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ORIGINAL REPORT

INCREASED CARDIOVASCULAR DISEASE RISK IN SWEDISH PERSONS WITH PARAPLEGIA: THE STOCKHOLM SPINAL CORD INJURY STUDY

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Objective: **Comparison of prevalence of cardiovascular disease risks in persons with chronic traumatic paraplegia with those in the general population.**
Design: **Cross-sectional comparative study.**
Subjects: **A total of 135 individuals, age range 18–79 years, with chronic (≥1 year) traumatic paraplegia.**
Methods: **The prevalences of diabetes mellitus, dyslipidaemia, hypertension, overweight, and smoking, were assessed in the study population and were compared with an age- and gender-matched sample of the general population in the region under study. History of myocardial infarction and medication for dyslipidaemia, hypertension, and diabetes mellitus were also recorded. χ^2 tests were used to compare the paraplegic cohort with the general population sample.**
Results: **Significantly more persons with paraplegia reported a history of myocardial infarction (5.9%) than those in the comparison group (0.7%). The prevalences of diabetes mellitus (5.9%), dyslipidaemia (11.1%), and hypertension (14.1%) were also significantly higher in the paraplegic group, as were drug treatment for these disorders.**
Conclusion: **Persons with paraplegia report increased prevalences of diabetes mellitus, hypertension, and dyslipidaemia, in particular, compared with the general population. Population-based screening and therapeutic counter-measures for these conditions may therefore be particularly indicated for this patient group.**

Key words: cardiovascular disease; risk; ageing; paraplegia; spinal cord injury.

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INTRODUCTION

Considerable research has focused on cardiovascular disease (CVD) in persons with chronic spinal cord injuries (SCI) (1–3). This issue gained importance after the reduction in mortality in this population from "classical" complications such as renal failure (4). Both early reports and more recent observations of acknowledged CVD risks, including atherogenic dyslipidaemia (DL) (5), diabetes mellitus (DM) (6) and overweight (7), have corroborated the presence of this problem among persons with SCI. Increase in CVD mortality and morbidity, may at least partially be a consequence of increased longevity and ageing.

Thus, the question as to whether there is a genuinely increased CVD risk after SCI remains unresolved. Neither Soden et al. (8) nor Lindal et al. (9) could find an increased CVD risk after SCI compared with a non-disabled cohort. Similar conclusions were reached in a Swedish study 15 years ago, in which CVD risk seemed to be comparable with that of a reference cohort (10). Additionally, by using the Framingham model for estimation of CVD risk, Cardus et al. (11) reported the hazard of CVD after SCI to be similar to that of deconditioned non-disabled persons. Krum et al. (12) found a comparable risk between disabled and non-disabled persons when using a CVD risk score that included diastolic blood pressure (DBP), total cholesterol (TC), smoking, and gender. Nevertheless, the issue cannot be considered resolved.

In an attempt to establish whether special health risks should be anticipated in the SCI population, we have recently undertaken a series of studies on CVD prevalence in a regional Swedish cohort with paraplegia (13). The results of our first study revealed a high prevalence of both isolated and clustered CVD risks, including DL, hypertension (HTN), and overweight. Advancing age was found to be a significant predictor for the latter 2 risks, but not for DL. Impaired fasting glucose was observed at frequencies below those previously reported among veteran and non-veteran populations with SCI in the USA.

The aim of the present study was to compare self-reported CVD-risk factors in persons with chronic traumatic paraplegia with those of an age- and gender-matched comparison sample from the general population living in the same geographic region.

METHODS

Participants

Participants in this study were persons with chronic (≥ 1 year duration) traumatic paraplegia living in the greater Stockholm area and registered

for medical follow-up at the regional SCI unit. A 1-year limit was chosen because: (*i*) at least by then, the primary rehabilitation phase is typically over; and (*ii*) neurological functional outcomes are likely to have stabilized. Included were men and women aged 18–79 years. All participants had "wheelchair-dependent" paraplegia, i.e., a neurological lesion level below T1 and an AIS American Spinal Cord Injury Association (ASIA) Impairment Scale grading of A–C (14). A total of 153 patients fulfilling these criteria were contacted consecutively to schedule an annual health check-up. Up to 3 attempts were made by telephone and post. This process led to 137 persons being examined during the 14-month study period. Of these, 135 persons (104 males and 31 females) consented to participate in the study. The study was approved by the human ethics committee at the Karolinska Institutet, Stockholm.

Comparison group

Data from the Swedish Annual Level-of-Living Survey (*Undersökning av Levnadsvanor*; ULF) was used as a comparison group (15). ULF has been compiled since 1975 by and under the authority of the Swedish government. It represents a nationwide survey covering all persons in the age range 16–84 years, focusing on health issues and living conditions. Data were collected by interviews, the results of which were published in annual reports. The ULF data used in this study were collected between the years 2003 and 2005 and represent a subset of the total ULF data-set, with persons of similar age and gender distribution and region of residence as that of the SCI group. The total ULF cohort in Sweden during the study period was 16,540 persons, while the age- and gender-matched comparison sub-cohort used in this study included 1,488 persons.

Participant interview and examination

A structured interview was used to obtain information from study participants regarding the presence or absence of: DM, HTN, DL, and/or history of MI; any current medication for these conditions; presence or absence of smoking; and body length. All participants of the study were enrolled in a regional SCI clinic, and were subject to annual medical check-ups. The check-up includes a neurological examination made by a specialist in SCI medicine, working exclusively with this diagnostic group. Examinations were performed according to international standards (14). In addition to AIS classification, body weight (kg) was measured by first weighing the participant sitting in the wheelchair on a calibrated scale adapted for wheelchairs. The wheelchair was then weighed separately, and its weight subtracted from the total weight.

Interview questions corresponded to those of the ULF survey, and included the following:

- Presence of DM, HTN, and DL; history of MI
- Drug treatment of these conditions
- Body length
- Daily smoking

The ULF standard data-set included additional questions, e.g. regarding other diseases and disabilities, and a question about present body weight, whereas the SCI group was only presented with the ULF subset of questions as above. Additionally, actual body weight was measured in the SCI group.

Data analysis

Data were analysed using SPSS 15.0. χ^2 tests were used to compare the proportion of CVD risk factors and history of MI between the SCI and ULF groups. Pairwise χ^2 were calculated to compare differences in the following age categories: youngest through 24, 25–34, 35–44, 45–54, 55–64, 65–74, and 75 years and older.

RESULTS

Demographics

The study group comprised 104 men (77%) and 31 women, ranging in age from 18 to 79 years with a mean of 47.8 (SD = 13.7) years. The frequencies and percentages by neurological level were: 45 (33%) at T1–T6, 66 (49%) at T7–T12, and 24 (18%) at L1–L4. The AIS grade distribution was: A 109 (80%), B 13 (10%), and C 13 (10%). Average time since injury was 18.4 (SD = 12.3) years, with a minimum of 1 year and a maximum of 48 years.

Table I summarizes the key findings for the total groups. A significantly higher percentage of persons with SCI reported a history of MI. More persons with SCI reported DM, being consistent with more frequent reporting of using medication for this disease. The reported prevalence of DL was also higher, as was the reported prevalence of medication use for this diagnosis. A similar result was found for HTN, corresponding to a higher percentage of the SCI group reporting use of antihypertensive medication. When analysing the female subgroups separately, the only difference found was for DM plus medication, with a higher percentage of SCI participants falling in this category (Table II). For men, a higher percentage of persons with SCI reported a history of MI compared with the male comparison subgroup. Furthermore, the male SCI subgroup reported a significantly higher prevalence of DL and HTN compared with the ULF male participants. Concordant with this, the male SCI subgroup reported a higher percentage of drug use for these conditions (Table III).

DISCUSSION

This study is the second in a series from our centre examining CVD risks after traumatic SCI (13). The 135 persons in the study represent nearly 90% of all persons living in the Greater Stockholm area with traumatic paraplegia (AIS A–C), making the study an almost complete assessment of population risk.

Table I. *Comparison of proportion of cardiovascular disease risk and history of myocardial infarction (MI) between the spinal cord injury (SCI) group and the comparison group (ULF), total sample*

Variable	Category	SCI (n = 135) n (%)	ULF (n = 1488) n (%)	Statistic, p-value
MI	Yes	8 (5.9)	11 (0.7)	$\chi^2(1)=28.8$,
	No	127 (94.1)	1477 (99.3)	$p<0.0001$
DM	Yes	8 (5.9)	40 (2.7)	$\chi^2(1)=4.52$,
	No	127 (94.1)	1448 (97.3)	$p=0.03$
DM plus	Yes	8 (5.9)	38 (2.6)	$\chi^2(1)=5.1$,
medication	No	127 (94.1)	1450 (97.4)	$p=0.02$
DL	Yes	15 (11.1)	26 (1.8)	$\chi^2(1)=44.1$,
	No	120 (88.9)	1462 (98.2)	$p<0.0001$
Drugs for DL	Yes	15 (11.1)	25 (1.7)	$\chi^2(1)=45.8$,
	No	120 (88.9)	1463 (98.3)	$p<0.0001$
HTN	Yes	19 (14.1)	129 (8.7)	$\chi^2(1)=4.4$,
	No	116 (85.9)	1359 (91.3)	$p=0.04$
Drugs for HTN	Yes	19 (14.1)	124 (8.3)	$\chi^2(1)=5.08$,
	No	116 (85.9)	1364 (91.7)	$p=0.02$
Overweight	Yes	57 (42.2)	545 (36.6)	$\chi^2(1)=1.66$,
	No	78 (57.8)	943 (63.4)	$p=0.20$
Smoking	Yes	22 (16.3)	231 (15.5)	$\chi^2(1)=0.06$,
	No	113 (83.7)	1257 (84.5)	$p=0.81$

MI: myocardial infarction; DM: diabetes mellitus; DL: dyslipidaemia; HTN: hypertension.

Table II. *Comparison of proportion of cardiovascular disease risk and history of myocardial infarction (MI) between the spinal cord injury (SCI) group and the comparison group (ULF), women only*

Variable	Category	SCI ($n=31$) *n* %	ULF ($n=769$) *n* %	Statistic, *p*-value
MI	Yes	1 (3.1)	5 (0.7)	$\chi^2(1)=2.66$,
	No	30 (96.9)	764 (99.3)	$p=0.10$
DM	Yes	2 (6.5)	14 (1.8)	$\chi^2(1)=3.26$,
	No	29 (93.5)	755 (98.2)	$p=0.07$
DM plus	Yes	2 (6.5)	12 (1.6)	$\chi^2(1)=4.15$,
medication	No	29 (93.5)	757 (98.4)	$p=0.04$
DL	Yes	2 (6.5)	15 (2.0)	$\chi^2(1)=2.90$,
	No	29 (93.5)	754 (98.0)	$p=0.09$
Drugs for DL	Yes	2 (6.5)	14 (1.8)	$\chi^2(1)=3.26$,
	No	29 (93.5)	755 (98.2)	$p=0.07$
HTN	Yes	1 (3.1)	77 (10.0)	$\chi^2(1)=1.56$,
	No	30 (96.9)	692 (90.0)	$p=0.21$
Drugs for HTN	Yes	1 (3.1)	76 (9.9)	$\chi^2(1)=1.52$,
	No	30 (96.9)	693 (90.1)	$p=0.22$
Overweight	Yes	12 (38.7)	218 (28.3)	$\chi^2(1)=1.56$,
	No	19 (61.3)	551 (71.7)	$p=0.21$
Smoking	Yes	6 (19.4)	125 (16.3)	$\chi^2(1)=0.21$,
	No	25 (80.6)	644 (83.7)	$p=0.65$

MI: myocardial infarction; DM: diabetes mellitus; DL: dyslipidaemia; HTN: hypertension.

Table III. *Comparison of proportion of cardiovascular disease risk and history of myocardial infarction (MI) between the spinal cord injury (SCI) group and the comparison group (ULF), men only*

Variable	Category	SCI ($n=104$) *n* %	ULF ($n=719$) *n* %	Statistic, *p*-value
MI	Yes	7 (6.7)	6 (0.8)	$\chi^2(1)=20.3$,
	No	97 (93.3)	713 (99.2)	$p<0.0001$
DM	Yes	6 (5.8)	26 (3.6)	$\chi^2(1)=1.13$,
	No	98 (94.2)	693 (96.4)	$p=0.29$
DM plus	Yes	6 (5.8)	26 (3.6)	$\chi^2(1)=1.13$,
medication	No	98 (94.2)	693 (96.4)	$p=0.29$
DL	Yes	13 (12.5)	11 (1.5)	$\chi^2(1)=38.6$,
	No	91 (87.5)	708 (98.5)	$p<0.0001$
Drugs for DL	Yes	13 (12.5)	11 (1.5)	$\chi^2(1)=38.6$,
	No	91 (87.5)	708 (98.5)	$p<0.0001$
HTN	Yes	18 (17.3)	52 (7.2)	$\chi^2(1)=11.9$,
	No	86 (82.7)	667 (92.8)	$p<0.001$
Drugs for HTN	Yes	18 (17.3)	48 (6.7)	$\chi^2(1)=13.9$,
	No	86 (82.7)	671 (93.3)	$p<0.001$
Overweight	Yes	45 (43.3)	327 (45.5)	$\chi^2(1)=0.18$,
	No	59 (56.7)	392 (54.5)	$p=0.67$
Smoking	Yes	16 (15.4)	106 (14.7)	$\chi^2(1)=0.30$,
	No	88 (84.6)	613 (85.3)	$p=0.86$

MI: myocardial infarction; DM: diabetes mellitus; DL: dyslipidaemia; HTN: hypertension.

Key findings were an increased prevalence of DM, DL, and HTN, compared with the general population. Medication use for DL and HTN was also significantly higher in the SCI group, which corroborates the presence of a higher disease risk. We found an 8.5-fold higher reported occurrence of MI in persons with SCI, which is consistent with earlier reports of elevated risk for ischaemic heart disease after SCI (16–19). It is noteworthy that the prevalence of silent MI has been reported to be higher in the SCI population than in the non-disabled population (20) and increased with higher lesion levels and/or more complete lesions (2, 21). This may lead to an under-reporting of MI, making the problem potentially even greater than suggested by our findings.

Our findings are in considerable agreement with several previous studies reporting an increased total CVD risk and larger atherosclerotic burden compared with the general population (22). The observations are also congruent with studies reporting an increased prevalence for isolated CVD risks including DM (1, 5, 6, 19, 23), atherogenic DL (24, 25), and HTN (17). however, as was indicated in the introduction, the results of previous research are conflicting. Prevalence of "overweight" was similar in both groups, a finding which differs from several previous reports of overweight and obesity in persons with SCI (7, 25–28). Because, "overweight" in this study was defined as a body mass index (BMI) ≥ 25 kg/m^2 this method may underestimate body fat in persons with SCI (29). Some studies suggest that a BMI of ≥ 23 kg/m^2 might be a truer indicator of elevated body fat percentage in persons with SCI (30), in which case the true prevalence of "overweight" in the SCI group in this study would, in fact, be increased.

Importantly, our results disagree with the findings of a recent meta-analysis examining CVD risk after SCI (30). This study concluded that no evidence exists for a markedly greater risk of carbohydrate and lipid disorders or cardiovascular morbidity or mortality in the SCI population.

The strengths of this study include comparisons between groups located within the same geographical area using data collected during a similar time period. All study data for the SCI group were queried and gathered by a single investigator (KW), favouring consistency in collection. The study is also one of few that includes a question about previous MI, while most other studies focus on isolated risk factors e.g., atherogenic dyslipidaemia (5, 31), HTN (32), DM (6, 33) risk clustering (2), risk prediction equations (10), or need for intervention (23).

Some caveats are required when interpreting the data. Self-report data are susceptible to errors in reliability. However, in this study we are comparing self-report data between 2 different populations and have no reason to suspect that one or the other of these groups would be more or less reliable in their reporting in a systematic way. We also like to note some methodological differences in data collected between groups for this study. First, ULF data reflect a randomly selected sample of a regional population ($n=1488$), while SCI data ($n=135$) represented 90% of all persons with traumatic paraplegia in the Greater Stockholm area. Secondly, ULF data were collected by telephone interviews, while the SCI data were collected by personal interviews. Additionally, "overweight" in this study was defined by BMI ≥ 25 kg/m^2, and this method is known to underestimate obesity in those with SCI. Since body weight was actually measured in the SCI group, whereas it was obtained by self-report in the comparison group, comparability is less certain for this particular outcome. Thus, it is not unlikely that the actual population differences were in fact larger (34). The age distribution between the SCI and ULF groups was

primarily similar. Due to the small number of participants in the youngest and oldest groups, no comparisons could be made within each category. Finally, factors including education and income were not part of the analysis.

In conclusion, persons with traumatic paraplegia reported a substantially increased prevalence of MI compared with a sample of the general population. Isolated CVD risk factors, such as DM, HTN, and DL, were also increased. The results indicate a specific need for screening and prevention for CVD in SCI populations. Health promotion programmes for modifiable CVD risk factors may therefore be indicated in rehabilitation settings for persons with SCI.

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