahrscheinlichkeit für das Erreichen der WHO-Empfehlungen zur KA. Diese ist hingegen niedriger, wenn Personen in der Durchführung der Selbstversorgung körperlich von anderen abhängig sind, und Emotionen in einer Form bewältigen, bei der sie sich auf diese fokussieren und sich damit sehr mit ihnen beschäftigen. Darüber hinaus hängt das Erleben von Hindernissen bei der Zugänglichkeit von öffentlichen Gebäuden positiv mit dem Erreichen der WHO-Empfehlungen zusammen. Für beide Aspekte der KA senkt ein höheres Alter und erhöht die Benutzung eines manuellen Rollstuhls die Wahrscheinlichkeit, diese zu erreichen.

Zusammenfassende Diskussion

Das übergeordnete Ziel dieser Forschungsarbeit war es, das Ausmaß der KA und damit im Zusammenhang stehende Faktoren zum ersten Mal bei Personen mit RMV in der Schweiz zu untersuchen.

Studie I und Studie II zeigten, dass das Ausmaß der KA bei Personen mit RMV in der Schweiz im Vergleich zu anderen Ländern recht hoch ist. Allerdings muss hierbei berücksichtigt werden, dass die Teilnehmer in beiden Studien das Ausmaß ihrer KA wahrscheinlich in den Fragebogen-basierten Umfragen überschätzt haben. Die Untergruppen mit niedrigerem Ausmaß an KA (Frauen, Ältere, Personen mit Tetraplegie) sollten bei der Interventionsplanung besondere Berücksichtigung finden. Die Tatsache, dass Personen, die keinen manuellen Rollstuhl benutzen, ein signifikant niedrigeres Ausmaß an KA zeigten, wurde in bisherigen Studien kaum untersucht. Derzeit kann nur angenommen werden, dass die Sportangebote für Personen mit RMV zu sehr auf Rollstuhlfahrer fokussiert sind und somit nicht auf die Bedürfnisse von Personen, die eine Beeinträchtigung des Ganges haben und keinen Rollstuhl benutzen, zugeschnitten sind. Um die möglichen Überschätzung der eigenen KA zu vermeiden, sollten zukünftig Erhebungsinstrumente benutzt werden, die besser mit dem tatsächlichen Energieverbrauch korrelieren. Auch die Benützung objektiver Erhebungsinstrumente wie Bewegungsmonitore, sollte bedacht werden.

Die Untersuchung zum Erreichen der Empfehlungen zur KA in Studie II zeigte, dass mit 48,9% an Teilnehmern, welche die WHO-Empfehlungen erreichten, dieser Anteil recht hoch ist. Das Ergebnis, dass Frauen, Personen älter als 71 Jahre und Personen mit einer Tetraplegie eine signifikant niedrigere Wahrscheinlichkeit besitzen, die WHO-Empfehlungen zu erreichen, trägt wiederum zur Identifizierung von spezifischen Zielgruppen für die Interventionsplanung bei. Interessanterweise verbrachten die Frauen und Personen mit einer Tetraplegie nicht insgesamt signifikant weniger Zeit mit KA, jedoch signifikant weniger Zeit für die körperlichen Aktivitäten mit den eher anstrengenden Intensitäten, welche zum Erreichen der WHO-Empfehlungen erforderlich sind. Interventionen sollten somit darauf zielen, diese Untergruppen zu befähigen, die eher anstrengenden Intensitäten der KA durchzuführen. Darüber hinaus sollte zukünftige Forschung untersuchen, inwiefern die bestehenden Empfehlungen zur KA tatsächlich zu besserer Gesundheit beitragen, beziehungsweise welches Ausmaß an KA notwendig ist, um einen gesundheitlichen Nutzen zu erzielen.

Die Anwendung des ICF-Rahmenkonzeptes zur Untersuchung von Zusammenhängen mit der KA und dem Erreichen der WHO-Empfehlungen zur KA in Studie III trägt zu einem umfassenden Verständnis des Verhaltens zur KA bei. Außer dem Alter und der Art der Fortbewegung wurden für beide Aspekte unterschiedliche Faktoren identifiziert, die erklären, ob Personen körperlich aktiv sind und die WHO-Empfehlungen erreichen. Daraus lässt sich schließen, dass unterschiedliche Interventionen notwendig sind, wenn es darum geht, Personen mit einer RMV überhaupt zur KA zu befähigen, und wenn es darum geht, dass Personen mit RMV KAen durchführen, die eine mindestens moderate Intensität besitzen. Um kausale Zusammenhänge zwischen den identifizierten Faktoren und der KA und dem Erreichen der WHO-Empfehlungen zu entdecken, sollten in Zukunft Studien mit einem longitudinalen Design durchgeführt werden.

6. Research article I

Participation in sport in persons with spinal cord injury in Switzerland

Alexandra Rauch[1], Christine Fekete[2], Cornelia Oberhauser[1], Albert Marti[2,3], Alarcos Cieza[1,2,4]

[1] Chair for Public Health and Health-Service Research, Research Unit for Biopsychosocial Health, Department of Medical Informatics, Biometry and Epidemiology – IBE, Ludwig-Maximilians-University, Munich, Germany

[2] Swiss Paraplegic Research (SPF), Nottwil, Switzerland

[3] Department of Health Sciences and Health Policy, University of Lucerne and SPF, Nottwil, Switzerland

[4] Faculty of Social and Human Sciences, University of Southampton, Southampton, United Kingdom

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ABSTRACT

Study design: Secondary data analysis of a questionnaire-based, cross-sectional survey in persons with spinal cord injury (SCI) in Switzerland.

Objective: To describe the frequency of participation in sport (PiS) and to identify correlates for PiS in persons with SCI in Switzerland.

Setting: Community sample

Methods: Frequency of PiS was assessed retrospectively for the time before the onset of SCI and the time of the survey using a single-item question. A comprehensive set of independent variables was selected from the original questionnaire. Descriptive statistics, bivariate analyses and ordinal regressions were carried out.

Results: Data from 505 participants were analyzed. Twenty independent variables were selected for analyses. PiS decreased significantly from the time before the onset of SCI to the time of the survey (P<.001). Sport levels were significantly lower in women than men for the time of the survey (P<.001), whereas no difference was observed before onset of SCI (P=.446). Persons with tetraplegia participated significantly less often in sport than persons with paraplegia (P<.001). Lesion level, active membership in a club, frequency of PiS before the onset of SCI and the subjective evaluation of the importance of sport correlate with PiS. When controlling for gender differences, only the subjective importance of sport for persons with SCI determines PiS, particularly among women.

Conclusions: Persons with tetraplegia and women need special attention when planning interventions to improve PiS. Furthermore, the subjective importance of sport is important for PiS, particularly among women, whereas most other factors were only weakly associated with PiS.

Key words

Spinal cord injury, Physical activity, Sport, Disability, Health behavior

INTRODUCTION

Persons with spinal cord injury (SCI) are at high risk of developing secondary conditions. The decreased physical capacity caused by the loss of physical functions leads to lower energy expenditure and metabolic changes[1] that contribute to the development of cardiovascular diseases.[2] Furthermore, people with SCI have more psychological disorders than the general population.[3] In this population, a healthy lifestyle, including regular physical activity (PA), plays an important role.

In general, the concept of PA comprises work- and household-related, as well as leisure-time PAs (LTPAs). The latter includes recreational activities, sport and exercise. Sport in SCI is an effective means to reduce health risks[4] when performed regularly, to improve quality of life and life satisfaction[5] and to increase social integration.[6] To date, only few studies have investigated participation in sport (PiS) and its determinants and correlates. Those existing investigated either LTPA or sport using different assessment instruments. Findings showed that the respective participation levels were low in that sense that 37% - 50% of persons with SCI did not engage in any LTPA[7,8] or sport.[9] It has also been shown that PiS decreased after the onset of SCI.[10] With respect to correlates and determinants for PiS in SCI, evidence is widely lacking. Findings regarding the more general concept of participation in PA show that the environment has a higher impact on PA levels than socio-demographic or SCI characteristics.[11] This leads to the assumption that PiS may depend on environmental characteristics, such as different physical and cultural contexts.

Persons with SCI living in Switzerland experience many barriers to participating in PA.[12] Thus, we assume that PiS in SCI is low and differs from the general population. The survey on sport behaviour in the general Swiss population assessed PiS with a question on the frequency (never, sometimes/rarely, once a week, several times a week, daily) and found that PiS has increased over the last decades, and gender differences have nearly disappeared.[13] For persons with SCI, there is a lack of data on the frequency of PiS and factors influencing PiS in Switzerland. Such information is, however, indispensable when developing interventions to improve PiS in persons with SCI.

The objective of this study was to provide initial insights into PiS in persons with SCI in Switzerland. The specific aims were (1) to present figures on the frequency of PiS in the study population and (2) to identify factors associated with PiS.

MATERIALS AND METHODS

Study design

This study was a secondary data analysis of a questionnaire-based, cross-sectional survey on labor-market participation performed in the SCI population in Switzerland.[14]

Participants

2097 members of the Swiss Paraplegic Association (SPA, national association of persons with SCI) with traumatic or non-traumatic SCI older than 18 years and living in the community for at least one year were invited to participate in the study by mail. Announcements were also placed in the consumer magazine 'Paracontact' and on the SPA homepage. A total of 559 of the invited persons (27%) completed the questionnaire.

Data collection

The original questionnaire comprised 86 variables. A detailed description of the survey is reported by Marti *et al*.[14] PiS was assessed with a single-item question asking participants about their frequency of PiS during a week and a month: 'How often do you perform sport (for at least half an hour)?' The five response options included 'less than several times a month', 'several times a month', 'once a week', 'several times a week' and 'daily'. PiS was assessed for the time of the survey and retrospectively for the time before the onset of SCI. The current PiS level was used as the dependent variable.

Based on evidence from the literature and expert opinion by two of the researchers (AR, AM), a set of independent variables considered as likely to be associated with PiS was selected for the analysis. These variables cover five socio-demographic, 10 disease-specific and 5 health-behavior-related characteristics.

Data analysis

Only participants who answered the dependent variable were included in the analysis. Cases with more than three missing values in the independent variables were excluded from the analysis.

First, descriptive statistics were used to characterize the study population and to describe PiS before the onset of SCI and at the time of the survey. Second, bivariate analyses were conducted: (1) Mann-Whitney-*U*-Tests to identify differences in PiS (for the two time points, for socio-demographic and SCI-related characteristics at the time of the survey) and (2) Spearman correlations to identify those variables associated with PiS at the time of the survey (correlation coefficient > 0.2). The correlation analysis was conducted separately for men and women due to identified gender differences in PiS in the Mann-Whitney-*U*-Test analysis. Finally, a multivariate analysis (stepwise ordinal regression) was carried out: In the first model, only variables with a Spearman correlation coefficient > 0.2 were included. In the second model, socio-demographic factors known to be associated with PiS in the Swiss general population[13] were also included. In the third model, interaction terms with gender were additionally considered for all variables that were included in model 1. The level of statistical significance was set at a *P*-value ≤ 0.05 in all analyses. Data were analyzed using SPSS V18 (SPSS Inc., Chicago, IL, USA).

RESULTS

In total, data from 505 subjects were included. An overview on the characteristics of the study population is presented in Table 1.

PiS decreased significantly after the onset of SCI: although before the onset of SCI, 72.7% of subjects participated in sport at least once a week, this proportion decreased to 59.8% at the time of the survey. In all, 33.3% of subjects performed sport fewer than several times in a month after the onset of SCI in comparison to 19.8% before the onset. The precise distribution of PiS levels is shown in Figure 1.

Table 1: Characteristics of the study population (n=505)

Variable	n (%)	Mean (SD; Min,Max)	Missing n(%)
Gender			0 (0.0)
Male	374 (74.1)		
Age (in years)		49.4 (12.6; 19,88)	0 (0.0)
Living situation			7 (1.4)
Living together (Cohabitating/married /living together)	293 (58.0)		
Living alone (Living alone/married but living separated/ divorced/ widowed)	205 (40.7)		
Formal education			4 (0.8)
6 years	64(12.7)		
8-9 years	320 (63.4)		
11-12 years	117 (23.1)		
Employment rate			20 (4.0)
0%	206 (40.8)		
1-33%	56 (11.1)		
34-50%	126 (25.0)		
51-66%	19 (3.8)		
67-100%	78 (15.4)		
Time since onset of SCI (in years)		18.3 (11.8; 1,50)	5 (1.0)
Cause for SCI			5 (1.0)
Traumatic (total)	425 (84.2)		
Traffic accident	183 (36.3)		
Fall	94 (18.6)		
Sport accident	99 /19.6)		
Violence	8 (1.6)		
Non-traumatic	75 (14.8)		
Not defined	41 (8.1)		
Level of SCI			3 (0.6)
Paraplegia	361 (71.3)		
Tetraplegia	142 (28.1)		
Severity of SCI			13 (2.6)
Motoric complete	247 (48.9)		
Motoric incomplete	245 (48.5)		
Length of first rehabilitation (in months)			25 (4.9)
Paraplegic		7.2 (4.5; 1,50)	
Tetraplegic		11.0 (7.0; 1,60)	
Wheelchair use			3 (0.6)
No wheelchair	63 (12.5)		
Manual wheelchair	406 (80.4)		
Power wheelchair	33 (6.5)		

SCI: spinal cord injury

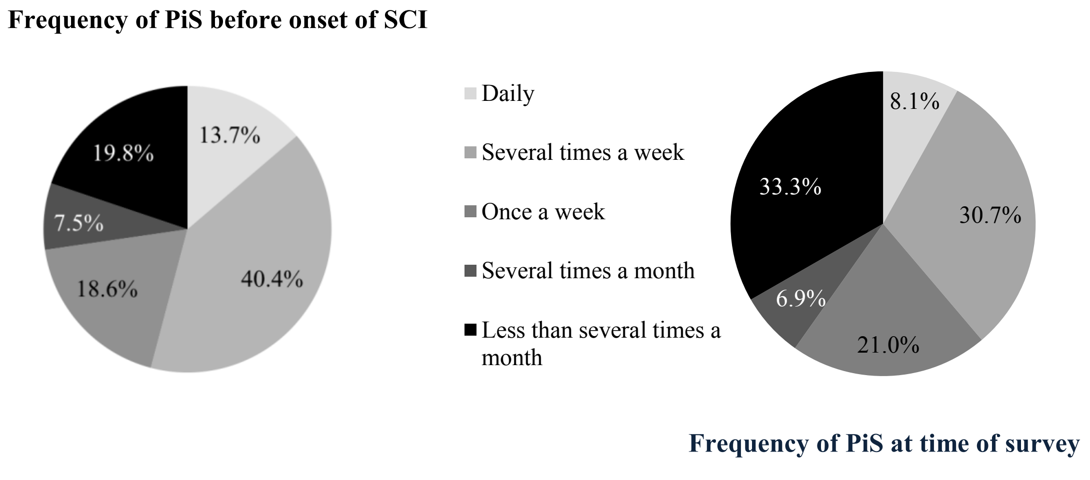

Figure 1: Frequency of participation in sport (PiS) before the onset of spinal cord injury (SCI) and at the time of the survey

The analysis of differences in PiS in the independent variables (Table 2) showed that the decrease of PiS was exceptionally high in women: before the onset of SCI, 74.9% of females performed sport at least once a week (once a week, several times a week or daily), whereas at the time of the survey only 47.3% participated at least once a week. A total of 45.0% participated even fewer than several times a month. This trend was less pronounced in males: 72.9% of males performed sport at least once a week (once a week, several times a week or daily) before the onset of SCI, and 64.2% still did at the time of the survey. Only 29.1% engaged in sport fewer than several times a month. This unequal decrease is reflected in a significant gender difference in PiS at the time of the survey, which did not exist before the onset of SCI.

Table 2: Frequency of participation in sport related to time-point, socio-demographic and SCI-related characteristics

Variables (n)	**n (%) for frequency of PiS**					**Median (IQR)**	**p**
PiS related to…	Less than several times a month (1)	Several times a month (2)	Once a week (3)	Several times a week (4)	Daily (5)		
Time-point							<.001*
Before onset of SCI (505)	100(19.8)	38(7.5)	94(18.6)	204(40.4)	69(13.7)	4.00(2.00;4.00)	
Time of survey (505)	168(33.3)	35(6.9)	106(21.0)	155(30.7)	41(8.1)	3.00(1.00;4.00)	
Gender, before SCI							.468
Men (367)	77(21.0)	28(7.6)	62(16.9)	151(41.1)	49(13.4)	4.00(2.00;4.00)	
Women (131)	23(17.7)	10(7.7)	24(18.5)	53(40.8)	20(15.4)	4.00(2.00;4.00)	
Gender, time of survey							.003*
Men (374)	109(29.1)	25(6.7)	87(23.2)	120(32.0)	34(9.1)	3.00(1.00;4.00)	
Women (130)	59(45.0)	10(7.6)	19(14.5)	36(27.5)	7(5.3)	2.00(1.00;4.00)	
Living situation°							.578
Living alone (205)	71(34.6)	16(7.8)	41(20.0)	62(30.2)	15(7.3)	3.00(1.00;4.00)	
Living together (293)	96(32.8)	19(6.5)	64(21.8)	89(30.4)	25(8.5)	3.00(1.00;4.00)	
Formal education°							.434
6-9 years (388)	131(33.8)	20(5.2)	83(21.4)	118(30.4)	36(9.3)	3.00(1.00;4.00)	
11-12 years (117)	37(31.6)	15(12.8)	23(19.7)	37(31.6)	5(4.3)	3.00(1.00;4.00)	
Employment rate°							.901
0-50% (388)	139(35.8)	24(6.2)	74(19.1)	115(29.6)	36(9.3)	3.00(1.00;4.00)	
51-100% (97)	25(25.8)	9(9.3)	30(30.9)	31(32.0)	2(2.1)	3.00(1.00;4.00)	
Cause for SCI°							.978
Traumatic (425)	138(32.5)	31(7.3)	92(21.6)	131(30.8)	33(7.8)	3.00(1.00;4.00)	
Non-traumatic (75)	27(36.0)	35(7.0)	105(21.0)	155(8.4)	40(8.0)	3.00(1.00;4.00)	
Level of SCI°							<.001*
Paraplegic (362)	101(27.9)	23(6.4)	78(21.5)	128(35.4)	32(8.8)	3.00(1.00;4.00)	
Tetraplegic (143)	67(46.9)	12(8.4)	28(19.6)	27(18.9)	9(6.3)	2.00(1.00;4.00)	
Severity of SCI°							.599
Motoric complete (247)	79(32.0)	17(6.9)	56(22.7)	76(30.8)	19(7.7)	3.00(1.00;4.00)	
Motoric incomplete (245)	86(35.1)	18(7.3)	50(20.4)	70(28.6)	21(8.6)	3.00(1.00;4.00)	

PiS: Participation in sport; SCI: spinal cord injury
IQR = Interquartile range (25^{th} to 75^{th} percentile)
p= p-value resulting from Mann-Whitney-U-Test on differences in PiS between each of the two groups:* = significant (<.05)
° presented for the time of survey

Persons with tetraplegia and persons with motoric incomplete lesions participated less often in sport than persons with paraplegia and motoric complete lesions. However, these differences were only significant for the level, but not for the severity of the lesion.

The correlation analysis (Table 3) showed that males who suffer from tetraplegia, who have spent longer time in first rehabilitation and who have performed sport more frequently before the onset of SCI had lower PiS at the time of the survey. Evaluating sport as important at the time of the survey and being an active member of a club correlated with higher PiS at the time of the survey. In women, only the latter two correlated with higher PiS at the time of the survey. For both genders, none of the socio-demographic characteristic correlated with PiS.

Table 3: Spearman correlations of socio-demographics, disease-specific and health-behavior related aspects with participation in sport at the time of the survey

Varaible group	**Independent variables**	**Specification**	**PiS at the time of the survey** (less than several times a month/several times a month/once a week/several times a week/daily)			
			Men		Women	
			Corr Co-eff	p	Corr Coeff	p
Socio-demo-graphic	Age	In years	.024	.641	.026	.764
	Living situation	Living alone /Living together	.028	.593	-.005	.957
	Children	No/Yes	.023	.656	.126	.154
	Formal education	In years	.029	.592	-.053	.564
	Remunerative employment	Percentage of 100%	.019	.714	.005	.956
Disease-specific	Time since onset of SCI	In years	-.047	.366	-.153	.086
	Level of SCI	Paraplegic/tetraplegic	**-.238**	<.001*	-.108	.225
	Severity of SCI	Motoric complete/incomplete	-.050	.340	.074	.412
	Cause for SCI	Traumatic/non-traumatic	.030	.559	.012	.887
	Length of first rehabilitation	In months	**-.241**	<.001*	-.194	.034*
	Rehospitalisations	No/Yes	013	.803	.052	.559
	Use of wheelchair	No/manual/electrical	-.075	.147	-.127	.148
	Performance of activities of daily living	Time in minutes to perform self care activities in the morning	-.195	.001*	-.042	.668
	Subjective physical health/pain	1 (no pain) - 10 (strongest pain)	-.027	.610	.001	.990
	Subjective general health	Very bad/rather bad/medium/ rather good/very good	.145	.005*	.111	.208
Health behavior	PiS before onset of SCI	Less/several times a month/ several times a week /once a week/daily	**-.242**	<.001*	-.106	.228
	Importance of sport before onset of SCI	Subjective rating in percent on a scale from 0 to 100	.179	.001*	.033	.714
	Importance of sport at time of survey	Subjective rating in percent on a scale from 0 to 100	**.560**	<.001*	**.530**	<.001*
	Active membership in a club before onset of SCI	No/Yes	-.115	.027*	.091	.301
	Active membership in a club at time of survey	No/Yes	**.234**	<.001*	**.241**	.006*

PiS: Participation in sport; SCI: spinal cord injury
Bold letters: correlation coefficients considered as relevant for further analysis (>.200)
p = p-value, * = significant (<.05)

The stepwise ordinal regression (Table 4) explained up to 34% of the variance and showed that lesion level, active membership in a club, frequency of PiS before the onset of SCI and the subjective importance of sport at the time of the survey were significantly linked to PiS in model 1. Controlling for socio-demographic characteristics (model 2) only slightly improved the explanatory power. When controlling for gender differences by adding interaction terms in model 3 (gender with all variables included in model 1), only the subjective importance of sport at the time of the survey remained significantly associated with PiS. In addition, the subjective importance of sport had a stronger relationship with PiS in women than in men.

Table 4: Regression coefficients of the stepwise ordinal regression using frequency of participation in sport at the time of the survey as an ordinal outcome

Included variables	Model 1		Model 2		Model 3	
	B (SE)	p	B (SE)	p	B (SE)	p
Intercept 1 (sport daily)	-.538 (.341)	<.001	.018 (.681)	<.001	.127 (.850)	<.001
Intercept 2 (sport several times a week)	-.137 (.339)	.005	.422 (.681)	.024	.539 (.851)	.050
Intercept 3 (sport once a week)	.968 (.342)	.686	1.537 (.683)	.535	1.671 (.854)	.401
Intercept 4 (sport several times a month)	3.420 (.391)	.114	4.015 (.714)	.979	4.145 (.877)	.022
Level of lesion (paraplegic)	.578 (.203)	.004*	.542 (.205)	.008*	-.127 (.396)	.748
Active membership in a club at time of survey (no)	-.511 (.178)	.004*	-.488 (.179)	.006*	-.510 (.360)	.157
Length of first rehabilitation	-.024 (.018)	.171	-.026 (.018)	.138	-.038 (.037)	.301
Frequency of PiS before onset of SCI	-.216 (.065)	.001*	-.242 (.066)	<.001*	-.080 (.135)	.554
Importance of sport at time of survey	.087 (.009)	<.001*	.090 (.007)	<.001*	.138 (.023)	<.001*
Gender (male)			.278 (.199)	.162	.567 (.751)	.450
Age			.013 (.007)	.063	.012 (.007)	.095
Formal education			-.023 (.046)	.611	-.029 (.046)	.526
Level of lesion*gender (male paraplegic)					.876 (.464)	.059
Length of first rehabilitation*gender (male)					.018 (.042)	.661
Frequency of PiS before onset of SCI*gender (male)					-.216 (.154)	.161
Importance of sport at time of survey*gender (male)					-.057 (.024)	.019*
Active membership in a club at time of survey*gender (No, male)					.024 (.415)	.954
R^2 (Nagelkerke)		.315		.325		.338

PiS: Participation in sport; SCI: spinal cord injury
B: Regression coefficient; SE: Standard error
p = p-value: * = significant (<.05)
Reference values for *Intercept 1, 2, 3 and 4*: ‘Less than several times a month’, for *Level of lesion*: ‘Tetraplegic’, for *Active membership in club at time of survey*: ‘Yes, member’, for *gender*: ‘female’

DISCUSSION

This study showed that PiS in persons with SCI in Switzerland significantly decreased after the onset of SCI, in particular in women and persons with tetraplegia. The subjective evaluation of the importance of sport was the only aspect that explained PiS after controlling for various influences. The characteristics of the study population corresponded to the well-known distribution of other SCI populations with respect to level and severity of SCI and gender distribution. This is one of the very few studies with a large sample size and presents results, which are shown in this manner for the first time.

Corresponding to results by Tasiemski *et al.*,[10] PiS significantly decreased after the onset of SCI. In comparison to existing evidence, where 37-50% do not engage in LTPA or sport[7-9] at all, the proportion of those who seldom or never participate in sport in Switzerland was lower (33.3%). No explanation for these differences in different countries and cultures has been discovered. In comparison to the general population in Switzerland, where 66.7% of the general population participated in sport at least once a week in 2008,[13] 59.8% in the SCI population participated in sport with this frequency. However, looking into gender differences provided more details.

The identified lower PiS in women confirms findings from one of the few studies with a large study population[7] that reports on gender differences based on the average duration of LTPA during the 3 days previous to the interview. Other studies with smaller sample sizes did not report on gender differences.[15-19] In the general Swiss population, gender differences in PiS disappeared almost completely in the able-bodied population.[13] Accordingly, no gender differences in PiS were observed in the study population at the time before the onset of SCI. This study revealed gender differences in PiS after suffering a SCI, which require a closer look into aspects that potentially explain this phenomenon that has arisen in connection with a disability.

Our finding of fewer Pis in persons with tetraplegia confirms existing evidence.[7,17] The greater loss of physical capacity in persons with tetraplegia may lead to a more frequent experience of barriers to performing sport. It is assumed that these experiences are related to lower perceived behavioral control, which is known to influence the intention to perform sport in persons with tetraplegia.[20] Results are inconsistent for the impact of the severity of the lesion and the time since the onset of SCI.[7,15] In this study population, these two characteristics made no difference in PiS. The inconsistent findings suggest that these characteristics cannot be applied to explain PiS universally and that more insight is required to understand when they influence PiS.

The bivariate analysis showed that the lesion level (tetraplegia) correlated with lower PiS in men only. Given the generally lower PiS levels in women, one could assume that lower physical capacity related to a more severe lesion determines PiS in males, whereas in women, suffering from a disability in general - irrespective of physical capacity - influences PiS. There is some evidence that athletic identity (being competitively oriented) is typically male[12,21] and that this phenomenon does not change over time. A loss of physical capacity caused by more severe levels of SCI may thus contribute to less interest in sport when a person loses the capacity to perform sport on a high level. If, in contrast, the motivation for sport is more associated with maintaining fitness or socializing, as it was shown for women,[12] the level of SCI may have less impact on PiS.

Although in this study 50% of the participants had a time since onset of SCI longer than 17 years, the number of years living with SCI did not correlate with PiS in both genders. Thus, this study found no hints that aging contributes to a decrease in PiS.

The correlation between more frequent PiS before the onset of SCI with less frequency at the time of the survey in men has already been observed by Tasiemski *et al.*,[22] while Anneken *et al.*[9] found the same phenomena, but did not report on gender differences. It is assumed that the comparison between the experience of able-bodied sport before the onset of SCI and a rather negative experience of disabled sport might cause this decrease. Based on the identified gender differences in our and a previous study,[12] one could again assume that performing sport on a high level is more important in men, while women perform sport for other reasons.

Interestingly, none of the socio-demographic characteristics correlated with PiS in either gender, which confirms evidence from other studies with SCI populations.[11] In comparison to the general population in Switzerland, where age, gender and formal education correlate with PiS,[13] respective findings from the SCI population provide interesting hints that disability shifts the correlates for PiS from socio-demographic to other factors.

Active membership in a sports club at the time of the survey and evaluating sport more important at the time of the survey correlated with higher PiS in both genders. The former connection is also known to associate with better social integration,[6] whereas it is not known whether persons become members in a club to become better integrated, e.g. to socialize, and thus are physically more active, or whether persons who want to perform sport become a member in a club more often and are thus better integrated. However, recent research has found that programs offered by wheelchair clubs do not always meet the needs of all persons with SCI.[12] This deficiency may contribute to lower levels of PiS in women and tetraplegics.[12] Identifying individuals' reasons for becoming a member of a club may provide important information for programs developed to increase PiS through sports clubs.

The evaluation of the subjective importance of sport was the only item that explained PiS after controlling for the impact of gender, and it was shown that the impact is higher in women. The subjective evaluation of sport may be based on a person's knowledge regarding risks and benefits related to sport, pre-existing norms, values, attitudes and preferences, but also to the need to socialize, to maintain health, or to have fun.[12] In any case, achieving a positive personal evaluation of the importance of sport may positively influence the intention to perform sport, which could contribute to higher PiS.

LIMITATIONS

Some limitations to this study should be noted. First, the selection of a convenience sample of members of the Swiss Paraplegic Association who are possibly more active in general and the low response rate (27%) may limit the generalizability of our findings. As no data were collected from the non-responders, there is no information whether the study sample is representative for the population invited to this study. Second, a single-item question was used to assess the frequency in PiS. Although similar single-item questions on PA showed acceptable reliability,[23] information is limited to the frequency of PiS, whereas information on the type, intensity and duration of sport activities is lacking. However, the analysis of this item allowed a comparison with data from the general Swiss population. Third, a recall bias, in particular in persons with long disease duration may have affected the results. Finally, aspects that may additionally relate to PiS (for example, environmental and additional personal factors) were not included in the original questionnaire and thus could not be investigated.

CONCLUSION

This study detected that women and persons of both genders with tetraplegia rarely participate in sport. This finding paves the way for future research that should investigate gender aspects in PiS in persons with SCI. Furthermore, we showed that disease-specific and sociodemographic characteristics do not explain PiS, but the personal evaluation of the importance of sport does. Studies are needed to better understand the evaluation of the importance of sport from the individual's perspective. We also recommend that information on the type (for example, aerobics or muscle-strengthening activities), intensity (low, moderate or intense) and duration (for example, minutes per day) of sport needs to be collected in the future to allow to additional investigation of the impact of PiS on the reduction of health risks.

Data archiving

There were no data to deposit.

Conflict of interest

The authors declare no conflict of interest.

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7. Research article II

Do people with spinal cord injury meet the WHO recommendations on physical activity?

Alexandra Rauch[1], Timo Hinrichs[2,3], Cornelia Oberhauser[1], Alarcos Cieza[1, 2, 4] for the SwiSCI study group

[1] Chair for Public Health and Health-Service Research, Research Unit for Biopsychosocial Health, Department of Medical Informatics, Biometry and Epidemiology – IBE, Ludwig-Maximilians-University, Munich, Germany

[2] Swiss Paraplegic Research, Nottwil, Switzerland

[3] Department of Health Sciences and Health Policy, University of Lucerne, Switzerland

[4] Faculty of Social and Human Sciences, University of Southampton, UK

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ABSTRACT

Objective: To describe physical activity (PA) levels in persons with spinal cord injury (SCI) and to investigate associated factors.

Methods: PA behavior of people with SCI in Switzerland was assessed in a community survey with four items from the Physical Activity Scale for individuals with physical disabilities (PA of light, moderate, and strenuous intensity and muscle-strengthening exercises). In addition to descriptive analyses, the odds of performing PA according to the WHO recommendations (at least 2.5 hours/week of at least moderate intensity) were analyzed by multivariable logistic regression.

Results: Participants (n=485; aged 52.9±14.8; 73.6% male) carried out PA a total of 6.0 hours/week (median). 18.6% were physically inactive, 50.3% carried out muscle-strengthening exercises, and 48.9% fulfilled the WHO recommendations. Regression analyses showed that women, people aged 71+, and people with complete tetraplegia had significantly lower odds of fulfilling the WHO recommendations than participants in the respective reference category (men, ages 17-30, incomplete paraplegia).

Conclusions: PA levels of people with SCI in Switzerland are rather high. However, some subgroups need special consideration when planning interventions to increase PA levels.

Key words: Spinal cord injury; Physical activity; Sport, Disability; Health behavior; WHO recommendations

INTRODUCTION

In general, regular physical activity (PA), usually understood as any bodily movement that increases energy expenditure above that of a resting level (ODPHP 2008), is an effective means to prevent the development of cardiovascular and other diseases (ODPHP 2008). The increased energy expenditure influences body composition and lipid metabolism positively and leads to reduced blood pressure and reduced systemic inflammation (Warburton et al. 2006). Persons affected by a spinal cord injury (SCI), however, have limited physical capacity due to the loss of muscle functions, which again reduces energy expenditure in the activities of daily living (Buchholz et al. 2003). This may explain the increased prevalence of cardiovascular conditions in the SCI population (Cragg et al. 2013). Regular and sufficiently intense PA is necessary to compensate for functional limitations. Evidence suggests that, despite functional limitations, regular PA can effectively improve fitness (aerobic capacity and muscular strength) (Hicks et al. 2011) and positively influence risk factors of chronic disease (Buchholz et al. 2009; de Groot et al. 2013).

Certain levels of PA are required to reduce the risks of cardiovascular disease. General exercise recommendations coincide with those of the World Health Organization (WHO) (WHO 2010) and suggest consistently performing at least 2.5 hours of moderate aerobic activities and muscle-strengthening exercises on at least 2 days per week (Australian Government Department of Health 2014; FOSP 2013; ODPHP 2008). These recommendations can also be applied to people with disabilities, but they need to be adapted to an individual's capacity, risk, or limitation (WHO 2010). SCI-specific exercise recommendations are available, but lack consensus. Recent exercise recommendations suggest performing 20 minutes of aerobic exercise of at least moderate intensity and muscle-strengthening exercises on at least two days per week to maintain or improve fitness (Martin Ginis et al. 2011). Previous recommendations refer to risk reduction and suggest levels comparable to those for the general population, namely to perform 20-60 minutes of aerobic exercises of at least moderate intensity on 3-5 days a week and muscle-strengthening exercises twice weekly (Jacobs and Nash 2004). Based on current knowledge and to allow a comparison with the general population, it is useful to apply the WHO exercise recommendations to people with SCI until more evidence is available.

There presently exists little knowledge on PA levels in people with SCI. In general, it has been reported that PA levels in the SCI population are rather low (Anneken et al. 2010; Buchholz et al. 2003; Kim et al. 2011; Martin Ginis et al. 2010a; Rauch et al. 2014; Sale et al. 2012; Tasiemski et al. 2000). The reported PA levels vary according to the types of activities and available information on their frequency, duration, and intensity. Figures on those who are physically inactive vary from 27% (Rauch et al. 2014) to 50% (Martin Ginis et al. 2016b). No study has investigated whether people with SCI achieve the recommended PA levels, and we have no information about the characteristics of those who fulfill the recommendations and those who do not. Such information is indispensable to facilitate the identification of target groups that require special consideration when promoting PA.

This study aims (1) to quantify the time spent on different types of PA (sports of different intensities and muscle-strengthening exercises) in people with SCI, (2) to report the proportions of those who are completely physically inactive, who carry out muscle-strengthening exercises regularly, and who perform sports according to the WHO exercise recommendations, and (3) to investigate the socio-demographic and SCI-related characteristics associated with the latter three PA categories.

METHODS

Study design

Data from the nationwide Swiss Spinal Cord Injury Cohort Study (SwiSCI) community survey were analyzed for this study. Participants were recruited via four specialized SCI rehabilitation centers, the national association for people living with SCI (Swiss Paraplegic Association), a SCI-specific home care institution (Parahelp) and a large national insurance company (SUVA). The SwiSCI survey contained three subsequent modules: (1) Starter Module (brief questionnaire on basic socio-demographics, lesion characteristics, care situation), (2) Basic Module (detailed information on functioning, health, environmental and personal factors), and (3) three thematically different specific modules (Post et al. 2011). A representative sample of 1549 individuals with traumatic or non-traumatic SCI with a minimum age of 16 years participated in the first two modules of the survey (response rate: 49.3%, median age: 52 years, 71.5% male, median time since injury: 13.5 years, paraplegia: 69.2%). 570 were randomly selected (stratified for gender, age, and level of injury) to participate in a specific module on psychological personal factors and health behavior, which included questions on PA behavior. The 511 subjects who answered this module were considered for this study.

Data collection

Four items from the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD; items 3 to 6) (Washburn et al. 2002) were selected to assess PA. These items cover sports and recreational activities of (1) light, (2) moderate, and (3) strenuous intensity and (4) muscle-strengthening exercises (power and endurance). For each item, the frequency (never, 1 to 2 days, 3 to 4 days, 5 to 7 days per week) and duration (less than 1 hour, 1 but less than two hours, 2-4 hours, more than 4 hours per day) of the corresponding activity were asked. Based on the combination of answers, the PASIPD provides an algorithm to obtain the average daily activity time (hours/day) spent on each PA category.

Socio-demographic (gender, age, partnership, education, and income), as well as SCI-related (etiology, time since injury, severity and type of locomotion) aspects likely to associate with PA levels, were selected as independent variables. The type of locomotion was assessed with item 13 (mobility for moderate distances, 10-100 meters) of the self-report version of the Spinal Cord Independence Measure (Fekete et al. 2013); the response options for walking with different devices were summarized to "pedestrian with device or support".

Data analysis

Only participants who completely answered the four items of the PASIPD were included in the analyses. Descriptive statistics were conducted to describe the study population. To calculate the hours per week spent on the four types of PA, the average hours/day was multiplied by seven. Sum scores were calculated for the weekly time spent on sports and recreational activities of at least moderate intensity (sum of moderate and strenuous PA items) and for the total time spent on PA per week (sum of all items). All figures were calculated for the total study sample and stratified by socio-demographic and SCI-related characteristics. Whenever feasible, variables collected as metric data were grouped based on current reporting guidelines (DeVivo et al. 2011). Education was categorized based on time required to achieve certain academic degrees, and income was categorized into quartiles of the income distribution. Bivariate non-parametric tests were conducted to identify group differences within the socio-demographic and SCI-related characteristics (binary data: Mann-Whitney; ordinal data: Kruskal-Wallis). The significance level was set at a p-value <0.05. Mann-Whitney U tests were applied to identify the subgroups that differ within the distinct characteristics. The significance level was now set at a p-value of <0.008 based on Bonferroni correction for six tests.

For additional analyzes, three following additional categories were created: (1) being completely physically inactive, (2) performing muscle-strengthening exercises on at least 1 to 2 days per week, and (3) performing sports or recreational activities of at least moderate intensity for at least 2.5 hours per week (according to the WHO exercise recommendations). Frequencies and proportions were calculated for each of these categories. Multivariate logistic regressions were performed, and odds ratios with 95% confidence intervals were calculated.

Missing values in the independent variables were addressed by conducting multiple imputations (MI). For the MI, all variables included in the regression models were entered, and 5 iterations were performed.

RESULTS

Data from 485 subjects were included in this study; their characteristics are presented in Table 1. For these characteristics no differences between the responders and the excluded subjects and non-responders of the survey have been found.

Table 1: Characteristics of the study population (n=485); Switzerland, 2015

		n (% of valid values)	Mean (SD); Median (range)
Gender	male	357 (73.6)	
	Missing	*0 (0.0)*	
Age	In years		52.9 (14.8); 53 (17;90)
	Missing	*0 (0.0)*	
Partnership	Yes	316 (67.4)	
	Missing	*16 (3.3)*	
Years of education	Compulsory school (≤ 9 years)	33 (7.0)	
	Vocational training (10-12 years)	134 (28.3)	
	Secondary education (13-16 years)	215 (45.3)	
	University education (≥17 years)	92 (19.4)	
	Missing	*11 (2.3)*	
Net income per month	In Swiss Francs (CHF)		4,197 (1,918); 3,750 (3,570;9,750)
	Missing	*47 (9.3)*	
Etiology of SCI	Traumatic	380 (78.7)	
	Non-traumatic	103 (21.3)	
	Missing	*2 (0.4)*	
Age at onset of SCI	In years		35.4 (17.5); 32 (0;86)
	Missing	*5 (1.0)*	
Time since injury	In years		17.3 (12.9); 14 (0;76)
	Missing	*0 (0.0)*	
Severity of SCI	Complete paraplegia	159 (32.9)	
	Incomplete paraplegia	169 (35.0)	
	Complete tetraplegia	55 (11.4)	
	Incomplete tetraplegia	100 (20.7)	
	Missing	*2 (0.4)*	
Type of locomotion (when moving around for 10-100m)	Pedestrian without device or assistance	70 (15.0)	
	Pedestrian using device or assistance	91 (19.4)	
	Wheelchair user (manual without assistance)	218 (46.6)	
	Wheelchair user (electric or manual with assistance)	89 (19.0)	
	Missing	*17 (3.5)*	

SCI: spinal cord injury
SD: standard deviation

The time spent on the different PA categories is shown for the total study sample and stratified for socio-demographic (Table 2) and SCI-related characteristics (Table 3). All results on the PA levels showed a non-normal distribution. Overall, participants spent the most time (median: 2.2 h) performing sports of light intensity. People with complete paraplegia, manual wheelchair users, and people with a time since injury of 16-25 years spent the most median time on sports of moderate intensity. The sample spent the least median time on strenuous sporting activities (0.0) and 0.8 h performing muscle-strengthening exercises. On average, participants carried out a total of 2.2 h (median) on sports of moderate or strenuous intensity, whereas the number of hours spent on these intensities was the lowest in women (1.8), the eldest participants (1.5), pedestrians requiring devices (0.8), and in those who needed an electric wheelchair (0.8). The median total time for all PAs per week was 6.0 h.

Table 2: Comparison of sport and exercise levels analyzed for the total sample and for subgroups with socio-demographic characteristics (n=485); Switzerland, 2015

		Mean; Median (Interquartile range)					
		Hours per week				Sum of hours per week	
		Intensity of sport			Muscle exercises	Moderate and strenuous intensity	Total hours
	Subgroups (n)	Light	Moderate	Strenuous			
Total sample	485	3.2; 2.2	2.8; 1.8	1.8; 0.0	1.2; 0.8	4.7; 2.2	9.1; 6.0
		(0.8;4.5)	(0.0; 3.0)	(0.0; 2.2)	(0.0; 1.8)	(0.0; 6.0)	(2.3; 12.0)
Gender	Men	3.3; 1.8	2.8; **1.8**	2.0; 0.0	1.2; 0.8	4.8; 3.0	9.3; 6.7
	(357)	(0.8; 5.3)	(0.0; 3.0)	(0.0; 2.2)	(0.0; 2.2)	(0.0; 6.4)	(2.3; 12.0)
	Women	3.0; 2.2	2.9; **0.8**	1.7; 0.0	1.1; 0.0	4.6; 1.8	8.7; 4.6
	(128)	(0.8; 4.1)	(0.0; 2.2)	(0.0; 2.2)	(0.0; 0.8)	(0.0; 5.8)	(2.2; 10.5)
	p-value[1]	.901	.032*	.152	.195	.062	.143
Age	17-30	3.2; 2.2	3.2; 2.2	2.6; **0.8**°	1.3; 0.8	5.8; **4.5**°	10.3; **8.8**°
	(41)	(0.8; 5.3)	(0.0; 4.9)	(0.0; 4.5)	(0.0; 2.2)	(1.2; 9,8)	(4.1; 13.5)
	31-50	3.8; 2.2	2.9; 1.3	2.5; **0.8**$^{+}$	1.2; 0.0	5.5; 2.8	10.4; 6.7
	(170)	(0.8; 5.3)	(0.0; 3.0)	(0.0; 2.2)	(0.0; 2.2)	(0.6; 7.1)	(2.3; 12.8)
	51-70	3.0; 2.2	2.9; 1.8	1.4; 0.0	1.1; 0.0	4.3; 2.2	8.4; 6.0
	(219)	(0.8; 4.5)	(0.0; 3.0)	(0.0; 2.2)	(0.0; 1.8)	(0.0; 6.0)	(2.3; 11.3)
	71 and older	2.5; 1.8	2.1; 0.8	1.0; **0.0**$^{°,+}$	1.4; 0.0	3.1; **1.5**°	6.9; **4.5**°
	(58)	(0.8; 3.0)	(0.0; 2.2)	(0.0; 0.8)	(0.0; 2.2)	(0.0; 5.3)	(1.5; 10.5)
	p-value[2]	.337	.302	.005*	.253	.058	.039*
Partnership	No partner	3.2; 2.2	3.0; 1.8	1.5; **0.0**	1.0; **0.8**	4.5; 2.2	8.6; 6.0
	(153)	(0.8; 5.3)	(0.0; 2.6)	(0.0; 2.2)	(0.0; 0.8)	(0.0; 6.4)	(2.2; 12.0)
	With partner	3.3; 2.2	2.8; 1.3	2.1; **0.8**	1.4; **0.8**	4.9; 2.5	9.5; 6.5
	(316)	(0.8; 4.5)	(0.0; 3.0)	(0.0; 2.2)	(0.0; 2.2)	(0.8; 6.0)	(2.3; 12.0)
	p-value[1]	.409	.832	.043*	.046*	.487	.621
Education	< 13 years	2.9; 1.8	2.8; 0.8	1.8; **0.0**	1.5; 0.0	4.5; 2.2	8.9; 6.0
	(167)	(0.8; 4.5)	(0.8; 2.2)	(0.0; 2.2)	(0.0; 2.2)	(0.0; 5.3)	(1.8; 12.0)
	>=13 years	3.4; 2.2	2.9; 1.8	2.0; **0.8**	1.0; 0.8	4.9; 3.0	9.3; 6.7
	(307)	(0.8; 5.3)	(0.0; 3.0)	(0.0; 2.2)	(0.0; 1.8)	(0.8; 6.7)	(3.0; 12.0)
	p-value[1]	.123	.555	.002*	.751	.076	.701
Net income per month (in CHF)	<=2.500	2.8; **1.8**°	3.2; 0.8	2.2; 0.0	1.3; 0.8	5.3; 2.2	9.5; 6.7
	(111)	(0.8; 4.5)	(0.0; 5.3)	(0.0; 2.2)	(0.0; 2.2)	(0.0; 7.5)	(1.5; 14.3)
	2.501-3.750	3.1; 1.8	2.6; 1.8	1.2; 0.0	0.9; **0.0**°	3.7; 2.2	7.7; 6.0
	(132)	(0.8; 4.5)	(0.0; 3.0)	(0.0; 2.2)	(0.0; 1.8)	(0.8; 5.3)	(2.2; 11.0)
	3.751-5.250	4.4; **2.2**$^{°,+}$	2.7; 0.8	2.6; 0.8	1.8; **0.8**$^{°,+}$	5.3; 2.4	11.4; 7.1
	(90)	(0.8; 5.3)	(0.0; 2.2)	(0.0; 2.2)	(0.0; 2.2)	(0.8; 6.0)	(3.0; 14.5)
	>5.250	2.8; **1.8**$^{+}$	2.9; 2.2	1.9; 0.0	1.0; **0.0**$^{+}$	4.8; 3.0	8.7; 6.2
	(109)	(0.8; 3.0)	(0.0; 2.2)	(0.0; 2.2)	(0.0; 0.8)	(0.8; 6.7)	(2.3; 11.0)
	p-value[2]	.018*	.981	.321	.019*	.817	.206

[1]p-values for Mann-Whitney-U Test; [2]p-values based on Kruskal-Wallis-Test; significance level for both: *<.05
Bold letters: Significant differences identified between marked groups; for ordinal data by applying post hoc Mann-Whitney-U Tests with Bonferroni adjusted significance level: <.008 (for each 6 test) marked with °,+,△.

People aged between 17 and 30 showed the highest total PA time (median: 8.8 h). People 71 and older (4.5), women (4.6), people with complete tetraplegia (4.5), and users of electric wheelchairs (3.8) showed the lowest total PA times.

Table 3: Comparison of sport and exercise levels analyzed for the total sample and for subgroups with spinal cord injury-specific characteristics (n=485); Switzerland, 2015

		Mean; Median (Interquartile range)					
		Hours per week				Sum of hours per week	
		Intensity of sport			Muscle exercises	Moderate and strenuous intensity	Total hours
	Subgroups (n)	Light	Moderate	Strenuous			
Total sample	485	3.2; 2.2	2.8; 1.8	1.8; 0.0	1.2; 0.8	4.7; 2.2	9.1; 6.0
		(0.8;4.5)	(0.0; 3.0)	(0.0; 2.2)	(0.0; 1.8)	(0.0; 6.0)	(2.3; 12.0)
Etiology of SCI	Traumatic	3.4; 2.2	2.8; 1.8	2.1; **0.8**	1.2; 0.0	5.0; 2.5	9.7; 6.7
	(380)	(0.8; 5.3)	(0.0; 3.0)	(0.0; 2.2)	(0.0; 2.1)	(0.8; 6.7)	(2.5; 12.4)
	Non-traumatic	2.4; 1.8	2.9; 0.8	0.9; **0.0**	1.0; 0.8	3.8; 2.2	7.2; 5.3
	(103)	(0.8; 3.0)	(0.0; 5.3)	(0.0; 1.8)	(0.0; 1.8)	(0.0; 5.3)	(1.8; 9.8)
	p-value[1]	.097	.840	.012*	.530	.180	.126
Time since injury	0-5 years	4.0; **2.2°**	2.8; 0.8	1.9; 0.0	1.8; **0.8°**	4.6; 2.2	10.4; 6.7
	(99)	(0.8; 5.3)	(0.0; 4.5)	(0.0; 2.2)	(0.0; 2.2)	(0.0; 5.3)	(1.8; 12.7)
	6-15 years	3.4; 2.2	2.6; 1.8	2.2; 0.8	1.2; **0.8**$^{+}$	4.8; 2.5	9.4; 6.7
	(155)	(0.8; 5.3)	(0.0; 2.2)	(0.0; 2.2)	(0.0; 2.2)	(0.8; 6.0)	(2.5; 12.0)
	16-25 years	3.0; 2.2	3.8; 2.2	2.0; 0.8	1.0; 0.0	5.8; 3.0	9.8; 6.7
	(108)	(0.8; 5.1)	(0.0; 5.3)	(0.0; 2.2)	(0.0; 1.5)	(0.8; 7.5)	(2.3; 13.5)
	26 years and	2.6; **1.8°**	2.4; 0.8	1.4; 0.0	0.9; **0.0**$^{\circ,+}$	3.8; 2.2	7.3; 5.1
	longer (118)	(0.8; 2.2)	(0.0; 2.2)	(0.0; 2.2)	(0.0; 0.8)	(0.6; 5.3)	(1.8; 9.7)
	p-value[2]	.034*	.310	.110	.010*	.210	.131
Severity of SCI	Incomplete	3.8; 2.2	2.9; 0.8	1.8; **0.0°**	1.4; **0.8°**	4.7; 2.2	9.9; 6.7
	Parapl. (169)	(0.8; 5.3)	(0.0; 3.0)	(0.0; 2.2)	(0.0; 2.2)	(0.0; 6.0)	(2.3; 13.5)
	Complete	2.7; 1.8	2.8; 2.2	2.5; **0.8**$^{+}$	0.9; **0.0°**	5.4; **3.0°**	9.0; 6.3
	Parapl. (159)	(0.8; 3.0)	(0.8; 3.0)	(0.0; 2.2)	(0.0; 1.8)	(0.8; 7.5)	(2.5; 11.3)
	Incomplete	3.1; 1.8	2.9; 0.8	1.6; 0.0	1.5; 0.0	4.5; 2.2	9.0; 5.3
	Tetrapl. (100)	(0.8; 3.0)	(0.0; 2.4)	(0.0; 2.2)	(0.0; 2.1)	(0.0; 6.0)	(1.7; 12.0)
	Complete	3.1; 1.8	2.7; 0.8	0.8; **0.0**$^{\circ,+}$	0.9; 0.0	3.4; **2.2°**	7.4; 4.5
	Tetrapl. (55)	(0.8; 3.0)	(0.0; 2.2)	(0.0; 0.8)	(0.0; 0.8)	(0.0; 4.5)	(2.2; 10.5)
	p-value[2]	.071	.333	.002*	.024*	.037*	.313
Type of locomotion	Pedestrian, no device (70)	3.6; 2.2	1.6; **0.8°**	1.6; **0.4°**	1.1; 0.8	3.1; **2.2°**	7.9; 6.0
		(0.8; 5.3)	(0.0; 2.2)	(0.0; 2.2)	(0.00; 2.24)	(0.0; 4.5)	(2.2; 10.5)
	Pedestrian,	3.2; 1.8	2.6; **0.8**$^{+}$	1.3; **0.0**$^{+}$	1.6; **0.8°**	3.9; **0.8**$^{+}$	8.7; 6.0
	with device (91)	(0.8; 5.3)	(0.0; 2.2)	(0.0; 1.8)	(0.0; 2.2)	(0.0; 5.3)	(1.5; 12.0)
	Wheelchair,	3.2; 2.2	3.2; **2.2**$^{\circ,+,\triangle}$	2.5; **0.8**$^{+,\triangle}$	1.1; 0.8	5.7; **3.0**$^{\circ,+,\triangle}$	10.0; **6.7°**
	manual (218)	(0.8; 4.5)	(0.8; 4.5)	(0.0; 2.2)	(0.0; 1.8)	(1.3; 7.5)	(3.0; 12.2)
	Wheelchair,	2.5; 1.8	3.0; **0.8**$^{\triangle}$	0.5; **0.0**$^{\circ,\triangle}$	0.7; **0.0°**	3.5; **0.8**$^{\triangle}$	6.7; **3.8°**
	electr./assist. (89)	(0.8; 3.0)	(0.0; 2.2)	(0.0; 0.0)	(0.0; 0.8)	(0.0; 5.3)	(1.5; 10.2)
	p-value[2]	.297	<.001**	<.001**	.002*	<.001**	.013*

[1]p-values for Mann-Whitney-U Test; [2]p-values based on Kruskal-Wallis-Test; significance level for both: *<.05; **<.001
Bold letters: Significant differences identified between marked groups; for ordinal data by applying post hoc Mann-Whitney-U Tests with Bonferroni adjusted significance level: <.008 (for each 6 test) marked with $^{\circ,+,\triangle}$.

Significant differences within the subgroups were found for all characteristics in at least one PA category, but most frequently for the "strenuous intensity" and the "muscle-strengthening exercises" category. For the type of locomotion, group differences were found in all PA categories except the "light-intensity" category.

Table 4 shows the proportions and the corresponding odds ratios of those who were completely physically inactive, of those meeting the WHO recommendations by carrying out sports of at least moderate intensity for at least 2.5 h/week, and of those carrying out muscle-strengthening exercises at least 1-2 days/week.

Table 4: Proportions and associations of characteristics with binary physical activity outcomes based on multivariate logistic regression (n=485; imputed dataset; regression analyses adjusted for all variables in the table); Switzerland, 2015

		Completely physically inactive n=90 (18.6%)			At least 1-2 days/week muscle exercises n=240 (50.3%)			>= 2.5 hours of sport with at least moderate intensity n=237 (48.9%)		
	Subgroups	n (% of subgroup)	OR (95%CI)	p-value	n (% of subgroup)	OR (95%CI)	p-value	n (% of subgroup)	OR (95%CI)	p-value
Gender	Men	65 (18.2)	1		183 (51.3)	1		184 (51.5)	1	
	Women	25 (19.5)	1.12 (0.63;2.02)	.696	61 (47.7)	0.82 (0.52;1.27)	.370	53 (41.4)	0.64 (0.41;1.00)	**.049***
Age	17-30	2 (4.9)	1		28 (68.3)	1		25 (61.0)	1	
	31-50	31 (18.2)	4.60 (0.98;21.54)	.053	80 (48.8)	0.47 (0.21;1.02)	.057	88 (51.8)	0.59 (0.27;1.28)	.179
	51-70	41 (18.2)	4.68 (1.00;21.98)	.051	107 (48.9)	0.49 (0.22;1.08)	.076	106 (48.4)	0.58 (0.26;1.26)	.167
	71 and older	16 (29.1)	6.82 (1.36;34.23)	**.020***	26 (47.3)	0.42 (0.16;1.65)	.064	18 (32.7)	0.31 (0.12;0.78)	**.013***
Partnership	No partner	58 (18.4)	1		160 (50.6)	1		159 (50.3)	1	
	With partner	27 (17.6)	0.90 (0.72;1.13)	.789	78 (51.0)	1.08 (0.70;1.66)	.729	71 (46.4)	1.23 (0.80;1.87)	.345
Education	Less than 13 years	40 (24.0)	1		81 (48.5)	1		72 (43.1)	1	
	13 years and more	49 (16.0)	0.69 (0.41;1.16)	.161	155 (50.5)	1.01 (0.67;1.53)	.953	160 (52.1)	1.26 (0.83;1.90)	.278
Net income	<2500 CHF	23 (20.7)	1		58 (47.7)	1		54 (48.6)	1	
	2501-3750 CHF	26 (19.7)	1.00 (0.50;2.00)	.990	64 (48.5)	0.82 (0.47;1.44)	.987	63 (47.7)	0.99 (0.57;1.70)	.962
	3750-5250 CHF	11 (12.2)	0.62 (0.26;1.49)	.281	56 (62.2)	1.51 (0.84;2.70)	.164	45 (50.0)	1.00 (0.56;1.81)	.988
	>5250 CHF	16 (14.7)	0.72 (0.32;1.62)	.430	48 (44.0)	0.82 (0.47;1.44)	.489	57 (52.3)	1.12 (0.63;2.01)	.703
Etiology of SCI	Traumatic	67 (17.6)	1		187 (49.2)	1		193 (50.8)	1	
	Non-traumatic	23 (22.3)	1.11 (0.56;2.18)	.770	55 (53.4)	0.95 (0.56;1.60)	.841	44 (42.7)	0.87 (0.51;1.48)	.611
Time since injury	0-5 years	24 (24.2)	1		56 (56.6)	1		46 (46.5)		
	6-15 years	21 (13.5)	0.48 (0.24;0.74)	**.041***	89 (57.4)	1.03 (0.60;1.76)	.922	78 (50.3)	1.12 (0.65;1.91)	.693
	16-25 years	22 (20.4)	0.87 (0.41;1.86)	.727	50 (46.3)	0.77 (0.42;1.40)	.385	60 (55.6)	1.24 (0.68;2.28)	.483
	26 years and longer	22 (18.6)	0.69 (0.31;1.52)	.353	47 (39.8)	0.63 (0.33;1.17)	.144	52 (44.1)	0.71 (0.37;1.34)	.285
Severity of SCI	Incompl.paraplegic	29 (17.2)	1		101 (59.8)	1		79 (46.7)	1	
	Complete paraplegic	22 (13.8)	2.07 (0.88;4.86)	.095	70 (44.0)	0.56 (0.32;0.99)	**.046**	92 (57.9)	0.90 (0.51;1.60)	.718
	Incompl. tetraplegic	24 (24.0)	1.75 (0.87;3.53)	.120	47 (47.0)	0.67 (0.39;1.16)	.152	45 (45.0)	0.90 (0.52;1.56)	.699
	Complete tetraplegic	15 (27.3)	3.29 (1.24;8.71)	**.017***	24 (43.6)	0.67 (0.32;1.43)	.303	20 (36.4)	0.43 (0.20;0.91)	**.029***
Type of locomotion	Pedestrian without device/support	16 (22.9)	1		38 (54.3)	1		27 (38.6)	1	
	Pedestrian with device or support	24 (26.4)	1.23 (0.54;2.77)	.620	55 (60.4)	1.22 (0.62;2.41)	.563	37 (40.7)	1.13 (0.57;2.21)	.731
	Wheelchair, manual without support	19 (8.7)	0.24 (0.09;0.61)	**.003***	110 (50.5)	1.20 (0.63;2.30)	.582	134 (61.5)	2.83 (1.46;5.47)	**.002***
	Wheelchair, electric or with support	28 (31.5)	0.92 (0.38;2.18)	.842	30 (33.7)	0.60 (0.29;1.24)	.168	31 (34.8)	1.28 (0.61;2.66)	.512

OR = odds ratio; CI = confidence interval; CHF = Swiss francs; SCI = spinal cord injury
* p-value level of significance < .05; marked in bold
To view the n of the subgroups refer to Table 2 and Table 3

18.6% of the study population was completely physically inactive. The youngest showed the lowest, and those requiring an electric wheelchair showed the highest proportion of physically inactive people. The proportion of those who were inactive increased with age, and those aged 71 and older had 6.8 times higher odds of being physically inactive compared to the youngest age group. Those with complete tetraplegia had 3.3 times higher odds of being physically inactive compared to those with incomplete paraplegia. Those with a time of 6-15 years since injury showed significantly lower odds of physical inactivity compared to those with a time since injury of 5 years or less. Manual wheelchair users had significantly reduced odds (OR=0.24) of being physically inactive compared to pedestrians without devices.

50.3% carried out muscle-strengthening exercises at least one to 2 days a week, the highest proportion again being among the youngest and the lowest among those requiring an electric wheelchair. Those with complete paraplegia showed significantly reduced odds (OR 0.56) of carrying out muscle-strengthening exercises compared to those with incomplete paraplegia.

48.9% of the study sample fulfilled the WHO recommendations on PA (at least 2.5 h of sports of at least moderate intensity). 61.5% of those using a manual wheelchair fulfilled these exercise recommendations. Among those aged 71 and older, only 32.7% did. Women, people aged 71 and older, and people with complete tetraplegia had significantly lower odds of fulfilling the recommendations compared to their respective reference population. Manual wheelchair users had significantly lower odds of not achieving the recommendations compared to pedestrians without devices.

DISCUSSION

This study indicates that PA levels in people with SCI in Switzerland are rather high with a median total time of 6.0 h/week (mean: 9.1) of sports and muscle-strengthening exercises. Several studies investigated PA levels in people with SCI (Anneken et al. 2010; Buchholz et al. 2003; de Groot et al. 2011; Martin Ginis et al. 2010a; Rauch et al. 2014; Tasiemski et al. 2000; van den Berg-Emons et al. 2008), but a comparison of the results is limited due to the use of different instruments assessing different concepts (all types of PA, leisure-time PA, or sports only). Three studies reported the time spent on PAs (means), which varied from 49 min/day of dynamic activities (measured using an activity monitor) in a Dutch (van den Berg-Emons et al. 2008) to 55 min/day of all types of leisure-time PAs in a Canadian (using the Physical Activity Recall Assessment for People with Spinal Cord Injury, PARA-SCI) (Martin Ginis et al. 2005) to 3.1 h/day on all types of leisure-time PAs in a Korean sample (using a self-developed questionnaire) (Kim et al. 2011). The differences in the PA levels in the different countries may relate to different amount of services and support for PAs, however, the use of the different instruments may as well contribute to the different findings.

The fact that this study population spent the most time on light and the least time on strenuous PAs differs from findings from the Canadian and Korean SCI populations, where people spent the most time on moderate-intensity PAs (Kim et al. 2011; Martin Ginis et al. 2010a). In our study, especially women, pedestrians using devices and people using an electric wheelchair carried out significantly fewer moderate-intensity PAs than men and people using a manual wheelchair. The time spent on strenuous-intensity PAs in general was rather low and differed significantly in some subgroups (age, partnership, education, etiology, severity of SCI, type of locomotion). Those spending only little time on sports of moderate intensities did not compensate for this by spending more time on sports of strenuous intensity. As a result, 50% of them performed PAs of moderate and strenuous intensities only 0.8 to 1.8 h/week. The preference for sports of low intensity in these subgroups requires investigating the potential reasons for this and how to facilitate their involvement in more strenuous PAs.

In a previous study it was found that interest in participating in performance-oriented types of sports is lower in women than in men (Rauch et al. 2013). The results of this study confirmed these findings. Although no gender differences have been found for the time spent performing sports of strenuous intensity, which indicates that a certain proportion of women are interested in performance-oriented sports, the majority of women preferred PAs of only light intensity. The same may apply to those who have less physical capacity (the elderly, those with more severe SCI). There are also hints that the existing sports programs in Switzerland are more performance oriented (Rauch et al. 2013) and therefore might not fulfill the interests of those who prefer sport with less intensity.

The time spent performing muscle-strengthening exercises is rather low compared to the time spent on light- or moderate-intensity sports. Analysis of differences in the time spent on muscle-strengthening exercises found significant differences in income, time since injury, severity of SCI, and type of locomotion. Future research is required to detect the motives for the certain subgroups that spend more time than others with muscle-strengthening exercises.

This study also showed that with 18.6% the proportion of those who are completely physically inactive is rather low. Previous studies reported much higher proportions: in a German sample 48.5% that did not participate in any sport (Anneken et al. 2010). In a Canadian sample 50.1% reported performing no leisure-time PAs at all (Martin Ginis et al. 2010b). In a previous study in Switzerland 33.3% reported to never participate in sports (Rauch et al. 2014). Even 27.1% of the Swiss general population reported never participating in sports (Lamprecht et al. 2008). Taking into account that the PA levels were assessed differently in these studies, this comparison should not be overemphasized, but it does provide hints that PA levels vary in different contexts. The low proportion of the physically inactive individuals in the Swiss SCI population suggests that the study sample is rather active, but as well a potential selection bias should be considered.

The given response options in the PASIPD do not allow the identification of people who perform muscle-strengthening exercises at least twice weekly, as recommended in general (WHO 2010) and in SCI-specific recommendations (Martin Ginis et al. 2011). In this study, we compared those who do (at least once per week) with those who do not engage in any muscle-strengthening exercises at all. The proportion (50.3%) of our study sample reporting performing muscle-strengthening exercises is high compared to other study populations where this proportion varied from 19.3% ('gym') (Sale et al. 2012) to 32.6% ('resistance training') (Martin Ginis et al. 2010a) and 37.6% ('fitness/resistance training') (Anneken et al. 2010).

48.9% of the study sample fulfilled the WHO exercise recommendations by reporting spending 2.5 h or more per week on sports of at least moderate intensity (WHO 2010). So far, no study has investigated whether people with SCI fulfill general or SCI-specific exercise recommendations, so a comparison with other SCI populations is not presently possible. It has been reported that about two thirds of the general European population does not reach recommended activity levels (WHO 2006), whereas about 41% of Swiss adults reported fulfilling exercise recommendations (Martin et al. 2009). Although our results suggest that the proportion of people who fulfill exercise recommendations is higher in the Swiss SCI-population than in the able-bodied population, a comparative study including both populations would be required to confirm this.

Analysis of subgroups and associations with the three PA categories identified some subgroups, which might require special consideration for future intervention planning. The socio-demographic characteristics partnership, education, and net income were not associated with any of the PA categories. Education and income are well-known determinants for PA in general populations in many countries (Stalsberg and Pedersen 2010), as well as in Switzerland (Lamprecht et al. 2008). Previous studies have already described that these characteristics are not associated with PA levels in people with SCI (Fekete and Rauch 2012; Rauch et al. 2014). This study confirms the assumption that different approaches than in the able-bodied population are required to explain PA behavior in people with SCI.

In this study, gender, age, severity of SCI, time since injury, and the type of locomotion were found to be associated with the PA categories. Women showed a total time of all PAs that was among the lowest. In principle, gender was associated with lower PA levels in women in only few previous studies (Martin Ginis et al. 2010b; Rauch et al. 2014). In this study, the proportion of completely physically inactive women and those who performed muscle-strengthening exercises regularly was comparable to those in men. However, women showed significantly higher odds of not fulfilling the exercise recommendations. Taking into account the fact that women spent significantly less time on moderate-intensity sports than men, future interventions should focus on how to encourage women to increase the intensity when performing sports.

People aged 71 and older have the highest odds of being completely physically inactive and of not fulfilling exercise recommendations compared to those aged 17-30 years. It has to be noted that the odds for the age groups 31-50 and 51-70 are also increased although not significantly. This finding differs from a previous study conducted in Switzerland (Rauch et al. 2014) and from studies conducted in other countries (Martin Ginis et al. 2010b; Wu and Williams 2001), where no association between age and sports participation could be found. However, it is in line with the Swiss general population (Lamprecht et al. 2008). Future PA interventions should target the expected increasing number of older individuals with SCI.

People with complete tetraplegia have significantly increased odds of becoming completely physically inactive and not fulfilling exercise recommendations compared to those with less severe SCIs. Previous research also identified that tetraplegia is associated with lower PA levels (Martin Ginis et al. 2010b; Rauch et al. 2014). Comparable to women and the elderly, people with complete tetraplegia reported spending very little time performing sports of strenuous intensity and did not reach the recommended 2.5 h of sports of at least moderate intensity. Taking into account these three subgroups, it should be investigated whether existing sports programs offer types of sports that are suitable and preferable for people with little physical capacity, such as women, the elderly, and people with tetraplegia.

People with complete paraplegia showed significantly lower odds for performing muscle-strengthening exercises regularly compared to those with incomplete paraplegia. However, they showed the highest proportion of participants fulfilling the exercise recommendations. Thus, people with complete paraplegia are physically active, but prefer sports to muscle-strengthening exercises.

Electric wheelchair users made up the highest proportion of the completely physically inactive and the second highest among those who did not fulfill exercise recommendations. Although no significant differences for sports-associated odds compared to pedestrians without devices could be found, they present a group which should be given special consideration, as they represent the group spending the least total time on PAs.

Pedestrians requiring devices require special attention regarding their PA levels. Although they are able to walk and suffer from less severe SCI, they spend significantly less time on sports of at least moderate intensity than those using a manual wheelchair. The severity of SCI and the related physical capacity alone does not explain PA behavior. The readiness to use a wheelchair only for sports when limitations in walking, running, or cycling do not allow participation in certain types of sports may also influence participation in sports. Future research should investigate this phenomenon since these results show that the type of locomotion should be taken into account when planning interventions for specific target populations.

Although this study shows that PA levels in people with SCI are generally rather high in Switzerland (with some exceptions for distinct subgroups), the available information cannot answer the question whether the achieved PA levels are sufficient to reduce the increased risk for PA-related chronic conditions in the SCI population. Thus, to answer the question whether general or SCI-specific exercise recommendations are applicable to people with SCI with respect to the reduction of risks for secondary conditions longitudinal cohort studies are required.

In this study, PA was assessed by the PASIPD, a self-report in which participants rate the intensity of PAs based on their own judgment. Research has shown that responders to the PASIPD tend to overestimate PA levels (van den Berg-Emons et al. 2011), making it likely that the participants in our study actually performed less and less-intense PAs than reported. This assumption is confirmed by two studies showing only weak correlation between self-reported PA levels and fitness parameters (de Groot et al. 2010) and overestimated energy expenditure when comparing the PASIPD to objective measures (Tanhoffer et al. 2012). Considering the more reliable measures used in the Dutch and Canadian study, the higher PA-levels reported in this Swiss sample should thus be interpreted with caution. Activity monitors designed for wheelchair users, as used in the Dutch study (Bussmann et al. 2001), could overcome the limitations regarding self-reported PA levels. The PARA-SCI (Martin Ginis et al. 2005), an interview-based self-report measure used in the Canadian study, proved to be a good method for predicting energy expenditure in persons with SCI (Tanhoffer et al. 2012). However, for larger studies in which both the use of activity monitors and interviews require large resources, the Leisure Time Physical Activity Questionnaire for People with Spinal Cord Injury (LTPAQ-

SCI) (Martin Ginis et al. 2012), could present a reliable alternative since it showed good correlation with the PARA-SCI. Generally, the use of the same assessment tool is desired to overcome the lack of comparability among different studies.

CONCLUSION

This study attempted for the first time to investigate whether people with SCI fulfill WHO exercise recommendations. It showed that PA levels of people with SCI in Switzerland are rather high, but also identified subgroups that need special consideration when planning interventions. To better understand the physically inactive, those who perform no muscle-strengthening exercises and those who do not fulfill exercise recommendations, future research needs to integrate additional aspects that are likely to be associated with PA levels, such as personal and environmental factors. Future research also needs to investigate whether general exercise recommendations are applicable to people with SCI and whether the achievement of these or SCI-specific recommendations actually lead to a risk reduction for cardiovascular conditions.

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8. Research article III

Associations with being physically active and the achievement of WHO recommendations on physical activity in people with spinal cord injury

Alexandra Rauch[1], Timo Hinrichs[2], Alarcos Cieza[1, 3, 4] for the SwiSCI study group

[1] Department of Medical Informatics, Biometry and Epidemiology – IBE, Chair for Public Health and Health Service Research, Research Unit for Biopsychosocial Health, Ludwig-Maximilians-University Munich, Munich, Germany

[2] Division of Sports and Exercise Medicine, Department of Sport, Exercise and Health, University of Basel, Basel, Switzerland

[3] Swiss Paraplegic Research, Nottwil, Switzerland

[4] Faculty of Social and Human Sciences, School of Psychology, University of Southampton, Southampton, UK

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ABSTRACT

Study design: Secondary data analysis from the cross-sectional survey of the Swiss Spinal Cord Injury Cohort Study.

Objective: To explore associations with physical activity (PA) levels in people with spinal cord injury (SCI) with the specific aim to identify aspects that potentially explain being physically active (PHYS-ACT) and the achievement of the World Health Organization recommendations on PA.

Setting: Community sample (n=485)

Methods: Participants who completely answered four items of the Physical Activity Scale for Individuals with Physical Disabilities were included. Two outcome measures were defined: (1) being PHYS-ACT vs. being completely inactive and (2) achieving WHO recommendations on PA (ACH-WHO-REC) (at least 2.5 hours/week of at least moderate intensity) vs. performing less. Independent variables were selected from the original questionnaire by applying the ICF framework. Multivariate logistic regression analyses were conducted.

Results: In the participants (aged 52.8±14.8; 73.6% male) older age decreased, but being a manual wheelchair user increased the odds of achieving both outcomes. Social support and self-efficacy increased the odds of being PHYS-ACT. Use of an intermittent catheter increased, whereas dependency in self-care mobility and coping with emotions decreased the odds for ACH-WHO-REC. Experiencing hindrances due to accessibility is associated with increased odds for ACH-WHO-REC.

Conclusion: Being PHYS-ACT at all and achieving the WHO recommendations on PA are associated with different aspects. Applying the ICF framework contributes to a comprehensive understanding of PA behavior in people with SCI, which can tailor the development of interventions. Longitudinal studies should be initiated to test these associations for causal relationships.

Key words: Physical activity; exercise; sport; spinal cord injuries; World Health Organization

INTRODUCTION

Physical inactivity is among the most frequent risk factors for mortality in the general population.[1] For people with spinal cord injury (SCI) living in high-income countries, the leading causes for death shift to those in the general population.[2] General and SCI specific guidelines for physical activity (PA) suggest specific types and amounts of PA to prevent diseases related to physical inactivity. The World Health Organization's (WHO) recommendations on PA suggest performing aerobic exercises of at least moderate intensity for at least 150 minutes (2.5 h) per week.[1] In contrast, the most recent SCI-specific guidelines suggest a minimum of at least moderate-intensity aerobic exercises for least 20 min (two times) per week.[3] However, recent research has shown that this amount might not be sufficient to reduce risks, in particular, for cardiovascular diseases.[4]

Recent research in people living with SCI in Switzerland showed that 81% are physically active (PHYS-ACT) by performing any leisure-time PA, whereas only 49% achieve the WHO recommendations for PA (ACH-WHO-REC).[5] When exploring sociodemographic and SCI-related characteristics, it was found that people aged 71 years and older and people with complete tetraplegia had significantly lower odds for being PHYS-ACT and to ACH-WHO-REC compared with their respective reference population. Furthermore, the odds to ACH-WHO-REC was lower for women and the odds to be PHYS-ACT was lower when the time since injury was shorter than 5 years. Manual wheelchair users had significantly higher odds to be PHYS-ACT and to ACH-WHO-REC compared to pedestrians without or with devices and users of an electric wheelchair. These findings ask to investigate associates with being PHYS-ACT and the ACH-WHO-REC.

To date, many aspects covering different areas have been found to explain PA levels in people with SCI;[6] however, comprehensive models have been rarely applied. Given a potential multidimensionality, a comprehensive model that controls for confounding effects among the different domains is useful. The International Classification of Functioning, Disability and Health (ICF)[7] provides a comprehensive model that is composed of body functions, body structures, activities and participation (referring to functioning) and environmental and personal factors (referring to contextual factors). The ICF Core Sets for SCI[8,9] present lists of categories of these components that are relevant to functioning in people with SCI. The ICF framework was first applied in a large quantitative study investigating predictors to explain PA levels in a Canadian population.[10] For Switzerland, a qualitative study used the ICF and identified associations with participation in PA from all ICF components.[11] However, these findings have not been validated with quantitative research yet.

Given that various factors from various domains have been found to associate with PA, the strength of the associations with PA may vary and some aspects may influence each other. A comprehensive approach applying multivariate analyses will help to identify those factors from different domains that finally associate with PA and the achievement of WHO recommendations without confounding each other. Thus, the overall objective of this study is to explore associations with PA levels by applying a comprehensive model based on the ICF framework. The specific aim is to identify those aspects that potentially explain being physically active and the achievement of the WHO recommendations on PA.

MATERIALS AND METHODS

Study design

This study analyzed data from the Swiss Spinal Cord Injury Cohort Study (SwiSCI) Community Survey 2012, which contained three modules: (1) questionnaire on basic sociodemographics, lesion characteristics, care situation; (2) detailed information on functioning, health, environmental and personal factors; and (3) three different specific modules.[12] The modules covered a 'Psychological Personal Factors and Health Behavior Module' module, a 'Work' module, and a 'Health Services Research' module. Participants were recruited via four SCI rehabilitation centers, the national association for people with SCI, an SCI-specific home care institution and a national insurance company. In total, 1549 individuals (traumatic or non-traumatic SCI, 16 years and older) participated in the first two modules of the survey (response rate: 49.3%, median age: 52 years, 71.5% male, median time since injury: 13.5 years, paraplegia: 69.2%). Thereof, 570 were randomly selected to participate in the specific module on 'Psychological Personal Factors and Health Behavior Module', which included questions on PA behavior. Of these, 511 subjects answered this module.

Data collection and item selection

Sociodemographic and SCI-related characteristics were selected to describe the study population. Furthermore, *age, sex, time since onset of SCI, severity of SCI*, and *type of locomotion* were included in the regression analysis as they showed associations with either both or one of the two outcomes in a previous study.[5] The type of locomotion was assessed with item

13 (mobility for moderate distances: 10-100 meters) of the Self-reported Spinal Cord Independence Measure (SR-SCIM),[13] the response options for walking with different devices were summarized to 'pedestrian with device or support'.

PA was assessed with four items (item 3-6) of the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD).[14] These items comprise sport and recreational PAs with light, moderate and strenuous intensity, and muscle strengthening exercises. The total time (hours per week) for each item and for combinations of the different items can be calculated. Moderate- and strenuous-intensity exercises comply with the intensities suggested in the WHO recommendations on PA.

The selection of ICF categories as covariables was based on the Brief ICF Core Set for SCI in the long-term context[8] as well as on considerations on potential predictors of PA levels. These considerations were informed by results from previous studies on correlates of PA in people with SCI.[6,10,11] Whenever more than one variable of the questionnaire referred to one selected ICF category, correlations between these variables and the ACH-WHO-REC were calculated. Only the variable with the highest correlation coefficient was selected. Alternatively, a parent item was created for some variables to combine similar information.

Body Structures*:* Body structures were covered with the severity of SCI. No additional body structure was included.

Body Functions: *Emotional functions* were assessed with the SF-36 five-item Mental Health Index[15] covering five 5-point questions with a sum score from 0 (worst) to 100 (best mental health). *Pain, bowel and bladder functions,* and *spasticity* were each assessed with a question asking for problems during the past 3 months (response options: no, little or rare, moderate or occasionally, severe or chronic problem).

Activities and Participation: *Intermittent catheterization* was assessed with item 6B and *self-care mobility* with the combined items 2A (washing upper body), 2B (washing lower body), 3A (dressing upper body), 3B (dressing lower body), and 11 (transferring from wheelchair to toilet/tub) of the SR-SCIM.[13] Problems in *outdoor mobility* were assessed with one question on the ability to perform the task (response options: not applicable, not possible, with assistance, with support, without support). *Employment* was assessed with one question on the amount of hours spent per week (response options: 0, 1-8, 9-16, 17-24, 25-35, 36 or more). *Social activities* were assessed with one question on the frequency of performing day trips or outdoor activities during the past 4 weeks (response options: 0, 1-2, 3-5, 6-10, 11-18, 19 or more).

Environmental Factors: *Accessibility* of public places was measured with item 1, *social attitudes* with item 3 of the Nottwil Environmental Factors Inventory Short Form[16] asking to evaluate the influence of the respective aspect (response options: no influence, made my life a little harder, made my life a lot harder). *Social support* was assessed with the Social Support Questionnaire.[17] The Social Support Questionnaire asks participants to name the number of supporters and to score the satisfaction with their support. A sum score is calculated (0 presents no and 90 the highest support).

Personal Factors: *Self-efficacy* was assessed with the General Self-Efficacy Scale,[18] which includes ten 4-point items with a total score from 10 to 40 (higher scores meaning better self-efficacy). The Purpose in Life Test-Short Form (PIL-SF)[19] was included to address general life *goals* as an indicator for goal orientation. The PIL-SF comprises four 7-point items with a total score from 4 to 28 (higher scores suggest greater purpose in life). To address coping, the sub-scale *coping with emotions* from the Brief Cope[20] was included as it showed the highest correlation with the ACH-WHO-REC among all scales. This scale summarizes two questions referring to focusing and venting of emotions. The score ranges from 2 to 8 (higher scores meaning increased tendency to apply the strategy).

Data analyses

Descriptive statistics were conducted to describe the study population and to calculate the proportion of those who were PHYS-ACT and those who achieved the WHO recommendations on PA (at least 2.5 hours of moderate and strenuous PAs per week).

Multivariate logistic regression analyses were performed with PHYS-ACT and the ACH-WHO-REC as dependent variables. To prepare data for regression analyses, response options of independent variables with ordinal scales were dichotomized into groups of people who had the corresponding outcome versus those who did not. Hierarchical models entering blocks successively were calculated for the two dependent variables. The first block (socio-demographic and SCI-related variables) consisted of variables that were identified to be independently associated with the respective PA outcome in the previous study.[5] Then, blocks of independent variables referring to each ICF component (body functions, activities and participation, environmental factors, personal factors) were added in a stepwise manner. Thus, the final model included all independent variables.

Missing values in the independent variables were addressed by conducting multiple imputations. Therefore, all variables included in the regression models were entered, and five iterations were performed. In all regression models, odds ratios with 95% confidence intervals and the according *P*-value were calculated. The level of significance was set as $P<.05$. The R^2 (Nagelkerke) was calculated for goodness-of-fit analyses. Statistical analyses were performed with SPSS 21 (SPSS Inc., Chicago, IL, USA).

The survey has been performed in accordance with the ethical standards according to the Declaration of Helsinki and has been approved by the Ethics Committee of the Canton of Lucerne. All participants gave written informed consent.

RESULTS

In total, 485 participants answered the PASIPD completely and were included in this study (Table 1). No differences in sociodemographic and SCI-related characteristics between the respondents and the excluded subjects and non-respondents of the survey have been found.

Table 1: Characteristics of the study population (*n*=485) and proportions of people being PHYS-ACT and achieving WHO recommendations on physical activity (≥2.5 h per week of at least moderate intensity)

		Mean (SD)	n (%)	PHYS-ACT n (valid%)	ACH-WHO-REC n (valid %)
Total sample			485 (100%)	395 (81.4)	237 (48.9)
Gender	male		357 (73.6)	292 (81.8)	184 (51.5)
	female		128 (26.4)	103 (80.5)	53 (41.4)[a]
	Missing		*0 (0.0)*		
Age		52.8 (14.8)			
	17-30		41 (8.5)	39 (95.1)	25 (61.0)
	31-50		170 (35.1)	139 (81.8)	88 (51.8)
	51-70		219 45.2)	178 (81.3)	106 (48.4)
	≥71		55 (11.3)	39 (70.9)[a]	18 (32.7)[a]
	Missing		*0 (0.0)*		
Years of education		13.8 (3.3)			
	<13 years		167 (34.4)	127 (76.0)	72 (43.1)
	13 years		307 (63.3)	258 (84.0)	160 (52.1)
	Missing		*11 (2.3)*		
Etiology of SCI	Traumatic		380 (78.7)	313 (82.4)	193 (50.8)
	Non-traumatic		103 (21.3)	80 (77.7)	44 (42.7)
	Missing		*2 (0.4)*		
Time since injury (in years)		17.3 (12.9)			
	0-5		99 (20.4)	75 (75.8)	46 (46.5)
	6-15		155 (32.0)	134 (86.5)[a]	78 (50.3)
	16-25		108 (22.3)	86 (79.6)	60 (55.6)
	≥26		118 (24.3)	96 (81.4)	52 (44.1)
	Missing		*5 (1.0)*		
Severity of SCI	Incomplete paraplegia		169 (35.0)	140 (82.8)	92 (57.9)
	Complete paraplegia		159 (32.9)	137 (86.2)	79 (46.7)
	Incomplete tetraplegia		100 (20.7)	76 (76.0)	20 (36.4)[a]
	Complete tetraplegia		55 (11.4)	40 (72.7)[a]	45 (45.0)
	Missing		*2 (0.4)*		
Type of locomotion (when moving around for 10-100m)	Pedestrian (neither device nor assistance)		70 (15.0)	54 (77.1)	27 (38.6)
	Pedestrian (with device or assistance)		91 (19.4)	67 (73.6)	37 (40.7)
	Manual wheelchair (no assistance)		218 (46.6)	199 (91.3)[a]	134 (61.5)[a]
	Electric wheelchair / manual with assistance		89 (19.0)	61 (68.5)	31 (34.8)
	Missing		*17 (3.5)*		

Abbreviations: ACH-WHO-REC, achievement of WHO recommendations on physical activity, PHYS-ACT, physically active; SCI, spinal cord injury; WHO, World Health Organization.
[a]For these subgroups, significant differences in being PHYS-ACT and achieving WHO recommendations on physical activity have been found in a previous study.[5]

Table 2 presents an overview of the selected items and the instruments used in the survey to assess these items. Furthermore, it presents the dichotomization of the ordinal variables into each two answer categories and the assessment results (mean value, respectively number of persons referring to each of the answer categories).

Table 2: Overview of the applied instruments used to assess the independent variables, the dichotomization of ordinal variables and the assessment results (n=485)

	Item	Assessment instruments (for the metric variables the total score is presented in brackets)	Mean (s.d.)	Dichotomized answer categories for ordinal variables	n (valid %)
BF	Emotional functions	Five-item MHI-SF36[15] (0-100)	72.5 (±18.0)		
	Pain	Question on severity of chronic pain problem		No pain[a]	130 (28.2)
				Pain	331 (71.8)
	Bowel and/or bladder problems	Question on frequency of bladder problems Question on fecal incontinence		No problem[a]	90 (19.9)
				Bowel and/or bladder problems	363 (80.1)
	Spasticity	Question on frequency of spasticity		No spasticity[a]	125 (27.2)
				Spasticity	335 (72.8)
AP	Use of intermittent catheter	SR-SCIM 14: Use of intermittent catheter		No use[a]	286 (62.2)
				Use	174 (37.8)
	Dependent in self-care mobility	SR-SCIM 2A: Washing upper body SR-SCIM 2B: Washing lower body SR-SCIM 3A: Dressing upper body SR-SCIM 3B: Dressing lower body SR-SCIM 11: Transfer wheelchair-toilet		Independent[a]	141 (29.7)
				Any dependency in at least one of the 5 items	333 (70.3)
	Difficulties in outdoor mobility	Question on difficulties in outdoor mobility		No difficulty[a]	167 (36.0)
				Difficulty	297 (64.0)
	Employment	Question on the amount of hours of paid work per week		Unemployed (0 hrs)[a]	210 (47.2)
				Employed (> 0 hrs)	235 (52.8)
	Social activities	Number of social activities outside of the home during the past 4 weeks		2 times or less[a]	201 (43.1)
				>= 3 times	265 (56.9)
EF	Hindrance due to accessibility	Question on the influence of accessibility of public buildings		No influence[a]	169 (36.0)
				Hindrance	300 (64.0)
	Hindrance due to social attitudes	Question on the influence of negative social attitudes of the society		No influence[a]	350 (75.4)
				Hindrance	114 (24.6)
	Social support	Social Support Questionnaire[17] (0-90)	25.3 (±10.4)		485 (100.0)
PF	Self-efficacy	General Self Efficacy Scale[18] (10-40)	30.4 (±5.6)		462
	Purpose in life	Purpose in Life-Short Form[19] (4-28)	21.3 (±4.7)		472
	Coping with emotions	Sum of items 9 and 21 of the Brief Cope[20] (2-8)	3.9 (±1.4)		472

Abbreviations: AP, activities and participation; BF, body functions; EF, environmental factors; MIH-SF36 = Mental Health Index of the Short Form[15]; PF, personal factors; s.d., standard deviation; SR-SCIM, Self-Reported Spinal Cord Independence Measure.[13]
[a]Reference categories for the dichotomized variables in the regression models (presented in Tables 3 and 4).

Table 3 presents the results for the logistic regression for being PHYS-ACT. The first model shows the significantly decreased and increased odds for being PHYS-ACT for the already known sociodemographic and SCI-related characteristics. While no variable from body functions and activities and participation associated with being PHYS-ACT in the following models, the environmental factors *social support* and the personal factor higher *self-efficacy* significantly increased the odds to be PHYS-ACT. From the first model, only the use of a *manual wheelchair* remained a significant association in the final model; increasing age was still close to the defined significance level. With each stepwise entering of the different blocks, the model fit presented with the Nagelkerke R^2 increased. The final model explained 25% of the variance.

Table 3: Stepwise multivariate logistic regression model for associations with being physically active (n=485; imputed dataset)

	Independent variable	Model 1 OR (95%CI)	p	Model 2 OR (95%CI)	p	Model 3 OR (95%CI)	p	Model 4 OR (95%CI)	p	Model 5 OR (95%CI)	p
	Constant	13.08 (2.57-66.53)		5.73 (0.74-44.3)		4.80 (0.57-40.64)		2.06 (0.22-19.37)		0.50 (0.03-7.32)	
Socio-demographic and SCI-related aspects	Age[a]										
	31-50	0.23 (0.05-1.06)	.059	0.23 (0.05-1.04)	.056	0.23 (0.05-1.06)	.060	0.24 (0.05-1.10)	.068	0.21 (0.04-1.02)	.053
	51-70	0.24 (0.05-1.06)	.060	0.23 (0.05-1.08)	.063	0.23 (0.05-1.10)	.067	0.26 (0.05-1.25)	.092	0.23 (0.45-1.20)	.081
	71 and older	0.15 (0.03-0.75)	**.021**	0.15 (0.03-0.75)	**.021**	0.17 (0.03-0.87)	**.034**	0.21 (0.04-1.16)	.074	0.20 (0.04-1.12)	.066
	Time since onset[a]										
	6-15 years	2.00 (1.01-3.96)	**.047**	2.01 (1.01-4.00)	**.047**	2.03 (1.00-4.10)	**.049**	2.09 (1.03-4.26)	**.043**	1.90 (0.90-4.00)	.092
	16-25years	1.18 (0.58-2.40)	.646	1.17 (0.57-2.40)	.661	1.10 (0.53-2.30)	.800	1.18 (0.56-2.49)	.664	1.01 (0.47-2.18)	.983
	26 years and longer	1.39 (0.66-2.92)	.385	1.30 (0.62-2.75)	.491	1.19 (0.55-2.58)	.656	1.28 (0.59-2.80)	.531	1.04 (0.46-2.34)	.923
	Severity of SCI[a]										
	Complete paraplegic	0.49 (0.22-1.13)	.093	0.49 (0.21-1.13)	.094	0.54 (0.23-1.26)	.153	0.52 (0.22-1.23)	.138	0.48 (0.20-1.15)	.099
	Incomplete tetraplegic	0.60 (0.31-1.17)	.136	0.60 (0.30-1.18)	.138	0.67 (0.33-1.34)	.254	0.68 (0.33-1.36)	.272	0.70 (0.34-1.44)	.329
	Complete tetraplegic	0.39 (0.16-0.97)	**.042**	0.37 (0.15-0.93)	**.035**	0.43 (0.17-1.09)	.076	0.46 (0.18-1.19)	.109	0.52 (0.19-1.41)	.202
	Type of locomotion[a]										
	Pedestrian with device	0.83 (0.38-1.82)	.641	0.89 (0.40-1.99)	.772	1.07 (0.43-2.66)	.891	0.91 (0.36-2.30)	.883	0.96 (0.37-2.47)	.927
	Manual wheelchair	4.29 (1.74-10.61)	**.002**	4.36 (1.74-10.93)	**.002**	5.05 (1.79-14.21)	**.002**	4.36 (1.51-12.58)	**.006**	5.31 (1.75-16.15)	**.003**
	Electrical wheelchair	0.98 (0.43-2.24)	.964	1.05 (0.45-2.45)	.910	1.39 (0.50-3.85)	.531	1.13 (0.39-3.23)	.827	1.19 (0.40-3.57)	.751
BF	Emotional functions			1.01 (0.99-1.03)	.098	1.01 (0.99-1.03)	.163	1.01 (0.99-1.03)	.131	0.99 (0.98-1.01)	.664
	Pain			1.08 (0.55-2.13)	.818	1.01 (0.51-1.97)	.998	0.93 (0.48-1.81)	.834	0.95 (0.48-1.87)	.872
	Bowel and/or bladder problems			0.92 (0.46-1.83)	.815	0.93 (0.46-1.86)	.832	0.86 (0.43-1.73)	.681	0.88 (0.43-1.78)	.718
	Spasticity			1.00 (0.53-1.88)	.998	0.99 (0.52-1.87)	.973	1.05 (0.55-1.99)	.880	0.99 (0.51-1.90)	.967
AP	Use of intermittent catheter					1.39 (0.76-2.53)	.285	1.39 (0.76-2.55)	.290	1.40 (0.75-2.61)	.294
	Dependent in self-care mobility					0.74 (0.35-1.58)	.438	0.66 (0.30-1.47)	.313	0.73 (0.32.1.66)	.449
	Difficulties in outdoor mobility					1.04 (0.55-1.94)	.915	0.92 (0.48-1.76)	.811	0.95 (0.49-1.86)	.885
	Employment					1.00 (0.55-1.81)	.989	0.97 (0.53-1.79)	.930	0.97 (0.52-1.79)	.909
	Social activities					1.56 (0.92-2.66)	.101	1.53 (0.90-2.62)	.118	1.38 (0.80-2.39)	.247
EF	Hindrance due to accessibility							1.40 (0.77-2.55)	.274	1.42 (0.77-2.62)	.257
	Hindrance due to social attitudes							1.54 (0.79-3.00)	.205	1.80 (0.90-3.59)	.095
	Social support							1.03 (1.00-1.06)	**.031**	1.03 (1.01-1.06)	**.020**
PF	Self-efficacy									1.07 (10.1-1.13)	**.014**
	Purpose in life									1.05 (0.98-1.12)	.148
	Coping with emotions									0.86 (0.70-1.04)	.124
	R^2 (Nagelkerke)		.15		.16		.18		.20		.25

Abbreviations: AP, activities and participation; BF, body functions; CI, confidence interval; EF, environmental factors; PF, personal factors, OR, odds ratio; SCI, spinal cord injury.
P-value level of significance < .05 is marked in bold; the reference categories for the independent variables are marked in Table 2.
[a]Reference groups for age = 17-30, for time since onset = 0-5 years, for severity of SCI = incomplete paraplegic and for type of locomotion = pedestrian without devices.

Table 4 presents the results for the analyses for ACH-WHO-REC. As in the previous analyses, no body function was found to explain ACH-WHO-REC. In contrast, from activities and participation the *use of an intermittent catheter* significantly increased, and being *dependent in self-care mobility* significantly decreased the odds to ACH-WHO-REC. From environmental factors, experiencing *hindrances due to accessibility* was significantly associated with ACH-WHO-REC and the personal factors *coping with emotions* significantly decreased the odds to ACH-WHO-REC. From the first model, only *age* and the use of a *manual wheelchair* remained significantly associated with ACH-WHO-REC in the final model: older age decreased and the use of a manual wheelchair increased the odds to ACH-WHO-REC. The stepwise adding of blocks to the fist model again increased the model fit with a R^2 of 20% in the final model.

Table 4: Stepwise multivariate logistic regression model for associations with the achievement of WHO recommendations on physical activity (n=485; imputed dataset)

	Independent variable	Model 1		Model 2		Model 3		Model 4		Model 5	
		OR (95%CI)	p	OR (95%CI)	p	OR (95%CI)	p	OR (95%CI)	p	OR (95%CI)	p
	Constant	1.39 (0.59-3.26)		0.67 (0.17-2.63)		0.52 (0.13-2.16)		0.52 (0.12-2.29)		1.01 (0.15-6.70)	
Socio-demographic and SCI-related aspects	Gender:[a]										
	Female	0.60 (0.39-0.93)	**.022**	0.62 (0.40-0.96)	**.034**	0.63 (0.40-0.99)	**.043**	0.63 (0.40-1.01)	.053	0.66 (0.42-1.06)	.085
	Age:[a]										
	31-50	0.62 (0.30-1.28)	.193	0.59 (0.28-1.24)	.165	0.54 (0.25-1.17)	.116	0.53 (0.24-1.15)	.109	0.49 (0.22-1.08)	.077
	51-70	0.53 (0.28-1.08)	.081	0.50 (0.24-1.05)	.068	0.47 (0.22-1.02)	.057	0.46 (0.21-1.01)	.051	0.39 (0.18-0.89)	**.024**
	71 and older	0.30 (0.12-0.72)	**.007**	0.28 (0.12-0.71)	**.007**	0.33 (0.12-0.87)	**.026**	0.32 (0.12-0.86)	**.024**	0.27 (0.10-0.74)	**.011**
	Severity of SCI:[a]										
	Complete paraplegic	0.86 (0.48-1.50)	.568	0.84 (0.47-1.49)	.547	0.90 (0.50-1.63)	.719	0.91 (0.50-1.66)	.764	0.93 (0.51-1.71)	.813
	Incomplete tetraplegic	0.91 (0.52-1.57)	.734	0.88 (0.51-1.55)	.669	1.02 (0.58-1.82)	.938	1.02 (0.57-1.82)	.955	1.05 (0.59-1.89)	.861
	Complete tetraplegic	0.42 (0.20-0.88)	**.022**	0.41 (0.19-0.88)	**.022**	0.50 (0.23-1.09)	.081	0.54 (0.24-1.20)	.128	0.56 (0.25-1.27)	.954
	Type of locomotion:[a]										
	Pedestrian with device	1.09 (0.56-2.12)	.802	1.08 (0.55-2.14)	.815	1.23 (0.59-2.57)	.589	1.06 (0.50-2.26)	.873	1.02 (0.47-2.21)	.954
	Manual wheelchair	2.79 (1.46-5.32)	**.002**	2.71 (1.40-5.25)	**.003**	2.95 (1.37-6.32)	**.006**	2.37 (1.08-5.20)	**.031**	2.21 (0.99-4.93)	**.052**
	Electrical wheelchair	1.21 (0.59-2.47)	.601	1.19 (0.57-2.50)	.637	1.55 (0.66-3.66)	.315	1.22 (0.50-2.96)	.665	1.10 (0.45-2.71)	.831
BF	Emotional functions			1.01 (0.99-1.02)	.151	1.01 (0.99-1.02)	.245	1.01 (0.99-1.02)	.167	1.00 (0.99-1.02)	.581
	Pain			1.17 (0.74-1.85)	.511	1.05 (0.65-1.70)	.828	1.04 (0.64-1.68)	.881	1.11 (0.67-1.81)	.692
	Bowel and/or bladder problems			0.98 (0.58-1.67)	.943	0.96 (0.55-1.66)	.879	0.93 (0.54-1.62)	.806	0.91 (0.52-1.60)	.747
	Spasticity			1.10 (0.69-1.73)	.695	1.08 (0.68-1.73)	.736	1.10 (0.69-1.75)	.705	1.06 (0.66-1.69)	.822
AP	Use of intermittent catheter					1.73 (1.10-2.70)	**.017**	1.70 (1.08-2.66)	**.022**	1.67 (1.05-2.67)	**.031**
	Dependent in self-care mobility					0.55 (0.32-0.96)	**.035**	0.48 (0.27-0.86)	**.013**	0.51 (0.28-0.91)	**.023**
	Difficulties in outdoor mobility					1.48 (0.93-2.37)	.102	1.44 (0.90-2.31)	.129	1.48 (0.92-2.40)	.108
	Employment					1.10 (0.70-1.73)	.683	1.12 (0.70-1.79)	.635	1.12 (0.69-1.81)	.653
	Social activities					1.48 (0.99-2.22)	.059	1.47 (0.98-2.21)	.065	1.47 (0.97-2.24)	.071
EF	Hindrance due to accessibility							1.67 (1.03-2.71)	**.037**	1.75 (1.07-2.85)	**.025**
	Hindrance due to social attitudes							1.31 (0.80-2.16)	.282	1.36 (0.81-2.27)	.239
	Social support							0.99 (0.97-1.01)	.482	0.99 (0.98-1.01)	.586
PF	Self-efficacy									1.01 (0.96-1.06)	.727
	Purpose in life									1.01 (0.96-1.07)	.680
	Coping with emotions									0.81 (0.69-0.95)	**.010**
	R^2 (Nagelkerke)		.11		.12		.16		.18		.20

Abbreviations: AP, activities and participation; BF, body functions; CI, confidence interval; EF, environmental factors; OR, odds ratio; PF, personal factors, SCI, spinal cord injury; WHO, World Health Organization.

P-value level of significance < .05 is marked in bold; the reference categories for the independent variables are marked in Table 2.

[a]Reference groups for sex = male, for age = 17-30, for severity of SCI = incomplete paraplegic and for type of locomotion = pedestrian without devices.

DISCUSSION

Within the use of a comprehensive model based on the ICF framework, we identified a number of aspects from all components, except from body functions, to associate with PHYS-ACT and the ACH-WHO-REC. Only the type of locomotion was significantly associated with both outcomes.

Being a manual wheelchair user increases the odds for both, being PHYS-ACT and for ACH-WHO-REC, compared to moving around as a pedestrian without using devices or support. Generally, it was already found that PA levels in people who are pedestrians are lower compared to manual wheelchair user.[21] This is relevant for two reasons: First, the finding points out that non-wheelchair users require special attention both in the context of future research as well as for intervention planning. A previous study found that psychosocial factors and the experience of pain may explain the lower levels; however, this is the only evidence yet.[5,22] Second, most research investigated the severity of SCI to explain PA levels and agrees that tetraplegia is associated with lower PA levels compared to paraplegia.[5,21,23-25] The association between the type of locomotion and PA levels, however, is rarely investigated. Furthermore, people with SCI not being wheelchair dependent have not been included in all existing studies. Thus, our findings suggests including the type of locomotion as potential predictor for being PHYS-ACT and ACH-WHO-REC when investigating PA levels.

In addition to the type of locomotion, older age decreased the odds to being PHYS-ACT (*P*-values for the three categories nearly reached significance value). Furthermore, only contextual factors explained the outcome. Both higher social support and higher levels of self-efficacy increased the odds of being PHYS-ACT. Social support in people with SCI is related to physical and mental health, pain, coping, adjustment and life satisfaction.[26] The finding that more social support increases the odds to be PHYS-ACT confirms findings from qualitative studies[11,27-29] but differs from the only quantitative study where social support was not found to associate with being PHYS-ACT.[10] Taking the different findings into account, we assume that whether social support explains being PHYS-ACT in people with SCI depends as well on how people overcome a potential lack of social support. The evaluation of the importance, respectively the strength of intentions to perform physical activities that were found to associate with being PHYS-ACT[10,23] may thereby have an important role.

The finding that higher scores in self-efficacy increase the odds of being PHYS-ACT agrees with existing evidence.[30] General self-efficacy is defined as the 'general beliefs in one's ability to respond to and control environmental demands and challenges'.[18] In addition to the evidence that better self-efficacy is associated with higher PA levels, self-efficacy is considered an intervention target in health promoting programmes.[31,32] Thus, our finding underscores the importance of considering self-efficacy when aiming to empower people with SCI to become or maintain PHYS-ACT.

The ACH-WHO-REC was associated with a larger number of aspects than being PHYS-ACT. The fact that older age decreased the odds for ACH-WHO-REC is well understood as performing increased intensities of physical activities becomes more difficult with age. Increased odds for ACH-WHO-REC were found for using an intermittent catheter. This confirms findings of a previous study that showed that intermittent catheterization is significantly associated with better mobility and social integration compared with those using an indwelling catheter.[33] The use of indwelling catheters or urinal condoms (in men) require one to carry an urine bag, which might be inconvenient and prevents people from performing physical activities.[34] However, people with limited hand functions, for whom the handling of intermittent catheters is rather difficult, are limited in using intermittent catheterization. Application of bladder management that facilitates performing physical activities might present a challenge for them.

Being dependent in self-care mobility decreased the odds for ACH-WHO-REC by about half. Based on a previous qualitative study,[11] we assume that spending considerable time for physical activities as required to ACH-WHO-REC is limited because of the increased time consumption for self-care when dependent, a lack of wheelchair-accessible toilets in public places, which might increase dependence, a lack of supportive persons, or to not wanting to take advantage of support for more time than necessary within the routine self-care. However, these assumptions are not proven and require additional research.

The finding that the experience of hindrances due to accessibility was positively associated with ACH-WHO-REC suggests that people who are more PHYS-ACT experience more physical barriers. Importantly, this does not prevent them from being PHYS-ACT. In previous qualitative studies, lack of accessibility was reported as a barrier to participate in PA.[11,27-29,35-37] Thus, different contexts may contribute to different findings, although more quantitative research including comparisons across different countries is required to validate this assumption. In our study, the question on hindrance due to accessibility did not specify distinct types of buildings. Thus, there is no information on the accessibility of sport facilities. To better understand accessibility in the context of PA, specific questions on accessibility of sport facilities[38,39] should be complemented in the future.

Finally, higher scores in coping with emotions decreased the odds for ACH-WHO-REC. This coping strategy is described as ’the tendency to focus on whatever distress or upset one is experiencing and to ventilate those feelings‘ whereas this tendency is considered as rather maladaptive for successful active coping strategies.[40] In general, different coping strategies contribute to psychosocial adaptation in people with SCI[41] and thus could contribute to participation in PA. In our study, only coping with emotions was included in the analyses because of the given preselection. This personal factor presented the strongest association with ACH-WHO-REC and suggests that people who mentally focus on and ventilate emotional problems are prevented from active coping, and thus from performing physical activities with sufficient duration and intensity. Thus, identifying people with the tendency to focus on their emotions could present a first step before offering strategies to overcome this coping style and replace it by increased physical activities.

None of the investigated body functions was found to associate with one of the two PA outcomes. This confirms the finding for pain and emotional functions from a Canadian study,[10] but differs from a study in Taiwan where PA was associated with less pain and less depressive symptoms.[42] Importantly, the identification of associations with pain and spasticity can be influenced by the fact that pain and spasticity can both be improved and be aggravated by PA.[11] To overcome this limitation and to better understand the associations, the quality of the relationships should be assessed in future assessments.

Some limitations related to our study need to be mentioned. Based on the cross-sectional design of the study we cannot draw any conclusions regarding causal relationships. Furthermore, data on PA were collected with a self-report questionnaire for which it is known that the PA levels are rather overestimated.[43] Importantly, to date, evidence is lacking on whether the ACH-WHO-REC indeed reduces the risk for cardiovascular diseases in people with SCI. Future research is required to confirm this, respectively to determine PA levels that are appropriate for people with SCI. Finally, the inclusion of potential aspects that additionally could associate with the ACH-WHO-REC was limited because of the fact that this study presented a secondary data analyses.

The application of the ICF framework contributed to a comprehensive understanding of PA levels in people with SCI. Except body functions, aspects from all components presented associations with the two outcomes. When aiming to empower people to become or remain physically active at all, social support and self-efficacy are significant aspects to consider. However, when aiming to empower people to achieve the WHO recommendations on PA, other aspects come to the fore. Then, dependence during self-care and coping with emotions should become intervention targets. Independently from the type of PA, people with SCI not using a wheelchair should receive specific attention in both future research and intervention planning for promoting PA. Longitudinal studies should be initiated to test these associations for causal relationships.

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Members of the SwiSCI Steering Committee:

Xavier Jordan, Bertrand Léger (Clinique Romande de Réadaptation, Sion); Michael Baumberger, Hans Peter Gmünder (Swiss Paraplegic Center, Nottwil); Armin Curt, Martin Schubert (University Clinic Balgrist, Zürich); Margret Hund-Georgiadis, Kerstin Hug (REHAB Basel, Basel); Hans Georg Koch, (Swiss Paraplegic Association, Nottwil); Hardy Landolt (Representative of persons with SCI, Glarus); Hansjörg Koch (SUVA, Luzern); Mirjam Brach, Gerold Stucki (Swiss Paraplegic Research, Nottwil); Martin Brinkhof, Christine Thyrian (SwiSCI Study Center at Swiss Paraplegic Research, Nottwil).

Conflict of interest

The authors declare no conflict of interest.

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9. Appendixes

9.1. Questions selected from the study "Labour market integration in people with spinal cord injury"

These data were analyzed in study I „Participation in sport in persons with spinal cord injury in Switzerland". The presented numbers of the questions refer to the numbering used in the original questionnaire.

3. Bitte geben Sie die Charakteristika Ihrer Querschnittlähmung an.
3.1 Bitte nennen Sie die Ursache Ihrer Querschnittlähmung:

☐ Sportunfall
☐ Verkehrsunfall
☐ Tätlichkeit
☐ Sturz
☐ Krankheit
☐ Folge einer OP
☐ andere Ursache, bitte eintragen: ____________________________

3.2 Bitte geben Sie das Datum Ihrer Verunfallung bzw. das (ungefähre) Datum des Eintritts Ihrer krankheitsbedingten Querschnittlähmung an.

_____________ Tag ______________ Monat ____________ Jahr

3.4 Geben Sie zusätzlich bitte an, ob Sie eine Para- oder Tetraplegie haben:

☐ Paraplegie
☐ Tetraplegie

3.5 Bitte spezifizieren Sie ferner den Vollständigkeitsgrad Ihrer Verletzung.

☐ komplett
☐ inkomplett, sensorische Funktion (teilweise) erhalten
☐ inkomplett, motorische Funktion (teilweise) erhalten
☐ inkomplett, motorische und sensorische Funktionen teilweise erhalten
☐ inkomplett (nicht spezifiziert)
☐ ist mir unbekannt

3.6 Sind Sie im täglichen Leben auf einen Rollstuhl angewiesen?

☐ Nein
☐ Ja, hauptsächlich mechanischer Rollstuhl
☐ Ja, hauptsächlich elektrischer Rollstuhl

4. Bitte kreuzen Sie Ihr Geschlecht an.

☐ männlich
☐ weiblich

5. Wann wurden Sie geboren?

Geburtsdatum: ________________/________________/19____________

6. Was ist Ihr jetziger …
6.1. … höchster allgemeinbildender Abschluss?

- ☐ Kein Abschluss
- ☐ Primarschule
- ☐ Sonderschule
- ☐ Realschule
- ☐ Sekundarschule
- ☐ Berufsmatura
- ☐ Matura
- ☐ Andere: ____

7. Was ist Ihr derzeitiger Familienstand?

- ☐ ledig (nie verheiratet) und nicht mit festem Partner zusammenlebend
- ☐ ledig (nie verheiratet), aber mit festem Partner zusammenlebend
- ☐ verheiratet und zusammen lebend
- ☐ verheiratet, aber getrennt lebend
- ☐ geschieden
- ☐ verwitwet

8. Haben Sie Kinder?

- ☐ Nein (-> Bitte weiter mit Frage 10)
- ☐ Ja. Wie viele? ____________________

22. Welchen der folgenden sozialen Aktivitäten sind Sie vor Eintritt Ihrer Querschnittlähmung nachgegangen? Sie können mehrere Antworten ankreuzen!

- ☐ Ich war aktives Mitglied in mindestens einem Verein.
- ☐ Ich habe mich ehrenamtlich engagiert (Freiwilligenarbeit).
- ☐ Ich habe mich politisch engagiert (z.B. in einer Partei, Initiative etc.).
- ☐ Ich habe mich im Rahmen von kirchlichen/religiösen Institutionen engagiert.
- ☐ Keine der genannten Aktivitäten.

23. Wie häufig haben Sie vor Eintritt Ihrer Querschnittlähmung (mindestens eine halbe Stunde) Sport getrieben?

Täglich	mehrmals pro Woche	einmal pro Woche	mehrmals im Monat	seltener
1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

25. Wie wichtig waren Ihnen folgende 5 Lebensbereiche vor Eintritt der Querschnittlähmung? Bitte geben Sie jeweils einen Prozentsatz an.

Arbeit	__________ %
Sport	__________ %
Familie/Partner	__________ %
Freundeskreis	__________ %
Sonstige Freizeitaktivitäten	__________ %
Total	100 %

49. Wie wichtig sind Ihnen heute folgende 5 Lebensbereiche? Bitte geben Sie jeweils einen Prozentsatz an.

Arbeit	___________ %
Sport	___________ %
Familie/Partner	___________ %
Freundeskreis	___________ %
Sonstige Freizeitaktivitäten	___________ %
Total	100 %

51. Zu wie viel Prozent gehen Sie heute einer Erwerbsarbeit nach?

___________ %

63. Bitte schätzen Sie Ihre heutige allgemeine gesundheitliche Situation ein

Sehr schlecht	eher schlecht	mittel	eher gut	sehr gut
1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

64. Welchen der folgenden sozialen Aktivitäten gehen Sie heute nach? Sie können mehrere Antworten ankreuzen!

☐ Ich bin aktives Mitglied in mindestens einem Verein.
☐ Ich engagiere mich ehrenamtlich (Freiwilligenarbeit).
☐ Ich engagiere mich politisch (z.B. in einer Partei, Initiative etc.).
☐ Ich engagiere mich im Rahmen von kirchlichen/religiösen Institutionen.
☐ Keine der genannten Aktivitäten.

65. Wie häufig treiben Sie heute (mindestens eine halbe Stunde) Sport?

Täglich	mehrmals pro Woche	einmal pro Woche	mehrmals im Monat	seltener
1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

71. Bitte schätzen Sie Ihre körperlichen Beschwerden/Schmerzen zum jetzigen Zeitpunkt ein.

keinerlei Schmerz											stärkster Schmerz, den ich mir vorstellen kann
	1	2	3	4	5	6	7	8	9	10	

9.2. QUESTIONNAIRES FROM THE SWISS SPINAL CORD INJURY STUDY (SWISCI)

These data were analyzed in study II „Do people with spinal cord injury achieve WHO recommendations on physical activity?“ and study III „Associations with being physically active and the achievement of WHO recommendations on physical activity in people with spinal cord injury“ The presented numbers of the questions refer to the numbering used in the original questionnaire.

Questions selected from the starter module (socio-demographics, lesion characteristics)

1. Geschlecht:

☐ Männlich
☐ Weiblich

2. Geburtsdatum:

__________________________________ *(Tag / Monat / Jahr, z.B. 18 / 08 / 1942)*

3. Was ist zurzeit Ihr Zivilstand?

☐ Ledig (nie verheiratet)
☐ Verheiratet, seit: ___________ *(Jahr)*
☐ Geschieden, seit: ___________ *(Jahr)*
☐ Verwitwet, seit: ___________ *(Jahr)*
☐ Eingetragene Partnerschaft, seit: ___________ *(Jahr)*

4. Haben Sie zurzeit einen festen Partner?

☐ Ja
☐ Nein

6. Bitte geben Sie an, wie viele Jahre Schul- und Berufsausbildung Sie insgesamt absolviert haben.
à *_Bsp.: 6 (Primarschule) + 3 (Sekundarschule) + 4 (Berufslehre) = 13 Jahre.* à *_Bsp.: 6 (Primarschule) + 7 (Gymnasium) + 4 (Studium) = 17 Jahre.*

Jahre in der Schul- und Berufsausbildung insgesamt: ______________Jahre

8. Was ist zurzeit Ihre berufliche Situation?

Mehrere Antworten möglich

☐ Erwerbstätig (Beschäftigung: _____% Pensum)
☐ In Ausbildung (Schule, Studium, etc.)
☐ In einer unbezahlten Arbeit (Umschulung, unbezahltes Praktikum, etc.)
☐ Arbeitslos (aber auf Arbeitssuche)
☐ Hausfrau, Hausmann
☐ Invalidenrente: ☐ ¼ / ☐ ½ / ☐ ¾ / ☐ 1
☐ Im Ruhestand
☐ Andere, nämlich: ______________________________

10. Bitte geben Sie so genau wie möglich das Datum an, an dem Ihre Rückenmarksverletzung eingetreten ist:

______________________________*(Tag / Monat / Jahr, z.B. 10 / 07 / 1982*

11. Bitte geben Sie die Ursache Ihrer Rückenmarksverletzung an

☐ **Folge eines Unfalls:** *mehrere Antworten möglich*
- ☐ Unfall bei Sport oder Freizeit
- ☐ Verkehrsunfall
- ☐ Sturz
- ☐ Verletzung durch Gewalteinfluss (z.B. Schussverletzung)
- ☐ Andere Unfallursache

☐ **Folge einer Krankheit:** *mehrere Antworten möglich*
- ☐ Tumor
- ☐ Entzündung
- ☐ Blutung
- ☐ Infektion
- ☐ Folge eines medizinischen Eingriffes
- ☐ Andere Krankheitsursache

☐ Andere Ursache: ____________________________________

13. Haben Sie eine Para- oder eine Tetraplegie?

- ☐ Paraplegie
- ☐ Tetraplegie

14. Habe Sie eine komplette oder eine inkomplette Lähmung?

- ☐ Komplett (keine Muskelkraft oder Sensibilität unterhalb der Lähmungshöhe)
- ☐ Inkomplett (Muskelkraft oder Sensibilität unterhalb der Lähmungshöhe vorhanden)

Questions selected from the Basic Module (functioning, health, environmental and personal factors)

Gesundheitliche Probleme	Bitte geben Sie bei den folgenden gesundheitlichen Problemen an, wie häufig diese Probleme in den letzten 3 Monaten aufgetreten sind und wie schwer sie waren.			
	nicht aufgetreten, unbedeutendes Problem	*leichtes oder seltenes Problem*	*mäßiges oder gelegentliches Problem*	*bedeutendes oder chronisches Problem*
14. Muskelkrämpfe, Spastik	☐	☐	☐	☐
15. Chronische Schmerzen	☐	☐	☐	☐
21. Störungen der Harnblasenfunktion *Hierzu zählen Inkontinenz, Blasen- oder Nierensteine, Nierenprobleme, Blaseschwäche und Harnrückstau*	☐	☐	☐	☐
22. Störungen der Darmfunktion *Hierzu zählen Durchfall und Verstopfung sowie Darminkontinenzprobleme*	☐	☐	☐	☐

Stimmung

In diesen Frage geht es darum, wie Sie sich fühlen und wie es Ihnen in den vergangenen 4 Wochen gegangen ist.

	Immer	*Meistens*	*Ziemlich oft*	*Manchmal*	*Selten*	*Nie*
38. Sehr nervös	☐	☐	☐	☐	☐	☐
39. so niedergeschlagen, dass Sie nichts aufheitern konnte?	☐	☐	☐	☐	☐	☐
40. ruhig und gelassen?	☐	☐	☐	☐	☐	☐
41. entmutigt und traurig?	☐	☐	☐	☐	☐	☐
42. glücklich?	☐	☐	☐	☐	☐	☐

Ausführen von alltäglichen Aktivitäten

Bitte kreuzen Sie zu jeder Frage diejenige Aussage an, die Ihrer derzeitigen Situation am besten entspricht. Bitte lesen Sie die Texte genau durch und kreuzen Sie jeweils immer nur eine Aussage an

49. Waschen des Oberkörpers und Kopfes

Das Waschen des Oberkörpers und Kopfes schließt das Einseifen und Abtrocknen sowie die Benutzung eines Wasserhahns ein.

☐ Ich benötige vollständige Unterstützung.
☐ Ich benötige teilweise Unterstützung.
☐ Ich bin selbstständig, benötige jedoch Hilfsvorrichtungen oder eine spezielle Ausstattung (z.B. Griffstangen, Stuhl).
☐ Ich bin selbstständig und benötige keine Hilfsvorrichtungen und keine spezielle Ausstattung.

50. Waschen des Unterkörpers

Das Waschen des Unterkörpers schließt das Einseifen und Abtrocknen sowie die Benutzung eines Wasserhahns ein.

☐ Ich benötige vollständige Unterstützung.
☐ Ich benötige teilweise Unterstützung.
☐ Ich bin selbstständig, benötige jedoch Hilfsvorrichtungen oder eine spezielle Ausstattung (z.B. Griffstangen, Stuhl).
☐ Ich bin selbstständig und benötige keine Hilfsvorrichtungen und keine spezielle Ausstattung.

51. Ankleiden des Oberkörpers

Das Ankleiden des Oberkörpers umfasst das An- und Ausziehen von Kleidungsstücken wie T-Shirts, Blusen, Hemden, BHs, Schals oder Orthesen (z.B. Armschienen, Halsmanschetten, Rückenkorsette).
Einfach anzuziehende Kleidungsstücke sind solche ohne Knöpfe, Reißverschlüsse oder Schnürbänder.
Schwierig anzuziehende Kleidungsstücke sind solche mit Knöpfen, Reißverschlüssen oder Schnürbändern.

☐ Ich benötige vollständige Unterstützung.
☐ Ich benötige teilweise Unterstützung, auch bei einfach anzuziehenden Kleidungsstücken.
☐ Ich benötige keine Unterstützung bei einfach anzuziehenden Kleidungsstücken, aber ich benötige dazu Hilfsvorrichtungen oder eine spezielle Ausstattung.
☐ Ich kleide mich mit einfach anzuziehenden Kleidungsstücken selbstständig an und benötige nur bei schwierig anzuziehenden Kleidungsstücken Unterstützung oder Hilfsvorrichtungen bzw. eine spezielle Ausstattung.
☐ Ich kleide mich vollkommen selbstständig an.

52. Ankleiden des Unterkörpers
Das Ankleiden des Unterkörpers umfasst das An- und Ausziehen von Kleidungsstücken wie Shorts, Hosen, Schuhe, Socken, Gürtel oder Orthesen (z.B. Beinschienen).
Einfach anzuziehende Kleidungsstücke sind solche ohne Knöpfe, Reißverschlüsse oder Schnürbänder.
Schwierig anzuziehende Kleidungsstücke sind solche mit Knöpfen, Reißverschlüssen oder Schnürbändern.

☐ Ich benötige vollständige Unterstützung.
☐ Ich benötige teilweise Unterstützung, auch bei einfach anzuziehenden Kleidungsstücken.
☐ Ich benötige keine Unterstützung bei einfach anzuziehenden Kleidungsstücken, aber ich benötige dazu Hilfsvorrichtungen oder eine spezielle Ausstattung.
☐ Ich kleide mich mit einfach anzuziehenden Kleidungsstücken selbstständig an und benötige nur bei schwierig anzuziehenden Kleidungsstücken Unterstützung oder Hilfsvorrichtungen bzw. eine spezielle Ausstattung.
☐ Ich kleide mich vollkommen selbstständig an.

55. b) Zeitweise Katheterisierung

☐ Ich benötige vollständige Unterstützung.
☐ Ich führe sie mit Unterstützung selbst durch (Selbstkatheterisierung).
☐ Ich führe sie ohne Unterstützung selbst durch (Selbstkatheterisierung).
☐ Ich wende sie nicht an.

60. Transfer vom Rollstuhl auf die Toilette/in die Badewanne
Dieser Transfer umfasst auch den Transfer vom Rollstuhl oder vom Bett auf einen Toilettenrollstuhl.

☐ Ich benötige vollständige Unterstützung.
☐ Ich benötige Unterstützung, Beaufsichtigung oder Hilfsvorrichtungen (z.B. Griffstangen).
☐ Ich benötige keine Unterstützung oder Hilfsvorrichtungen.
☐ Ich benutze keinen Rollstuhl.

63. Fortbewegung außer Haus über mehr als 100 Meter

Ich benutze einen Rollstuhl. Zur Fortbewegung benötige ich…

☐ vollständige Unterstützung.

☐ einen elektrischen Rollstuhl oder teilweise Unterstützung in einem manuellen Rollstuhl.
☐ keine Unterstützung in einem manuellen Rollstuhl.

Ich gehe über mehr als 100 Meter zu Fuß und...
☐ benötige beim Gehen Beaufsichtigung (mit oder ohne Gehhilfen).
☐ gehe mit einem Gehgestell oder mit Krücken und schwinge beide Füße gleichzeitig vor.
☐ gehe mit Krücken oder mit zwei Gehstöcken und setze einen Fuß nach dem anderen auf.
☐ gehe mit einem Gehstock.
☐ gehe nur mit Beinorthose/-n (z.B. Beinschiene).
☐ gehe ohne Gehhilfen

Teilnahme an Aktivitäten

Der folgende Abschnitt enthält Fragen zu Ihren Alltagsaktivitäten und ist in vier Bereiche unterteilt:
(A) Wie viel Zeit verbringen Sie mit Arbeiten, Aus-/Fortbildung und Haushaltsarbeiten?
(B) Wie oft führen Sie bestimmte Aktivitäten aus?
(C) Sind Sie in Ihren Alltagsaktivitäten eingeschränkt?
(D) Wie zufrieden sind Sie mit Ihrem Alltagsleben?

A. Wie viele Stunden verbringen Sie pro Woche mit folgenden Aktivitäten?
Die folgenden Fragen beziehen sich auf eine normale Woche (Ferien/Urlaub und eventuelle Anfahrts-/Reisezeiten sind ausgeschlossen).
Die Fragen beziehen sich auf die Anzahl Stunden pro Woche.
Bitte kreuzen Sie die Antwort an, die Ihre Situation am besten beschreibt.

	0 Std.	*1-8 Std.*	*9-16 Std.*	*17-24 Std.*	*25-35 Std.*	*36 Std. oder länger*
73. Bezahlte Arbeit *alle Arten bezahlter Arbeit, auch Arbeit im eigenen Betrieb*	☐	☐	☐	☐	☐	☐

B. Wie oft haben Sie in den vergangenen 4 Wochen folgende Aktivitäten durchgeführt?
Wenn Sie beispielsweise ca. zwei Mal pro Woche Spazierengehen, sind das acht Mal in vier Wochen. Wählen Sie dann die Kategorie „6-10 Mal“.
Berücksichtigen Sie jede Aktivität nur in jeweils einer Kategorie.
Aktivitäten bezüglich Arbeit, Schule oder Haushalt sind ausgeschlossen. Anfahrts-/Reisezeiten sind ausgeschlossen.
Die Fragen beziehen sich auf die Häufigkeit in den vergangenen 4 Wochen.

	Nie	*1-2 Mal*	*3-5 Mal*	*6-10 Mal*	*11-18 Mal*	*19 Mal oder öfter*
79. Tagesausflüge und andere Aktivitäten außer Haus *z.B. Shopping, Veranstaltungsbesuche, Badeausflüge, Kirchen- oder Moscheen-Besuche*	☐	☐	☐	☐	☐	☐

C. Werden Sie durch Ihre Rückenmarksverletzung momentan in Ihrem Alltagsleben eingeschränkt?
Nicht zutreffend: Sie führen diese Aktivität nicht aus, jedoch nicht aufgrund Ihrer Rückenmarksverletzung.

Nicht möglich: Sie führen diese Aktivität nicht aus, und zwar aufgrund Ihrer Rückenmarksverletzung.
Hilfe erforderlich: Sie führen diese Aktivität teilweise selbst aus, Sie benötigen dabei aber Hilfe aufgrund Ihrer Rückenmarksverletzung. Zum Beispiel: Sie haben eine Hilfe für anstrengende Haushaltsarbeiten, Familienmitglieder fahren Sie mit dem Auto zu Ihren Zielen. Dies bezieht sich sowohl auf bezahlte Hilfe als auch auf unbezahlte Hilfe von Familienmitgliedern oder Freunden.
Mit Mühe: Wenn Sie aufgrund Ihrer Rückenmarksverletzung mit der Durchführung der Aktivität mehr Mühe haben, und Sie z. B. wesentlich länger brauchen, zwischendurch ausruhen müssen, die Aktivität jetzt seltener oder kürzer oder auf weniger anstrengende Art durchführen.

	Nicht zutreffen d	*Nicht möglich*	*Hilfe er-forder-lich*	*Mit Mühe*	*Ohne Mühe*
86. Außerhäusliche Mobilität *z.B. Autofahren, Bus- oder Bahnreisen, mit dem Handbike/Rollstuhl zur Arbeit oder zum Einkaufen fahren*	☐	☐	☐	☐	☐

Äußere Einflüsse (Umweltfaktoren)

Im alltäglichen Leben ist man vielfältigen äußeren Einflüssen (so genannten Umweltfaktoren) ausgesetzt, die einem den Alltag erleichtern oder erschweren können
Welche Faktoren haben Ihre Teilhabe am gesellschaftlichen Leben in den letzten vier Wochen etwas oder massiv erschwert? Bitte beziehen Sie sich dabei darauf, wie Sie sich Ihr gesellschaftliches Leben wünschen würden.

	Trifft nicht zu	*Hatte keinen Einfluss*	*Hat mein Leben etwas erschwert*	*Hat mein Leben massiv erschwert*
105. Fehlende oder unzureichende Zugänglichkeit zu öffentlichen Orten *z.B. öffentliche Gebäude oder Park*	☐	☐	☐	☐
107. Negative gesellschaftliche Einstellungen gegenüber Menschen mit Behinderung *z.B. fehlende Akzeptanz, Ignoranz*	☐	☐	☐	☐

Questions selected from the Specific Module (health behavior, psychological personal factors)

Bewegung und Sport (PASIPD)

Die folgenden Fragen zu Bewegung und Sport beziehen sich auf unterschiedliche Intensitäten der Bewegung. Es wird gefragt, wie oft Sie in einer durchschnittlichen Woche leichte, mäßige und anstrengende sportliche Aktivitäten/Freizeitaktivitäten und Krafttraining absolvieren und wie lange Sie dies an den aktiven Tagen tun.

6. a) Wie oft führen Sie in einer durchschnittlichen Woche leichte sportliche Aktivitäten oder Freizeitaktivitäten wie Bowling, Darts, therapeutische Übungen (Physio- oder Ergotherapie, Dehnübungen, Benutzung eines Stehpultes) oder andere vergleichbare Aktivitäten aus?

- ☐ Nie >> weiter zu Frage 7
- ☐ An 1 bis 2 Tagen
- ☐ An 3 bis 4 Tagen
- ☐ An 5 bis 7 Tagen

6. b) Wie viele Stunden pro Tag wenden Sie für diese leichten sportlichen Aktivitäten oder Freizeitaktivitäten durchschnittlich auf?

- ☐ Weniger als 1 Stunde
- ☐ 1 bis 2 Stunden
- ☐ 2 bis 4 Stunden
- ☐ Mehr als 4 Stunden

7. a) Wie oft führen Sie in einer durchschnittlichen Woche mäßige sportliche Aktivitäten und Freizeitaktivitäten wie Golf, Softball, mit dem Rollstuhl Spazieren fahren oder andere vergleichbare Aktivitäten aus?

- ☐ Nie >> weiter zu Frage 8
- ☐ An 1 bis 2 Tagen
- ☐ An 3 bis 4 Tagen
- ☐ An 5 bis 7 Tagen

7. b) Wie viele Stunden pro Tag wenden Sie für diese mäßigen sportlichen Aktivitäten oder Freizeitaktivitäten durchschnittlich auf?

- ☐ Weniger als 1 Stunde
- ☐ 1 bis 2 Stunden
- ☐ 2 bis 4 Stunden
- ☐ Mehr als 4 Stunden

8. a) Wie oft führen Sie in einer durchschnittlichen Woche anstrengende sportliche Aktivitäten und Freizeitaktivitäten wie Rollstuhlfahren im Gelände, Schwimmen, Training am Armkurbel-Ergometer, Rollstuhl oder Handbike-Training, Tennis, Rugby, Basketball oder andere vergleichbare Aktivitäten aus?

- ☐ Nie >> weiter zu Frage 9
- ☐ An 1 bis 2 Tagen
- ☐ An 3 bis 4 Tagen
- ☐ An 5 bis 7 Tagen

8. b) Wie viele Stunden pro Tag wenden Sie für diese anstrengenden sportlichen Aktivitäten oder Freizeitaktivitäten durchschnittlich auf?

- ☐ Weniger als 1 Stunde
- ☐ 1 bis 2 Stunden
- ☐ 2 bis 4 Stunden
- ☐ Mehr als 4 Stunden

9. a) Wie oft führen Sie in einer durchschnittlichen Woche Übungen speziell zur Steigerung der Muskelkraft und Muskelausdauer wie Gewichtheben, Liegestützen, Klimmzüge oder andere vergleichbare Aktivitäten aus?

- ☐ Nie >> weiter zu Frage 10

☐ An 1 bis 2 Tagen
☐ An 3 bis 4 Tagen
☐ An 5 bis 7 Tagen

9. b) Wie viele Stunden pro Tag wenden Sie für diese Übungen zur Steigerung der Muskelkraft und Muskelausdauer durchschnittlich auf?
☐ Weniger als 1 Stunde
☐ 1 bis 2 Stunden
☐ 2 bis 4 Stunden
☐ Mehr als 4 Stunden

Einschätzung eigener Fähigkeiten (Self-efficacy)

Bitte lesen Sie jede Aussage genau durch und kreuzen Sie das Kästchen an, welches Sie am besten beschreibt.

	Stimmt nicht	*Stimmt kaum*	*Stimmt eher*	*Stimmt genau*
65. Die Lösung schwieriger Probleme gelingt mir immer, wenn ich mich sehr darum bemühe.	☐	☐	☐	☐
66. Wenn sich Widerstände auftun, finde ich Mittel und Wege, mich durchzusetzen.	☐	☐	☐	☐
67. Es bereitet mir keine Schwierigkeiten, meine Absichten und Ziele zu verwirklichen.	☐	☐	☐	☐
68. In unerwarteten Situationen weiß ich immer, wie ich mich verhalten soll.	☐	☐	☐	☐
69. Auch bei überraschenden Ereignissen glaube ich, dass ich gut mit ihnen zurechtkommen kann.	☐	☐	☐	☐
70. Wenn ein Problem auftaucht, kann ich es aus eigener Kraft meistern.	☐	☐	☐	☐
71. Schwierigkeiten sehe ich gelassen entgegen, weil ich meinen Fähigkeiten immer vertrauen kann.	☐	☐	☐	☐
72. Für jedes Problem kann ich eine Lösung finden.	☐	☐	☐	☐
73. Wenn eine neue Sache auf mich zukommt, weiß ich, wie ich damit umgehen kann.	☐	☐	☐	☐
74. Was auch immer passiert, ich werde schon klarkommen.	☐	☐	☐	☐

Umgang mit belastenden Lebenssituationen (Coping)

In den folgenden Aussagen geht es darum, wie Sie mit belastenden Situationen in Ihrem Leben umgegangen sind. Es gibt viele Möglichkeiten, zu versuchen, Probleme zu bewältigen. Wir interessieren uns dafür, wie Sie versucht haben, damit umzugehen. Jeder Satz sagt etwas über eine bestimmte Art der Bewältigung aus. Wir möchten von Ihnen wissen, in welchem Ausmaß Sie die jeweilige Art der Bewältigung angewendet haben. Es geht nicht darum, ob es zu nützen scheint oder nicht, sondern nur darum, ob Sie etwas so gemacht haben oder nicht.

	Überhaupt nicht	*Ein bisschen*	*Ziemlich*	*Sehr*
108. Ich habe meinen unangenehmen Gefühlen freien Lauf gelassen	☐	☐	☐	☐
120. Ich habe offen gezeigt, wie schlecht es mir geht	☐	☐	☐	☐

Unterstützung durch Andere (Social support)

In den folgenden Fragen geht es um die Menschen, die Ihnen Hilfe und Unterstützung geben. Jede Frage hat zwei Teile. Im ersten Teil nennen Sie bitte alle Personen, die Sie kennen, außer sich selbst, auf deren Hilfe oder Unterstützung Sie in der beschriebenen Form zählen können. Nennen Sie jede Person mit ihren Initialen und der Beziehung, die sie zu Ihnen hat (siehe Beispiel).
Im zweiten Teil kreuzen Sie bitte an, wie zufrieden Sie insgesamt mit der Unterstützung sind, die Sie erfahren.
Wenn es bei einer Frage niemanden gibt, der Sie unterstützt, kreuzen Sie das Kästchen beim Wort „Niemand“ an, geben Sie aber dennoch Ihre Zufriedenheit an. Nennen Sie nicht mehr als neun Personen pro Frage.

165. a) Auf wen können Sie sich wirklich verlassen, wenn Sie Hilfe brauchen?

☐ Niemand
☐ Folgende Personen:

………………………………………………… …………………………………………………………

………………………………………….........… …………………………………………………………

………………………………………………… ………………………………………………….......

………………………………………………… …………………………………………………………

…………………………………………………

b) Wie zufrieden sind Sie damit?

Sehr zufrieden	Ziemlich zufrieden	Ein wenig zufrieden	Ein wenig unzufrieden	Ziemlich unzufrieden	Sehr unzufrieden
☐	☐	☐	☐	☐	☐

166. a) Wer hilft Ihnen wirklich, sich entspannter zu fühlen, wenn Sie unter Druck oder Anspannung stehen?

☐ Niemand
☐ Folgende Personen:

……………………………………………… ………………………………………………

……………………………………………… ………………………………………………

……………………………………………… ………………………………………………

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………………………………………………

b) Wie zufrieden sind Sie damit?

Sehr zufrieden	Ziemlich zufrieden	Ein wenig zufrieden	Ein wenig unzufrieden	Ziemlich unzufrieden	Sehr unzufrieden
☐	☐	☐	☐	☐	☐

167. a) Wer akzeptiert Sie wirklich vollkommen, mit all Ihren guten und schlechten Seiten?
☐ Niemand
☐ Folgende Personen:

……………………………………………… ………………………………………………

……………………………………………… ………………………………………………

……………………………………………… ………………………………………………

……………………………………………… ………………………………………………

………………………………………………

b) Wie zufrieden sind Sie damit?

Sehr zufrieden	Ziemlich zufrieden	Ein wenig zufrieden	Ein wenig unzufrieden	Ziemlich unzufrieden	Sehr unzufrieden
☐	☐	☐	☐	☐	☐

168. a) Wer kümmert sich wirklich um Sie, egal was Ihnen geschieht?
☐ Niemand
☐ Folgende Personen:

……………………………………………… ………………………………………………

……………………………………………… ………………………………………………

……………………………………………… ………………………………………………

……………………………………………… ………………………………………………

………………………………………………

b) Wie zufrieden sind Sie damit?

Sehr zufrieden	Ziemlich zufrieden	Ein wenig zufrieden	Ein wenig unzufrieden	Ziemlich unzufrieden	Sehr unzufrieden
☐	☐	☐	☐	☐	☐

169. a) Wer hilft Ihnen wirklich, sich besser zu fühlen, wenn Sie allgemein niedergeschlagen sind?
☐ Niemand

☐ Folgende Personen:

………………………………………………… …………………………………………………………
………………………………………………… …………………………………………………………
………………………………………………… …………………………………………………………
………………………………………………… …………………………………………………………
…………………………………………………

b) Wie zufrieden sind Sie damit?

Sehr zufrieden	Ziemlich zufrieden	Ein wenig zufrieden	Ein wenig unzufrieden	Ziemlich unzufrieden	Sehr unzufrieden
☐	☐	☐	☐	☐	☐

170. a) Wer besänftigt Sie, wenn Sie sehr aufgebracht sind?
☐ Niemand
☐ Folgende Personen:

………………………………………………… …………………………………………………………
………………………………………………… …………………………………………………………
………………………………………………… …………………………………………………………
………………………………………………… …………………………………………………………
…………………………………………………

b) Wie zufrieden sind Sie damit?

Sehr zufrieden	Ziemlich zufrieden	Ein wenig zufrieden	Ein wenig unzufrieden	Ziemlich unzufrieden	Sehr unzufrieden
☐	☐	☐	☐	☐	☐

9.3. Published Articles

Rauch A, Fekete C, Oberhauser C, Marti A, Cieza A. *Participation in sport in persons with spinal cord injury in Switzerland.* Spinal Cord 2014; 52(9): 706-711.

Rauch A, Hinrichs T, Oberhauser C, Cieza A. *Do people with spinal cord injury meet WHO recommendations on physical activity?* Int J Public Health 2016; 61:17-27.

Rauch A, Hinrichs T, Cieza A. *Associations with being physically active and the achievement of the WHO recommendations on physical activity in people with spinal cord injury.* Spinal Cord 2017; 55(3): 235-243

Spinal Cord (2014) 52, 706–711

www.nature.com/sc

ORIGINAL ARTICLE

Participation in sport in persons with spinal cord injury in Switzerland

A Rauch[1], C Fekete[2], C Oberhauser[1], A Marti[2,3] and A Cieza[1,2,4]

Study design: Secondary data analysis of a questionnaire-based, cross-sectional survey in persons with spinal cord injury (SCI) in Switzerland.

Objective: To describe the frequency of participation in sport (PiS) and to identify correlates for PiS in persons with SCI in Switzerland.

Setting: Community sample

Methods: Frequency of PiS was assessed retrospectively for the time before the onset of SCI and the time of the survey using a single-item question. A comprehensive set of independent variables was selected from the original questionnaire. Descriptive statistics, bivariate analyses and ordinal regressions were carried out.

Results: Data from 505 participants were analyzed. Twenty independent variables were selected for analyses. PiS decreased significantly from the time before the onset of SCI to the time of the survey ($P<0.001$). Sport levels were significantly lower in women than men for the time of the survey ($P<0.001$), whereas no difference was observed before onset of SCI ($P=0.446$). Persons with tetraplegia participated significantly less often in sport than persons with paraplegia ($P<0.001$). Lesion level, active membership in a club, frequency of PiS before the onset of SCI and the subjective evaluation of the importance of sport correlate with PiS. When controlling for gender differences, only the subjective importance of sport for persons with SCI determines PiS, particularly among women.

Conclusions: Persons with tetraplegia and women need special attention when planning interventions to improve PiS. Furthermore, the subjective importance of sport is important for PiS, particularly among women, whereas most other factors were only weakly associated with PiS.

Spinal Cord (2014) **52,** 706–711; doi:10.1038/sc.2014.102; published online 17 June 2014

INTRODUCTION

Persons with spinal cord injury (SCI) are at high risk of developing secondary conditions. The decreased physical capacity caused by the loss of physical functions leads to lower energy expenditure and metabolic changes[1] that contribute to the development of cardiovascular diseases.[2] Furthermore, people with SCI have more psychological disorders than the general population.[3] In this population, a healthy lifestyle, including regular physical activity (PA), plays an important role.

In general, the concept of PA comprises work- and household-related, as well as leisure-time PAs (LTPAs). The latter includes recreational activities, sport and exercise. Sport in SCI is an effective means to reduce health risks[4] when performed regularly, to improve quality of life and life satisfaction[5] and to increase social integration.[6] To date, only few studies have investigated participation in sport (PiS) and its determinants and correlates. Those existing investigated either LTPA or sport using different assessment instruments. Findings showed that the respective participation levels were low in that sense that 37–50% of persons with SCI did not engage in any LTPA[7,8] or sport.[9] It has also been shown that PiS decreased after the onset of SCI.[10] With respect to correlates and determinants for PiS in SCI, evidence is widely lacking. Findings regarding the more general concept of participation in PA show that the environment has a higher impact on PA levels than socio-demographic or SCI characteristics.[11] This leads to the assumption that PiS may depend on environmental characteristics, such as different physical and cultural contexts.

Persons with SCI living in Switzerland experience many barriers to participating in PA.[12] Thus, we assume that PiS in SCI is low and differs from the general population. The survey on sport behavior in the general Swiss population assessed PiS with a question on the frequency (never, sometimes/rarely, once a week, several times a week, daily) and found that PiS has increased over the last decades, and gender differences have nearly disappeared.[13] For persons with SCI, there is a lack of data on the frequency of PiS and factors influencing PiS in Switzerland. Such information is, however, indispensible when developing interventions to improve PiS in persons with SCI.

[1]Chair of Public Health and Health Service Research, Research Unit for Biopsychosocial Health, Department of Medical Informatics, Biometry and Epidemiology–IBE, Ludwig-Maximilians-University, Munich, Germany; [2]Swiss Paraplegic Research (SPF), Nottwil, Switzerland; [3]Department of Health Sciences and Health Policy, University of Lucerne and SPF, Nottwil, Switzerland and [4]Faculty of Social and Human Sciences, University of Southampton, Southampton, UK
Correspondence: A Rauch, Chair of Public Health and Health Service Research, Research Unit for Biopsychosocial Health, Department of Medical Informatics, Biometry and Epidemiology—IBE, Ludwig-Maximilians-University, Marchioninistrasse 17, 81377 Munich, Germany.
E-mail: alexandra.rauch@med.lmu.de
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The objective of this study was to provide initial insights into PiS in persons with SCI in Switzerland. The specific aims were (1) to present figures on the frequency of PiS in the study population and (2) to identify factors associated with PiS.

MATERIALS AND METHODS

Study design

This study was a secondary data analysis of a questionnaire-based, cross-sectional survey on labor-market participation performed in the SCI population in Switzerland.[14]

Participants

A total of 2097 members of the Swiss Paraplegic Association (national association of persons with SCI) with traumatic or non-traumatic SCI older than 18 years and living in the community for at least 1 year were invited to participate in the study by mail. Announcements were also placed in the consumer magazine 'Paracontact' and on the Swiss Paraplegic Association homepage. A total of 559 of the invited persons (27%) completed the questionnaire.

Data collection

The original questionnaire comprised 86 variables. A detailed description of the survey is reported by Marti *et al.*[14] PiS was assessed with a single-item question asking participants about their frequency of PiS during a week respectively a month: 'How often do you perform sport (for at least half an hour)?' The five response options included 'less than several times a month', 'several times a month', 'once a week', 'several times a week' and 'daily'. PiS was assessed for the time of the survey and retrospectively for the time before the onset of SCI. The current PiS level was used as the dependent variable.

Based on evidence from the literature and expert opinion by two of the researchers (AR, AM), a set of independent variables considered as likely to be associated with PiS was selected for the analysis. These variables cover 5 socio-demographic, 10 disease-specific and 5 health-behavior-related characteristics.

Data analysis

Only participants who answered the dependent variable were included in the analysis. Cases with more than three missing values in the independent variables were excluded from the analysis.

First, descriptive statistics were used to characterize the study population and to describe PiS before the onset of SCI and at the time of the survey. Second, bivariate analyses were conducted: (1) Mann–Whitney *U*-tests to identify differences in PiS (for the two time points, for socio-demographic and SCI-related characteristics at the time of the survey) and (2) Spearman correlations to identify those variables associated with PiS at the time of the survey (correlation coefficient >0.2). The correlation analysis was conducted separately for men and women because of identified gender differences in PiS in the Mann–Whitney *U*-test analysis. Finally, a multivariate analysis (stepwise ordinal regression) was carried out: in the first model, only variables with a Spearman correlation coefficient >0.2 were included. In the second model, socio-demographic factors known to be associated with PiS in the Swiss general population[13] were also included. In the third model, interaction terms with gender were additionally considered for all variables that were included in model 1. The level of statistical significance was set at a *P*-value ≤ 0.05 in all analyses. Data were analyzed using SPSS V18 (SPSS Inc., Chicago, IL, USA).

RESULTS

In total, data from 505 subjects were included. An overview on the characteristics of the study population is presented in Table 1.

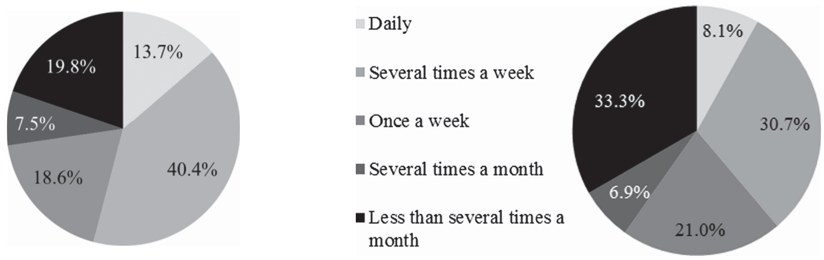
Table 1 Characteristics of the study population ($n=505$)

Variable	n *(%)*	*Mean (s.d.; min, max)*	*Missing, n (%)*
Gender			0 (0.0)
Male	374 (74.1)		
Age (in years)		49.4 (12.6; 19,88)	0 (0.0)
Living situation			7 (1.4)
Living together (Cohabitating/ married/living together)	293 (58.0)		
Living alone (living alone/married but living separated/divorced/ widowed)	205 (40.7)		
Formal education (years)			4 (0.8)
6	64 (12.7)		
8–9	320 (63.4)		
11–12	117 (23.1)		
Employment rate (%)			20 (4.0)
0	206 (40.8)		
1–33	56 (11.1)		
34–50	126 (25.0)		
51–66	19 (3.8)		
67–100	78 (15.4)		
Time since onset of SCI (in years)		18.3 (11.8; 1.50)	5 (1.0)
Cause for SCI			5 (1.0)
Traumatic (total)	425 (84.2)		
Traffic accident	183 (36.3)		
Fall	94 (18.6)		
Sport accident	99 (19.6)		
Violence	8 (1.6)		
Non-traumatic	75 (14.8)		
Not defined	41 (8.1)		
Level of SCI			3 (0.6)
Paraplegia	361 (71.3)		
Tetraplegia	142 (28.1)		
Severity of SCI			13 (2.6)
Motoric complete	247 (48.9)		
Motoric incomplete	245 (48.5)		
Length of first rehabilitation (in months)			25 (4.9)
Paraplegic		7.2 (4.5; 1,50)	
Tetraplegic		11.0 (7.0; 1,60)	
Wheelchair use			3 (0.6)
No wheelchair	63 (12.5)		
Manual wheelchair	406 (80.4)		
Power wheelchair	33 (6.5)		

Abbreviations: max, maximum; min, minimum; SCI, spinal cord injury.

PiS decreased significantly after the onset of SCI: although before the onset of SCI, 72.7% of subjects participated in sport at least once a week, this proportion decreased to 59.8% at the time of the survey. In all, 33.3% of subjects performed sport fewer than several times in a month after the onset of SCI in comparison to 19.8% before the onset. The precise distribution of PiS levels is shown in Figure 1.

The analysis of differences in PiS in the independent variables (Table 2) showed that the decrease of PiS was exceptionally high in women: before the onset of SCI, 74.9% of females performed sport at least once a week (once a week, several times a week or daily), whereas at the time of the survey only 47.3% participated at least once a week. A total of 45.0% participated even fewer than several times a month. This trend was less pronounced in males: 72.9% of males performed sport at least once a week (once a week, several times a week or daily) before the onset of SCI, and 64.2% still did at the time of the survey. Only 29.1% engaged in sport fewer than several times a month. This unequal decrease is reflected in a significant gender difference in PiS at the time of the survey, which did not exist before the onset of SCI.



Frequency of PiS before onset of SCI **Frequency of PiS at time of survey**

Figure 1 Frequency of participation in sport (PiS) before the onset of spinal cord injury (SCI) and at the time of the survey.

Table 2 Frequency of PiS related to time-point, socio-demographic and SCI-related characteristics

Variables (n)	*n (%) for frequency of PiS*					*Median (IQR)*	P
PiS-related to…	*Less than several times a month (1)*	*Several times a month (2)*	*Once a week (3)*	*Several times a week (4)*	*Daily (5)*		
Time point							<0.001*
Before onset of SCI (505)	100 (19.8)	38 (7.5)	94 (18.6)	204 (40.4)	69 (13.7)	4.00 (2.00;4.00)	
Time of survey (505)	168 (33.3)	35 (6.9)	106 (21.0)	155 (30.7)	41 (8.1)	3.00 (1.00;4.00)	
Gender, before SCI							0.468
Men (367)	77 (21.0)	28 (7.6)	62 (16.9)	151 (41.1)	49 (13.4)	4.00 (2.00;4.00)	
Women (131)	23 (17.7)	10 (7.7)	24 (18.5)	53 (40.8)	20 (15.4)	4.00 (2.00;4.00)	
Gender, time of survey							0.003*
Men (374)	109 (29.1)	25 (6.7)	87 (23.2)	120 (32.0)	34 (9.1)	3.00 (1.00;4.00)	
Women (130)	59 (45.0)	10 (7.6)	19 (14.5)	36 (27.5)	7 (5.3)	2.00 (1.00;4.00)	
Living situation[a]							0.578
Living alone (205)	71 (34.6)	16 (7.8)	41 (20.0)	62 (30.2)	15 (7.3)	3.00 (1.00;4.00)	
Living together (293)	96 (32.8)	19 (6.5)	64 (21.8)	89 (30.4)	25 (8.5)	3.00 (1.00;4.00)	
Formal education[a] *(years)*							0.434
6–9 (388)	131 (33.8)	20 (5.2)	83 (21.4)	118 (30.4)	36 (9.3)	3.00 (1.00;4.00)	
11–12 (117)	37 (31.6)	15 (12.8)	23 (19.7)	37 (31.6)	5 (4.3)	3.00 (1.00;4.00)	
Employment rate[a] *(%)*							0.901
0–50 (388)	139 (35.8)	24 (6.2)	74 (19.1)	115 (29.6)	36 (9.3)	3.00 (1.00;4.00)	
51–100 (97)	25 (25.8)	9 (9.3)	30 (30.9)	31 (32.0)	2 (2.1)	3.00 (1.00;4.00)	
Cause for SCI[a]							0.978
Traumatic (425)	138 (32.5)	31 (7.3)	92 (21.6)	131 (30.8)	33 (7.8)	3.00 (1.00;4.00)	
Non-traumatic (75)	27 (36.0)	35 (7.0)	105 (21.0)	155 (8.4)	40 (8.0)	3.00 (1.00;4.00)	
Level of SCI[a]							<0.001*
Paraplegic (362)	101 (27.9)	23 (6.4)	78 (21.5)	128 (35.4)	32 (8.8)	3.00 (1.00;4.00)	
Tetraplegic (143)	67 (46.9)	12 (8.4)	28 (19.6)	27 (18.9)	9 (6.3)	2.00 (1.00;4.00)	
Severity of SCI[a]							0.599
Motoric complete (247)	79 (32.0)	17 (6.9)	56 (22.7)	76 (30.8)	19 (7.7)	3.00 (1.00;4.00)	
Motoric incomplete (245)	86 (35.1)	18 (7.3)	50 (20.4)	70 (28.6)	21 (8.6)	3.00 (1.00;4.00)	

Abbreviations: IQR, interquartile range; PiS, participation in sport; SCI, spinal cord injury.
IQR = 25th to 75th percentile.
P-value resulting from Mann–Whitney *U*-test on differences in PiS between each of the two groups: *Significant (<0.05).
[a]Presented for the time of survey.

Persons with tetraplegia and persons with motoric incomplete lesions participated less often in sport than persons with paraplegia and motoric complete lesions. However, these differences were only significant for the level, but not for the severity of the lesion.

The correlation analysis (Table 3) showed that males who suffer from tetraplegia, who have spent longer time in first rehabilitation and who have performed sport more frequently before the onset of SCI had lower PiS at the time of the survey. Evaluating sport as important at the time of the survey and being an active member of a club correlated with higher PiS at the time of the survey. In women, only the latter two correlated with higher PiS at the time of the survey. For both genders, none of the socio-demographic characteristic correlated with PiS.

The stepwise ordinal regression (Table 4) explained up to 34% of the variance and showed that lesion level, active membership in a club, frequency of PiS before the onset of SCI and the subjective importance of sport at the time of the survey were significantly linked to PiS in model 1. Controlling for socio-demographic characteristics (model 2)

Table 3 Spearman correlations of socio-demographics, disease-specific and health-behavior-related aspects with PiS at the time of the survey

Variable group	*Independent variables*	*Specification*	*PiS at the time of the survey (less than several times a month/several times a month/once a week/several times a week/daily)*			
			Men		*Women*	
			Corr Coeff	P	*Corr Coeff*	P
Socio-demographic	Age	In years	0.024	0.641	0.026	0.764
	Living situation	Living alone/living together	0.028	0.593	−0.005	0.957
	Children	No/yes	0.023	0.656	0.126	0.154
	Formal education	In years	0.029	0.592	−0.053	0.564
	Remunerative employment	Percentage of 100%	0.019	0.714	0.005	0.956
Disease specific	Time since onset of SCI	In years	−0.047	0.366	−0.153	0.086
	Level of SCI	Paraplegic/tetraplegic	−**0.238**	<0.001*	−0.108	0.225
	Severity of SCI	Motoric complete/incomplete	−0.050	0.340	0.074	0.412
	Cause for SCI	Traumatic/non-traumatic	0.030	0.559	0.012	0.887
	Length of first rehabilitation	In months	−**0.241**	<0.001*	−0.194	0.034*
	Rehospitalizations	No/yes	013	0.803	0.052	0.559
	Use of wheelchair	No/manual/electrical	−0.075	0.147	−0.127	0.148
	Performance of activities of daily living	Time in minutes to perform self-care activities in the morning	−0.195	0.001*	−0.042	0.668
	Subjective physical health/pain	1 (no pain)–10 (strongest pain)	−0.027	0.610	0.001	0.990
	Subjective general health	Very bad/rather bad/medium/rather good/very good	0.145	0.005*	0.111	0.208
Health behavior	PiS before onset of SCI	Less/several times a month/ several times a week /once a week/daily	−**0.242**	<0.001*	−0.106	0.228
	Importance of sport before onset of SCI	Subjective rating in percent on a scale from 0 to 100	0.179	0.001*	0.033	0.714
	Importance of sport at the time of survey	Subjective rating in percent on a scale from 0 to 100	**0.560**	<0.001*	**0.530**	<0.001*
	Active membership in a club before onset of SCI	No/yes	−0.115	0.027*	0.091	0.301
	Active membership in a club at the time of survey	No/yes	**0.234**	<0.001*	**0.241**	0.006*

Abbreviations: Corr coeff, correlation coefficient; PiS, participation in sport; SCI: spinal cord injury.
Bold letters: correlation coefficients considered as relevant for further analysis (>0.200).
P= *Significant (<0.05).

only slightly improved the explanatory power. When controlling for gender differences by adding interaction terms in model 3 (gender with all variables included in model 1), only the subjective importance of sport at the time of the survey remained significantly associated with PiS. In addition, the subjective importance of sport had a stronger relationship with PiS in women than in men.

DISCUSSION

This study showed that PiS in persons with SCI in Switzerland significantly decreased after the onset of SCI, in particular in women and persons with tetraplegia. The subjective evaluation of the importance of sport was the only aspect that explained PiS after controlling for various influences. The characteristics of the study population corresponded to the well-known distribution of other SCI populations with respect to level and severity of SCI and gender distribution. This is one of the very few studies with a large sample size and presents results, which are shown in this manner for the first time.

Corresponding to results by Tasiemski *et al.*,[10] PiS significantly decreased after the onset of SCI. In comparison to existing evidence, where 37–50% do not engage in LTPA or sport[7–9] at all, the proportion of those who seldom or never participate in sport in Switzerland was lower (33.3%). No explanation for these differences in different countries and cultures has been discovered. In comparison to the general population in Switzerland, where 66.7% of the general population participated in sport at least once a week in 2008,[13] 59.8% in the SCI population participated in sport with this frequency. However, looking into gender differences provided more details.

The identified lower PiS in women confirms findings from one of the few studies with a large study population[7] that reports on gender differences based on the average duration of LTPA during the 3 days previous to the interview. Other studies with smaller sample sizes did not report on gender differences.[15–19] In the general Swiss population, gender differences in PiS disappeared almost completely in the able-bodied population.[13] Accordingly, no gender differences in PiS were observed in the study population at the time before the onset of SCI. This study revealed gender differences in PiS after suffering a SCI, which require a closer look into aspects that potentially explain this phenomenon that has arisen in connection with a disability.

Table 4 Regression coefficients of the stepwise ordinal regression using frequency of PiS at the time of the survey as an ordinal outcome

Included variables	*Model 1*		*Model 2*		*Model 3*	
	B *(s.e.)*	P	B *(s.e.)*	P	B *(s.e.)*	P
Intercept 1 (sport daily)	−0.538 (0.341)	<0.001	0.018 (0.681)	<0.001	0.127 (0.850)	<0.001
Intercept 2 (sport several times a week)	−0.137 (0.339)	0.005	0.422 (0.681)	0.024	0.539 (0.851)	0.050
Intercept 3 (sport once a week)	0.968 (0.342)	0.686	1.537 (0.683)	0.535	1.671 (0.854)	0.401
Intercept 4 (sport several times a month)	3.420 (0.391)	0.114	4.015 (0.714)	0.979	4.145 (0.877)	0.022
Level of lesion (paraplegic)	0.578 (0.203)	0.004*	0.542 (0.205)	0.008*	−0.127 (0.396)	0.748
Active membership in a club at the time of survey (no)	−0.511 (0.178)	0.004*	−0.488 (0.179)	0.006*	−0.510 (0.360)	0.157
Length of first rehabilitation	−0.024 (0.018)	0.171	−0.026 (0.018)	0.138	−0.038 (0.037)	0.301
Frequency of PiS before onset of SCI	−0.216 (0.065)	0.001*	−0.242 (0.066)	<0.001*	−0.080 (0.135)	0.554
Importance of sport at the time of survey	0.087 (0.009)	<0.001*	0.090 (0.007)	<0.001*	0.138 (0.023)	<0.001*
Gender (male)			0.278 (0.199)	0.162	0.567 (0.751)	0.450
Age			0.013 (0.007)	0.063	0.012 (0.007)	0.095
Formal education			−0.023 (0.046)	0.611	−0.029 (0.046)	0.526
Level of lesion*gender (male paraplegic)					0.876 (0.464)	0.059
Length of first rehabilitation*gender (male)					0.018 (0.042)	0.661
Frequency of PiS before onset of SCI*gender (male)					−0.216 (0.154)	0.161
Importance of sport at the time of survey*gender (male)					−0.057 (0.024)	0.019*
Active membership in a club at the time of survey*gender (no, male)					0.024 (0.415)	0.954
R^2 (Nagelkerke)		0.315		0.325		0.338

Abbreviations: PiS, participation in sport; SCI, spinal cord injury.
B: Regression coefficient; s.e.: Standard error.
P= *significant (<0.05).
Reference values for Intercept 1, 2, 3 and 4: 'Less than several times a month', for Level of lesion: 'Tetraplegic', for Active membership in club at the time of survey: 'Yes, member', for gender: 'female'.

Our finding of fewer PiS in persons with tetraplegia confirms existing evidence.[7,17] The greater loss of physical capacity in persons with tetraplegia may lead to a more frequent experience of barriers to performing sport. It is assumed that these experiences are related to lower perceived behavioral control, which is known to influence the intention to perform sport in persons with tetraplegia.[20] Results are inconsistent for the impact of the severity of the lesion and the time since the onset of SCI.[7,15] In this study population, these two characteristics made no difference in PiS. The inconsistent findings suggest that these characteristics cannot be applied to explain PiS universally and that more insight is required to understand when they influence PiS.

The bivariate analysis showed that the lesion level (tetraplegia) correlated with lower PiS in men only. Given the generally lower PiS levels in women, one could assume that lower physical capacity related to a more severe lesion determines PiS in males, whereas in women, suffering from a disability in general—irrespective of physical capacity—influences PiS. There is some evidence that athletic identity (being competitively oriented) is typically male[12,21] and that this phenomenon does not change over time. A loss of physical capacity caused by more severe levels of SCI may thus contribute to less interest in sport when a person loses the capacity to perform sport on a high level. If, in contrast, the motivation for sport is more associated with maintaining fitness or socializing, as it was shown for women,[12] the level of SCI may have less impact on PiS.

Although in this study 50% of the participants had a time since onset of SCI longer than 17 years, the number of years living with SCI did not correlate with PiS in both genders. Thus, this study found no hints that aging contributes to a decrease in PiS.

The correlation between more frequent PiS before the onset of SCI with less frequency at the time of the survey in men has already been observed by Tasiemski *et al.*[22] Anneken *et al.*[9] found the same phenomena, but did not report on gender differences. It is assumed that the comparison between the experience of able-bodied sport before the onset of SCI and a rather negative experience of disabled sport might cause this decrease. Based on the identified gender differences in our and a previous study,[12] one could again assume that performing sport on a high level is more important in men, whereas women perform sport for other reasons.

Interestingly, none of the socio-demographic characteristics correlated with PiS in either gender, which confirms evidence from other studies with SCI populations.[11] In comparison to the general population in Switzerland, where age, gender and formal education correlate with PiS,[13] respective findings from the SCI population provide interesting hints that disability shifts the correlates for PiS from socio-demographic to other factors.

Active membership in a sports club at the time of the survey and evaluating sport more important at the time of the survey correlated with higher PiS in both genders. The former connection is also known to associate with better social integration,[6] whereas it is not known whether persons become members in a club to become better integrated, for example, to socialize, and thus are physically more active, or whether persons who want to perform sport become a member in a club more often and are thus better integrated. However, recent research has found that programs offered by wheelchair clubs do not always meet the needs of all persons with SCI.[12] This deficiency may contribute to lower levels of PiS in women and tetraplegics.[12] Identifying individuals' reasons for becoming a member of a club may provide important information for programs developed to increase PiS through sports clubs.

The evaluation of the subjective importance of sport was the only item that explained PiS after controlling for the impact of gender, and it was shown that the impact is higher in women. The subjective evaluation of sport may be based on a person's knowledge regarding risks and benefits related to sport, pre-existing norms, values, attitudes and preferences, but also to the need to socialize, to maintain health or to have fun.[12] In any case, achieving a positive personal evaluation of the importance of sport may positively influence the intention to perform sport, which could contribute to higher PiS.

Limitations

Some limitations to this study should be noted. First, the selection of a convenience sample of members of the Swiss Paraplegic Association who are possibly more active in general and the low response rate (27%) may limit the generalizability of our findings. As no data were collected from the non-responders, there is no information whether the study sample is representative for the population invited to this study. Second, a single-item question was used to assess the frequency in PiS. Although similar single-item questions on PA showed acceptable reliability,[23] information is limited to the frequency of PiS, whereas information on the type, intensity and duration of sport activities is lacking. However, the analysis of this item allowed a comparison with data from the general Swiss population. Third, a recall bias, in particular in persons with long disease duration may have affected the results. Finally, aspects that may additionally relate to PiS (for example, environmental and additional personal factors) were not included in the original questionnaire and thus could not be investigated.

CONCLUSION

This study detected that women and persons of both genders with tetraplegia rarely participate in sport. This finding paves the way for future research that should investigate gender aspects in PiS in persons with SCI. Furthermore, we showed that disease-specific and socio-demographic characteristics do not explain PiS, but the personal evaluation of the importance of sport does. Studies are needed to better understand the evaluation of the importance of sport from the individual's perspective. We also recommend that information on the type (for example, aerobics or muscle-strengthening activities), intensity (low, moderate or intense) and duration (for example, minutes per day) of sport needs to be collected in the future to allow for additional investigation of the impact of PiS on the reduction of health risks.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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ORIGINAL ARTICLE

Do people with spinal cord injury meet the WHO recommendations on physical activity?

Alexandra Rauch · Timo Hinrichs · Cornelia Oberhauser · Alarcos Cieza · For the SwiSCI study group

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Abstract

Objectives To describe physical activity (PA) levels in persons with spinal cord injury (SCI) and to investigate associated factors.

Methods PA behavior of people with SCI in Switzerland was assessed in a community survey with four items from the Physical Activity Scale for individuals with physical disabilities (PA of light, moderate, and strenuous intensity and muscle-strengthening exercises). In addition to descriptive analyses, the odds of performing PA according to the WHO recommendations (at least 2.5 h/week of at least moderate intensity) were analyzed by multivariable logistic regression.

Results Participants ($n = 485$; aged 52.9 ± 14.8; 73.6 % male) carried out PA a total of 6.0 h/week (median). 18.6 % were physically inactive, 50.3 % carried out muscle-strengthening exercises, and 48.9 % fulfilled the WHO recommendations. Regression analyses showed that women, people aged 71+, and people with complete tetraplegia had significantly lower odds of fulfilling the WHO recommendations than participants in the respective reference category (men, ages 17–30, incomplete paraplegia).

Conclusions PA levels of people with SCI in Switzerland are rather high. However, some subgroups need special consideration when planning interventions to increase PA levels.

Keywords Spinal cord injury · Physical activity · Sport · Disability · Health behavior · WHO recommendations

Introduction

In general, regular physical activity (PA), usually understood as any bodily movement that increases energy expenditure above that of a resting level (ODPHP 2008), is an effective means to prevent the development of cardiovascular and other diseases (ODPHP 2008). The increased energy expenditure influences body composition and lipid metabolism positively and leads to reduced blood pressure and reduced systemic inflammation (Warburton et al. 2006). Persons affected by a spinal cord injury (SCI), however, have limited physical capacity due to the loss of muscle functions, which again reduces energy expenditure in the activities of daily living (Buchholz et al. 2003). This may explain the increased prevalence of cardiovascular conditions in the SCI population (Cragg et al. 2013). Regular and sufficiently intense PA is necessary to compensate for functional limitations. Evidence suggests that, despite functional limitations, regular PA can effectively improve fitness (aerobic capacity and muscular strength)

The members of the SwiSCI study group are listed in the "Acknowledgments" section.

A. Rauch (✉) · C. Oberhauser
Chair for Public Health and Health-Service Research, Research Unit for Biopsychosocial Health, Department of Medical Informatics, Biometry and Epidemiology-IBE, Ludwig-Maximilians-University, Marchioninistrasse 17, 81377 Munich, Germany
e-mail: rauchalex@hotmail.com; alexandra.rauch@med.lmu.de

T. Hinrichs · A. Cieza
Swiss Paraplegic Research, Nottwil, Switzerland

T. Hinrichs
Department of Health Sciences and Health Policy, University of Lucerne, Lucerne, Switzerland

A. Cieza
Faculty of Social and Human Sciences, University of Southampton, Southampton, UK

(Hicks et al. 2011) and positively influence risk factors of chronic disease (Buchholz et al. 2009; de Groot et al. 2013).

Certain levels of PA are required to reduce the risks of cardiovascular disease. General exercise recommendations coincide with those of the World Health Organization (WHO) (WHO 2010) and suggest consistently performing at least 2.5 h of moderate aerobic activities and muscle-strengthening exercises on at least 2 days per week (Australian Government Department of Health 2014; FOSPO 2013; ODPHP 2008). These recommendations can also be applied to people with disabilities, but they need to be adapted to an individual's capacity, risk, or limitation (WHO 2010). SCI-specific exercise recommendations are available, but lack consensus. Recent exercise recommendations suggest performing 20 min of aerobic exercise of at least moderate intensity and muscle-strengthening exercises on at least 2 days per week to maintain or improve fitness (Martin Ginis et al. 2011). Previous recommendations refer to risk reduction and suggest levels comparable to those for the general population, namely to perform 20–60 min of aerobic exercises of at least moderate intensity on 3–5 days a week and muscle-strengthening exercises twice weekly (Jacobs and Nash 2004). Based on current knowledge and to allow a comparison with the general population, it is useful to apply the WHO exercise recommendations to people with SCI until more evidence is available.

There presently exists little knowledge on PA levels in people with SCI. In general, it has been reported that PA levels in the SCI population are rather low (Anneken et al. 2010; Buchholz et al. 2003; Kim et al. 2011; Martin Ginis et al. 2010a; Rauch et al. 2014; Sale et al. 2012; Tasiemski et al. 2000). The reported PA levels vary according to the types of activities and available information on their frequency, duration, and intensity. Figures on those who are physically inactive vary from 27 % (Rauch et al. 2014) to 50 % (Martin Ginis et al. 2010b). No study has investigated whether people with SCI achieve the recommended PA levels, and we have no information about the characteristics of those who fulfill the recommendations and those who do not. Such information is indispensable to facilitate the identification of target groups that require special consideration when promoting PA.

This study aims (1) to quantify the time spent on different types of PA (sports of different intensities and muscle-strengthening exercises) in people with SCI, (2) to report the proportions of those who are completely physically inactive, who carry out muscle-strengthening exercises regularly, and who perform sports according to the WHO exercise recommendations, and (3) to investigate the socio-demographic and SCI-related characteristics associated with the latter three PA categories.

Methods

Study design

Data from the nationwide Swiss Spinal Cord Injury Cohort Study (SwiSCI) community survey were analyzed for this study. Participants were recruited via four specialized SCI rehabilitation centers, the national association for people living with SCI (Swiss Paraplegic Association), a SCI-specific home care institution (Parahelp) and a large national insurance company (SUVA). The SwiSCI survey contained three subsequent modules: (1) Starter Module (brief questionnaire on basic socio-demographics, lesion characteristics, care situation), (2) Basic Module (detailed information on functioning, health, environmental and personal factors), and (3) three thematically different specific modules (Post et al. 2011). A representative sample of 1549 individuals with traumatic or non-traumatic SCI with a minimum age of 16 years participated in the first two modules of the survey (response rate: 49.3 %, median age: 52 years, 71.5 % male, median time since injury: 13.5 years, paraplegia: 69.2 %). 570 were randomly selected (stratified for gender, age, and level of injury) to participate in a specific module on psychological personal factors and health behavior, which included questions on PA behavior. The 511 subjects who answered this module were considered for this study.

Data collection

Four items from the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD; items 3–6) (Washburn et al. 2002) were selected to assess PA. These items cover sports and recreational activities of (1) light, (2) moderate, and (3) strenuous intensity and (4) muscle-strengthening exercises (power and endurance). For each item, the frequency (never, 1–2 days, 3–4 days, 5–7 days per week) and duration (less than 1 h, 1 but less than 2 h, 2–4 h, more than 4 h per day) of the corresponding activity were asked. Based on the combination of answers, the PASIPD provides an algorithm to obtain the average daily activity time (hours/day) spent on each PA category.

Socio-demographic (gender, age, partnership, education, and income) as well as SCI-related (etiology, time since injury, severity and type of locomotion) aspects likely to associate with PA levels, were selected as independent variables. The type of locomotion was assessed with item 13 (mobility for moderate distances, 10–100 m) of the self-report version of the Spinal Cord Independence Measure (Fekete et al. 2013); the response options for walking with different devices were summarized to "pedestrian with device or support".

Data analysis

Only participants who completely answered the four items of the PASIPD were included in the analyses. Descriptive statistics were conducted to describe the study population. To calculate the hours per week spent on the four types of PA, the average hours/day was multiplied by seven. Sum scores were calculated for the weekly time spent on sports and recreational activities of at least moderate intensity (sum of moderate and strenuous PA items) and for the total time spent on PA per week (sum of all items). All figures were calculated for the total study sample and stratified by socio-demographic and SCI-related characteristics. Whenever feasible, variables collected as metric data were grouped based on current reporting guidelines (DeVivo et al. 2011). Education was categorized based on time required to achieve certain academic degrees, and income was categorized into quartiles of the income distribution. Bivariate non-parametric tests were conducted to identify group differences within the socio-demographic and SCI-related characteristics (binary data: Mann–Whitney; ordinal data: Kruskal–Wallis). The significance level was set at a p value <0.05. Mann–Whitney U tests were applied to identify the subgroups that differ within the distinct characteristics. The significance level was now set at a p value of <0.008 based on Bonferroni correction for six tests.

For additional analyzes, three following additional categories were created: (1) being completely physically inactive, (2) performing muscle-strengthening exercises on at least 1–2 days per week, and (3) performing sports or recreational activities of at least moderate intensity for at least 2.5 h per week (according to the WHO exercise recommendations). Frequencies and proportions were calculated for each of these categories. Multivariate logistic regressions were performed, and odds ratios with 95 % confidence intervals were calculated. Missing values in the independent variables were addressed by conducting multiple imputations (MI). For the MI, all variables included in the regression models were entered, and 5 iterations were performed.

Results

Data from 485 subjects were included in this study; their characteristics are presented in Table 1. For these characteristics no differences between the responders and the excluded subjects and non-responders of the survey have been found.

The time spent on the different PA categories is shown for the total study sample and stratified for socio-demographic (Table 2) and SCI-related characteristics (Table 3). All results on the PA levels showed a non-normal distribution. Overall, participants spent the most time (median 2.2 h) performing sports of light intensity. People with complete paraplegia, manual wheelchair users, and people with a time since injury of 16–25 years spent the most median time on sports of moderate intensity. The sample spent the least median time on strenuous sporting activities (0.0) and 0.8 h performing muscle-strengthening exercises. On average, participants carried out a total of 2.2 h (median) on sports of moderate or strenuous intensity, whereas the number of hours spent on these intensities was the lowest in women (1.8), the eldest participants (1.5), pedestrians requiring devices (0.8), and in those who needed an electric wheelchair (0.8). The median total time for all PAs per week was 6.0 h.

People aged between 17 and 30 showed the highest total PA time (median 8.8 h). People 71 and older (4.5), women (4.6), people with complete tetraplegia (4.5), and users of electric wheelchairs (3.8) showed the lowest total PA times.

Significant differences within the subgroups were found for all characteristics in at least one PA category, but most frequently for the "strenuous intensity" and the "muscle-strengthening exercises" category. For the type of locomotion, group differences were found in all PA categories except the "light-intensity" category.

Table 4 shows the proportions and the corresponding odds ratios of those who were completely physically inactive, of those meeting the WHO recommendations by carrying out sports of at least moderate intensity for at least 2.5 h/week, and of those carrying out muscle-strengthening exercises at least 1–2 days/week.

18.6 % of the study population was completely physically inactive. The youngest showed the lowest, and those requiring an electric wheelchair showed the highest proportion of physically inactive people. The proportion of those who were inactive increased with age, and those aged 71 and older had 6.8 times higher odds of being physically inactive compared to the youngest age group. Those with complete tetraplegia had 3.3 times higher odds of being physically inactive compared to those with incomplete paraplegia. Those with a time of 6–15 years since injury showed significantly lower odds of physical inactivity compared to those with a time since injury of 5 years or less. Manual wheelchair users had significantly reduced odds (OR = 0.24) of being physically inactive compared to pedestrians without devices.

50.3 % carried out muscle-strengthening exercises at least one to 2 days a week, the highest proportion again being among the youngest and the lowest among those requiring an electric wheelchair. Those with complete paraplegia showed significantly reduced odds (OR 0.56) of carrying out muscle-strengthening exercises compared to those with incomplete paraplegia.

Table 1 Characteristics of the study population ($n = 485$); Switzerland, 2015

	n (% of valid values)	Mean (SD); median (range)
Gender		
Male	357 (73.6)	
Missing	0 (0.0)	
Age		
In years		52.9 (14.8); 53 (17; 90)
Missing	0 (0.0)	
Partnership		
Yes	316 (67.4)	
Missing	16 (3.3)	
Years of education		
Compulsory school (≤9 years)	33 (7.0)	
Vocational training (10–12 years)	134 (28.3)	
Secondary education (13–16 years)	215 (45.3)	
University education (≥17 years)	92 (19.4)	
Missing	11 (2.3)	
Net income per month		
In Swiss Francs (CHF)		4197 (1918); 3750 (3570; 9750)
Missing	47 (9.3)	
Etiology of SCI		
Traumatic	380 (78.7)	
Non-traumatic	103 (21.3)	
Missing	2 (0.4)	
Age at onset of SCI		
In years		35.4 (17.5); 32 (0; 86)
Missing	5 (1.0)	
Time since injury		
In years		17.3 (12.9); 14 (0; 76)
Missing	0 (0.0)	
Severity of SCI		
Complete paraplegia	159 (32.9)	
Incomplete paraplegia	169 (35.0)	
Complete tetraplegia	55 (11.4)	
Incomplete tetraplegia	100 (20.7)	
Missing	2 (0.4)	
Type of locomotion (when moving around for 10–100 m)		
Pedestrian without device or assistance	70 (15.0)	
Pedestrian using device or assistance	91 (19.4)	
Wheelchair user (manual without assistance)	218 (46.6)	
Wheelchair user (electric or manual with assistance)	89 (19.0)	
Missing	17 (3.5)	

SCI spinal cord injury, *SD* standard deviation

48.9 % of the study sample fulfilled the WHO recommendations on PA (at least 2.5 h of sports of at least moderate intensity). 61.5 % of those using a manual wheelchair fulfilled these exercise recommendations. Among those aged 71 and older, only 32.7 % did. Women, people aged 71 and older, and people with complete

Table 2 Comparison of sport and exercise levels analyzed for the total sample and for subgroups with socio-demographic characteristics ($n = 485$); Switzerland, 2015

	Subgroups (*n*)	Mean; median (interquartile range)					
		Hours per week				Sum of hours per week	
		Intensity of sport			Muscle exercises	Moderate and strenuous intensity	Total hours
		Light	Moderate	Strenuous			
Total sample	485	3.2; 2.2 (0.8; 4.5)	2.8; 1.8 (0.0; 3.0)	1.8; 0.0 (0.0; 2.2)	1.2; 0.8 (0.0; 1.8)	4.7; 2.2 (0.0; 6.0)	9.1; 6.0 (2.3; 12.0)
Gender	Men (357)	3.3; 1.8 (0.8; 5.3)	2.8; **1.8** (0.0; 3.0)	2.0; 0.0 (0.0; 2.2)	1.2; 0.8 (0.0; 2.2)	4.8; 3.0 (0.0; 6.4)	9.3; 6.7 (2.3; 12.0)
	Women (128)	3.0; 2.2 (0.8; 4.1)	2.9; **0.8** (0.0; 2.2)	1.7; 0.0 (0.0; 2.2)	1.1; 0.0(0.0; 0.8)	4.6; 1.8 (0.0; 5.8)	8.7; 4.6 (2.2; 10.5)
	p value[1]	0.901	0.032*	0.152	0.195	0.062	0.143
Age	17–30 (41)	3.2; 2.2 (0.8; 5.3)	3.2; 2.2 (0.0; 4.9)	2.6; **0.8**° (0.0; 4.5)	1.3; 0.8 (0.0; 2.2)	5.8; **4.5**° (1.2; 9,8)	10.3; **8.8**° (4.1; 13.5)
	31–50 (170)	3.8; 2.2 (0.8; 5.3)	2.9; 1.3 (0.0; 3.0)	2.5; **0.8**$^{+}$ (0.0; 2.2)	1.2; 0.0 (0.0; 2.2)	5.5; 2.8 (0.6; 7.1)	10.4; 6.7 (2.3; 12.8)
	51–70 (219)	3.0; 2.2 (0.8; 4.5)	2.9; 1.8 (0.0; 3.0)	1.4; 0.0 (0.0; 2.2)	1.1; 0.0 (0.0; 1.8)	4.3; 2.2 (0.0; 6.0)	8.4; 6.0 (2.3; 11.3)
	71 and older (58)	2.5; 1.8 (0.8; 3.0)	2.1; 0.8 (0.0; 2.2)	1.0; **0.0**$^{\circ,+}$ (0.0; 0.8)	1.4; 0.0 (0.0; 2.2)	3.1; **1.5**° (0.0; 5.3)	6.9; **4.5**° (1.5; 10.5)
	p value[2]	0.337	0.302	0.005*	0.253	0.058	0.039*
Partnership	No partner (153)	3.2; 2.2 (0.8; 5.3)	3.0; 1.8 (0.0; 2.6)	1.5; **0.0** (0.0; 2.2)	1.0; **0.8** (0.0; 0.8)	4.5; 2.2 (0.0; 6.4)	8.6; 6.0 (2.2; 12.0)
	With partner (316)	3.3; 2.2 (0.8; 4.5)	2.8; 1.3 (0.0; 3.0)	2.1; **0.8** (0.0; 2.2)	1.4; **0.8** (0.0; 2.2)	4.9; 2.5 (0.8; 6.0)	9.5; 6.5 (2.3; 12.0)
	p value[1]	0.409	0.832	0.043*	0.046*	0.487	0.621
Education	<13 years (167)	2.9; 1.8 (0.8; 4.5)	2.8; 0.8 (0.8; 2.2)	1.8; **0.0** (0.0; 2.2)	1.5; 0.0 (0.0; 2.2)	4.5; 2.2 (0.0; 5.3)	8.9; 6.0 (1.8; 12.0)
	≥13 years (307)	3.4; 2.2 (0.8; 5.3)	2.9; 1.8 (0.0; 3.0)	2.0; **0.8** (0.0; 2.2)	1.0; 0.8 (0.0; 1.8)	4.9; 3.0 (0.8; 6.7)	9.3; 6.7 (3.0; 12.0)
	p value[1]	0.123	0.555	0.002*	0.751	0.076	0.701
Net income per month (in CHF)	≤2.500 (111)	2.8; **1.8**° (0.8; 4.5)	3.2; 0.8 (0.0; 5.3)	2.2; 0.0 (0.0; 2.2)	1.3; 0.8 (0.0; 2.2)	5.3; 2.2 (0.0; 7.5)	9.5; 6.7 (1.5; 14.3)
	2.501–3.750 (132)	3.1; 1.8 (0.8; 4.5)	2.6; 1.8 (0.0; 3.0)	1.2; 0.0 (0.0; 2.2)	0.9; **0.0**° (0.0; 1.8)	3.7; 2.2 (0.8; 5.3)	7.7; 6.0 (2.2; 11.0)
	3.751–5.250 (90)	4.4; **2.2**$^{\circ,+}$ (0.8; 5.3)	2.7; 0.8 (0.0; 2.2)	2.6; 0.8 (0.0; 2.2)	1.8; **0.8**$^{\circ,+}$ (0.0; 2.2)	5.3; 2.4 (0.8; 6.0)	11.4; 7.1 (3.0; 14.5)
	>5.250 (109)	2.8; **1.8**$^{+}$ (0.8; 3.0)	2.9; 2.2 (0.0; 2.2)	1.9; 0.0 (0.0; 2.2)	1.0; **0.0**$^{+}$ (0.0; 0.8)	4.8; 3.0 (0.8; 6.7)	8.7; 6.2 (2.3; 11.0)
	p value[b]	0.018*	0.981	0.321	0.019*	0.817	0.206

Bold letters: significant differences identified between marked groups; for ordinal data by applying post hoc Mann–Whitney *U* tests with Bonferroni adjusted significance level: <0.008 (for each 6 test) marked with $^{\circ,\,+,\,\Delta}$

[1] *p* values for Mann–Whitney *U* test; [2] *p* values based on Kruskal–Wallis test; significance level for both: * <0.05

Table 3 Comparison of sport and exercise levels analyzed for the total sample and for subgroups with spinal cord injury-specific characteristics ($n = 485$); Switzerland, 2015

	Subgroups (n)	Mean; median (interquartile range)					
		Hours per week				Sum of hours per week	
		Intensity of sport			Muscle exercises	Moderate and strenuous intensity	Total hours
		Light	Moderate	Strenuous			
Total sample	485	3.2; 2.2 (0.8; 4.5)	2.8; 1.8 (0.0; 3.0)	1.8; 0.0 (0.0; 2.2)	1.2; 0.8 (0.0; 1.8)	4.7; 2.2 (0.0; 6.0)	9.1; 6.0 (2.3; 12.0)
Etiology of SCI	Traumatic (380)	3.4; 2.2 (0.8; 5.3)	2.8; 1.8 (0.0; 3.0)	2.1; **0.8** (0.0; 2.2)	1.2; 0.0 (0.0; 2.1)	5.0; 2.5 (0.8; 6.7)	9.7; 6.7 (2.5; 12.4)
	Non-traumatic (103)	2.4; 1.8 (0.8; 3.0)	2.9; 0.8 (0.0; 5.3)	0.9; **0.0** (0.0; 1.8)	1.0; 0.8 (0.0; 1.8)	3.8; 2.2 (0.0; 5.3)	7.2; 5.3 (1.8; 9.8)
	p value[1]	0.097	0.840	0.012*	0.530	0.180	0.126
Time since injury	0–5 years (99)	4.0; **2.2**° (0.8; 5.3)	2.8; 0.8 (0.0; 4.5)	1.9; 0.0 (0.0; 2.2)	1.8; **0.8**° (0.0; 2.2)	4.6; 2.2 (0.0; 5.3)	10.4; 6.7 (1.8; 12.7)
	6–15 years (155)	3.4; 2.2 (0.8; 5.3)	2.6; 1.8 (0.0; 2.2)	2.2; 0.8 (0.0; 2.2)	1.2; **0.8**$^{+}$ (0.0; 2.2)	4.8; 2.5 (0.8; 6.0)	9.4; 6.7 (2.5; 12.0)
	16–25 years (108)	3.0; 2.2 (0.8; 5.1)	3.8; 2.2 (0.0; 5.3)	2.0; 0.8 (0.0; 2.2)	1.0; 0.0 (0.0; 1.5)	5.8; 3.0 (0.8; 7.5)	9.8; 6.7 (2.3; 13.5)
	26 years and longer (118)	2.6; **1.8**° (0.8; 2.2)	2.4; 0.8 (0.0; 2.2)	1.4; 0.0 (0.0; 2.2)	0.9; **0.0**$^{\circ,+}$ (0.0; 0.8)	3.8; 2.2 (0.6; 5.3)	7.3; 5.1 (1.8; 9.7)
	p value[2]	0.034*	0.310	0.110	0.010*	0.210	0.131
Severity of SCI	Incomplete parapl. (169)	3.8; 2.2 (0.8; 5.3)	2.9; 0.8 (0.0; 3.0)	1.8; **0.0**° (0.0; 2.2)	1.4; **0.8**° (0.0; 2.2)	4.7; 2.2 (0.0; 6.0)	9.9; 6.7 (2.3; 13.5)
	Complete parapl. (159)	2.7; 1.8 (0.8; 3.0)	2.8; 2.2 (0.8; 3.0)	2.5; **0.8**$^{+}$ (0.0; 2.2)	0.9; **0.0**° (0.0; 1.8)	5.4; **3.0**° (0.8; 7.5)	9.0; 6.3 (2.5; 11.3)
	Incomplete tetrapl. (100)	3.1; 1.8 (0.8; 3.0)	2.9; 0.8 (0.0; 2.4)	1.6; 0.0 (0.0; 2.2)	1.5; 0.0 (0.0; 2.1)	4.5; 2.2 (0.0; 6.0)	9.0; 5.3 (1.7; 12.0)
	Complete tetrapl. (55)	3.1; 1.8 (0.8; 3.0)	2.7; 0.8 (0.0; 2.2)	0.8; **0.0**$^{\circ,+}$ (0.0; 0.8)	0.9; 0.0 (0.0; 0.8)	3.4; **2.2**° (0.0; 4.5)	7.4; 4.5 (2.2; 10.5)
	p value[2]	0.071	0.333	0.002*	0.024*	0.037*	0.313
Type of locomotion	Pedestrian, no device (70)	3.6; 2.2 (0.8; 5.3)	1.6; **0.8**° (0.0; 2.2)	1.6; **0.4**° (0.0; 2.2)	1.1; 0.8 (0.00; 2.24)	3.1; **2.2**° (0.0; 4.5)	7.9; 6.0 (2.2; 10.5)
	Pedestrian, with device (91)	3.2; 1.8 (0.8; 5.3)	2.6; **0.8**$^{+}$ (0.0; 2.2)	1.3; **0.0**$^{+}$ (0.0; 1.8)	1.6; **0.8**° (0.0; 2.2)	3.9; **0.8**$^{+}$ (0.0; 5.3)	8.7; 6.0 (1.5; 12.0)
	Wheelchair, manual (218)	3.2; 2.2 (0.8; 4.5)	3.2; **2.2**$^{\circ,+,\Delta}$ (0.8; 4.5)	2.5; **0.8**$^{+,\Delta}$ (0.0; 2.2)	1.1; 0.8 (0.0; 1.8)	5.7; **3.0**$^{\circ,+,\Delta}$ (1.3; 7.5)	10.0; **6.7**° (3.0; 12.2)
	Wheelchair, electr./assist. (89)	2.5; 1.8 (0.8; 3.0)	3.0; **0.8**$^{\Delta}$ (0.0; 2.2)	0.5; **0.0**$^{\circ,\Delta}$ (0.0; 0.0)	0.7; **0.0**° (0.0; 0.8)	3.5; **0.8**$^{\Delta}$ (0.0; 5.3)	6.7; **3.8**° (1.5; 10.2)
	p value[2]	0.297	<0.001**	<0.001**	0.002*	<0.001**	0.013*

Bold letters: significant differences identified between marked groups; for ordinal data by applying post hoc Mann–Whitney U tests with Bonferroni adjusted significance level: <0.008 (for each 6 test) marked with °, +, Δ

[1] p values for Mann–Whitney U test; [2] p values based on Kruskal–Wallis test; significance level for both: * <0.05; ** <0.001

Table 4 Proportions and associations of characteristics with binary physical activity outcomes based on multivariate logistic regression ($n = 485$; imputed dataset; regression analyses adjusted for all variables in the table); Switzerland, 2015

	Subgroups	Completely physically inactive $n = 90$ (18.6 %)			At least 1–2 days/week muscle exercises $n = 240$ (50.3 %)			≥2.5 h of sport with at least moderate intensity $n = 237$ (48.9 %)		
		n (% of subgroup)	OR (95 %CI)	*p* value	*n* (% of subgroup)	OR (95 %CI)	*p* value	*n* (% of subgroup)	OR (95 %CI)	*p* value
Gender	Men	65 (18.2)	1		183 (51.3)	1		184 (51.5)	1	
	Women	25 (19.5)	1.12 (0.63; 2.02)	0.696	61 (47.7)	0.82 (0.52; 1.27)	0.370	53 (41.4)	0.64 (0.41; 1.00)	**0.049***
Age	17–30	2 (4.9)	1		28 (68.3)	1		25 (61.0)	1	
	31–50	31 (18.2)	4.60 (0.98; 21.54)	0.053	80 (48.8)	0.47 (0.21; 1.02)	0.057	88 (51.8)	0.59 (0.27; 1.28)	0.179
	51–70	41 (18.2)	4.68 (1.00; 21.98)	0.051	107 (48.9)	0.49 (0.22; 1.08)	0.076	106 (48.4)	0.58 (0.26; 1.26)	0.167
	71 and older	16 (29.1)	6.82 (1.36; 34.23)	**0.020***	26 (47.3)	0.42 (0.16; 1.65)	0.064	18 (32.7)	0.31 (0.12; 0.78)	**0.013***
Partnership	No partner	58 (18.4)	1		160 (50.6)	1		159 (50.3)	1	
	With partner	27 (17.6)	0.90 (0.72; 1.13)	0.789	78 (51.0)	1.08 (0.70; 1.66)	0.729	71 (46.4)	1.23 (0.80; 1.87)	0.345
Education	Less than 13 years	40 (24.0)	1		81 (48.5)	1		72 (43.1)	1	
	13 years and more	49 (16.0)	0.69 (0.41; 1.16)	0.161	155 (50.5)	1.01 (0.67; 1.53)	0.953	160 (52.1)	1.26 (0.83; 1.90)	0.278
Net income	Less than 2500 CHF	23 (20.7)	1		58 (47.7)	1		54 (48.6)	1	
	2501–3750 CHF	26 (19.7)	1.00 (0.50; 2.00)	0.990	64 (48.5)	0.82 (0.47; 1.44)	0.987	63 (47.7)	0.99 (0.57; 1.70)	0.962
	3750–5250 CHF	11 (12.2)	0.62 (0.26; 1.49)	0.281	56 (62.2)	1.51 (0.84; 2.70)	0.164	45 (50.0)	1.00 (0.56; 1.81)	0.988
	>5250 CHF	16 (14.7)	0.72 (0.32; 1.62)	0.430	48 (44.0)	0.82 (0.47; 1.44)	0.489	57 (52.3)	1.12 (0.63; 2.01)	0.703
Etiology of SCI	Traumatic	67 (17.6)	1		187 (49.2)	1		193 (50.8)	1	
	Non-traumatic	23 (22.3)	1.11 (0.56; 2.18)	0.770	55 (53.4)	0.95 (0.56; 1.60)	0.841	44 (42.7)	0.87 (0.51; 1.48)	0.611
Time since injury	0–5 years	24 (24.2)	1		56 (56.6)	1		46 (46.5)		
	6–15 years	21 (13.5)	0.48 (0.24; 0.74)	**0.041***	89 (57.4)	1.03 (0.60; 1.76)	0.922	78 (50.3)	1.12 (0.65; 1.91)	0.693
	16–25 years	22 (20.4)	0.87 (0.41; 1.86)	0.727	50 (46.3)	0.77 (0.42; 1.40)	0.385	60 (55.6)	1.24 (0.68; 2.28)	0.483
	26 years and longer	22 (18.6)	0.69 (0.31; 1.52)	0.353	47 (39.8)	0.63 (0.33; 1.17)	0.144	52 (44.1)	0.71 (0.37; 1.34)	0.285
Severity of SCI	Incompl. paraplegic	29 (17.2)	1		101 (59.8)	1		79 (46.7)	1	
	Complete paraplegic	22 (13.8)	2.07 (0.88; 4.86)	0.095	70 (44.0)	0.56 (0.32; 0.99)	**0.046**	92 (57.9)	0.90 (0.51; 1.60)	0.718
	Incompl. tetraplegic	24 (24.0)	1.75 (0.87; 3.53)	0.120	47 (47.0)	0.67 (0.39; 1.16)	0.152	45 (45.0)	0.90 (0.52; 1.56)	0.699
	Complete tetraplegic	15 (27.3)	3.29 (1.24; 8.71)	**0.017***	24 (43.6)	0.67 (0.32; 1.43)	0.303	20 (36.4)	0.43 (0.20; 0.91)	**0.029***
Type of locomotion	Pedestrian without device/support	16 (22.9)	1		38 (54.3)	1		27 (38.6)	1	
	Pedestrian with device or support	24 (26.4)	1.23 (0.54; 2.77)	0.620	55 (60.4)	1.22 (0.62; 2.41)	0.563	37 (40.7)	1.13 (0.57; 2.21)	0.731
	Wheelchair, manual without support	19 (8.7)	0.24 (0.09; 0.61)	**0.003***	110 (50.5)	1.20 (0.63; 2.30)	0.582	134 (61.5)	2.83 (1.46; 5.47)	**0.002***
	Wheelchair, electric or with support	28 (31.5)	0.92 (0.38; 2.18)	0.842	30 (33.7)	0.60 (0.29; 1.24)	0.168	31 (34.8)	1.28 (0.61; 2.66)	0.512

To view the n of the subgroups refer to Tables 2 and 3

OR odds ratio, *CI* confidence interval, *CHF* Swiss francs, *SCI* spinal cord injury

* *p* value level of significance <0.05; marked in bold

tetraplegia had significantly lower odds of fulfilling the recommendations compared to their respective reference population. Manual wheelchair users had significantly lower odds of not achieving the recommendations compared to pedestrians without devices.

Discussion

This study indicates that PA levels in people with SCI in Switzerland are rather high with a median total time of 6.0 h/week (mean 9.1) of sports and muscle-strengthening exercises. Several studies investigated PA levels in people with SCI (Anneken et al. 2010; Buchholz et al. 2003; de Groot et al. 2011; Martin Ginis et al. 2010a; Rauch et al. 2014; Tasiemski et al. 2000; van den Berg-Emons et al. 2008), but a comparison of the results is limited due to the use of different instruments assessing different concepts (all types of PA, leisure-time PA, or sports only). Three studies reported the time spent on PAs (means), which varied from 49 min/day of dynamic activities (measured using an activity monitor) in a Dutch (van den Berg-Emons et al. 2008) to 55 min/day of all types of leisure-time PAs in a Canadian (using the Physical Activity Recall Assessment for People with Spinal Cord Injury, PARA-SCI) (Martin Ginis et al. 2005) to 3.1 h/day on all types of leisure-time PAs in a Korean sample (using a self-developed questionnaire) (Kim et al. 2011). The differences in the PA levels in the different countries may relate to different amount of services and support for PAs, however, the use of the different instruments may as well contribute to the different findings.

The fact that this study population spent the most time on light and the least time on strenuous PAs differs from findings from the Canadian and Korean SCI populations, where people spent the most time on moderate-intensity PAs (Kim et al. 2011; Martin Ginis et al. 2010a). In our study, especially women, pedestrians using devices and people using an electric wheelchair carried out significantly fewer moderate-intensity PAs than men and people using a manual wheelchair. The time spent on strenuous-intensity PAs in general was rather low and differed significantly in some subgroups (age, partnership, education, etiology, severity of SCI, type of locomotion). Those spending only little time on sports of moderate intensities did not compensate for this by spending more time on sports of strenuous intensity. As a result, 50 % of them performed PAs of moderate and strenuous intensities only 0.8–1.8 h/week. The preference for sports of low intensity in these subgroups requires investigating the potential reasons for this and how to facilitate their involvement in more strenuous PAs.

In a previous study, it was found that interest in participating in performance-oriented types of sports is lower in women than in men (Rauch et al. 2013). The results of this study confirmed these findings. Although no gender differences have been found for the time spent performing sports of strenuous intensity, which indicates that a certain proportion of women are interested in performance-oriented sports, the majority of women preferred PAs of only light intensity. The same may apply to those who have less physical capacity (the elderly, those with more severe SCI). There are also hints that the existing sports programs in Switzerland are more performance oriented (Rauch et al. 2013) and therefore might not fulfill the interests of those who prefer sport with less intensity.

The time spent performing muscle-strengthening exercises is rather low compared to the time spent on light- or moderate-intensity sports. Analysis of differences in the time spent on muscle-strengthening exercises found significant differences in income, time since injury, severity of SCI, and type of locomotion. Future research is required to detect the motives for the certain subgroups that spend more time than others with muscle-strengthening exercises.

This study also showed that with 18.6 % the proportion of those who are completely physically inactive is rather low. Previous studies reported much higher proportions: In a German sample 48.5 % that did not participate in any sport (Anneken et al. 2010). In a Canadian sample 50.1 % reported performing no leisure-time PAs at all (Martin Ginis et al. 2010b). In a previous study in Switzerland 33.3 % reported to never participate in sports (Rauch et al. 2014). Even 27.1 % of the Swiss general population reported never participating in sports (Lamprecht et al. 2008). Taking into account that the PA levels were assessed differently in these studies, this comparison should not be overemphasized, but it does provide hints that PA levels vary in different contexts. The low proportion of the physically inactive individuals in the Swiss SCI population suggests that the study sample is rather active, but as well a potential selection bias should be considered.

The given response options in the PASIPD do not allow the identification of people who perform muscle-strengthening exercises at least twice weekly, as recommended in general (WHO 2010) and in SCI-specific recommendations (Martin Ginis et al. 2011). In this study, we compared those who do (at least once per week) with those who do not engage in any muscle-strengthening exercises at all. The proportion (50.3 %) of our study sample reporting performing muscle-strengthening exercises is high compared to other study populations where this proportion varied from 19.3 % ('gym') (Sale et al. 2012) to 32.6 % ('resistance training') (Martin Ginis et al. 2010a) and 37.6 % ('fitness/resistance training') (Anneken et al. 2010).

48.9 % of the study sample fulfilled the WHO exercise recommendations by reporting spending 2.5 h or more per week on sports of at least moderate intensity (WHO 2010). So far, no study has investigated whether people with SCI fulfill general or SCI-specific exercise recommendations, so a comparison with other SCI populations is not presently possible. It has been reported that about two-thirds of the general European population does not reach recommended activity levels (WHO 2006), whereas about 41 % of Swiss adults reported fulfilling exercise recommendations (Martin et al. 2009). Although our results suggest that the proportion of people who fulfill exercise recommendations is higher in the Swiss SCI population than in the able-bodied population, a comparative study including both populations would be required to confirm this.

Analysis of subgroups and associations with the three PA categories identified some subgroups, which might require special consideration for future intervention planning. The socio-demographic characteristics partnership, education, and net income were not associated with any of the PA categories. Education and income are well-known determinants for PA in general populations in many countries (Stalsberg and Pedersen 2010), as well as in Switzerland (Lamprecht et al. 2008). Previous studies have already described that these characteristics are not associated with PA levels in people with SCI (Fekete and Rauch 2012; Rauch et al. 2014). This study confirms the assumption that different approaches than in the able-bodied population are required to explain PA behavior in people with SCI.

In this study, gender, age, severity of SCI, time since injury, and the type of locomotion were found to be associated with the PA categories. Women showed a total time of all PAs that was among the lowest. In principle, gender was associated with lower PA levels in women in only few previous studies (Martin Ginis et al. 2010b; Rauch et al. 2014). In this study, the proportion of completely physically inactive women and those who performed muscle-strengthening exercises regularly was comparable to those in men. However, women showed significantly lower odds of fulfilling the exercise recommendations. Taking into account the fact that women spent significantly less time on moderate-intensity sports than men, future interventions should focus on how to encourage women to increase the intensity when performing sports.

People aged 71 and older have the highest odds of being completely physically inactive and of not fulfilling exercise recommendations compared to those aged 17–30 years. It has to be noted that the odds for the age groups 31–50 and 51–70 are also increased although not significantly. This finding differs from a previous study conducted in Switzerland (Rauch et al. 2014) and from studies conducted in other countries (Martin Ginis et al. 2010b; Wu and Williams 2001), where no association between age and sports participation could be found. However, it is in line with the Swiss general population (Lamprecht et al. 2008). Future PA interventions should target the expected increasing number of older individuals with SCI.

People with complete tetraplegia have significantly increased odds of becoming completely physically inactive and not fulfilling exercise recommendations compared to those with less severe SCIs. Previous research also identified that tetraplegia is associated with lower PA levels (Martin Ginis et al. 2010b; Rauch et al. 2014). Comparable to women and the elderly, people with complete tetraplegia reported spending very little time performing sports of strenuous intensity and did not reach the recommended 2.5 h of sports of at least moderate intensity. Taking into account these three subgroups, it should be investigated whether existing sports programs offer types of sports that are suitable and preferable for people with rather little physical capacity, such as women, the elderly, and people with tetraplegia.

People with complete paraplegia showed significantly lower odds for performing muscle-strengthening exercises regularly compared to those with incomplete paraplegia. However, they showed the highest proportion of participants fulfilling the exercise recommendations. Thus, people with complete paraplegia are physically active, but prefer sports to muscle-strengthening exercises.

Electric wheelchair users made up the highest proportion of the completely physically inactive and the second highest among those who did not fulfill exercise recommendations. Although no significant differences for sports-associated odds compared to pedestrians without devices could be found, they present a group which should be given special consideration, as they represent the group spending the least total time on PAs.

Pedestrians requiring devices require special attention regarding their PA levels. Although they are able to walk and suffer from less severe SCI, they spend significantly less time on sports of at least moderate intensity than those using a manual wheelchair. The severity of SCI and the related physical capacity alone does not explain PA behavior. The readiness to use a wheelchair only for sports when limitations in walking, running, or cycling do not allow participation in certain types of sports may also influence participation in sports. Future research should investigate this phenomenon since these results show that the type of locomotion should be taken into account when planning interventions for specific target populations.

Although this study shows that PA levels in people with SCI are generally rather high in Switzerland (with some exceptions for distinct subgroups), the available information cannot answer the question whether the achieved PA levels are sufficient to reduce the increased risk for PA-related chronic conditions in the SCI population. Thus, to answer the question whether general or SCI-specific exercise recommendations are applicable to people with SCI with respect to the reduction of risks for secondary conditions longitudinal cohort studies are required.

In this study, PA was assessed by the PASIPD, a self-report in which participants rate the intensity of PAs based on their own judgment. Research has shown that responders to the PASIPD tend to overestimate PA levels (van den Berg-Emons et al. 2011), making it likely that the participants in our study actually performed less and less-intense PAs than reported. This assumption is confirmed by two studies showing only weak correlation between self-reported PA levels and fitness parameters (de Groot et al. 2010) and overestimated energy expenditure when comparing the PASIPD to objective measures (Tanhoffer et al. 2012). Considering the more reliable measures used in the Dutch and Canadian study, the higher PA levels reported in this Swiss sample should thus be interpreted with caution. Activity monitors designed for wheelchair users, as used in the Dutch study (Bussmann et al. 2001), could overcome the limitations regarding self-reported PA levels. The PARA-SCI (Martin Ginis et al. 2005), an interview-based self-report measure used in the Canadian study, proved to be a good method for predicting energy expenditure in persons with SCI (Tanhoffer et al. 2012). However, for larger studies in which both the use of activity monitors and interviews require large resources, the Leisure Time Physical Activity Questionnaire for People with Spinal Cord Injury (LTPAQ-SCI) (Martin Ginis et al. 2012) could present a reliable alternative since it showed good correlation with the PARA-SCI. Generally, the use of the same assessment tool is desired to overcome the lack of comparability among different studies.

Conclusion

This study attempted for the first time to investigate whether people with SCI fulfill WHO exercise recommendations. It showed that PA levels of people with SCI in Switzerland are rather high, but also identified subgroups that need special consideration when planning interventions. To better understand the physically inactive, those who perform no muscle-strengthening exercises and those who do not fulfill exercise recommendations, future research needs to integrate additional aspects that are likely to be associated with PA levels, such as personal and environmental factors. Future research also needs to investigate whether general exercise recommendations are applicable to people with SCI and whether the achievement of these or SCI-specific recommendations actually lead to a risk reduction for cardiovascular conditions.

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ORIGINAL ARTICLE

Associations with being physically active and the achievement of WHO recommendations on physical activity in people with spinal cord injury

A Rauch[1], T Hinrichs[2] and A Cieza[1,3,4] for the SwiSCI study group[5]

Study Design: Secondary data analysis from the cross-sectional survey of the Swiss Spinal Cord Injury Cohort Study.
Objectives: To explore associations with physical activity (PA) levels in people with spinal cord injury (SCI) with the specific aim to identify aspects that potentially explain being physically active (PHYS-ACT) and the achievement of the World Health Organization recommendations on PA.
Setting: Community sample ($n = 485$).
Methods: Participants who completely answered four items of the Physical Activity Scale for Individuals with Physical Disabilities were included. Two outcome measures were defined: (1) being PHYS-ACT vs being completely inactive and (2) achieving WHO recommendations on PA (ACH-WHO-REC) (at least 2.5 h per week of at least moderate intensity) vs performing less. Independent variables were selected from the original questionnaire by applying the ICF framework. Multivariate logistic regression analyses were conducted.
Results: In the participants (aged 52.8 ± 14.8; 73.6% male) older age decreased, but being a manual wheelchair user increased the odds of achieving both outcomes. Social support and self-efficacy increased the odds of being PHYS-ACT. Use of an intermittent catheter increased, whereas dependency in self-care mobility and coping with emotions decreased the odds for ACH-WHO-REC. Experiencing hindrances due to accessibility is associated with increased odds for ACH-WHO-REC.
Conclusion: Being PHYS-ACT at all and achieving the WHO recommendations on PA are associated with different aspects. Applying the ICF framework contributes to a comprehensive understanding of PA behavior in people with SCI, which can tailor the development of interventions. Longitudinal studies should be initiated to test these associations for causal relationships.
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INTRODUCTION

Physical inactivity is among the most frequent risk factors for mortality in the general population.[1] For people with spinal cord injury (SCI) living in high-income countries, the leading causes for death shift to those in the general population.[2] General and SCI-specific guidelines for physical activity (PA) suggest specific types and amounts of PA to prevent diseases related to physical inactivity. The World Health Organization's (WHO) recommendations on PA suggest performing aerobic exercises of at least moderate intensity for at least 150 min (2.5 h) per week.[1] In contrast, the most recent SCI-specific guidelines suggest a minimum of moderate-intensity aerobic exercises for least 20 min (two times) per week.[3] However, recent research has shown that this amount might not be sufficient to reduce risks, in particular, for cardiovascular diseases.[4]

Recent research in people living with SCI in Switzerland showed that 81% are physically active (PHYS-ACT) by performing any leisure-time PA, whereas only 49% achieve the WHO recommendations for PA (ACH-WHO-REC).[5] When exploring sociodemographic and SCI-related characteristics, it was found that people aged 71 years and older and people with complete tetraplegia had significantly lower odds for being PHYS-ACT and to ACH-WHO-REC compared with their respective reference population. Furthermore, the odds to ACH-WHO-REC was lower for women and the odds to be PHYS-ACT was lower when the time since injury was shorter than 5 years. Manual wheelchair users had significantly higher odds to be PHYS-ACT and to ACH-WHO-REC compared with pedestrians without or with devices and users of an electric wheelchair. These findings ask to investigate associations with being PHYS-ACT and the ACH-WHO-REC.

To date, many aspects covering different areas have been found to explain PA levels in people with SCI;[6] however, comprehensive models have been rarely applied. Given a potential multidimensionality, a comprehensive model that controls for confounding effects among the different domains is useful. The International Classification of Functioning, Disability and Health (ICF)[7] provides a comprehensive model that is composed of body functions, body structures, activities and participation (referring to functioning) and environmental and personal factors (referring to contextual factors). The ICF Core Sets

[1]Department of Medical Informatics, Biometry and Epidemiology—IBE, Chair for Public Health and Health Services Research, Research Unit for Biopsychosocial Health, Ludwig-Maximilians-University Munich, Munich, Germany; [2]Division of Sports and Exercise Medicine, Department of Sport, Exercise and Health, University of Basel, Basel, Switzerland; [3]Swiss Paraplegic Research, Nottwil, Switzerland and [4]Faculty of Social and Human Sciences, School of Psychology, University of Southampton, Southampton, UK
[5]The members of the SwiSCI Steering Committee are listed before references.
Correspondence: A Rauch, Department of Medical Informatics, Biometry and Epidemiology—IBE, Chair for Public Health and Health Services Research, Research Unit for Biopsychosocial Health, Ludwig-Maximilians-University Munich, Marchioninistrasse 17, Munich 81377, Germany.
E-mail: rauchalex@hotmail.com
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for SCI[8,9] present lists of categories of these components that are relevant to functioning in people with SCI. The ICF framework was first applied in a large quantitative study investigating predictors to explain PA levels in a Canadian population.[10] For Switzerland, a qualitative study used the ICF and identified associations with participation in PA from all ICF components.[11] However, these findings have not been validated with quantitative research yet.

Given that various factors from various domains have been found to associate with PA, the strength of the associations with PA may vary and some aspects may influence each other. A comprehensive approach applying multivariate analyses will help to identify those factors from different domains that finally associate with PA and the achievement of WHO recommendations without confounding each other. Thus, the overall objective of this study is to explore associations with PA levels by applying a comprehensive model based on the ICF framework. The specific aim is to identify those aspects that potentially explain being physically active and the achievement of the WHO recommendations on PA.

MATERIALS AND METHODS

Study design

This study analyzed data from the Swiss Spinal Cord Injury Cohort Study (SwiSCI) Community Survey 2012, which contained three modules: (1) questionnaire on basic sociodemographics, lesion characteristics, care situation; (2) detailed information on functioning, health, environmental and personal factors; and (3) three different specific modules.[12] The specific modules covered a 'Psychological Personal Factors and Health Behavior Module' module, a 'Work' module and a 'Health Services Research' module. Participants were recruited via four SCI rehabilitation centers, the national association for people with SCI, an SCI-specific home care institution and a national insurance company. In total, 1549 individuals (traumatic or non-traumatic SCI, 16 years and older) participated in the first two modules of the survey (response rate: 49.3%, median age: 52 years, 71.5% male, median time since injury: 13.5 years, paraplegia: 69.2%). Thereof, 570 individuals were randomly selected to participate in the specific module on 'Psychological Personal Factors and Health Behavior Module', which included questions on PA behavior. Of these, 511 subjects answered this module.

Data collection and item selection

Sociodemographic and SCI-related characteristics were selected to describe the study population. Furthermore, *age, sex, time since onset of SCI, severity of SCI* and *type of locomotion* were included in the regression analysis as they showed associations with either both or one of the two outcomes in a previous study.[5] The type of locomotion was assessed with item 13 (mobility for moderate distances: 10–100 m) of the Self-reported Spinal Cord Independence Measure (SR-SCIM);[13] the response options for walking with different devices were summarized to 'pedestrian with device or support'.

PA was assessed with four items (items 3–6) of the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD).[14] These items comprise sport and recreational PAs with light, moderate and strenuous intensity, and muscle strengthening exercises. The total time (hours per week) for each item and for combinations of the different items can be calculated. Moderate- and strenuous-intensity exercises comply with the intensities suggested in the WHO recommendations on PA.

The selection of ICF categories as covariables was based on the Brief ICF Core Set for SCI in the long-term context[8] as well as on considerations on potential predictors of PA levels. These considerations were informed by results from previous studies on correlates of PA in people with SCI.[6,10,11] Whenever more than one variable of the questionnaire referred to one selected ICF category, correlations between these variables and the ACH-WHO-REC were calculated. Only the variable with the highest correlation coefficient was selected. Alternatively, a parent item was created for some variables to combine similar information.

Body structures. Body structures were covered with the severity of SCI. No additional body structure was included.

Body functions. *Emotional functions* were assessed with the SF-36 five-item Mental Health Index[15] covering five 5-point questions with a sum score from 0 (worst) to 100 (best mental health). *Pain, bowel and bladder functions* and *spasticity* were each assessed with a question asking for problems during the past 3 months (response options: no, little or rare, moderate or occasionally, severe or chronic problem).

Activities and participation. *Intermittent catheterization* was assessed with item 6B and *self-care mobility* with the combined items 2A (washing upper body), 2B (washing lower body), 3A (dressing upper body), 3B (dressing lower body) and 11 (transferring from wheelchair to toilet/tub) of the SR-SCIM.[13] Problems in *outdoor mobility* were assessed with one question on the ability to perform the task (response options: not applicable, not possible, with assistance, with support, without support). *Employment* was assessed with one question on the amount of hours spent per week (response options: 0, 1–8, 9–16, 17–24, 25–35, 36 or more). *Social activities* were assessed with one question on the frequency of performing day trips or outdoor activities during the past 4 weeks (response options: 0, 1–2, 3–5, 6–10, 11–18, 19 or more).

Environmental factors. *Accessibility* of public places was measured with item 1, and *social attitudes* with item 3, of the Nottwil Environmental Factors Inventory Short Form[16] asking to evaluate the influence of the respective aspect (response options: no influence, made my life a little harder, made my life a lot harder). *Social support* was assessed with the Social Support Questionnaire.[17] The Social Support Questionnaire asks participants to name the number of supporters and to score the satisfaction with their support. A sum score is calculated (0 presents no and 90 the highest support).

Personal factors. *Self-efficacy* was assessed with the General Self-Efficacy Scale,[18] which includes ten 4-point items with a total score from 10 to 40 (higher scores meaning better self-efficacy). The Purpose in Life Test-Short Form (PIL-SF)[19] was included to address general life *goals* as an indicator for goal orientation. The PIL-SF comprises four 7-point items with a total score from 4 to 28 (higher scores suggest greater purpose in life). To address coping, the sub-scale *coping with emotions* from the Brief Cope[20] was included as it showed the highest correlation with ACH-WHO-REC among all scales. This scale summarizes two questions referring to focusing and venting of emotions. The score ranges from 2 to 8 (higher scores meaning increased tendency to apply the strategy).

Data analyses

Descriptive statistics were conducted to describe the study population and to calculate the proportion of those who were PHYS-ACT and those who achieved the WHO recommendations on PA (at least 2.5 h of moderate and strenuous PAs per week).

Multivariate logistic regression analyses were performed with PHYS-ACT and the ACH-WHO-REC as dependent variables. To prepare data for regression analyses, response options of independent variables with ordinal scales were dichotomized into groups of people who had the corresponding outcome versus those who did not. Hierarchical models entering blocks successively were calculated for the two dependent variables. The first block (sociodemographic and SCI-related variables) consisted of variables that were identified to be independently associated with the respective PA outcome in the previous study.[5] Then, blocks of independent variables referring to each ICF component (body functions, activities and participation, environmental factors, personal factors) were added in a stepwise manner. Thus, the final model included all independent variables.

Missing values in the independent variables were addressed by conducting multiple imputations. Therefore, all variables included in the regression models were entered, and five iterations were performed. In all regression models, odds ratios with 95% confidence intervals and the corresponding P-value were calculated. The level of significance was set as $P<0.05$. The R^2 (Nagelkerke) was calculated for goodness-of-fit analyses. Statistical analyses were performed with SPSS 21 (SPSS Inc., Chicago, IL, USA).

The survey has been performed in accordance with the ethical standards according to the Declaration of Helsinki and has been approved by the Ethics Committee of the Canton of Lucerne. All participants gave written informed consent.

RESULTS

In total, 485 participants answered the PASIPD completely and were included in this study (Table 1). No differences in sociodemographic and SCI-related characteristics between the respondents and

Table 1 Characteristics of the study population ($n=485$) and proportions of people being PHYS-ACT and achieving WHO recommendations on physical activity (⩾2.5 h per week of at least moderate intensity)

	Mean (s.d.) *Median (min; max)*	n *(%)*	*PHYS-ACT,* n *(valid %)*	*ACH-WHO-REC,* n *(valid %)*
Total sample		485 (100%)	395 (81.4)	237 (48.9)
Sex				
Male		357 (73.6)	292 (81.8)	184 (51.5)
Female		128 (26.4)	103 (80.5)	53 (41.4)[a]
Missing		0 (0.0)		
Age (years)				
	52.8 (14.8)			
	53.0 (17; 90)			
17–30		41 (8.5)	39 (95.1)	25 (61.0)
31–50		170 (35.1)	139 (81.8)	88 (51.8)
51–70		219 (45.2)	178 (81.3)	106 (48.4)
⩾71		55 (11.3)	39 (70.9)[a]	18 (32.7)[a]
Missing		0 (0.0)		
Years of education (years)				
	13.8 (3.3)			
	13.0 (2; 25)			
<13		167 (34.4)	127 (76.0)	72 (43.1)
13		307 (63.3)	258 (84.0)	160 (52.1)
Missing		11 (2.3)		
Etiology of SCI				
Traumatic		380 (78.7)	313 (82.4)	193 (50.8)
Non-traumatic		103 (21.3)	80 (77.7)	44 (42.7)
Missing		2 (0.4)		
Time since injury (in years)				
	17.3 (12.9)			
	14.0 (0; 76)			
0–5		99 (20.4)	75 (75.8)	46 (46.5)
6–15		155 (32.0)	134 (86.5)[a]	78 (50.3)
16–25		108 (22.3)	86 (79.6)	60 (55.6)
⩾26		118 (24.3)	96 (81.4)	52 (44.1)
Missing		5 (1.0)		
Severity of SCI				
Incomplete paraplegia		169 (35.0)	140 (82.8)	92 (57.9)
Complete paraplegia		159 (32.9)	137 (86.2)	79 (46.7)
Incomplete tetraplegia		100 (20.7)	76 (76.0)	20 (36.4)[a]
Complete tetraplegia		55 (11.4)	40 (72.7)[a]	45 (45.0)
Missing		2 (0.4)		
Type of locomotion (when moving around for 10–100 m)				
Pedestrian (neither device nor assistance)		70 (15.0)	54 (77.1)	27 (38.6)
Pedestrian (with device or assistance)		91 (19.4)	67 (73.6)	37 (40.7)
Manual wheelchair (no assistance)		218 (46.6)	199 (91.3)[a]	134 (61.5)[a]
Electric wheelchair/manual with assistance		89 (19.0)	61 (68.5)	31 (34.8)
Missing		17 (3.5)		

Abbreviations: ACH-WHO-REC, achievement of WHO recommendations on physical activity; PHYS-ACT, physically active; SCI, spinal cord injury; WHO, World Health Organization.
[a]For these subgroups, significant differences in being PHYS-ACT and achieving WHO recommendations on physical activity have been found in a previous study.[5]

the excluded subjects and non-respondents of the survey have been found.

Table 2 presents an overview of the selected items and the instruments used in the survey to assess these items. Furthermore, it presents the dichotomization of the ordinal variables into each two answer categories and the assessment results (mean value, respectively number of persons referring to each of the answer categories).

Table 3 presents the results for the logistic regression for being PHYS-ACT. The first model shows the significantly decreased and increased odds for being PHYS-ACT for the already known sociodemographic and SCI-related characteristics. While no variable from body functions and activities and participation associated with being PHYS-ACT in the following models, the environmental factors *social support* and the personal factor higher *self-efficacy* significantly increased the odds to be PHYS-ACT. From the first model, only the use of a *manual wheelchair* remained a significant association in the final model; increasing age was still close to the defined significance level. With each stepwise entering of the different blocks, the model fit presented with the Nagelkerke R^2 increased. The final model explained 25% of the variance.

Table 4 presents the results for the analyses for ACH-WHO-REC. As in the previous analyses, no body function was found to explain ACH-WHO-REC. In contrast, from activities and participation the *use of an intermittent catheter* significantly increased, and being *dependent in self-care mobility* significantly decreased the odds to ACH-WHO-REC. From environmental factors, experiencing *hindrances due to accessibility* was significantly associated with ACH-WHO-REC and the personal factors *coping with emotions* significantly decreased the odds to ACH-WHO-REC. From the first model, only *age* and the use of a *manual wheelchair* remained significantly associated with ACH-WHO-REC in the final model: older age decreased and the use of a manual wheelchair increased the odds to ACH-WHO-REC. The stepwise

Table 2 Overview of the applied instruments used to assess the independent variables, the dichotomization of ordinal variables and the assessment results ($n=485$)

Item	*Assessment instruments (for the metric variables the total score is presented in brackets)*	*Mean (s.d.)*	*Dichotomized answer categories for ordinal variables*	*n (valid %)*
BF				
Emotional functions	Five-item MHI-SF36[15] (0–100)	72.5 (±18.0)		
Pain	Question on severity of chronic pain problem		No pain[a]	130 (28.2)
			Pain	331 (71.8)
Bowel and/or bladder problems	Question on frequency of bladder problems		No problem[a]	90 (19.9)
	Question on fecal incontinence		Bowel and/or bladder problems	363 (80.1)
Spasticity	Question on frequency of spasticity		No spasticity[a]	125 (27.2)
			Spasticity	335 (72.8)
AP				
Use of intermittent catheter	SR-SCIM 14: Use of intermittent catheter		No use[a]	286 (62.2)
			Use	174 (37.8)
Dependent in self-care mobility	SR-SCIM 2A: Washing upper body		Independent[a]	141 (29.7)
	SR-SCIM 2B: Washing lower body		Any dependency in at least one of the five items	333 (70.3)
	SR-SCIM 3A: Dressing upper body			
	SR-SCIM 3B: Dressing lower body			
	SR-SCIM 11: Transfer wheelchair-toilet			
Difficulties in outdoor mobility	Question on difficulties in outdoor mobility		No difficulty[a]	167 (36.0)
			Difficulty	297 (64.0)
Employment	Question on the amount of hours of paid work per week		Unemployed (0 h)[a]	210 (47.2)
			Employed (>0 h)	235 (52.8)
Social activities	Number of social activities outside of the home during the past 4 weeks		2 times or less[a]	201 (43.1)
			⩾3 times	265 (56.9)
EF				
Hindrance due to accessibility	Question on the influence of accessibility of public buildings		No influence[a]	169 (36.0)
			Hindrance	300 (64.0)
Hindrance due to social attitudes	Question on the influence of negative social attitudes of the society		No influence[a]	350 (75.4)
			Hindrance	114 (24.6)
Social support	Social Support Questionnaire[17] (0–90)	25.3 (±10.4)		485 (100.0)
PF				
Self-efficacy	General Self-Efficacy Scale[18] (10–40)	30.4 (±5.6)		462
Purpose in life	Purpose in Life-Short Form[19] (4–28)	21.3 (±4.7)		472
Coping with emotions	Sum of items 9 and 21 of the Brief Cope[20] (2–8)	3.9 (±1.4)		472

Abbreviations: AP, activities and participation; BF, body functions, EF, environmental factors; MHI-SF36, Mental Health Index of the Short Form;[15] PF, personal factors; s.d., standard deviation; SR-SCIM, Self-Reported Spinal Cord Independence Measure.[13]
[a]Reference categories for the dichotomized variables in the regression models (presented in Tables 3 and 4).

Table 3 Stepwise multivariate logistic regression model for associations with being physically active ($n = 485$; imputed data set)

Independent variable	*Model 1*		*Model 2*		*Model 3*		*Model 4*		*Model 5*	
	OR (95%CI)	P-*value*	*OR (95% CI)*	P-*value*	*OR (95% CI)*	P-*value*	*OR (95% CI)*	P-value	*OR (95% CI)*	P-value
Constant	13.08 (2.57–66.53)		5.73 (0.74–44.3)		4.80 (0.57–40.64)		2.06 (0.22–19.37)		0.50 (0.03–7.32)	
Sociodemographic and SCI-related aspects										
Age (years)[a]										
31–50	0.23 (0.05–1.06)	0.059	0.23 (0.05–1.04)	0.056	0.23 (0.05–1.06)	0.060	0.24 (0.05–1.10)	0.068	0.21 (0.04–1.02)	0.053
51–70	0.24 (0.05–1.06)	0.060	0.23 (0.05–1.08)	0.063	0.23 (0.05–1.10)	0.067	0.26 (0.05–1.25)	0.092	0.23 (0.45–1.20)	0.081
71 and older	0.15 (0.03–0.75)	**0.021**	0.15 (0.03–0.75)	**0.021**	0.17 (0.03–0.87)	**0.034**	0.21 (0.04–1.16)	0.074	0.20 (0.04–1.12)	0.066
Time since onset[a]										
6–15 years	2.00 (1.01–3.96)	**0.047**	2.01 (1.01–4.00)	**0.047**	2.03 (1.00–4.10)	**0.049**	2.09 (1.03–4.26)	**0.043**	1.90 (0.90–4.00)	0.092
16–25 years	1.18 (0.58–2.40)	0.646	1.17 (0.57–2.40)	0.661	1.10 (0.53–2.30)	0.800	1.18 (0.56–2.49)	0.664	1.01 (0.47–2.18)	0.983
26 years and longer	1.39 (0.66–2.92)	0.385	1.30 (0.62–2.75)	0.491	1.19 (0.55–2.58)	0.656	1.28 (0.59–2.80)	0.531	1.04 (0.46–2.34)	0.923
Severity of SCI[a]										
Complete paraplegic	0.49 (0.22–1.13)	0.093	0.49 (0.21–1.13)	0.094	0.54 (0.23–1.26)	0.153	0.52 (0.22–1.23)	0.138	0.48 (0.20–1.15)	0.099
Incomplete tetraplegic	0.60 (0.31–1.17)	0.136	0.60 (0.30–1.18)	0.138	0.67 (0.33–1.34)	0.254	0.68 (0.33–1.36)	0.272	0.70 (0.34–1.44)	0.329
Complete tetraplegic	0.39 (0.16–0.97)	**0.042**	0.37 (0.15–0.93)	**0.035**	0.43 (0.17–1.09)	0.076	0.46 (0.18–1.19)	0.109	0.52 (0.19–1.41)	0.202
Type of locomotion[a]										
Pedestrian with device	0.83 (0.38–1.82)	0.641	0.89 (0.40–1.99)	0.772	1.07 (0.43–2.66)	0.891	0.91 (0.36–2.30)	0.883	0.96 (0.37–2.47)	0.927
Manual wheelchair	4.29 (1.74–10.61)	**0.002**	4.36 (1.74–10.93)	**0.002**	5.05 (1.79–14.21)	**0.002**	4.36 (1.51–12.58)	**0.006**	5.31 (1.75–16.15)	**0.003**
Electrical wheelchair	0.98 (0.43–2.24)	0.964	1.05 (0.45–2.45)	0.910	1.39 (0.50–3.85)	0.531	1.13 (0.39–3.23)	0.827	1.19 (0.40–3.57)	0.751
BF										
Emotional functions			1.01 (0.99–1.03)	0.098	1.01 (0.99–1.03)	0.163	1.01 (0.99–1.03)	0.131	0.99 (0.98–1.01)	0.664
Pain			1.08 (0.55–2.13)	0.818	1.01 (0.51–1.97)	0.998	0.93 (0.48–1.81)	0.834	0.95 (0.48–1.87)	0.872
Bowel and/or bladder problems			0.92 (0.46–1.83)	0.815	0.93 (0.46–1.86)	0.832	0.86 (0.43–1.73)	0.681	0.88 (0.43–1.78)	0.718
Spasticity			1.00 (0.53–1.88)	0.998	0.99 (0.52–1.87)	0.973	1.05 (0.55–1.99)	0.880	0.99 (0.51–1.90)	0.967
AP										
Use of intermittent catheter					1.39 (0.76–2.53)	0.285	1.39 (0.76–2.55)	0.290	1.40 (0.75–2.61)	0.294
Dependent in self-care mobility					0.74 (0.35–1.58)	0.438	0.66 (0.30–1.47)	0.313	0.73 (0.32–1.66)	0.449
Difficulties in outdoor mobility					1.04 (0.55–1.94)	0.915	0.92 (0.48–1.76)	0.811	0.95 (0.49–1.86)	0.885
Employment					1.00 (0.55–1.81)	0.989	0.97 (0.53–1.79)	0.930	0.97 (0.52–1.79)	0.909
Social activities					1.56 (0.92–2.66)	0.101	1.53 (0.90–2.62)	0.118	1.38 (0.80–2.39)	0.247
EF										
Hindrance due to accessibility							1.40 (0.77–2.55)	0.274	1.42 (0.77–2.62)	0.257
Hindrance due to social attitudes							1.54 (0.79–3.00)	0.205	1.80 (0.90–3.59)	0.095
Social support							1.03 (1.00–1.06)	**0.031**	1.03 (1.01–1.06)	**0.020**
PF										
Self-efficacy									1.07 (1.01–1.13)	**0.014**
Purpose in life									1.05 (0.98–1.12)	0.148
Coping with emotions									0.86 (0.70–1.04)	0.124
R^2 (Nagelkerke)		0.15		0.16		0.18		0.20		0.25

Abbreviations: AP, activities and participation; BF, body functions; CI, confidence interval; EF, environmental factors; PF, personal factors; OR, odds ratio; SCI, spinal cord injury.
P-value level of significance <0.05 is marked in bold; the reference categories for the independent variables are marked in Table 2.
[a]Reference groups for age = 17–30 years, for time since onset = 0–5 years, for severity of SCI = incomplete paraplegic and for type of locomotion = pedestrian without devices.

Table 4 Stepwise multivariate logistic regression model for associations with the achievement of WHO recommendations on physical activity ($n=485$; imputed data set)

Independent variable	*Model 1*		*Model 2*		*Model 3*		*Model 4*		*Model 5*	
	OR (95% CI)	P-*value*	*OR (95% CI)*	P-*value*	*OR (95% CI)*	P-*value*	*OR (95% CI)*	P-*value*	*OR (95% CI)*	P-*value*
Constant	1.39 (0.59–3.26)		0.67 (0.17–2.63)		0.52 (0.13–2.16)		0.52 (0.12–2.29)		1.01 (0.15–6.70)	
Sociodemographic and SCI-related aspects										
Sex[a]										
Female	0.60 (0.39–0.93)	**0.022**	0.62 (0.40–0.96)	**0.034**	0.63 (0.40–0.99)	**0.043**	0.63 (0.40–1.01)	0.053	0.66 (0.42–1.06)	0.085
Age (years)[a]										
31–50	0.62 (0.30–1.28)	0.193	0.59 (0.28–1.24)	0.165	0.54 (0.25–1.17)	0.116	0.53 (0.24–1.15)	0.109	0.49 (0.22–1.08)	0.077
51–70	0.53 (0.28–1.08)	0.081	0.50 (0.24–1.05)	0.068	0.47 (0.22–1.02)	0.057	0.46 (0.21–1.01)	0.051	0.39 (0.18–0.89)	**0.024**
71 and older	0.30 (0.12–0.72)	**0.007**	0.28 (0.12–0.71)	**0.007**	0.33 (0.12–0.87)	**0.026**	0.32 (0.12–0.86)	**0.024**	0.27 (0.10–0.74)	**0.011**
Severity of SCI[a]										
Complete paraplegic	0.86 (0.48–1.50)	0.568	0.84 (0.47–1.49)	0.547	0.90 (0.50–1.63)	0.719	0.91 (0.50–1.66)	0.764	0.93 (0.51–1.71)	0.813
Incomplete tetraplegic	0.91 (0.52–1.57)	0.734	0.88 (0.51–1.55)	0.669	1.02 (0.58–1.82)	0.938	1.02 (0.57–1.82)	0.955	1.05 (0.59–1.89)	0.861
Complete tetraplegic	0.42 (0.20–0.88)	**0.022**	0.41 (0.19–0.88)	**0.022**	0.50 (0.23–1.09)	0.081	0.54 (0.24–1.20)	0.128	0.56 (0.25–1.27)	0.954
Type of locomotion[a]										
Pedestrian with device	1.09 (0.56–2.12)	0.802	1.08 (0.55–2.14)	0.815	1.23 (0.59–2.57)	0.589	1.06 (0.50–2.26)	0.873	1.02 (0.47–2.21)	0.954
Manual wheelchair	2.79 (1.46–5.32)	**0.002**	2.71 (1.40–5.25)	**0.003**	2.95 (1.37–6.32)	**0.006**	2.37 (1.08–5.20)	**0.031**	2.21 (0.99–4.93)	**0.052**
Electrical wheelchair	1.21 (0.59–2.47)	0.601	1.19 (0.57–2.50)	0.637	1.55 (0.66–3.66)	0.315	1.22 (0.50–2.96)	0.665	1.10 (0.45–2.71)	0.831
BF										
Emotional functions			1.01 (0.99–1.02)	0.151	1.01 (0.99–1.02)	0.245	1.01 (0.99–1.02)	0.167	1.00 (0.99–1.02)	0.581
Pain			1.17 (0.74–1.85)	0.511	1.05 (0.65–1.70)	0.828	1.04 (0.64–1.68)	0.881	1.11 (0.67–1.81)	0.692
Bowel and/or bladder problems			0.98 (0.58–1.67)	0.943	0.96 (0.55–1.66)	0.879	0.93 (0.54–1.62)	0.806	0.91 (0.52–1.60)	0.747
Spasticity			1.10 (0.69–1.73)	0.695	1.08 (0.68–1.73)	0.736	1.10 (0.69–1.75)	0.705	1.06 (0.66–1.69)	0.822
AP										
Use of intermittent catheter					1.73 (1.10–2.70)	**0.017**	1.70 (1.08–2.66)	**0.022**	1.67 (1.05–2.67)	**0.031**
Dependent in self-care mobility					0.55 (0.32–0.96)	**0.035**	0.48 (0.27–0.86)	**0.013**	0.51 (0.28–0.91)	**0.023**
Difficulties in outdoor mobility					1.48 (0.93–2.37)	0.102	1.44 (0.90–2.31)	0.129	1.48 (0.92–2.40)	0.108
Employment					1.10 (0.70–1.73)	0.683	1.12 (0.70–1.79)	0.635	1.12 (0.69–1.81)	0.653
Social activities					1.48 (0.99–2.22)	0.059	1.47 (0.98–2.21)	0.065	1.47 (0.97–2.24)	0.071
EF										
Hindrance due to accessibility							1.67 (1.03–2.71)	**0.037**	1.75 (1.07–2.85)	**0.025**
Hindrance due to social attitudes							1.31 (0.80–2.16)	0.282	1.36 (0.81–2.27)	0.239
Social support							0.99 (0.97–1.01)	0.482	0.99 (0.98–1.01)	0.586
PF										
Self-efficacy									1.01 (0.96–1.06)	0.727
Purpose in life									1.01 (0.96–1.07)	0.680
Coping with emotions									0.81 (0.69–0.95)	**0.010**
R^2 (Nagelkerke)		0.11		0.12		0.16		0.18		0.20

Abbreviations: AP, activities and participation; BF, body functions; CI, confidence interval; EF, environmental factors; OR, odds ratio; PF, personal factors; SCI, spinal cord injury; WHO, World Health Organization.
P-value level of significance <0.05 is marked in bold; the reference categories for the independent variables are marked in Table 2.
[a]Reference groups for sex = male, for age = 17–30, for severity of SCI = incomplete paraplegic and for type of locomotion = pedestrian without devices.

adding of blocks to the first model again increased the model fit with a R^2 of 20% in the final model.

DISCUSSION

Within the use of a comprehensive model based on the ICF framework, we identified a number of aspects from all components, except from body functions, to associate with PHYS-ACT and the ACH-WHO-REC. Only the type of locomotion was significantly associated with both outcomes.

Being a manual wheelchair user increases the odds for both, being PHYS-ACT and for ACH-WHO-REC, compared to moving around as a pedestrian without using devices or support. Generally, it was already found that PA levels in people who are pedestrians are lower compared to those of a manual wheelchair user.[21] This is relevant for two reasons: First, the finding points out that non-wheelchair users require special attention both in the context of future research as well as for intervention planning. A previous study found that psychosocial factors and the experience of pain may explain the lower levels; however, this is the only evidence yet.[5,22] Second, most research investigated the severity of SCI to explain PA levels and agrees that tetraplegia is associated with lower PA levels compared with paraplegia.[5,21,23–25] The association between the type of locomotion and PA levels, however, is rarely investigated. Furthermore, people with SCI not being wheelchair dependent have not been included in all existing studies. Thus, our finding suggests including type of locomotion as a potential predictor for being PHYS-ACT and ACH-WHO-REC when investigating PA levels.

In addition to the type of locomotion, older age decreased the odds to being PHYS-ACT (*P*-values for the three categories nearly reached significance value). Furthermore, only contextual factors explained the outcome. Both higher social support and higher levels of self-efficacy increased the odds of being PHYS-ACT. Social support in people with SCI is related to physical and mental health, pain, coping, adjustment and life satisfaction.[26] The finding that more social support increases the odds to be PHYS-ACT confirms findings from qualitative studies,[11,27–29] but differs from the only quantitative study where social support was not found to associate with being PHYS-ACT.[10] Taking the different findings into account, we assume that whether social support explains being PHYS-ACT in people with SCI depends as well on how people overcome a potential lack of social support. The evaluation of the importance, respectively the strength of intentions to perform physical activities that were found to associate with being PHYS-ACT[10,23]—may thereby have an important role.

The finding that higher scores in self-efficacy increase the odds of being PHYS-ACT agrees with existing evidence.[30] General self-efficacy is defined as the 'general beliefs in one's ability to respond to and control environmental demands and challenges'.[18] In addition to the evidence that better self-efficacy is associated with higher PA levels, self-efficacy is considered an intervention target in health-promoting programmes.[31,32] Thus, our finding underscores the importance of considering self-efficacy when aiming to empower people with SCI to become or maintain PHYS-ACT.

The ACH-WHO-REC was associated with a larger number of aspects than being PHYS-ACT. The fact that older age decreased the odds for ACH-WHO-REC is well understood as performing increased intensities of physical activities becomes more difficult with age. Increased odds for ACH-WHO-REC were found for using an intermittent catheter. This confirms findings of a previous study that showed that intermittent catheterization is significantly associated with better mobility and social integration compared with those using an indwelling catheter.[33] The use of indwelling catheters or urinal condoms (in men) requires one to carry a urine bag, which might be inconvenient and prevents people from performing physical activities.[34] However, people with limited hand functions, for whom the handling of intermittent catheters is rather difficult, are limited in using intermittent catheterization. Application of bladder management that facilitates performing physical activities might present a challenge for them.

Being dependent in self-care mobility decreased the odds for ACH-WHO-REC by about half. Based on a previous qualitative study,[11] we assume that spending considerable time for physical activities as required to ACH-WHO-REC is limited because of the increased time consumption for self-care when dependent, a lack of wheelchair-accessible toilets in public places, which might increase dependence, a lack of supportive persons, or to not wanting to take advantage of support for more time than necessary within routine self-care. However, these assumptions are not proven and require additional research.

The finding that the experience of hindrances due to accessibility was positively associated with ACH-WHO-REC suggests that people who are more PHYS-ACT experience more physical barriers. Importantly, this does not prevent them from being PHYS-ACT. In previous qualitative studies, lack of accessibility was reported as a barrier to participating in PA.[11,27–29,35–37] Thus, different contexts may contribute to different findings, although more quantitative research including comparisons across different countries is required to validate this assumption. In our study, the question on hindrance due to accessibility did not specify distinct types of buildings. Thus, there is no information on the accessibility of sport facilities. To better understand accessibility in the context of PA, specific questions on accessibility of sport facilities[38,39] should be complemented in the future.

Finally, higher scores in coping with emotions decreased the odds for ACH-WHO-REC. This coping strategy is described as 'the tendency to focus on whatever distress or upset one is experiencing and to ventilate those feelings', whereas this tendency is considered rather maladaptive for successful active coping strategies.[40] In general, different coping strategies contribute to psychosocial adaptation in people with SCI[41] and thus could contribute to participation in PA. In our study, only coping with emotions was included in the analyses because of the given preselection. This personal factor presented the strongest association with ACH-WHO-REC and suggests that people who mentally focus on and ventilate emotional problems are prevented from active coping, and thus from performing physical activities with sufficient duration and intensity. Thus, identifying people with the tendency to focus on their emotions could present a first step before offering strategies to overcome this coping style and replace it by increased physical activities.

None of the investigated body functions was found to associate with one of the two PA outcomes. This confirms the finding for pain and emotional functions from a Canadian study,[10] but differs from a study in Taiwan where PA was associated with less pain and fewer depressive symptoms.[42] Importantly, the identification of associations with pain and spasticity can be influenced by the fact that pain and spasticity can both be improved and be aggravated by PA.[11] To overcome this limitation and to better understand the associations, the quality of the relationships should be assessed in future assessments.

Some limitations related to our study need to be mentioned. Based on the cross-sectional design of the study we cannot draw any conclusions regarding causal relationships. Furthermore, data on PA were collected with a self-report questionnaire, for which it is known that the PA levels are rather overestimated.[43] Importantly, to date, evidence is lacking on whether the ACH-WHO-REC indeed reduces the risk for cardiovascular diseases in people with SCI. Future research is required to confirm this, in order to determine PA levels that are appropriate for people with SCI. Finally, the inclusion of potential aspects that additionally could associate with the ACH-WHO-REC was limited because of the fact that this study presented a secondary data analysis.

The application of the ICF framework contributed to a comprehensive understanding of PA levels in people with SCI. Except body functions, aspects from all components presented associations with the two outcomes. When aiming to empower people to become or remain PHYS-ACT at all, social support and self-efficacy are significant aspects to consider. However, when aiming to empower people to achieve the WHO recommendations on PA, other aspects come to the fore. Then, dependence during self-care and coping with emotions should become intervention targets. Independently from the type of PA, people with SCI not using a wheelchair should receive specific attention in both future research and intervention planning for promoting PA. Longitudinal studies should be initiated to test these associations for causal relationships.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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MEMBERS OF THE SWISCI STEERING COMMITTEE

Xavier Jordan, Bertrand Léger (Clinique Romande de Réadaptation, Sion); Michael Baumberger, Hans Peter Gmünder (Swiss Paraplegic Center, Nottwil); Armin Curt, Martin Schubert (University Clinic Balgrist, Zürich); Margret Hund-Georgiadis, Kerstin Hug (REHAB Basel, Basel); Hans Georg Koch, (Swiss Paraplegic Association, Nottwil); Hardy Landolt (Representative of persons with SCI, Glarus); Hansjörg Koch (SUVA, Luzern); Mirjam Brach, Gerold Stucki (Swiss Paraplegic Research, Nottwil); Martin Brinkhof, Christine Thyrian (SwiSCI Study Center at Swiss Paraplegic Research, Nottwil).

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