Spinal Cord (2020) 58:18–24
https://doi.org/10.1038/s41393-019-0333-x

ARTICLE

Poor adherence to influenza vaccination guidelines in spinal cord injury: results from a community-based survey in Switzerland

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Received: 7 May 2019 / Revised: 10 July 2019 / Accepted: 11 July 2019 / Published online: 1 August 2019

Abstract

Study design Cross-sectional survey.

Objectives To evaluate the annual influenza vaccination coverage rate (IVCR) among community-dwelling individuals with spinal cord injury (SCI).

Setting SCI community in Switzerland.

Methods Participants were responders to the influenza vaccination question ($n = 492$) in the 2012 community survey of the Swiss Spinal Cord Injury (SwiSCI) cohort study. IVCR of SwiSCI participants were compared to the normative Swiss population, sampled in the Swiss Health Survey of 2012 using direct standardization, logistic regression standardization, and a genetic matching approach to control for differences in age, sex, and quarterly period of survey response.

Results Individuals with SCI showed higher crude (26%, 95% confidence interval (CI): 22–30%) and age- and sex-standardized (24%, CI: 23–24%) IVCR than observed in the general population (15% CI, 14–15%). The adjustment for age and sex as well as quarterly period of survey response showed that the standardized IVCR of individuals with SCI (17%; CI: 12–23%) approached that of the general population. Low IVCR of about 10% were found among individuals with SCI younger than 45 years. IVCR were similar between men and women and between individuals with incomplete and complete paraplegia and tetraplegia.

Conclusion The IVCR in individuals with chronic SCI was not higher than in the general population and much lower than guidelines recommend. The improvement of the IVCR is an important target of health policy in SCI in Switzerland as to reduce the evidenced excess burden in respiratory-disease related morbidity and mortality.

Introduction

Influenza and pneumonia are among the main causes of death in individuals with spinal cord injury (SCI) [1–3] leading to increased mortality rates of up to 37-fold [4]. Individuals with traumatic SCI in Switzerland who survived at least one year after injury have a more than 4 times higher risk of dying from respiratory infections than the general population [5]. The risk of dying from influenza-related complications is increased due to impaired cough and less effective clearance of secretions, weak respiratory muscles, autonomic changes, including bronchoconstriction, and decreased overall mobility [6]. This is especially the case for individuals with tetraplegia and complete lesions who are at a particularly high risk of dying from respiratory infection-related complications [5].

A growing number of studies provide strong evidence that influenza vaccination reduces the risk of acquiring influenza or lessens the severity of the illness if the vaccine strains are identical or similar to the currently circulating influenza virus strains [7–9]. Therefore, death due to influenza-related complications is potentially preventable through vaccination. Individuals with SCI have shown to mount an appropriate antibody response to the inactivated influenza vaccine that is comparable to that of able-bodied

Supplementary information The online version of this article (https://doi.org/10.1038/s41393-019-0333-x) contains supplementary material, which is available to authorized users.

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individuals [10]. Thus, individuals with SCI would be expected to benefit equally from the influenza vaccination.

In line with the European Centre for Disease Prevention and Control [11] and similarly to the Advisory Committee on Immunization Practices of the United States (CDC) [12], the Swiss Federal Office of Public Health recommends the influenza vaccination for individuals aged 65 and older and among others to individuals with diabetes, and neurological, pulmonary, or cardiovascular disorders [13]. The CDC explicitly recommends the influenza vaccination for individuals with SCI [14]. The follow-up care guidelines of the Consortium for Spinal Cord Medicine, the SCI center Craig, and the Swiss SCI centers recommend the influenza vaccination to all individuals with SCI [15–17]. The guidelines of Craig and the Swiss SCI centers further recommend the influenza vaccination especially to those with injuries at T8 and higher [16] and to those with comorbidities [15].

The overall objective of this study was to evaluate the influenza vaccination coverage rate (IVCR) among community-dwelling individuals living with SCI in Switzerland, a country in which influenza vaccination is recommended by public health authorities to all individuals with SCI. In this paper we compare the IVCR of individuals with SCI to that of the general population in order to determine whether the healthcare system is sufficiently responding to the special needs of individuals with SCI. We further aim to identify possible predictors of influenza vaccination underuse by examining IVCR stratified by socio-demographic and medical factors. To the best of our knowledge, this is the first study to determine IVCR in a representative sample of individuals with chronic SCI living in the community.

Methods

Survey sample and data preparation in SCI

The study sample ($n = 492$) was derived from the first community survey of the nationwide Swiss Spinal Cord Injury (SwiSCI) Cohort Study [18]. The survey was conducted between late 2011 and early 2013 based on registries from the national association for individuals with SCI, three specialized SCI-rehabilitation centers, and a SCI-specific homecare institution. Eligible were individuals living in Switzerland, with traumatic or on-traumatic SCI aged 16 years or older. Questionnaires were distributed in three consecutive modules, with the question about influenza vaccination being part of the third module that received an overall, cumulative response rate of 43% with moderate response bias [19]. Participants of the third module were on average 3 years older than respondents to the initial survey module [18]. The influenza vaccination status was assessed by asking the participants "when have you had your last influenza vaccination". Possible answers were "in the past 12 months", "1 to 2 years ago", "longer than 2 years ago", and "never". Participants who did not provide their vaccination status ($n = 9$) were coded as"never". Age categories were created in consideration of recommendations given by Biering-Sørensen et al. [20] whereas the age categories 45–59, 60–74 and 75 + years were changed to 45–64 and to 65 + years in order to account for age-related influenza vaccination recommendations made by the Swiss Federal Office of Public Health [13]. Lesion severity was categorized into complete paraplegia, incomplete paraplegia, complete tetraplegia, and incomplete tetraplegia. Respiratory and cardiovascular disorders as well as diabetes were self-reported and coded as existent when present in the three months prior to answering the survey.

Survey sample and data preparation in the general population

IVCR of SwiSCI participants were compared to the normative Swiss population, sampled in the Swiss Health Survey (SHS) of 2012 [21]. The SHS surveyed basic information on the health state, health behavior, and health service use in a random sample of 21,597 individuals (0.27% of the Swiss population). The influenza vaccination status was assessed in 18,357 participants by asking "Have you ever had an influenza vaccination? If yes, please indicate the month and year of your last influenza vaccination". In order to create a vaccination status that is equivalent to that of the SwiSCI survey, we calculated the time interval between the influenza vaccination and the date when participants answered the survey. Respiratory and cardiovascular disorders as well as diabetes were coded according to a recent study by Zürcher et al. who estimated IVCR in the general population based on SHS data [22]. Diabetes was defined by the use of any diabetic drug, cardiovascular disorders by the use of any heart medication, and pulmonary disorders were recorded as self-reported. Age was categorized into the same groups as the SCI sample. To match the age distribution to the SCI sample, participants younger than 16 years ($n = 139$) were excluded.

Statistical analysis

Age- and sex-standardized IVCR were calculated using direct standardization. Additional adjustment of IVCRs for the quarterly period of survey response as well as unit nonresponse [18] was achieved using logistic regression standardization, applying the R package "stdReg" that allows for estimation of standardized probabilities from a fitted regression model [23]. The logistic regression model was fitted with the vaccination status as the dependent variable

and age, sex, quarterly period of survey response, and group (SCI or general population) as the independent variables. Survey weights were included in the model for both populations to correct for unit non-response bias [18]. Crude IVCR in SCI were compared across categories of personal characteristics, lesion severity, health conditions, and the quarterly period of survey response to an age- and sex-matched sample of the general population using two-sided Fisher's exact tests. Every SwiSCI participant was case matched with four SHS participants. Matching was performed using a multivariate genetic search algorithm implemented in the R package Matching [24]. In a supplementary analysis, crude IVCR in SCI were compared to a sample of the general population that was matched based on age, sex, and the exact month and year of survey response. Statistical analyses and data preparation were performed using the R programming language version 3.5.1.

Results

The 492 participants with SCI in the SwiSCI survey were on average older (57 vs. 49 years) than participants of the SHS survey and more likely male (71% vs. 47%) (Table 1). Among participants with SCI, incomplete paraplegia was the most frequent lesion characteristic (39%), followed by complete paraplegia (30%), incomplete tetraplegia (22%), and complete tetraplegia (9%). The median time since SCI onset was 12 years (interquartile range 6–25 years). The occurrence of diabetes and cardiovascular disorders in the last three months were similarly reported by about 10% of study participants with SCI. Respiratory disorders were more frequent and reported by 23% of study participants. More than half of SwiSCI participants answered the survey in the last quarter of the year 2011, whereas response by SHS participants was more equally distributed across all quarters of 2012. The crude, self-reported IVCR in the year prior to the survey was higher in individuals with SCI (26%) than the general population (15%). Likewise, the fraction of individuals who reported ever having had an influenza vaccination was higher in individuals with SCI (49%) than in the general population (33%).

Table 2 compares IVCR of individuals with SCI to IVCR of the age- and sex-matched sample of the general population by personal characteristics, lesion severity, health conditions, and quarterly period of survey response. Overall, individuals with SCI were slightly more often vaccinated against influenza (26, 95% confidence interval (CI): 22–30%) than the individuals of the matched sample of the general population (18%; CI: 16–19%). Similar IVCR were found for men and women with SCI, and across individuals with different lesion severity. IVCR were higher in the elderly and consistently higher in individuals with SCI than in the general population. Individuals with SCI and respiratory disorders were 1.5 times more often vaccinated than those from the general population with respiratory disorders. IVCR of individuals with cardiovascular disorders or diabetes were similar between the two populations. SwiSCI and SHS study participants were about equally often vaccinated when they answered the surveys in the first three quarters of the year 2012 whereas SwiSCI participants who answered the survey in the last quarter of 2011 were more often vaccinated and SHS participants who answered the survey in the fourth quarter of 2012 were less often vaccinated.

The crude (26%, CI: 22–30%) and age and sex- standardized (24% CI: 23–24%) estimates of IVCRs in individuals with SCI were higher than in the general population (15% CI, 14–15%). When adjusting for age, sex, the quarterly period of survey response, and when including survey weights, the standardized IVCR of individuals with

Table 1 Baseline characteristics of participants in the SwiSCI and SHS survey of 2012

	Individuals with SCI	General population	
		SCI matched 1:4*	Original
Categorical variables [*n* missing in SCI]	*n* (%)	*n* (%)	*n* (%)
Study participants	492 (100)	1968 (100)	18,218 (100)
Sex male [0]	350 (71)	1400 (71)	8579 (47)
Age at survey [0]			
16–29 years	25 (5)	100 (5)	
30–44 years	101 (21)	404 (21)	
45–64 years	201 (41)	804 (41)	
65 + years	165 (34)	660 (34)	
Lesion severity [4]			
Incomplete paraplegia	191 (39)		
Complete paraplegia	147 (30)		
Incomplete tetraplegia	105 (22)		
Complete tetraplegia	45 (9)		
Respiratory disorders, yes [42]	103 (23)	189 (10)	1845 (10)
Cardiovascular disorders, yes [20]	44 (9)	207 (19)	1246 (14)
Diabetes, yes [18]	38 (8)	135 (7)	868 (5)
Quarterly period of survey response [0]			
3rd quarter 2011	16 (3)	0 (0)	0 (0)
4th quarter 2011	333 (68)	0 (0)	0 (0)
1st quarter 2012	98 (20)	424 (22)	3834 (21)
2nd quarter 2012	31 (6)	484 (25)	4871 (27)
3rd quarter 2012	14 (3)	508 (26)	4778 (26)
4th quarter 2012	0 (0)	552 (28)	4735 (26)
Influenza vaccination receipt [0]			
Past year	128 (26)	368 (19)	2691 (15)
Never	249 (51)	1276 (65)	12,141 (67)
Continuous variables	Median (Q1–Q3)	Median (Q1–Q3)	Median (Q1–Q3)
Age at survey (years) [0]	57 (44–67)	57 (44–67)	49 (35–63)
Time since injury (years) [12]	12 (6–25)		

SwiSCI Swiss Spinal Cord Injury Cohort Study, *SHS* Swiss Health Survey, *SCI* spinal cord injury, *Q1* lower quartile, *Q3* upper quartile

*Matched for age and sex

Table 2 Reported influenza vaccination rate in the past year

	Individuals with SCI		General population SCI matched 1:4*		Between-sample comparison
	Relative frequency; % (95% CI)	*P*-value	Relative frequency; % (95% CI)	*P*-value	*P*-value
All	26 (22–30)		18 (16–19)		<0.001
Sex		0.114		0.473	
Male	24 (20–29)		17 (15–19)		0.004
Female	31 (24–39)		19 (16–22)		0.002
Age		<0.001		<0.001	
16–29 years	12 (4–30)		0 (0–4)		0.007
30–44 years	9 (5–16)		4 (2–6)		0.067
45–64 years	23 (18–29)		12 (10–15)		<0.001
65 + years	42 (35–50)		35 (32–39)		0.087
Lesion severity		0.266			
Incomplete paraplegia	29 (23–36)				
Complete paraplegia	21 (15–28)				
Incomplete tetraplegia	26 (18–35)				
Complete tetraplegia	33 (21–48)				
Respiratory disorders		0.004		0.004	
No	22 (18–27)		17 (15–19)		0.017
Yes	37 (28–47)		25 (20–32)		0.045
Cardiovascular disorders		0.001		<0.001	
No	24 (20–28)		23 (20–26)		0.888
Yes	48 (34–62)		44 (37–51)		0.710
Diabetes		0.121		<0.001	
No	25 (21–29)		16 (14–18)		<0.001
Yes	37 (23–53)		41 (33–49)		0.852
Quarterly period of survey response		0.667		0.010	
3rd quarter 2011	19 (7–43)		0 (0)		
4th quarter 2011	28 (24–33)		0 (0)		
1st quarter 2012	21 (14–31)		20 (17–24)		0.783
2nd quarter 2012	23 (11–40)		17 (14–20)		0.463
3rd quarter 2012	21 (8–48)		20 (17–24)		1.000
4th quarter 2012	0 (0)		13 (11–17)		

SCI spinal cord injury, *95% CI* 95% confidence interval Note: *P*-values were calculated using two-sided Fisher's exact tests

*Matched for age and sex

SCI (17%; CI: 12–23%) approached that of the general population. A sensitivity analysis that used a matching approach to control for differences in age, sex and month and year of survey response between the SCI and general populations confirmed the similarity of IVCR rates (Tables S1 and S2).

Discussion

The crude IVCR of individuals with SCI in Switzerland (26%) was higher than that of the general population (15%). However, the adjusted analysis suggested that the difference is essentially explained by differences in age structures and survey period between the survey in SCI and the general population. IVCR were highest in individuals aged 65 years or older, and in those with diabetes, cardiovascular and respiratory disorders, but did not exceed 50%. Low IVCR of about 10% were found among individuals with SCI younger than 45 years. IVCR were similar between men and women and between groups with different lesion severity.

There is a remarkably scant evidence-base regarding IVCR in community-dwelling individuals with SCI. Most evidence comes from studies that investigated interventions

to increase influenza vaccination rates in veterans with SCI in the United States [25, 26]. Weaver et al. reported IVCR in veterans aged 65 years or older of 34% [25]. This is lower than the 42% that we report for our study population with SCI aged 65 years or older. A Canadian survey among physicians in the family practice found that 33 of 60 (55%) patients with SCI had been vaccinated against influenza [27]. The median time since influenza vaccination of these patients with an average age of 52 years was 19 months. This finding is therefore not directly comparable to the annual IVCR reported in this study, but it is similar to the proportion of individuals with SCI in our study who reported having ever had an influenza vaccination (49%).

The comparably low IVCR rate in individuals with SCI is surprising, given that national and international guidelines recommend the influenza vaccination for individuals with neurological impairments, or for individuals with SCI specifically. IVCRs were for instance considerably below the coverage rate of 75% that is recommended by influenza vaccination guidelines issued by the European Centre for Disease Prevention and Control for individuals older than 65 years and other risk groups [11]. Particularly unexpected were the low IVCR in individuals with SCI and concomitant risk factors for influenza–related complications. Only 33% of individuals with complete tetraplegia, 37% with respiratory disorders, 48% with cardiovascular disorders, and 37% with diabetes were vaccinated against influenza. In accordance with guideline recommendations for the general population, individuals with SCI aged 65 years and older were more likely vaccinated than their younger counterparts. Similarly, those with cardiovascular disorders or diabetes were more often vaccinated than those without these health conditions. However, when compared to the general population with the same age or with the same health conditions, we found that IVCR were not markedly elevated in individuals with SCI. This suggests that influenza vaccination recommendations were partly followed with respect to conditions that are common in the general population, but guideline recommendations related to the neurological impairments of individuals with SCI seem to be insufficiently considered.

Physicians should be encouraged to recommend the influenza vaccination to individuals with SCI given the low IVCR in these individuals and the high influenza-related mortality [5]. Weaver et al. showed that it is possible to increase IVCR using patient reminder letters and education, provider reminders, and computerized clinical reminders. They were able to increase annual IVCR from 34 to 67% in veterans with SCI treated at 23 veterans SCI centers [25]. A similar intervention to increase IVCR in the community-dwelling individuals with chronic SCI of this study would likely require an involvement of general practitioners as they visit specialized centers less frequently than the US veterans and rely more often on general practitioner services [28–30]. The authors of the Canadian survey among physicians in family practices concluded that it would be relatively easy to increase influenza vaccination uptake in individuals with SCI with high potential gains, particularly as all responding physicians reported comfort with providing vaccinations [27].

This study was subject to several limitations. First, SwiSCI and SHS participants answered the surveys at different time points. A majority of SwiSCI participants answered the survey in the fourth quarter of the year 2011, whereas all SHS participants answered the survey in the year 2012. A significant portion of the SwiSCI respondents were therefore reporting on the influenza season 2010/11 whereas all SHS respondents reported on the season 2011/12. The influenza season 2010/11 was of moderate severity and the influenza vaccination was considered effective whereas the season 2011/12 was of mild severity and the influenza vaccination was considered only partly effective [31]. It is therefore possible that crude IVCR in individuals with SCI were overestimated as compared to the general population. To account for this problem, we adjusted in the logistic regression standardization for the quarter of the year when the survey was answered. Second, the data was recorded in the year 2012 and might be therefore considered outdated. However, there is strong evidence that the situation has not changed in more recent years. When dividing the sold vaccination doses by the Swiss population size, the numbers remain mostly constant over the past years (Table S3). Third, the data in both surveys is self-reported and therefore subject to recall bias.

Conclusion

Influenza vaccination rates in individuals living with chronic SCI in Switzerland were not higher than in the general population. This is an unexpected finding, considering that all relevant guidelines recommend the vaccination to individuals with SCI. The improvement of influenza vaccination rates is an important target of health policy in SCI in Switzerland as to reduce the evidenced excess burden in respiratory-disease related morbidity and mortality.

Data archiving

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Acknowledgements We are grateful to all the participants of the SwiSCI and SHS surveys for their time and effort spent in responding to the questions. This study has been financed in the framework of the SwiSCI study, supported by the Swiss Paraplegic Foundation.

Members of the SwiSCI Steering Committee Xavier Jordan[4], Bertrand Léger[4], Michael Baumberger[5], Hans Peter Gmünder[5], Armin Curt[6], Martin Schubert[6], Margret Hund-Georgiadis[7], Kerstin Hug[7], Thomas Troger[8], Daniel Joggi[9], Hardy Landolt[10], Nadja Münzel[11], Mirjam Brach[1], Gerold Stucki[1], Christine Fekete[12],

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

Author contributions ER and MM were responsible for data analysis. ER and MB were responsible for research design. ER, MM, and MB were responsible for introduction, methods, results, discussion, and conclusion sections.

Compliance with ethical standards

Statement of ethics We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research. All SwiSCI participants signed a written consent form before completing the survey. The study was approved by the ethics committee of northwest/central Switzerland. Data of the SHS were anonymized before analysis. The permission to analyze and publish the data was obtained through a contract with the Swiss Federal Office of Statistics.

Conflict of interest The authors declare that they have no conflict of interest.

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