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ORIGINAL ARTICLE

Leisure time physical activity among older adults with long-term spinal cord injury

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Study design: Cross-sectional.
Objectives: To describe participation in leisure time physical activity (LTPA) (amount, intensity and type) among older adults with long-term spinal cord injury (SCI), and to investigate the associations with sociodemographics, injury characteristics and secondary health conditions (SHCs).
Setting: Home settings in southern Sweden.
Methods: Data from the Swedish Aging with Spinal Cord Injury Study (SASCIS). The physical activity recall assessment for people with SCI was used to assess LTPA among 84 men and 35 women (mean age 63.5 years, mean time since injury 24 years, injury levels C1–L5, American Spinal Injury Association Impairment Scale A–D). Associations were analyzed statistically using hierarchical multivariable regression.
Results: Twenty-nine percent reported no LTPA, whereas 53% performed moderate-to-heavy intensity LTPA. The mean minutes per day of total LTPA was 34.7 (±41.5, median 15, range 0–171.7) and of moderate-to-heavy LTPA 22.5 (±35.1, median 5.0, range 0–140.0). The most frequently performed activities were walking and wheeling. Sociodemographics, injury characteristics and SHCs (bowel-related and bladder-related problems, spasticity and pain) explained 10.6% and 13.4%, respectively, of the variance in total and moderate-to-heavy LTPA. Age and wheelchair use were significantly, negatively associated with total LTPA. Women, wheelchair users and employed participants performed significantly less moderate-to-heavy LTPA than men, those using walking devices/no mobility device and unemployed participants.
Conclusion: Many older adults with long-term SCI do not reach the amount or intensity of LTPA needed to achieve fitness benefits. Research is needed on how to increase LTPA and to identify modifiable factors that could enhance their participation.
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INTRODUCTION

Physical activity (PA) has emerged as one of the most important issues for global health.[1] It is well known that regular participation in PA has beneficial effects on health and longevity, and physical inactivity is a major risk factor for mortality. For populations with physical disabilities, such as spinal cord injury (SCI), participation in PA may be particularly challenging. People living with SCI are often faced with physical deconditioning,[2] and impairments and environmental barriers that can impede the ability to participate in PA.[3–5] A sedentary lifestyle contributes to the development of other health conditions such as cardiovascular disease, diabetes and osteoporosis.[6,7] Although people with SCI are considered one of the most inactive groups among people with lifelong physical disabilities,[8] large-scale, generalizable research quantifying their participation in PA is scarce.[7,9]

There is considerable evidence that PA can improve physical capacity and muscle strength in people with SCI.[6,7,10] Furthermore, associations between participation in PA and life satisfaction have emerged,[11] possibly mediated by the positive effects of PA on physical independence and depression.[12] Leisure time physical activity (LTPA) is the form of PA mainly associated with such health and fitness benefits. LTPA includes activities performed during free time, such as sports, recreational activities, walking and wheeling, and is distinguished from activities of daily living.[1] Accordingly, habitual LTPA is often recommended in health interventions for people with SCI.[13,14] Population-based studies have found that about half of participants with SCI do not perform any type of LTPA or sports whatsoever.[5,15,16] Even though knowledge of participation in LTPA among individuals with SCI is increasing, further studies are needed to investigate the amount of LTPA and factors associated with participation in LTPA in all segments of the SCI population.

With the advances in rehabilitation and long-term management of SCI, many people live with their injury into old age. With advancing age, people with SCI are less physically active.[9,15] The injury itself is associated with earlier age-related disability[17] and some health conditions occur more frequently with increasing age and time since injury.[18] A sedentary lifestyle therefore most likely contributes further to deconditioning and accelerated aging, increased dependency and ultimately a reduced quality of life. To promote healthy and active aging in older adults with long-term SCI, knowledge about their participation in LTPA and associated factors is needed. To the best of

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our knowledge, no study has investigated participation in LTPA among older adults with long-term SCI, and the associations with sociodemographics, injury characteristics and secondary health conditions (SHCs) in this group are yet to be determined.

Hence, the objectives of this study are (1) to describe participation in LTPA (amount, intensity and type) among older adults with long-term SCI; and (2) to investigate the association between participation in LTPA and sociodemographics, injury characteristics and SHCs (bowel-related and bladder-related problems, spasticity and pain). Based on previous research,[15,19] we hypothesize that sociodemographics, injury characteristics and SHCs will explain modest variance in LTPA.

METHODS

This study is part of the Swedish Aging with Spinal Cord Injury Study (SASCIS).[20] The SASCIS is a population-based, longitudinal cohort survey assessing individuals 50 years or older and at least 10 years after a traumatic or non-traumatic SCI. The overarching aim of the SASCIS is to increase our knowledge of factors associated with healthy aging in individuals with long-term SCI. For detailed information about the study design, methodology, dropout analysis and descriptive sociodemographic and injury-related data, see Jörgensen *et al.*[20] For the present study, a subset of the data from the SASCIS was used to address the two objectives.

Participants

In Sweden, with a population of close to 10 million people, about 250 individuals (mean age 51 years, 54% traumatic SCI) sustain a SCI each year.[21] The participants in the SASCIS were all community dwelling and recruited from clinical databases at the SCI Unit at Skåne University Hospital in Lund, Sweden. The unit serves a catchment area of ~1.8 million people and admits 35-55 traumatic SCI or non-traumatic SCI annually for primary rehabilitation.

The main inclusion criteria for the SASCIS were 50 years or older and 10 years or more after traumatic SCI or non-progressive, acquired non-traumatic SCI. A total of 184 individuals met the inclusion criteria and the final cohort comprised 123 individuals (36 women and 87 men, mean age 63, range 50–89, years).

The severity of injury was classified according to the American Spinal Injury Association Impairment Scale (AIS).[22] Based on the AIS, three groups of SCI severity were formed: (1) tetraplegia AIS A–C ($n=22$; 15 AIS A, 4 AIS B and 3 AIS C); (2) paraplegia AIS A–C ($n=41$; 23 AIS A, 8 AIS B and 10 AIS C); and (3) all AIS D ($n=60$).[20]

Statement of ethics

The Declaration of Helsinki for research on humans was followed and the SASCIS was approved by the Regional Ethical Review Board in Lund, Sweden (No. 2010/692). Before enrollment, the participants were given written and oral information about the study. They were informed about their right to withdraw at any time and written informed consent was obtained from each participant. We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

Data collection

Sociodemographics, injury characteristics and SHCs. Data regarding sociodemographics (gender, chronological age, marital status, vocational situation and residential location), injury characteristics (age at injury, time since injury, cause of injury, level and severity of injury and use of mobility device outdoors) and SHCs were collected from the participants' medical records and by a study-specific questionnaire. The participants were interviewed during visits in their homes ($n=122$) or at another place ($n=1$).

Bowel-related and bladder-related problems (that is, bowel and urinary incontinence, constipation, diarrhea, bowel irregularity, hemorrhoids, flatulence, urinary urgency and frequent urinary tract infections), spasticity and nociceptive and neuropathic pain were recorded as present if recurring during the past year. Pain was rated on a standard visual analog scale for pain (0–100 mm between 'no pain' and 'the worst pain imaginable') and the greatest intensity of pain experienced in daily life was recorded. According to Jensen *et al.*,[23] mild pain was defined as 5–44 mm, moderate pain as 45–74 mm and severe pain as 75–100 mm. Pain was then dichotomized as no/mild pain versus moderate/severe pain.

LTPA. To assess LTPA, the SCI-specific physical activity recall assessment for people with spinal cord injury (PARA-SCI)[24] was used.

According to a standardized, structured interview protocol,[25] the participants were asked to describe all activities performed during the past 3 days, including LTPA (for example, sports or going for a walk/wheel) and lifestyle activities/activities of daily living (for example, dressing, grocery shopping or transfers). In this study, only data on LTPA were used. For each activity, the intensity, duration, type and frequency are reported. To facilitate the ratings of intensity, the interviewer provided a chart with SCI-specific definitions of four intensity levels, validated for use with the PARA-SCI:[24] (1) nothing at all (no physical effort), (2) mild (very light physical effort), (3) moderate (some physical effort) and (4) heavy (maximum physical effort).[15]

The PARA-SCI is scored by calculating the mean number of minutes of activity per day, performed at each intensity.[24] A total LTPA value is also calculated by summing the mean number of minutes for activities that are of mild, moderate and heavy intensity. As activities of moderate-to-heavy intensity are required to produce fitness benefits in people with SCI,[10] the average number of minutes per day of moderate-to-heavy intensity LTPA was also calculated.

The PARA-SCI has demonstrated good test–retest reliability, comparable to other well-used measures of PA.[24] It also demonstrates convergent validity as scores are positively correlated with measures of aerobic fitness and muscle strength,[26] and it is a good estimate of PA energy expenditure in people with SCI.[27] In collaboration with the developers, we made a forward–backward translation of the PARA-SCI and performed a pilot study to assure its usability in the Swedish context.[28]

Data and statistical analysis

Descriptive statistics were computed for sociodemographics, injury characteristics and SHCs. The number of SHCs was collapsed to generate a total number of SHCs for each participant, ranging from 0 to 5; 0 represents no SHC and 5 represents the occurrence of bowel-related and bladder-related problems, as well as spasticity, and moderate/severe nociceptive and neuropathic pain. The participants were then grouped into three groups based on the number of SHCs: 0–1 SHC, 2 SHCs and 3–5 SHCs.

For each participant, the average minutes per day of total LTPA were calculated along with LTPA of mild, moderate, heavy intensity and moderate-to-heavy intensity. Two outliers were identified (greater than the mean ± 3 s.d.'s) and reduced to one unit less than the next lowest value in the distribution.[29] The assumption of normality was tested[30] and as the LTPA data were found not to be normally distributed, the data were square root transformed to remedy this problem. Between-group differences in total and moderate-to-heavy LTPA were then calculated using a one-way analysis of variance (ANOVA). For *post hoc* comparisons between more than two groups, Bonferroni-corrected *P*-values were calculated. Frequencies of the types of reported LTPA were recorded.

To investigate associations between the average number of minutes per day of LTPA and the independent variables, hierarchical multivariable linear regression models were computed using untransformed data. Separate models were computed for total LTPA and moderate-to-heavy LTPA. The selection of independent variables was based on previous research, the objectives of the study and the results of the ANOVA. The order of entry was (i) age and gender; (ii) time since injury and level and severity of injury (with the all AIS D as the reference category); (iii) use of mobility device (with use of walking devices/no mobility device as the reference category) and number of SHCs (0–5); (iv) residential location (urban versus rural) and vocational situation (employed versus pensioned). The models exhibited no multicollinearity and no influential cases. However, there was some evidence of heteroscedasticity,

Table 1 Sociodemographics, injury characteristics and SHCs among older adults with long-term SCI ($n=119$)

Gender (n (%))	
Men	84 (71)
Women	35 (29)
Age (years; mean ± s.d.; median, range)	63.5 ± 8.7; 63.0, 50–89
Age at injury (years; mean ± s.d.; median, range)	39.4 ± 16.3; 39.0, 7–74
Time since injury (years; mean ± s.d.; median, range)	23.9 ± 11.7; 22.0, 10–56
Cause of injury (n (%))	
Traumatic[a]	72 (61)
Non-traumatic[b]	47 (39)
Level and severity of injury (n (%))	
Tetraplegia AIS A–C	21 (18)
Paraplegia AIS A–C	39 (33)
All AIS D	59 (50)
Marital status[c] (*n* (%))	64 (54)
Vocational situation (n (%))	
Working full-time/part-time	43 (36)
Disability pension/old-age pension	76 (64)
Residential location	
Urban	74 (62)
Rural	45 (38)
Use of mobility device outdoors[d] (n (%))	
Manual wheelchair	39 (33)
Powered wheelchair/scooter	47 (39)
Walking devices/no mobility device	33 (28)
SHCs [e] (n (%))	
0–1	47 (39)
2	31 (26)
3–5	41 (34)

Abbreviations: AIS, American Spinal Injury Association (ASIA) Impairment Scale;[22] s.d., standard deviation; SHCs, secondary health conditions.
[a]Traffic/transportation (motor vehicle, train and bicycle), fall, workplace accident, diving accident, gunshot/assault/torture, other traumatic (e.g., sports and leisure activities).
[b]Spinal tumor, spinal disc herniation, spinal arteriovenous malformation, spinal infarction and spinal infection.
[c]Having a partner/married/cohabiting.
[d]Primary mode of mobility for longer distances outdoors.
[e]Occurrence (number, 0–5) of bowel-related and bladder-related problems, (i.e., bowel and urinary incontinence, constipation, diarrhea, bowel irregularity, hemorrhoids, flatulence, urinary urgency and frequent urinary tract infections), spasticity and nociceptive and neuropathic pain. Participants were grouped based on the number of reported SHCs (median = 2; range 0–5).

with the model yielding greater residuals when the level of LTPA was higher than lower.

All statistical analyses were performed using the SPSS v. 22 software for Windows (IBM Corporation, Armonk, NY, USA). Throughout, we report exact significance levels; *P*-values less than 5% represent statistical significance.

RESULTS

Sociodemographics, injury characteristics and SHCs

In Table 1, data on sociodemographics, injury characteristics and SHCs are presented. From the original SASCIS study sample ($n=123$),[20] 119 participants had completed the PARA-SCI and were included in this study. Their mean age was 63.5 years, their mean time since injury was 23.9 years and the majority (71%) were men. There were no significant differences between the responders and the four non-responders regarding chronological age, time since injury and gender. The distribution of participants in each group of SCI severity did not differ from the entire SASCIS sample. More than half of the participants (54%) were living in a relationship and 36% were working full-time or part-time. The majority (62%) lived in urban areas and 72% used a manual or powered wheelchair/scooter as primary mode of mobility outdoors.

Bowel-related and bladder-related problems were reported by 31% and 43%, respectively, 44% reported spasticity, 39% experienced moderate/severe nociceptive pain and 48% experienced moderate/severe neuropathic pain. The participants reported on average two SHCs (median = 2), where 12% ($n=14$) reported no SHCs and 7% ($n=8$) reported five SHCs.

LTPA

Amount and intensity of LTPA. Thirty-five participants (29%) reported no LTPA, whereas 84 participants (71%) reported more than zero (0) minutes per day of LTPA. Forty-one participants (34%) performed mild intensity LTPA, 49 participants (41%) performed moderate intensity LTPA and 35 participants (29%) performed heavy intensity LTPA. A total of 63 participants (53%) participated in moderate-to-heavy intensity LTPA.

In Table 2, the minutes per day of total LTPA and moderate-to-heavy LTPA, both as a function of sociodemographics, injury characteristics and SHCs are presented. For total LTPA, the participants reported a mean of 34.7 (± s.d. 41.5, range 0–171.7) and median of 15 min per day. Participants who used a powered wheelchair/scooter reported significantly ($P=0.006$) less minutes per day of total LTPA compared to those who used a walking device/no mobility device. There was no significant difference in total LTPA between participants using a manual wheelchair compared to those using a powered wheelchair/scooter or those using walking devices/no mobility device. There was no significant difference in total LTPA for gender, level and severity of injury, cause of injury, marital status, vocational situation, residential location and SHCs.

For moderate-to-heavy LTPA, the participants reported a mean of 22.5 (± s.d. 35.1, range 0–140) and median of 5 min per day (Table 2). Women reported significantly ($P=0.043$) less moderate-to-heavy LTPA than men, as did participants who used a powered wheelchair/scooter compared to those who used a walking device/no mobility device ($P=0.012$). There was no significant difference in moderate-to-heavy LTPA between participants using a manual wheelchair compared to those using a powered wheelchair/scooter or those using walking devices/no mobility device. There was no significant difference in moderate-to-heavy LTPA for the other variables.

Those who participated in moderate-to-heavy LTPA ($n=63$; 53%) reported a mean of 42.5 (± s.d. 38.5, range 0.5–140) and median of 30 min per day (data not shown in Table 2). The distribution of their average minutes per day of moderate-to-heavy LTPA is presented in Figure 1.

Type of LTPA. In Table 3, the types of reported LTPA among the active participants are presented. The three most frequently reported activities were walking (32%), wheeling (25%) and general fitness (that is, activities that could not be categorized as resistance or aerobic training, for example, dancing or physical therapy) (24%).

Associations with sociodemographics, injury characteristics and SHCs

In Table 4, the results of the hierarchical multivariable regression analyses for total LTPA are presented. Overall, the final model explained a significant 10.6% of the variance in minutes per day of total LTPA. Age and use of mobility device were significantly associated with total LTPA; older age and the use of a manual or

Table 2 Descriptive statistics of LTPA (minutes per day) as a function of sociodemographics, injury characteristics and SHCs among older adults with long-term SCI ($n = 119$)

	LTPA (minutes per day)						
	Total				*Moderate-to-heavy*		
	N	*Mean ± s.d.*	*Range*	*Median*	*Mean ± s.d.*	*Range*	*Median*
Total sample	119	34.7 ± 41.5	0.0–171.7	15.0	22.5 ± 35.1	0.0–140.0	5.0
Gender							
Male	84	37.8 ± 45.0	0.0–171.7	20.0	26.7 ± 38.7*	0.0–140.0	10.0
Female	35	27.2 ± 31.2	0.0–122.2	15.0	12.5 ± 21.6*	0.0–85.0	0.0
Level and severity of injury							
Tetraplegia AIS A–C	21	23.1 ± 26.5	0.0–90.0	15.0	9.0 ± 15.4	0.0–45.0	0.0
Paraplegia AIS A–C	39	36.4 ± 41.9	0.0–150.0	15.0	23.6 ± 35.7	0.0–140.0	2.7
All AIS D	59	37.7 ± 45.4	0.0–171.7	23.3	26.6 ± 38.8	0.0–139.0	10.0
Cause of injury							
Traumatic[a]	72	33.6 ± 43.7	0.0–171.7	15.0	20.9 ± 36.4	0.0–139.0	0.0
Non-traumatic[b]	47	36.4 ± 38.5	0.0–170.7	30.0	24.9 ± 33.2	0.0–140.0	15.0
Marital status							
Partner	64	33.5 ± 36.9	0.0–170.7	20.0	20.3 ± 28.3	0.0–139.0	10.0
No partner	55	36.0 ± 46.7	0.0–171.7	15.0	25.0 ± 41.8	0.0–140.0	0.0
Vocational situation							
Working full-time/part-time	43	32.9 ± 38.8	0.0–171.7	20.0	18.1 ± 28.3	0.0–130.0	0.0
Disability pension/old-age pension	76	35.7 ± 43.2	0.0–170.7	15.0	25.0 ± 38.3	0.0–140.0	10.0
Residential location							
Urban	74	38.0 ± 46.3	0.0–171.7	15.9	24.1 ± 39.4	0.0–140.0	1.7
Rural	45	29.1 ± 31.9	0.0–118.3	15.0	20.0 ± 26.9	0.0–100.0	6.7
Use of mobility device outdoors[c]							
Manual wheelchair	39	33.6 ± 40.9	0.0–150.0	13.3	21.4 ± 34.5	0.0–140.0	0.0
Powered wheelchair/scooter	47	23.6 ± 29.7***	0.0–118.3	10.0	12.7 ± 20.4**	0.0–78.3	0.0
Walking devices/no mobility device	33	51.6 ± 51.3***	0.0–171.7	33.3	37.9 ± 46.4**	0.0–139.0	20.0
SHCs[d]							
0–1	47	37.9 ± 44.1	0.0–171.7	23.3	25.5 ± 37.4	0.0–139.0	5.0
2	31	37.1 ± 42.6	0.0–150.0	26.7	21.8 ± 33.4	0.0–140.0	0.0
3–5	41	29.2 ± 38.0	0.0–170.7	15.0	19.7 ± 34.1	0.0–139.0	6.7

Abbreviations: AIS, American Spinal Injury Association (ASIA) Impairment Scale;[22] LTPA, leisure time physical activity; s.d., standard deviation; SHCs, secondary health conditions.
Values in Table 2 are untransformed values that do not control for any covariates. Two outliers were identified (greater than the mean ± 3 s.d.'s) and reduced to one unit less than the next lowest value in the distribution. *$P = 0.043$, **$P = 0.012$ (Bonferroni corrected), ***$P = 0.006$ (Bonferroni corrected), within a particular category. *P*-values are calculated based on square root transformed data.
[a]Traffic/transportation (motor vehicle, train and bicycle), fall, workplace accident, diving accident, gunshot/assault/torture, other traumatic (e.g., sports and leisure activities).
[b]Spinal tumor, spinal disc herniation, spinal arteriovenous malformation, spinal infarction and spinal infection.
[c]Primary mode of mobility for longer distances outdoors.
[d]Occurrence (number, 0–5) of bowel-related and bladder-related problems, (i.e., bowel and urinary incontinence, constipation, diarrhea, bowel irregularity, hemorrhoids, flatulence, urinary urgency and frequent urinary tract infections), spasticity and nociceptive and neuropathic pain. Participants were grouped based on the number of reported SHCs (median = 2; range 0–5).

powered wheelchair/scooter (compared to use of a walking device/no mobility device) were associated with fewer minutes per day of total LTPA.

In Table 5, the results of the hierarchical multivariable regression analyses for moderate-to-heavy LTPA are presented. Overall, the final model explained a significant 13.4% of the variance in minutes per day of moderate-to-heavy LTPA. Gender, use of mobility device and vocational situation were significantly associated with moderate-to-heavy LTPA; being a woman, using a manual or powered wheelchair/scooter (compared to use of a walking device/no mobility device) and working full-time/part-time were associated with fewer minutes per day of moderate-to-heavy LTPA.

DISCUSSION

To the best of our knowledge, this is the first study that has assessed LTPA in older adults with long-term SCI. There was a large variability in LTPA among the participants and they were active on average 35 min per day (median 15 min per day) at a mild intensity or

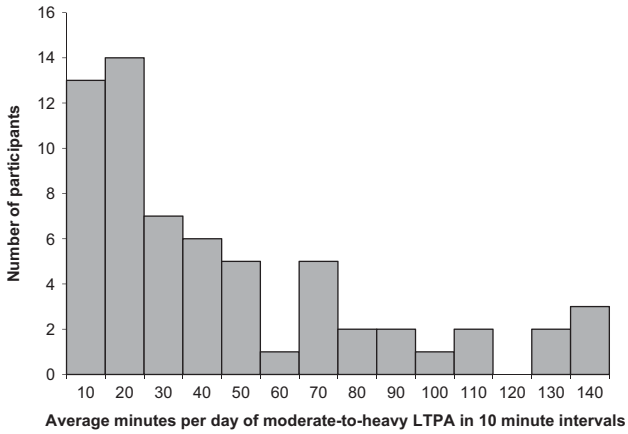

Figure 1 Distribution of participation in moderate-to-heavy LTPA (minutes per day) in ten minute intervals among participants active at this intensity level ($n=63$).

Table 3 Types of activities reported by active older adults with long-term SCI ($n=84$)

Type of activity	n *(%)*
Walking	27 (32)
Wheeling	21 (25)
General fitness[a]	20 (24)
Gardening	15 (18)
Resistance training	14 (17)
Aerobic exercise	11 (13)
Play[b]	6 (7)
Craftsmanship	5 (6)
Sports	5 (6)
Standing	5 (6)
Swimming	5 (6)
Riding a bike	5 (6)

[a]Activities that could not be categorized as resistance or aerobic training, e.g., dancing and physical therapy.
[b]Playing with child or pet.

greater, but almost one-third of the participants reported no LTPA whatsoever. The average amount of LTPA of moderate-to-heavy intensity was 23 min per day (median 5 min per day), and the most frequently performed activities were walking and wheeling. Socio-demographics, injury characteristics and SHCs explained only 10.6% and 13.4% of the variance in total and moderate-to-heavy LTPA, respectively. Being older and using a wheelchair were significantly negatively associated with total LTPA, whereas being a woman, using a wheelchair and working were significantly negatively associated with moderate-to-heavy LTPA.

Amount and intensity of LTPA

Among our participants, 29% did not participate in any LTPA. In Sweden, 18% of non-disabled adults above the age of 65 years report a sedentary lifestyle,[31] demonstrating that older adults with long-term SCI are more likely to be sedentary than the aging general population. In a population-based Canadian study ($n=695$) of adults with SCI who used a mobility device, and who completed the PARA-SCI, 50% did not participate in any LTPA.[15] Moreover, the average amount of total LTPA in our study is higher compared to the Canadian sample where participants reported on average 27.1 ±49.4 min per day of LTPA. The inclusion of participants who did not use a mobility device, as well as more individuals with AIS D injuries in the present study, could explain the higher rates of LTPA participation. Other studies report LTPA/sports participation rates from about 50%[5,16,32] to 80%.[9] These studies used different measures of PA, which limits the comparison between studies and indicates a need to reach consensus on how to assess participation in PA among individuals with SCI. In addition, contextual and cultural differences, such as differences in PA accessibility, services and support for PA among individuals with SCI might also contribute to the discrepancies between our Swedish study and studies from other countries.[5,9,15,16,32]

The average amount of both total LTPA (35 min per day) and moderate-to-heavy LTPA (23 min per day) could be interpreted as rather high. However, the low medians of 15 min per day and 5 min per day, respectively, indicate that most were doing much less. The low amount of moderate-to-heavy LTPA is especially concerning from a population health perspective, as this intensity of activity is required to reach important fitness benefits among people with SCI.[6,10] Thus, the majority of our participants spend an insufficient amount of time on moderate-to-heavy LTPA to achieve fitness benefits, and almost half do not even participate in any LTPA at this intensity. Nevertheless, 63 participants reported moderate-to-heavy LTPA with an average amount of 43 min per day (median 30 min per day), indicating that some older adults many years post SCI can maintain a physically active lifestyle. Taken together, LTPA levels are generally low among older adults with long-term SCI and further research on how to increase their participation in LTPA is needed.

Type of LTPA

The most frequently reported type of LTPA was walking (32%) followed by wheeling (25%). This is promising as these activities are inexpensive and accessible and can be performed almost anywhere. Both wheeling and walking can be performed at mild, moderate or heavy intensity after SCI[33] and the more vigorous level of intensity should be encouraged.

Apart from wheeling, the most common activities among our participants differ from those reported in previous studies where participants commonly reported resistance training (33–45%),[33,34] aerobic exercise (25%)[33] and swimming (28%).[34] By comparison, in the present study, these three activities were reported by only 17%, 13% and 6% of the active participants, respectively. Furthermore, only 5 of our 119 participants (4%) were involved in organized sports, which is similar to the results reported by Martin Ginis *et al.*[33] (4%), but much less than reported by others (20–22%).[35,36] The discrepancies in frequently reported activities between our study and previous studies could be explained by an older mean age in our sample. Older adults might perform less resistance training and aerobic PA and are less likely to participate in organized sports compared to their younger counterparts. Moreover, adults with AIS D injuries were common in our sample (50%) and 28% of our participants did not use a wheelchair, which explains why walking was a frequently performed activity in our study. It is concerning though, that so few reported resistance training (17%). Muscle mass progressively declines with increasing age[37,38] and age-related sarcopenia might have even greater consequences for individuals aging with SCI than for non-injured older adults. Thus, how to successfully promote resistance training in this population is an important area for future research.

Associations with sociodemographics, injury characteristics and SHCs

The regression analyses revealed some associations between LTPA and sociodemographics (age, gender and vocational situation) and injury

Table 4 Hierarchical multivariable regression analyses for total LTPA (minutes per day) among older adults with long-term SCI ($n = 118$[a])

Model	*Independent variables*	*B*	*s.e.*	β	P-*value*	*Adjusted* R^2; P-*value*
1	Age	−0.39	0.45	−0.08	0.39	0.004
	Female gender	−11.14	8.46	−0.12	0.19	$P=0.29$
2	Age	−0.57	0.46	−0.12	0.22	0.002
	Female gender	−11.92	8.71	−0.13	0.17	$P=0.39$
	Time since injury	−0.22	0.37	−0.06	0.56	
	Tetraplegia AIS A–C[b]	−14.85	11.29	−0.14	0.19	
	Paraplegia AIS A–C[b]	−2.66	9.22	−0.03	0.77	
3	Age	−0.61	0.45	−0.13	0.18	0.066
	Female gender	−10.74	8.44	−0.12	0.21	**$P=0.049$**
	Time since injury	0.08	0.39	0.02	0.83	
	Tetraplegia AIS A–C[b]	1.48	12.17	0.01	0.90	
	Paraplegia AIS A–C[b]	12.90	10.80	0.15	0.24	
	Manual wheelchair[c]	−32.61	13.38	−0.37	**0.016**	
	Powered wheelchair/scooter[c]	−34.04	11.90	−0.40	**0.005**	
	SHCs[d]	−2.19	2.89	−0.07	0.45	
4	Age	−1.03	0.50	−0.21	**0.041**	0.106
	Female gender	−11.88	8.30	−0.13	0.16	**$P=0.014$**
	Time since injury	0.10	0.38	0.03	0.80	
	Tetraplegia AIS A–C[b]	0.73	11.93	0.01	0.95	
	Paraplegia AIS A–C[b]	16.55	10.73	0.19	0.13	
	Manual wheelchair[c]	−33.17	13.12	−0.37	**0.013**	
	Powered wheelchair/scooter[c]	−38.69	11.80	−0.46	**0.001**	
	SHCs[d]	−3.18	2.88	−0.11	0.27	
	Urban residence	15.06	7.84	0.18	0.057	
	Working full-time/part-time	−17.04	9.18	−0.20	0.066	

Abbreviations: AIS, American Spinal Injury Association (ASIA) Impairment Scale;[22] LTPA, leisure time physical activity; s.e., standard error; SHCs, secondary health conditions.
Models were computed using untransformed data. Two outliers were identified (greater than the mean ± 3 s.d.'s) and reduced to one unit less than the next lowest value in the distribution. *P*-values <0.05 are indicated in bold.
[a]One participant reporting three–five SHCs was omitted from the regression analyses as the exact number of SHCs was unknown.
[b]Reference category: all AIS D.
[c]Primary mode of mobility for longer distances outdoors. Reference category: walking devices/no mobility device.
[d]Occurrence (number, 0–5) of bowel-related and bladder-related problems (i.e., bowel and urinary incontinence, constipation, diarrhea, bowel irregularity, hemorrhoids, flatulence, urinary urgency and frequent urinary tract infections), spasticity and nociceptive and neuropathic pain.

characteristics (use of mobility device). Overall though, the amount of variance explained by these variables was rather small, indicating that several other factors can contribute to participation in LTPA among older adults with long-term SCI.

Wheelchair use was the strongest contributor to the explained variance in both total and moderate-to-heavy LTPA and was significantly associated with lower levels of LTPA. Given the greater impairments among individuals using powered wheelchairs, it is not surprising that they were the least physically active. Conversely, the finding that manual wheelchair users performed less LTPA than ambulatory participants contrasts previous findings, which indicated that manual wheelchair users were more active than participants using walking devices[9,15] or no mobility devices.[9] This discrepancy could be related to poor wheelchair skills among older adults with long-term SCI. Indeed, a negative relationship between age and wheelchair skills has been reported[39] as well as greater LTPA participation in those with better skills.[40] This calls for continuous assessment of the need for wheelchair skills training programs in this population.

The finding that older age and female gender was associated with less LTPA is supported by previous findings among individuals with SCI,[9,15] even if the results are not entirely consistent.[4] In our study, the association between age and total LTPA exhibited a weak level of significance ($P=0.041$) and age did not contribute significantly to explaining the variance in moderate-to-heavy LTPA. As our study population is already in their sixth decade, the associations between chronological age and LTPA might be more apparent in cohorts with larger age ranges. Regarding gender, qualitative findings suggest that women with SCI underestimate their ability to participate in PA and prefer activities that are less competitive and more group oriented.[41] They also experience a greater responsibility for domestic life resulting in less time and energy to be physically active.[41] As our participants were born in the 1960s or earlier, these traditional gender roles might be even more prominent in our study population and, thus, more likely to impede participation in LTPA.

The significant association between lower levels of LTPA and employment has not been observed in previous studies.[19,35,42] Lack of energy[32] and time due to work,[5] as well as problems with work activities[43] have been reported as barriers to PA participation after SCI. Therefore, it seems important to investigate if modifiable factors in the work environment are potential targets for PA interventions. Whether retirement results in increased LTPA levels in our sample is an interesting topic for future longitudinal studies from our cohort.

For total LTPA, the association with residential location approached significance ($P=0.057$) with participants living in urban areas being more likely to participate in LTPA. This might be attributed to greater accessibility to transportation and more opportunities for LTPA participation in more densely populated areas. However, our data do not permit a more in-depth investigation of facilitators of and

Table 5 Hierarchical multivariable regression analyses for moderate-to-heavy LTPA (minutes per day) among older adults with long-term SCI ($n = 118$[a])

Model	*Independent variables*	*B*	*s.e.*	β	P-*value*	*Adjusted* R^2; P-*value*
1	Age	−0.04	0.37	−0.01	0.91	0.022
	Female gender	−15.20	7.10	−0.20	**0.034**	$P = 0.10$
2	Age	−0.19	0.38	−0.05	0.61	0.033
	Female gender	−15.98	7.23	−0.21	**0.029**	$P = 0.12$
	Time since injury	−0.07	0.31	−0.02	0.82	
	Tetraplegia AIS A–C[b]	−17.82	9.37	−0.19	0.060	
	Paraplegia AIS A–C[b]	−5.66	7.66	−0.08	0.46	
3	Age	−0.22	0.38	−0.05	0.56	0.091
	Female gender	−15.29	7.02	−0.20	**0.032**	**$P = 0.017$**
	Time since injury	0.21	0.32	0.07	0.51	
	Tetraplegia AIS A–C[b]	−3.88	10.13	−0.04	0.70	
	Paraplegia AIS A–C[b]	8.52	8.98	0.11	0.35	
	Manual wheelchair[c]	−28.33	11.13	−0.38	**0.012**	
	Powered wheelchair/scooter[c]	−30.21	9.90	−0.42	**0.003**	
	SHCs[d]	−0.03	2.40	−0.001	0.99	
4	Age	−0.64	0.41	−0.16	0.12	0.134
	Female gender	−15.92	6.89	−0.21	**0.023**	**$P = 0.004$**
	Time since injury	0.23	0.31	0.08	0.47	
	Tetraplegia AIS A–C[b]	−4.19	9.91	−0.05	0.67	
	Paraplegia AIS A–C[b]	11.04	8.91	0.15	0.22	
	Manual wheelchair[c]	−28.44	10.89	−0.38	**0.010**	
	Powered wheelchair/scooter[c]	−34.48	9.80	−0.48	**0.001**	
	SHCs[d]	−1.05	2.39	−0.04	0.66	
	Urban residence	10.34	6.51	0.14	0.11	
	Working full-time/part-time	−17.24	7.62	−0.24	**0.026**	

Abbreviations: AIS, American Spinal Injury Association (ASIA) Impairment Scale;[22] LTPA, leisure time physical activity; SHCs, secondary health conditions.
Models were computed using untransformed data. Two outliers were identified (greater than the mean ± 3 s.d.'s) and reduced to one unit less than the next lowest value in the distribution. *P*-values <0.05 are indicated in bold.
[a]One participant reporting three–five SHCs was omitted from the regression analyses as the exact number of SHCs was unknown.
[b]Reference category: all AIS D.
[c]Primary mode of mobility for longer distances outdoors. Reference category: walking devices/no mobility device.
[d]Occurrence (number, 0–5) of bowel-related and bladder-related problems (i.e., bowel and urinary incontinence, constipation, diarrhea, bowel irregularity, hemorrhoids, flatulence, urinary urgency and frequent urinary tract infections), spasticity and nociceptive and neuropathic pain.

barriers to LTPA. Further studies are needed to understand the importance of the environment for LTPA participation among older adults with long-term SCI.

Interestingly, there were no significant associations between LTPA and level and severity of injury, although there was a trend for less LTPA in the tetraplegia AIS A–C group. Previous studies have found lower levels of PA in individuals with severe tetraplegia,[9,15,44] which intuitively relates to their higher degree of impairment and a need for more adapted equipment to participate in PA.[15] Notably, the paraplegia AIS A–C and the AIS D participants performed almost the same average amount of LTPA, indicating that individuals with severe lower-level injuries can maintain almost the same level of PA as those with minor neurological impairments.

Although a large majority (88%) reported at least one SHC, there was no significant association between the occurrence of SHCs during the past year and participation in LTPA. In a previous study,[45] we reported that only spasticity was significantly associated with activity limitations, whereas none of the SHCs were significantly related to life satisfaction. Thus, the occurrence of SHCs during the past year seems to play a limited role for activity, participation in LTPA and life satisfaction among older adults with long-term SCI. However, further studies of the duration as well as intensity of SHCs are needed before we can determine its significance in relation to participation in LTPA in this population.

The independent variables explained only 10.6–13.4% of the variance in LTPA. These numbers are similar to the study by Martin Ginis *et al.*[15] who found that a similar set of demographic and injury-related variables accounted for 9% of the explained variance in total LTPA. These findings are, paradoxically, rather encouraging as most sociodemographic and injury characteristics are non-modifiable. Future studies investigating modifiable factors related to LTPA participation in older adults with long-term SCI are therefore warranted to provide targets for lifestyle interventions. For example, personal factors, such as stronger intentions[46] and higher levels of self-efficacy,[19] seem to increase LTPA participation after SCI. Whether associations between personal factors and LTPA hold true among older adults with long-term injury is yet to be determined.

Strengths and limitations

A strength of this study is that it was conducted in a sample representative of older adults with long-term SCI in southern Sweden.[20] Furthermore, we used a validated measure of LTPA, developed specifically for people with SCI that has previously been used in population-based studies and interventions.[4] Conversely, self-report assessments are susceptible to recall bias but given the

large study sample, it was not feasible to use objective measures of LTPA. We have confidence in our findings as the PARA-SCI has a short recall time of 3 days, which limits the risk for recall bias. There are also some limitations to this study. Grouping of the participants into the three SCI severity groups might have concealed differences in LTPA participation according to level and severity of injury. A larger sample size would have permitted further grouping of participants and a more in-depth analysis of differences in LTPA participation in relation to level and severity of injury. Another limitation is the cross-sectional study design that cannot identify causal relationships of the observed associations. Moreover, there might be other sociodemographics, injury characteristics or SHCs associated with LTPA that were not taken into account in this study.

CONCLUSION

There is large variation in daily LTPA among older adults with long-term SCI in southern Sweden. Although a majority participates in LTPA, many do not reach the amount or intensity required to achieve fitness benefits. The weak association with mostly non-modifiable sociodemographics and injury characteristics, as well as common SCI-related SHCs, indicates that other factors could contribute to participation in LTPA. Further research is needed on how to increase LTPA among older adults with long-term SCI and to identify modifiable factors that could enhance their participation.

DATA ARCHIVING

All data were archived according to the Swedish Act concerning the Ethical Review of Research Involving Humans to attain confidentiality and are available on request.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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