

ORIGINAL ARTICLE

# Health care utilization in persons with spinal cord injury: part 2—determinants, geographic variation and comparison with the general population

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**Study design:** Cross-sectional survey.

**Objectives:** To investigate annual rates and geographic variation of health care utilization in persons with spinal cord injury (SCI), and to identify factors associated with health care utilization.

**Setting:** Community setting, entire country of Switzerland.

**Methods:** Annual rates of planned and emergency visits to the general practitioner (GP), planned and emergency outpatient clinic visits and in-patient hospitalizations were compared between individuals with chronic SCI, over 16 years of age residing in Switzerland between late 2011 and early 2013 and a population sample (2012) of the Swiss general population. Risk factors for increased health service utilization were identified by means of regression models adjusted for spatial variation.

**Results:** Of 492 participants (86.2% response rate), 94.1% visited a health care provider in the preceding year, with most persons visiting GPs (88.4%) followed by outpatient clinics (53.1%) and in-patient hospitals (35.9%). The increase in utilization as compared with the general population was 1.3-, 4.0- and 2.9-fold for GP, outpatient clinic and in-patient hospital visit, respectively. GP utilization was highest in persons with low income (incidence rate ratio (IRR) 1.85) and old age (IRR 2.62). In the first 2 years post injury, health service visits were 1.7 (GP visits) to 5.8 times (emergency outpatient clinic visits) more likely compared with those later post injury.

**Conclusions:** People with SCI more frequently use health services as compared with the general population, across all types of medical service institutions. GP services were used most often in areas where availability of specialized outpatient clinic services was low. *Spinal Cord* advance online publication, 2 May 2017; doi:10.1038/sc.2017.38

## INTRODUCTION

Persons with spinal cord injury (SCI) are at a greater risk of medical complications than the general population<sup>1</sup> and more often face visits to general practitioners (GPs),<sup>1–3</sup> specialists<sup>1</sup> and rehospitalizations.<sup>1,2</sup> The most common causes for rehospitalizations in persons with SCI are respiratory, digestive, urinary and skin complications.<sup>1,4–7</sup> Rehospitalization rates and length of stay are affected by factors like lesion level, severity of injury, time since injury, chronological age and socioeconomic background.<sup>8–11</sup> These factors also determine whether a GP or specialist is consulted for the treatment of secondary health problems.<sup>12,13</sup> In some cases, rehospitalizations are preventable through health maintenance strategies, such as promotion of self-care or timely interference by experienced health professionals.<sup>5,7,14–17</sup>

Health care utilization rates often depend on place of residence through mechanisms of accessibility of care,<sup>18</sup> availability of specialized care,<sup>19</sup> provider-driven demand<sup>20</sup> or locally different patient preference.<sup>21</sup> Utilization of outpatient clinics and in-patient hospital services in persons with SCI were noted to decrease with longer travel distance to health care facilities.<sup>19</sup> In areas with reduced availability of primary-care services, hospital emergency departments have been used despite low adequacy as surrogate for primary-care services.<sup>7,18</sup> Geographic variation of health service utilization that is not related

to patient preference raises questions about equity and appropriateness of provided health care.<sup>22</sup>

The present study provides a complete picture on utilization of health care services and determinants of regional variation in a large cohort of individuals living in the community after SCI.<sup>23,24</sup> Participants live in Switzerland, a country with a market-based, multipayer, universal health care coverage model without gate keeping, an ample mix of private and public providers and high cost sharing. The objectives of this study were as follows: (1) to determine the annual rates of planned and emergency visits to the GP, planned and emergency visits to outpatient clinics and in-patient hospitalizations, in an extensive sample of persons with SCI in Switzerland; (2) to compare health care utilization patterns of persons with SCI to the general population; (3) to ascertain determinants of high health care utilization; and (4) to identify regional variation in health care utilization in the Swiss SCI population.

## MATERIALS AND METHODS

### Participants

Cross-sectional data were analyzed from a community survey of the Swiss Spinal Cord Injury Cohort Study (SwiSCI).<sup>23</sup> The survey was conducted between late 2011 and early 2013 in persons with chronic SCI, who were

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16 years of age or older and living in Switzerland. All participants signed a written consent form before completing the survey. The study was approved by the ethics committee of northwest/central Switzerland. SwiSCI participants were matched to a normative Swiss population, sampled in the Swiss Health Survey 2012,<sup>25</sup> based on age, sex and language with a matching ratio of 1:2 using a multivariate genetic search algorithm implemented in the R package Matching.<sup>26</sup> The Swiss Health Survey 2012 surveys basic information on the health state, health behavior and health service use in a random sample of 21 597 persons (0.27% of the Swiss population).

### Analysis data set

Age and time since injury categories were created in consideration of recommendations given by DeVivo *et al.*<sup>27</sup> and Hinrichs *et al.*<sup>28</sup> Household income was converted to net equivalent household income using the definition by the Organization for Economic Co-operation and Development,<sup>29</sup> based on the number of adults and children in the household. Persons' place of residence was recorded at MedStat regions, a subdivision of Switzerland into 705 zones, each containing between 3500 and 10 000 inhabitants.<sup>30</sup> Information about degree of urbanization<sup>31</sup> was provided by the Swiss Federal Statistical Office on the municipality level and mapped to MedStat regions. The degree of urbanization of a MedStat region was made equivalent to the enclosed

municipality with the highest degree of urbanization. The two categories, core city of an agglomeration and isolated city, were lumped together into the category urban area. The density of practicing physicians, as in Table 3 was available at the cantonal level from the Swiss Medical Association.<sup>32</sup> In the spatial analysis, areal units (spatial mobility regions<sup>33</sup>) with at least five observations per region were included. Regions with fewer observations were iteratively merged with the neighboring unit with the highest number of observations until a minimum of five observations per region was reached.

### Statistical analysis

Spatially structured negative binomial models were computed using the R package R-INLA,<sup>34</sup> which allows fast Bayesian inference using Laplace approximation. Determinants of health care utilization were investigated with the number of annual health service visits as the dependent variable, and sex, age, cause of injury, lesion level, lesion severity, time since injury, net equivalent household income, type of health insurance, language, degree of urbanization and density of practicing physicians in residential region included in the model as fixed effects. Residual spatial autocorrelation, due to neighborhood effects (where individual areal unit's outcomes are correlated with that of neighboring units), was accounted for via area-specific random effects with conditional autoregressive prior distribution<sup>35</sup> within the hierarchical Bayesian model. Highest posterior density credibility intervals were computed. The deviance information criterion was used to determine the best-fitting regression model (Supplementary Table S1). Missing covariate values were imputed using the R package missForest<sup>36</sup> with all regression variables used as covariates in the imputation process. Statistical analyses were performed using the statistical computing environment R version 3.2.3.<sup>37</sup>

**Table 1 Baseline characteristics of the SCI and general population**

	General population		
	SCI N = 492	Original N = 21 597	SCI matched 1:2 N = 984
<i>Socioeconomic characteristics</i>			
Age in years, mean (s.d.)	55.3 (15.1)	48.2 (18.6)	55.4 (15.0)
Sex, female, n (%)	142 (28.9)	11,314 (52.4)	284 (28.9)
Language, n (%)			
German	347 (70.5)	13998 (64.8)	694 (70.5)
French	122 (24.8)	5727 (26.5)	244 (24.8)
Italian	23 (4.7)	1872 (8.7)	46 (4.7)
Health insurance, n (%)			
General	344 (69.9)	11625 (53.8)	539 (54.8)
Semiprivate	91 (18.5)	3529 (16.3)	177 (18.0)
Private	32 (6.5)	1494 (6.9)	94 (9.6)
Missing	25 (5.1)	4949 (22.9)	174 (17.7)
Net equivalent household income, n (%)			
<3000 CHF per month	120 (24.4)	5727 (26.5)	255 (25.9)
3000–4000 CHF per month	102 (20.7)	4930 (22.8)	236 (24.0)
4001–5500 CHF per month	141 (28.7)	3610 (16.7)	179 (18.2)
>5500 CHF per month	76 (15.4)	4000 (18.5)	206 (20.9)
Missing	53 (10.8)	3330 (15.4)	108 (11.0)
Living alone, n (%)	113 (23.4)	3578 (16.6)	164 (16.7)
<i>Spinal cord injury characteristics</i>			
Cause of SCI, n (%)			
Traumatic	373 (76.6)		
Nontraumatic	114 (23.4)		
Lesion level, n (%)			
Tetraplegia	150 (30.7)		
Paraplegia	338 (69.3)		
Severity, n (%)			
Complete	192 (39.3)		
Incomplete	297 (60.7)		
Years since onset of SCI, mean (s.d.)			
	16.5 (13.1)		

Abbreviations: CHF, Swiss Francs; SCI, spinal cord injury. The number of missing data was <2.4% per category or listed otherwise.

### Depicting utilization rates

Estimates of absolute health care utilization rates in persons with SCI were derived for every region, by adding up (a) the absolute rate for an average person with SCI as estimated by the regression model, without adjustment of language and degree of urbanization; (b) the region-specific effect of language and degree of urbanization on utilization based on its proportions in the general population and the estimated effect in the regression model; and (c) the region-specific, spatially structured random effects. The absolute utilization rates were depicted per region in maps and as dotplots, on a log-scale and centered at the mean, to illustrate regional variation in health care utilization. Measures of geographic variation were computed, such as the ratio of maximum to minimum utilization rates and the coefficient of variation<sup>38</sup> (s.d. of absolute utilization rates divided by the mean).

## RESULTS

### Sociodemographic and injury characteristics

The 492 participants with SCI (86.2% response rate) were on average older (55.3 vs 48.2 years) and more likely male (71.1% vs 47.6%) than what would have been estimated from the general population (Table 1). They were more frequently living in German-speaking regions (70.5% vs 64.8%) and less frequently living in French-speaking (24.8% vs 26.5%) and Italian-speaking (4.7% vs 8.7%) regions. Not considering missing data, persons with SCI were less likely insured with a semiprivate or private health insurance (26.3% vs 33.5%) and more likely found in the two highest income categories (49.4% vs 43.9%) than individuals in the general population. More persons with SCI were living alone than persons in the general population (23.4% vs 16.7%). The most frequent lesion characteristics in the SCI population were traumatic injury (76.6%), paraplegia (69.3%) and incomplete lesion (60.7%). The average time since injury was 16.5 years.

### Health care utilization

Compared with the general population, persons with SCI more likely visited a health care provider and in average visited the health care provider more often (Table 2). This was found across all types of

**Table 2 Health care utilization of the SCI and general population**

	SCI		General population			
	Utilization last year N = 492 n (%)	Number of visits Mean ± s.d.	Original		SCI matched 1:2	
			Utilization last year N = 21 597 n (%)	Number of visits Mean ± s.d.	Utilization last year N = 984 n (%)	Number of visits Mean ± s.d.
Any medical consultation	463 (94.1)	6.8 ± 8.9	15 022 (69.6)	2.9 ± 5.4	712 (72.4)	3.0 ± 5.4
General practitioner visits	428 (88.4)	5.3 ± 8.3	13 685 (65.7)	2.4 ± 4.6	657 (69.5)	2.6 ± 4.6
Planned	372 (76.9)	3.8 ± 7.1				
Emergency	222 (46.0)	1.4 ± 3.1				
Outpatient clinic visits	257 (53.1)	1.2 ± 2.2	3100 (14.4)	0.3 ± 1.4	132 (13.4)	0.2 ± 0.9
Planned	193 (40.9)	0.9 ± 1.9	1154 (5.4)	0.1 ± 1.2	43 (4.4)	0.1 ± 0.7
Emergency	94 (19.9)	0.3 ± 0.8	2563 (11.9)	0.1 ± 0.5	105 (10.7)	0.1 ± 0.5
In-patient hospitalizations	170 (35.9)	0.7 ± 1.7	2524 (11.7)	0.2 ± 1.5	120 (12.2)	0.2 ± 1.2

Abbreviation: SCI, spinal cord injury.

No distinction in planned and unplanned general practitioner visit was made in the survey of the general population. The number of missings was <4.1% per category for utilization in the preceding year and between 1.6 and 9.8% per category for number of visits in the preceding year.

services. In total, there were (a mean of) 6.8 contacts with any of the mentioned health services during 1 year for individuals with SCI. This was 2.3 times more contacts compared with the general population and an increase by a factor of 2.0-, 6.0- and 3.5-fold for GP, outpatient clinic and in-patient hospital visits, respectively. The in-patient hospitalization rate in persons with SCI (35.9%) was 2.9 times that of the general population (12.2%). In contrast to the SCI population, with more planned visits (40.9%) than emergency outpatient visits (19.9%), there were more emergency visits (10.7%) than planned outpatient (4.4%) visits for the general population. The information about the number of health care visits was missing for 1.6% (planned GP visits) to 9.8% (outpatient clinic visits) of the persons with SCI and for <4% of the general population. The information of whether any health services was used or not was missing for <4.1% of the SCI population and 3.7% of the general population.

#### Determinants of health care utilization in persons with SCI

Women with SCI had more emergency outpatient clinic visits than men with SCI had (incidence rate ratio (IRR) 1.75, 95% credibility interval (CI): 1.01–3.10) (Table 3). Compared with the youngest age group (16–30 years), persons with SCI from the oldest age group (>75 years) had more planned GP visits (IRR 2.62, 95% CI: 1.39–4.94), and persons from the second oldest age group (60–75 years) had less planned visits to outpatient clinics (IRR 0.42, 95% CI: 0.17–0.99). In the first 2 years post injury, GP visits were 1.7–1.8 times more often, compared with later. The risk of an emergency visit to an outpatient clinic was 3.8–5.8 times higher in the first 2 years post injury, compared with later years post injury. In-patient hospitalizations were 2.6 times more likely in the first two years post injury than 5–10, respectively, 20 years or more later. Persons in the highest, second-highest and third-highest income categories consulted GPs 1.9 times (IRR 0.54, 95% CI: 0.39–0.74), 1.6 times (IRR 0.61, 95% CI: 0.47–0.80) and 1.4 times (IRR 0.74, 95% CI: 0.55–0.99) less often compared with persons in the lowest income category. Compared with the German-speaking regions, persons with SCI in the French-speaking regions had more planned and less emergency GP visits (IRR 1.42, 95% CI: 1.08–1.88 vs IRR: 0.60, 95% CI: 0.40–0.91, planned and emergency, respectively). Persons with SCI in the Italian-speaking regions also had more planned GP visits, but less

planned outpatient clinic visits than persons in the German-speaking regions (IRR 2.10, 95% CI: 1.23–3.74 for GP visits, and IRR 0.29, 95% CI: 0.09–0.91 for outpatient clinic visits, respectively). In rural areas, GP visits were 1.4 times more frequent than in urban areas (IRR 1.37, 95% CI: 1.03–1.81). In urban areas, outpatient clinic visits were 1.8 times more often (IRR 0.57, 95% CI: 0.35–0.93) and when planned 2.9 times more often (IRR 0.34, 95% CI: 0.16–0.68) than in rural areas. No influence on health care utilization was found for type of health insurance, cause of injury, lesion level and lesion severity.

#### Geographic variation of health care utilization in persons with SCI

Major variation in health care utilization was observed among the 45 Swiss regions across all types of health services (Figure 1). The highest coefficient of variation (Supplementary Table S2) was found for emergency outpatient clinic visits (0.30). The lowest coefficients of variation were found for all GP visits (0.15) and in-patient hospitalizations (0.17). Coefficients of variation for GP visits were higher if separated into planned (0.24) and emergency (0.23) visits. Persons from the Italian-speaking regions show relatively high utilization in planned GP visits with vastly reduced planned outpatient clinic visits (two outliers in Supplementary Figure S1).

#### DISCUSSION

Nine out of ten persons with SCI who completed the survey visited a GP, an outpatient clinic or were hospitalized within 1 year. Health services were more frequently used by persons with SCI as compared with the general population, across all types of medical service institutions. The increase in higher utilization as compared with the general population was 1.3-, 4.0- and 2.9-fold for GP, outpatient clinic and in-patient hospital visits, respectively. The rate of planned outpatient clinic visits was more than ninefold higher than that of the normative population. Utilization rates differed by years since injury and age, as well as income, degree of urbanization and language of the residential region. Highest geographic variation of health care utilization was found for emergency outpatient clinic visits. Little variation was found for GP visits (planned or emergency) and in-patient hospitalizations.

The literature reports GP visit rates between 77 and 86%.<sup>14,39–41</sup> In-patient hospitalization rates following initial rehabilitation were

**Table 3 Association of the number of annual health care consultations with personal and environmental characteristics in persons with SCI**

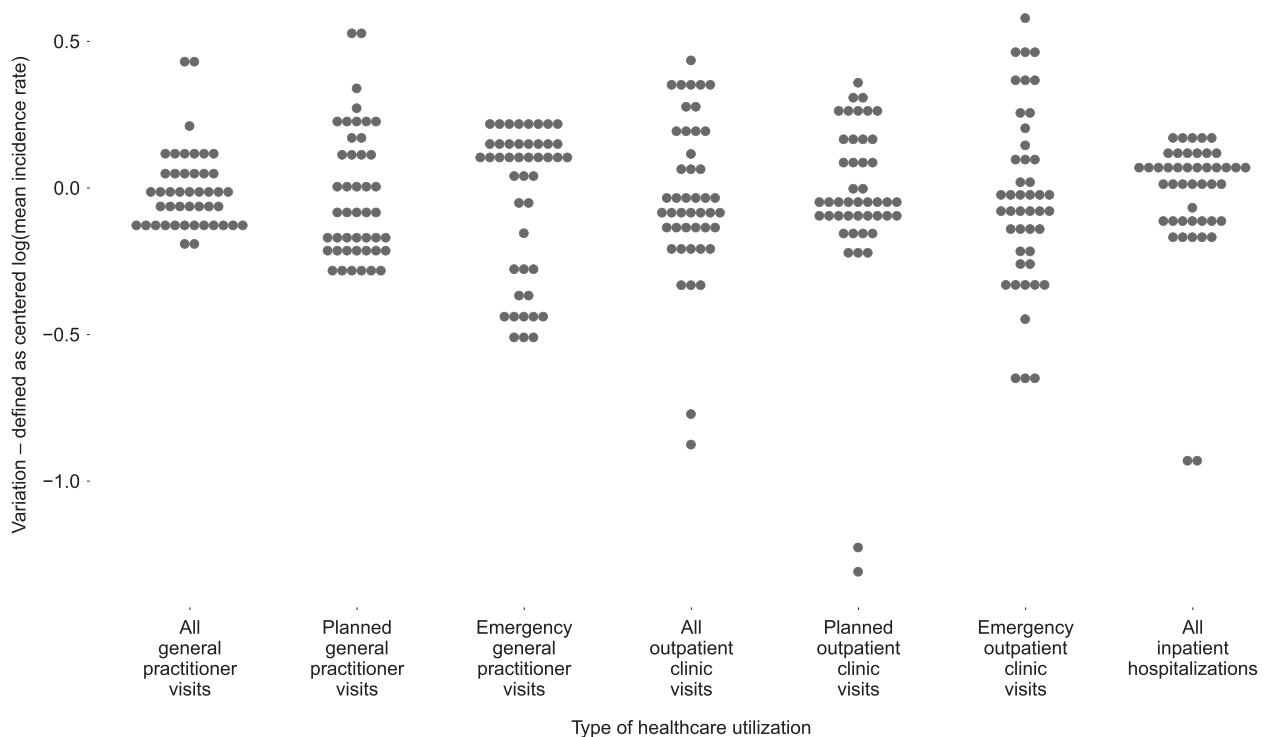
	General practitioner visits			Outpatient clinic visits			In-patient hospitalizations
	All IRR (95% CI)	Planned IRR (95% CI)	Emergency IRR (95% CI)	All IRR (95% CI)	Planned IRR (95% CI)	Emergency IRR (95% CI)	All IRR (95% CI)
Sex, female	0.97 (0.78–1.21)	0.91 (0.71–1.18)	1.12 (0.78–1.62)	1.37 (0.93–2.05)	1.30 (0.86–1.97)	1.75 (1.01–3.10)*	1.14 (0.72–1.81)
<i>Age (years), ref: 16–30</i>							
31–45	1.19 (0.74–1.88)	1.41 (0.82–2.39)	0.78 (0.36–1.62)	0.56 (0.25–1.23)	0.60 (0.26–1.39)	0.63 (0.21–1.90)	1.08 (0.39–2.99)
46–60	1.22 (0.77–1.92)	1.51 (0.89–2.50)	0.80 (0.37–1.67)	0.70 (0.31–1.55)	0.61 (0.25–1.44)	0.83 (0.28–2.42)	1.84 (0.68–4.97)
61–75	1.23 (0.77–1.92)	1.54 (0.91–2.55)	0.79 (0.37–1.62)	0.47 (0.21–1.03)	0.42 (0.17–0.99)*	0.53 (0.18–1.52)	2.00 (0.76–5.21)
>75	1.80 (1.02–3.17)*	2.62 (1.39–4.94)**	0.42 (0.16–1.12)	0.85 (0.30–2.40)	1.18 (0.39–3.54)	0.33 (0.08–1.38)	0.96 (0.27–3.44)
<i>Time since injury (years), ref: &lt; 2 years</i>							
2–<5	0.66 (0.43–1.01)	0.58 (0.36–0.94)*	0.84 (0.40–1.75)	0.52 (0.24–1.12)	0.96 (0.40–2.25)	0.18 (0.06–0.48)**	0.54 (0.21–1.29)
5–<10	0.60 (0.39–0.91)*	0.59 (0.36–0.96)*	0.54 (0.26–1.13)	0.39 (0.18–0.82)*	0.62 (0.26–1.41)	0.19 (0.07–0.51)**	0.39 (0.16–0.95)*
10–<20	0.55 (0.36–0.81)**	0.51 (0.32–0.79)**	0.63 (0.31–1.27)	0.60 (0.29–1.21)	0.85 (0.37–1.89)	0.45 (0.18–1.07)	0.62 (0.27–1.39)
≥20	0.55 (0.37–0.83)**	0.54 (0.34–0.84)**	0.56 (0.27–1.12)	0.67 (0.31–1.36)	1.30 (0.56–2.95)	0.26 (0.10–0.62)**	0.39 (0.16–0.87)*
<i>Net equivalent monthly household income (CHF), ref: &lt; 3000 CHF</i>							
3000–4000	0.74 (0.55–0.99)*	0.85 (0.61–1.18)	0.57 (0.35–0.92)*	0.62 (0.36–1.05)	0.61 (0.35–1.06)	0.80 (0.38–1.66)	1.49 (0.83–2.67)
4001–5500	0.61 (0.47–0.80)**	0.60 (0.44–0.82)**	0.62 (0.39–0.98)*	0.63 (0.38–1.04)	0.65 (0.38–1.11)	0.86 (0.43–1.70)	1.17 (0.66–2.07)
>5500	0.54 (0.39–0.74)**	0.51 (0.35–0.74)**	0.59 (0.35–1.00)*	0.97 (0.56–1.71)	0.89 (0.49–1.61)	1.74 (0.81–3.78)	1.41 (0.73–2.74)
<i>Language, ref: German</i>							
French	1.15 (0.90–1.47)	1.42 (1.08–1.88)*	0.60 (0.40–0.91)*	1.43 (0.96–2.15)	1.32 (0.86–2.04)	1.47 (0.83–2.57)	0.79 (0.48–1.30)
Italian	1.73 (1.08–2.85)*	2.10 (1.23–3.74)**	1.06 (0.49–2.42)	0.46 (0.18–1.22)	0.29 (0.09–0.91)*	0.82 (0.24–2.82)	0.37 (0.12–1.11)
<i>Degree of urbanization, ref: Urban area</i>							
Suburban area	1.09 (0.84–1.40)	0.89 (0.67–1.19)	1.52 (0.99–2.32)	0.70 (0.45–1.07)	0.72 (0.45–1.14)	0.57 (0.32–1.03)	0.89 (0.52–1.52)
Rural area	1.37 (1.03–1.81)*	1.22 (0.88–1.69)	1.56 (0.96–2.53)	0.57 (0.35–0.93)*	0.64 (0.38–1.08)	0.34 (0.16–0.68)**	1.05 (0.58–1.91)
<i>Density of practicing physicians (per 100 000 inhabitants), ref: &lt; 200</i>							
200–239	0.86 (0.68–1.08)	0.76 (0.58–0.98)*	1.26 (0.85–1.89)	1.02 (0.65–1.58)	0.96 (0.61–1.53)	1.39 (0.75–2.58)	1.27 (0.78–2.08)
≥240	1.03 (0.76–1.40)	0.88 (0.62–1.25)	1.64 (0.99–2.74)	1.03 (0.62–1.74)	1.00 (0.59–1.72)	0.96 (0.46–2.00)	0.87 (0.46–1.65)

Abbreviations: IRR (95% CI), incidence rate ratio with 95% credibility interval; ref, reference category; SCI, spinal cord injury. Parameter estimates based on multivariable mixed-effects negative binomial regression, adjusted for all shown variables, plus for type of health insurance, cause of injury, lesion level, lesion severity and spatial correlation. \* $P < 0.05$  and \*\* $P < 0.01$ .

reported to range between 19 and 57%<sup>6</sup> and were reported as low as 13%<sup>1</sup> in the succeeding years. The present study found a slightly higher GP visit rate (88%), whereas the in-patient hospitalization rate (36%) was within the range described in the literature. Only a few studies compared health care utilization pattern of persons with SCI to the general population. Laursen and Helweg-Larsen<sup>2</sup> found higher GP, outpatient clinic and in-patient hospital use over a study period of 9 years, among persons with SCI compared with the general population. Johnson *et al.*,<sup>8</sup> Savic *et al.*<sup>4</sup> and Dryden *et al.*<sup>1</sup> reported 2.0, 2.4 and 2.6 times, respectively, the hospitalization rates in persons with SCI as compared with the general population. The present study found a ratio of 2.9. Rates of planned outpatient clinic visits were more than nine times higher in persons with SCI, and, in contrast to the general population, more frequent than emergency outpatient clinic visits. This might be explained by the regular use of annual check-up provided by the outpatient departments at SCI centers.<sup>42</sup>

In accordance with Guilcher *et al.*<sup>18</sup> and Munce *et al.*<sup>43</sup> who found increased physician utilization in elderly persons with SCI, the present study found approximately twice the rates of planned GP visit in persons older than 75 years of age as compared with persons aged 30 years and younger. More GP visits were also found in persons with

low income. Several studies found low income to be associated with a higher risk for pressure ulcers,<sup>44</sup> poor general health,<sup>44</sup> low health literacy<sup>45</sup> and limited access to specialty services.<sup>46</sup> In the present study, no significant associations were found between health care utilization and cause of injury, lesion level or severity of injury. The only significant correlation between lesion characteristics and health care utilization was found for years since SCI. In the first 2 years post injury, persons with SCI visited GPs more often and had more emergency outpatient clinic visits and in-patient hospitalizations than in succeeding years. For in-patient hospitalizations, this result matches those of previous studies.<sup>1,2</sup> In contrast to some earlier findings, however, no trend toward lower health care utilization rates with increasing years post injury was found.<sup>10,47,48</sup> The present study found that persons with SCI from the Italian-speaking regions or rural regions were more likely visiting GPs and less likely visiting outpatient clinics. This result is in agreement with a recent study by Ronca *et al.*,<sup>49</sup> reporting that persons with SCI from the Italian part of Switzerland rarely leave their residential region for in-patient hospitalization even though there is no local SCI center. This suggests a preference for care in the own language by local GPs over more specialized treatment at SCI clinics in differently speaking regions.



**Figure 1** Geographical variation in health care utilization in 45 Swiss regions. Every dot represents one of the 45 regions in Switzerland. Incidence rates were adjusted for sex, age, time since injury, language, income, degree of urbanization, density of practicing physicians, health insurance type, cause of injury, lesion level, lesion severity and spatial correlation.

Furthermore, the high variation in outpatient clinic visits among Swiss regions, and the fact that GP visit rates were particularly high where rates of outpatient clinic visits were low, suggests that the utilization of outpatient clinic services strongly depends on their local availability and that an undersupply of this type of care is compensated with GP visits. This might be a problem because SCI is a rare condition, and most GPs do not often see persons with SCI. Thus, they may lack specific knowledge about SCI and associated secondary health conditions.<sup>50</sup> Cox *et al.*<sup>51</sup> found that 81% of persons with SCI reported limited local provider expertise. The majority of patients were reported to prefer specialist care, and they were happiest to receive their follow-up care from rehabilitation specialists.<sup>14,15,52</sup> A consequence of inadequately treating patients in primary care or in the outpatient setting is a high rehospitalization rate for preventable secondary health conditions.<sup>7,11</sup>

The present study found low geographic variation in utilization of in-patient hospital care services among persons with SCI, which was only slightly higher than in the general population.<sup>38</sup> Hence, it could be argued that persons with SCI living in rural and minority language regions do not have more severe medical complications that require rehospitalizations compared with persons who are living closer to SCI centers. However, studies about satisfaction with SCI-specific health care or incidence of preventable secondary health conditions among patients living in rural and minority language regions are necessary to obtain a better understanding.

#### Study limitations

There are several potential limitations to this study. First, this cross-sectional study was based on a convenience sample. The validity of the sample has been investigated by the SwiSCI team, where socio-demographic and injury characteristics of the nonresponders were

collected and compared with the study sample. Little nonresponse bias was found, and the sample can be considered as representative of the general Swiss SCI population.<sup>24</sup> Second, all data were self-reported. This raises the issue of recall bias and accuracy of reporting, especially for the health care utilization rates in the present study.<sup>53</sup> Third, a spatial areal analysis might be underpowered considering 492 persons distributed over 45 regions. To derive adequate spatial estimates, the study allowed borrowing strength from nearby regions by implying a spatial autocorrelation.

#### CONCLUSIONS

Persons with SCI are high users of the health care system, where under limited supply, specialized health care is substituted with GP services, such as in rural areas and minority language regions. If persons with SCI rely predominantly on GP services due to language barriers or regional unavailability of specialist care, they might be at risk of not receiving adequate care for their complex health conditions. A suggested solution to that problem is the introduction of small specialized ambulatory clinics in these areas.

#### DATA ARCHIVING

There were no data to deposit.

#### CONFLICT OF INTEREST

All authors were salaried by organizations financially compensated by the Swiss Paraplegic Foundation.

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Supplementary Information accompanies this paper on the Spinal Cord website (<http://www.nature.com/sc>)