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Original Research—CME

Self-Efficacy and Pressure Ulcer Prevention After Spinal Cord Injury—Results From a Nationwide Community Survey in Switzerland (SwiSCI)

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Abstract

Background: Pressure ulcers (PUs) are a common and severe health condition in persons with spinal cord injury (SCI). Skin-care strategies for PU prevention are usually provided during initial rehabilitation. However, individuals with SCI often do not perform these strategies continuously, especially after discharge. The influence of psychological factors such as general self-efficacy (GSE) on the performance of PU prevention behavior has not yet been sufficiently explored.
Objective: To investigate whether persons with greater levels of GSE are more likely to perform skin-care strategies for PU prevention regularly.
Design: Nationwide cross-sectional survey within the Swiss Spinal Cord Injury Cohort Study.
Setting: Community setting, data collection between 2011 and 2013.
Participants: A total of 456 subjects with a traumatic or nontraumatic SCI living in Switzerland.
Methods: Associations between GSE and PU prevention behavior were analyzed by multivariate proportional odds regression models, including potential sociodemographic, lesion-related, and lifestyle-related confounders without and with interaction terms between GSE and potential effect modifiers.
Main Outcome Measurements: Self-efficacy was assessed by the GSE scale comprising 10 items. PU preventive behavior was operationalized using 5 items of an adapted version of the Spinal Cord Injury Lifestyle scale. Both measurements were components of a self-administered questionnaire.
Results: Based on the regression model without interaction terms, GSE levels were not associated with skin-care PU prevention. After we included interaction terms, the final model showed statistically significant associations between GSE and 3 skin-care items with odds ratios ranging from 1.09 to 1.17 (all $P < .001$). The slightly positive effect of GSE on PU prevention behavior was restricted to persons who sustained their SCI at a younger age.
Conclusions: GSE was generally not associated with skin-care PU prevention behavior among persons with SCI in this study. In further research, it might be of interest to assess SCI-specific concepts of self-efficacy.
Level of Evidence: III

Introduction

Pressure ulcers (PUs) are a common complication in persons with spinal cord injury (SCI) and rank among the most frequent causes of rehospitalization [1], despite the large number of recommendations for prevention available. According to the internationally acknowledged definition, "a pressure ulcer is a localized injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure, or pressure in combination with shear" [2]. Already at first admission to a SCI unit, PU occurrence rates range from 27% to 42% [3]. One year after discharge from a rehabilitation center, a PU prevalence of 41% was reported by a Dutch study [4]. Five years after discharge PU prevalence decreased to 29% in the same sample. Similarly, a PU point prevalence of 35% was recently reported by the Swiss Spinal Cord Injury Cohort Study (SwiSCI) based on

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a nationwide survey among community-dwelling individuals with SCI [5].

Usually, persons with SCI are educated about preventive skin care behavior during their initial rehabilitation. Among other recommendations, these skin self-care strategies comprise 4 routinely preventive activities: regular wheelchair pressure reliefs, daily skin inspections, night turning, and cushion checking. However, it has been shown that persons with SCI often do not perform these measures consistently, especially after discharge from hospital and return to the community [6,7]. In addition, paradoxical statements of persons with SCI have been documented about their health beliefs and their performance of preventive behavior. In a qualitative study, many participants did not adhere to PU prevention practices, although the majority of them stated that preventive care was important [8]. These observations are supported by a review of several meta-analyses indicating that behavior intentions are not sufficient to gain a satisfactory prediction of future behavior [9].

According to the Health Action Process Approach (HAPA), the critical factor to overcome this "intention-behavior gap" is self-efficacy as a facilitator for the translation of intentions into action [10]. Because self-efficacy has also been identified as a resource for performing specific self-care behavior [11], this concept might also help to explain some of the discrepancies in skin-care behavior among persons with SCI. According to the social—cognitive theory, self-efficacy is defined as "people's beliefs in their capabilities to produce designated levels of performance that exercise influence over events that affect their life" [12]. Moreover, self-efficacy is regarded as a deeper driving force for the crucial adaptive processes characterizing the performance and maintenance of protective measures [12,13].

In individuals with SCI, it has already been observed that a specific form of self-efficacy related to managing health conditions was associated with better health behavior, less need for health-care services, and a lower risk of secondary health conditions [14]. It has also been reported that individuals with SCI with positive beliefs such as confidence in their ability to perform skin care and to overcome barriers tend to consider skin care as a high priority [8].

Moreover, self-efficacy has repeatedly been shown to be associated with engagement in health behavior among individuals living with SCI [14-16], as well as with participation [17-19] and functional independence [20]. In addition, greater levels of self-efficacy predicted better mental health and lower depressive symptoms [21-24].

Regarding the impact of self-efficacy on adherence to skin-care behavior for PU prevention among individuals with SCI, there is currently little literature available, and the results of the existing studies are inconsistent. In an American study, self-efficacy was associated with more frequent wheelchair pressure reliefs and nightly position changes but not with 2 other PU prevention parameters [25]. Further, perceived behavioral control, a concept similar to self-efficacy, was not associated with pressure relief intention or skin checking behavior in a study among hospitalized patients with SCI [26]. One single-blinded, randomized trial aimed to enhance skin-care behavior in war veterans with SCI by strengthening their self-management skills while they were hospitalized for the treatment of severe PUs [27]. The results showed a tendency for larger self-reported improvement in skin care behavior within the intervention group, but the difference was not statistically significant and the drop-out rate was considerably high (about 50% of the randomized participants).

However, the performance of preventive behavior is not only influenced by psychological factors but has to be considered as a result of a multifactorial process. Some general predictors of preventive behavior have been identified in previous research. One study revealed a significant association between greater levels of education and engagement in preventive health practices among persons with SCI [14]. Another study showed a positive association between age and health behavior [28]. In the same study, PU prevention items were applied more frequently by participants with complete SCI lesions and by those with a history of pressure sores within the previous 12 months.

The primary aim of the present study was to investigate the association between general self-efficacy (GSE) and performance of PU prevention in a large, community-based sample of persons with SCI living in Switzerland. We hypothesized that persons with greater GSE levels were more likely to perform PU prevention items more frequently even after we controlled for potential confounders.

In addition, it is conceivable that the association between GSE and PU prevention behavior depends on the level of risk for developing a PU. For example, persons with complete SCI may demonstrate a stronger relationship between GSE and performance of PU prevention than individuals with incomplete injuries. Therefore, as a second study objective, we explored several lesion-related factors and sociodemographic characteristics as potential moderators by including the appropriate interaction terms in the regression models.

Materials and Methods

Study Design

SwiSCI is a population-based cohort study for persons with SCI in Switzerland and is funded by the Swiss Paraplegic Foundation. A detailed description of the study design has been published elsewhere [29]. The main objective of SwiSCI is to investigate the determinants of health, quality of life, and functioning among individuals with SCI. The study aims to establish an evidence-based care for persons with SCI both during initial rehabilitation and in the community setting. The

present secondary analysis is based on cross-sectional data collected by a nationwide, community-based survey conducted between 2011 and 2013. The research hypothesis of the present analysis was formulated after data collection. The SwiSCI community survey followed a modular structure. It was formally approved by the respective regional medical ethics committees. All participants provided written consent for anonymous use of their responses. In reporting, we adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (ie, STROBE) guidelines [30].

Participants

The SwiSCI community survey included all Swiss residents with a traumatic or nontraumatic SCI aged 16 years and older. Persons with congenital conditions leading to SCI, neurodegenerative disorders, Guillain-Barré syndrome, and newly developed SCI in the context of palliative (end-of-life) care were excluded from the study. The SwiSCI population was recruited through the national association for persons with SCI (Swiss Paraplegic Association), 3 specialized SCI-rehabilitation centres, and a specific home-care institution. A detailed description of the recruitment procedures and characteristics of the study population has recently been published [31]. The SwiSCI community survey comprised 2 core questionnaires that were sent to all eligible individuals via postal mail and were answered by 1549 persons, representing 49.3% of the sampled population [31]. In addition, 3 specific questionnaire modules were sent out after the first distribution, each of them addressing a randomly assigned one third of the study participants. One of these modules assessed health behavior and personal factors including self-efficacy and skin prevention behavior. This module was answered by a total of 511 participants, thereby delivering data for the present analysis.

Main Predictor and Outcome Variables

General Self-Efficacy

To measure self-efficacy, the General Self-Efficacy Scale (GSES) was applied [32]. This psychometric scale comprises 10 items assessing the sense of personal competence to deal with stressful situations. Two examples are "I am confident that I could deal efficiently with unexpected events" (item no. 4) and "I can usually handle whatever comes my way" (item no. 10). The questions had to be answered by indicating 1 of the following Likert-scaled response categories: "not at all true" (1), "hardly true" (2), "moderately true" (3), or "exactly true" (4). The total GSES score ranges from 10 to 40 points, with a greater score indicating greater levels of self-efficacy. The internal consistency of the GSES has been reported as good, ranging from 0.75 to 0.91, and its unidimensionality has been supported by several studies using the scale written in several languages [33]. The GSES has been applied in other SCI studies demonstrating a very high internal consistency with a Cronbach alpha of 0.93 [34,35]. Similarly, high values were found for the present study resulting in a Cronbach alpha of 0.91. Furthermore, the GSES has previously been shown to be psychometrically robust and suitable for application in a SCI population based on a Rasch analysis [36].

Skin-Care Behavior for PU Prevention

SCI-specific preventive behavior was evaluated by the use of 5 items of an adapted version of the Spinal Cord Injury Lifestyle scale (SCILS) [28,37]. The scale demonstrated a good internal consistency with a Cronbach alpha of 0.80 [28]. In the present analysis a similar internal consistency was revealed with a Cronbach alpha of 0.83.

For the SwiSCI questionnaire, 5 items of the 22-item SCILS were used, namely (1) "I take care not to develop skin breakdown or areas of redness, when I am sleeping," (2) "I check my skin daily on areas of redness or breakdown or I have checked my skin daily," (3) "I am aware of the condition of my anti-pressure sore devices (e.g. cushions)," (4) "If I have a skin breakdown/pressure sore, I would be careful not to put weight on it (I would not sit or lie on it)," and (5) "In case of incontinence, I would take care to have my skin dried as soon as possible." There were 6 response categories: "not applicable," "never," "rarely," "sometimes," "frequently," and "(almost) always." For our analyses, the response categories were treated as ordinal scaled and statistical modelling was conducted separately for each of the 5 items, taking into account that only a part of the adapted SCILS was used.

Potential Confounders

Selection of Potential Confounders

Because the current literature on the research question under investigation is scarce, we applied a rather explorative approach when selecting the potential confounders for the multivariate regression model. However, PU prevention behavior has previously been reported in SCI samples to be associated with age, level of education, completeness of SCI, and a history of preceding PUs [14,28]. Moreover, self-efficacy was related to social support, educational level, economic status, and age at SCI [38,39]. In addition, we included established risk factors for PU occurrence in SCI populations such as sex, professional status, cigarette smoking, age at SCI, and time since SCI [40]. The reason for this was that we assumed—based on the HAPA model—that individuals being aware of their greater PU risk would have a greater motivation to perform prevention strategies regularly [10].

Sociodemographic Characteristics

As potential sociodemographic confounders sex, years of education, work status (in work "yes"/"no"),

perceived financial hardship, level of support at home ("high"/"low") and social support were included in our multivariate analyses. Subsequently, age had to be excluded because of multicollinearity with the variables age at SCI and time since SCI. According to the International Standard Classification of Education, the level of education was quantified as total years of formal education, including school years as well as vocational education years [41].

To assess perceived financial hardship, participants were asked: "Did you experience financial difficulties that restricted your everyday life (participation)?" Response categories were "not applicable," "had no impact," "has complicated my life somewhat," and "has complicated my life massively." In our analyses, the first 2 categories were merged. Social support was constructed as a combined variable by the same procedure as described in a former SwiSCI paper [42]. The 2 variables "partner status" ("yes"/"no") and "living arrangement" ("living alone"/"living with others") were combined and "no social support" was indicated only in case that both questions were answered negatively. The presence of support at home was indicated if participants received formal and/or informal support in routine activities (household, self-care).

Lesion-Related Characteristics

To characterize the SCI lesion of the study participants, time since SCI, age at SCI, type of lesion, cause of SCI, occurrence of PUs in the previous 3 months, and functional independence were used. Age at SCI was treated as a nongrouped interval-scaled variable. Time since SCI was grouped taking into account the thresholds proposed by the guidelines for reporting based on the International Spinal Cord Injury Core Data Set ie, <1 year, 1-5, 6-10, 11-15, and 5-year increments afterwards [43]. However, the recommended grouping strategy had to be relaxed to avoid groups with <10 observations and thus to improve the statistical power. Finally, time since SCI was grouped as ≤ 5, >5 to ≤ 10, >10 to ≤ 20, and >20 years. Type of lesion was described as a combination of the injury level (paraversus tetraplegia) and injury completeness (complete versus incomplete). Cause of SCI was coded as "traumatic" versus "nontraumatic."

The participants' ability to perform PU prevention independently was assessed by the appropriate item of the self-reported Spinal Cord Independence Measure (SCIM-SR, item no. 9) [44]. In this SCIM-SR item, the participants indicated if they were able to perform one, several, or all of the 4 activities of PU prevention independently ("turning upper body in bed," "turning lower body in bed," "sitting up in bed," and "doing push-ups in wheelchair"). Participants had the options to answer "None, I need assistance in all these activities," "One activity," "Two or three activities," or "All of them" responding to an ordinal scale.

Lifestyle Characteristics

Smoking status was assessed with 3 response categories ("current smoker," "nonsmoker," or "ex-smoker"). Alcohol consumption was also included as a potential confounding variable containing the response options "less than once per month or never," "1 to 3 times per months," "1 to 3 times per week," "4 to 6 times per week," or "daily."

Table 1
Basic characteristics of the study sample (n = 456)

Sample Characteristics*	n/Mean	%/SD
GSES, mean, SD	30.1	5.6
Sociodemographic		
Gender, n, %		
Male	330	72%
Female	126	28%
Age, y, mean, SD	53.0	14.6
Education, y, mean, SD	13.8	3.3
Work status, % employed	186	41%
Financial hardship, n, %		
Had no impact	303	66%
Has complicated my life somewhat	113	25%
Has complicated my life massively	40	9%
Home support, % yes	345	76%
Social support, % yes	355	78%
Lesion-related		
Aetiology of SCI, % traumatic	360	79%
Type of SCI lesion, n, %		
Paraplegia, incomplete	155	34%
Paraplegia, complete	167	37%
Tetraplegia, incomplete	80	17%
Tetraplegia, complete	54	12%
Age at SCI, y, mean, SD	34.8	17.4
Age at SCI, y, median, range	31.0	0-86
Time since SCI, n, %		
≤ 5 y	87	19%
>5 to ≤ 10 y	66	15%
>10 to ≤ 20 y	119	26%
>20 y	184	40%
Pressure ulcer last 3 mo, % occurred	102	22%
SCIM-SR item 9, bed mobility/ PU prophylaxis, n, %		
Need assistance in all 4 activities	79	17%
Need assistance in 3 activities	42	9%
Need assistance in 1 or 2 activities	62	14%
Need no assistance	273	60%
Behavior-related		
Smoking status, n, %		
Never smoked	205	45%
Former smoker	141	31%
Current smoker	110	24%
Alcohol consumption, n, %		
Never or less than once a month	98	22%
1-3 times a mo	108	24%
1-3 times a wk	146	32%
4-6 times a wk	52	11%
Daily	52	11%

GSES = General Self-Efficacy Scale; SD = standard deviation; SCI = spinal cord injury; SCIM-SR = self-reported Spinal Cord Independence Measure; PU = pressure ulcer.

* Data set including imputed values for missing responses. The proportion of missing values in the original data set ranged from 0% to 5.5% for all predictors.

Table 2
Responses of the study participants regarding PU prevention behavior (n = 456)

PU Prevention Item*	n	%
Item 1: Skin care during night		
Never	47	10%
Sometimes/rarely	114	25%
Frequently/(almost) always	295	65%
Item 2: Daily skin checks		
Never	28	6%
Sometimes/rarely	154	34%
Frequently/(almost) always	274	60%
Item 3: Control of antipressure sore devices		
Never	39	9%
Sometimes/rarely	105	23%
Frequently/(almost) always	312	68%
Item 4: Skin care in case skin breakdown/ pressure sore		
Never	21	5%
Sometimes/rarely	71	15%
Frequently/(almost) always	288	63%
Not applicable	76	17%
Item 5: Skin care in case of incontinence		
Never	18	4%
Sometimes/rarely	58	13%
Frequently/(almost) always	286	63%
Not applicable	94	20%

PU = pressure ulcer.
* Data set including imputed values for missing responses for items 1-3. The proportion of missing values in the original data set ranged from 4% to 7%. PU prevention items 4 and 5 were only relevant in case of skin breakdown and incontinence, respectively. Therefore, 17% (item 4) and 20% (item 5) answering "not applicable" were excluded from the analysis for these items.

Data Analysis

Imputation

Since PU prevention items 4 and 5 were only relevant in case of skin breakdown/pressure sore or incontinence, respectively, about 20% of the total sample answered "not applicable" and were therefore excluded from further analyses with these 2 items. Concerning the PU prevention questions 1-3 and all other variables, missing values were statistically imputed with the function "missForest" from the R-package of the same name [45]. MissForest is a distribution-free missing value imputation technique based on random forests [46]. Its 2-step algorithm repeatedly applies a random forest estimation on the available data for a prediction of the missing values until a convergence criterion is reached.

Proportional Odds Regression Models

The statistical analysis primarily aimed to evaluate the importance of GSE as a predictor of the performance of skin prevention. The originally 5 valid response options for the prevention items were collapsed to 3 categories: "never" (0 = reference group), "rarely/sometimes" (1), and "frequently/(almost) always" (2). This collapsing strategy aimed to assure a clinically relevant and reliable ordering that reflected a similar increase in the frequency of performing PU prevention behavior as the original response categories. Because the scoring was ordered, however, not interval-scaled, predictive modelling with the proportional odds regression model was favored instead of a classical linear regression approach. Proportional odds models resemble logistic regression models but call a cumulative link function for the ordered categorical dependent variable instead of the logit transformation for dichotomous responses [47]. The proportional odds function was calculated with the "polr" function from the R-package MASS [48,49]. A variance inflation test supported the absence of multicollinearity among all predictor variables included in the regression models. The parallel line assumption, one important requirement for proportional odds models testing that parameters do not change significantly for different response categories, was verified with the Brant test as implemented in the "ologit" function of STATA 13 (Version 13.1 for Windows, College Station, TX). In our analysis, the Brant test supported the ordering of the response options of the dependent variables.

For each of the 5 PU prevention items, an analysis strategy consisting of 4 separate proportional odds models was performed. The first 2 models without interaction terms were built with regard to our primary study aim. The first one of these 2 models comprised all 15 variables. Ordinal variables, such as the SCIM-SR item no. 9, can be entered as a series of polynomial effects,

Table 3
Bivariate correlations between numeric predictors and PU prevention in individuals with SCI (items 1-5)

	Spearman Rank Correlation								
Item	General Self-Efficacy	Age	Education	Age at SCI	Social Support	Financial Hardship	SCIM-SR Item 9	Alcohol Consumption	Time Since SCI
Skin care during night	−0.004	0.036	−0.082	−0.038	0.009	0.056	−0.243	−0.073	0.071
Daily skin checks	−0.021	0.063	−0.077	−0.011	0.051	0.06	−0.335	−0.029	0.036
Control of antipressure sore devices	0.013	0.053	−0.021	−0.059	0.066	0.05	−0.191	0.009	0.113
Skin care in case of skin breakdown/pressure sore	0.083	−0.099	0.059	−0.122	0.004	−0.012	−0.064	−0.094	0.054
Skin care in case of incontinence	0.155	−0.072	0.058	−0.128	0.033	−0.047	−0.047	−0.046	0.099

PU = pressure ulcer; SCI = spinal cord injury; SCIM-SR = self-reported Spinal Cord Independence Measure.

Table 4
Bivariate relationships between categorical predictors and PU prevention items 1-5 in individuals with SCI

Item	χ^2 Test Statistic (*P* Values)						
	Gender	Work Status	Cause of SCI	Type of SCI	Home Support	PU Last 3 Months	Smoking
Skin care during night	10.224 (.037)	5.563 (.234)	2.846 (.584)	68.229 (<.001)	37.66 (<.001)	21.984 (<.001)	12.59 (.127)
Daily skin checks	5.991 (.2)	16.031 (.003)	6.064 (.194)	68.488 (<.001)	52.328 (<.001)	23.619 (<.001)	6.81 (.557)
Control of antipressure sore devices	3.393 (.494)	9.436 (.051)	3.411 (.492)	59.473 (<.001)	47.254 (<.001)	9.507 (.05)	6.179 (.627)
Skin care in case of skin breakdown/pressure sore	0.903 (.924)	6.612 (.158)	3.851 (.427)	36.704 (<.001)	7.891 (.096)	10.374 (.035)	6.285 (.615)
Skin care in case of incontinence	2.707 (.608)	5.438 (.245)	4.827 (.306)	29.011 (.004)	13.708 (.008)	2.323 (.677)	5.284 (.727)

PU = pressure ulcer; SCI = spinal cord injury.

eg, linear, quadratic, cubic. The combined effect might be assumed to capture the effect of the variable. Significant quadratic and other higher-order effects might be used as evidence that the equal-distance assumption is invalid. An alternative explanation of such higher-order effects is that the effect of the ordinal variable is actually nonlinear. The second model was produced by applying a stepwise statistical selection algorithm based on the Akaike information criterion.

To explore potential effect modifiers, 2 more models including interaction terms were built. For this purpose, the statistically selected main effects were kept in the model and several interaction terms, always including GSE, were added. Factors expected to potentially interact with GSE were education years, work status, age at SCI, time since SCI, type of lesion, and cause of SCI. The final proportional odds model was obtained by another statistical selection process followed by a regression analysis of the reduced main effects and the previously retained interactions. To avoid false-positive associations due to multiple testing, the alpha-level of statistical significance was set to a value of .0025 (= .05/20), thereby adjusting for the four regression models performed for each of the 5 response variables. In addition, sensitivity analyses were conducted to compare GSES-scores, frequency of PU prevention

Table 5
Multivariate associations between GSE and skin-care for PU prevention (items 1-3) in individuals with SCI based on proportional odds regression models (n = 456)

Variables (measure)*	PU Prevention During Night				Daily Skin Checks				Control of Antipressure Sore Devices			
	OR	CI Lower	CI Upper	*P* Value	OR	CI Lower	CI Upper	*P* Value	OR	CI Lower	CI Upper	*P* Value
GSES	1.02	0.98	1.06	.438	1.04	1.00	1.08	.058	1.04	1.00	1.09	.046
Sociodemographic												
Work status, employed	0.67	0.42	1.05	.079	0.60	0.38	0.93	.022	0.68	0.42	1.10	.116
Social support, high†	—	—	—	—	—	—	—	—	1.57	1.09	2.25	.016
Home support, yes	1.90	1.17	3.10	.009	2.50	1.54	4.05	<.001‡	3.69	2.20	6.20	<.001‡
Lesion-related												
Paraplegia, complete§	4.48	2.68	7.50	<.001‡	3.38	2.07	5.51	<.001‡	5.50	3.04	9.93	<.001‡
Tetraplegia, incomplete§	1.33	0.74	2.40	.345	1.90	1.03	3.49	.038	1.00	0.53	1.86	.989
Tetraplegia, complete§	3.72	1.49	9.27	.005	10.48	3.37	32.53	<.001‡	1.45	0.62	3.38	.396
Cause of injury, nontraumatic†	—	—	—	—	—	—	—	—	1.80	0.99	3.26	.054
PU last 3 mo, yes	2.50	1.40	4.47	.002‡	1.97	1.15	3.35	.013	1.89	1.04	3.41	.036
Mobility in bed (SCIM-SR 9)	0.59	0.35	1.00	.035	0.49	0.29	0.82	.007	0.61	0.35	1.05	.072
Time since SCI, y†	—	—	—	—	—	—	—	—	0.98	0.36	2.68	.973
Behavior-related												
Former smoker†,¶	—	—	—	—	1.47	0.89	2.43	.129	—	—	—	—
Current smoker†,¶	—	—	—	—	0.62	0.38	1.02	.061	—	—	—	—
Alcohol consumption†	0.84	0.50	1.41	.508	—	—	—	—	—	—	—	—

GSE = general self-efficacy; GSES = General Self-Efficacy Scale; PU = pressure ulcer; SCI = spinal cord injury; OR = odds ratio; 95% CI = 95% confidence interval; SCIM-SR 9 = self-reported Spinal Cord Injury Independence Measure item no. 9.

* The following variables were included in the basic regression model but were not selected for the final models by the stepwise selection algorithm because they did not have any influence on the effect estimates: sex, years of education, financial hardship, and age at SCI. Mobility in bed (SCIM-SR 9), alcohol consumption, and time since injury were also analyzed after several transformations (quadratic, cubic, to the power of 4) but the transformed variables did not reveal any significant association with PU prevention behavior and therefore are not shown in the tables.

† This variable was selected only for some of the 5 skin-care items by the statistical selection algorithm.

‡ Statistically significant at alpha level of .0025 after Bonferroni correction.

§ Reference group: persons with incomplete paraplegia.

¶ Reference group: nonsmokers.

behavior and other characteristics between included and excluded participants.

Results

Sample

Of the 511 participants, 52 individuals had to be excluded from the analysis because they either provided no answers to the 5 questions concerning skin prevention behavior (n = 6) or responded "not applicable" to all of them (n = 46). Furthermore, 3 individuals with missing information for all 10 GSES items were excluded.

Finally, a total of 456 people, 330 men and 126 women, were included in the analyses. Their basic characteristics after imputation of missing values are displayed in Table 1. The mean total score on the GSES was 30.1 points (SD = 5.6). This corresponds well with the results of a general survey conducted in Germany (mean = 29.3) [50]. According to a sensitivity analysis, participants with missing information either about skin-care PU prevention items or GSES were more likely to have an incomplete SCI lesion (96.4% versus 51.4%), older age at SCI (mean: 40.1 versus 34.8 years), shorter time since SCI (mean: 11.9 versus 18.1 years), and greater GSES scores (mean: 32.2 versus 30.1 points) (all $P < .05$).

Without imputation, the proportion of missing answers for all sociodemographic, lesion-related, and behavioral predictors was less than 6% in the original data set. As shown in Table 2, each of the 5 PU prevention items was performed frequently or (almost) always by about two thirds of the included participants (n = 456). Around one quarter of the sample stated to conduct skin care during night, daily skin checks, or control of antipressure sore devices only sometimes or rarely.

In the original data set, the extent of missing responses was below 8% for the PU prevention items 1-3. For these 3 items, a statistical imputation was performed. Regarding prevention strategies 4 and 5 (in case of skin lesions or incontinence) a considerable proportion of the study sample answered "not applicable" because they were not affected by these health conditions (17% and 20%, respectively). These respondents were excluded from further analysis.

Bivariate Relationships Between GSE and Skin-Care Strategies for PU Prevention

The bivariate relationships between all predictor variables and the 5 PU prevention items are presented in Tables 3 and 4. As can be seen from the tables, several sociodemographic characteristics, lesion-related factors, and level of GSE were not correlated with prevention behavior. However, for the variables type of SCI lesion, history of previous PUs and home

Table 6
Multivariate associations between GSE and skin care for PU prevention (items 4 and 5) in individuals with SCI based on proportional odds regression models

	Skin Care in Case of Skin Breakdown (n = 380)				Skin Care in Case of Incontinence (n = 362)			
Variables (measure)*	OR	CI Lower	CI Upper	*P* Value	OR	CI Lower	CI Upper	*P* Value
GSES	1.01	0.96	1.05	.787	1.02	0.98	1.08	.337
Sociodemographic								
Years of education†	—	—	—	—	1.08	0.99	1.17	.100
Home support, yes	2.04	1.11	3.74	.021	2.73	1.47	5.06	.001‡
Lesion-related								
Paraplegia, complete§	2.31	1.25	4.30	.008	3.42	1.80	6.50	<.001‡
Tetraplegia, incomplete§	0.87	0.45	1.70	.688	1.66	0.79	3.49	.185
Tetraplegia, complete§	2.99	1.11	8.07	.031	4.17	1.35	12.90	.013
PU last 3 mo, yes†	1.72	0.91	3.26	.098	—	—	—	—
Age at SCI, y†	0.98	0.97	1.00	.010	—	—	—	—
Behavior-related								
Former smoker†,¶	2.03	1.10	3.75	.025	—	—	—	—
Current smoker†,¶	1.34	0.71	2.51	.371	—	—	—	—
Alcohol consumption	0.45	0.24	0.84	.012	0.60	0.31	1.14	.120

GSE = general self-efficacy; GSES = General Self-Efficacy Scale; PU = pressure ulcer; SCI = spinal cord injury; OR = odds ratio; 95% CI = 95% confidence interval.

* The following variables were included in the basic regression model but were not selected for the final models by the stepwise selection algorithm because they did not have any influence on the effect estimates: sex, financial hardship, work status, social support, cause of injury, mobility in bed (SCIM-SR item 9), and time since SCI. Alcohol consumption was also analyzed after several transformations of the variable (quadratic, cubic, to the power of 4) but the transformed variables did not reveal any significant association with PU prevention behavior and therefore are not shown in the tables.

† This variable was selected only for some of the 5 skin-care items by the statistical selection algorithm.

‡ Statistically significant at alpha level of .0025 after Bonferroni correction.

§ Reference group: persons with incomplete paraplegia.

¶ Reference group: nonsmokers.

support some highly significant associations with several prevention strategies were observed. In addition, work status and sex were related to single prevention items.

Multivariate Relationships Between GSE and Skin-Care Strategies for PU Prevention

The main results of the multivariate analyses are presented in Table 5 for PU prevention items 1-3 and in Table 6 for items 4 and 5. Based on the proportional odds regression model without interaction terms (corresponding to the second model as mentioned in the methods section) GSES score was not associated with any of the 5 skin-care PU prevention items, given the alpha level of 0.0025 after Bonferroni correction (all odds ratios very close to 1 with confidence intervals including 1).

Regarding other influencing factors, it was observed that participants with complete paraplegia were consistently more likely to perform PU prevention regularly than participants with incomplete paraplegia (Tables 5 and 6). These associations were statistically significant for the prevention items 1, 2, 3, and 5 with considerably high odds ratios between 3.4 and 5.5 (all $P < .001$) and were only slightly attenuated after including an interaction term between GSES and type of

Table 7
Multivariate associations between GSE and PU prevention (items 1-3) in individuals with SCI based on proportional odds regression models including interaction terms (n = 456)

	PU Prevention During Night				Daily Skin Checks				Control of Antipressure Sore Devices			
Variables (measure)*	OR	CI Lower	CI Upper	*P* Value	OR	CI Lower	CI Upper	*P* Value	OR	CI Lower	CI Upper	*P* Value
GSES	1.16	1.13	1.20	<.001†	1.17	1.12	1.23	<.001†	1.09	1.05	1.14	<.001†
Sociodemographic												
Years of education‡	—	—	—	—	0.95	0.89	1.02	.158	—	—	—	—
Work status, employed	0.61	0.37	1.00	.049	0.60	0.37	0.97	.039	0.06	0.05	0.06	<.001†
Social support, high‡	—	—	—	—	—	—	—	—	1.69	1.18	2.42	.004
Home support, yes	1.94	1.19	3.17	.008	2.63	1.61	4.29	<.001†	3.52	2.13	5.81	<.001†
Lesion-related												
Age at SCI, y	1.11	1.06	1.16	<.001†	1.10	1.05	1.15	<.001†	1.08	1.04	1.12	<.001†
Paraplegia, complete§	4.26	2.52	7.21	<.001†	3.22	1.94	5.32	<.001†	4.98	2.77	8.94	<.001†
Tetraplegia, incomplete§	1.32	0.73	2.40	.361	1.91	1.04	3.51	.038	1.01	0.54	1.89	.972
Tetraplegia, complete§	3.63	1.41	9.31	.007	11.05	3.50	34.89	<.001†	1.44	0.60	3.43	.415
Cause of injury, nontraumatic‡	—	—	—	—	—	—	—	—	0.06	0.05	0.06	<.001†
PU last 3 mo, yes	2.53	1.41	4.55	.002†	1.93	1.13	3.31	.017	2.08	1.15	3.75	.015
Mobility in bed (SCIM-SR 9)	0.57	0.33	0.96	.035	0.48	0.28	0.82	.007	0.61	0.35	1.05	.072
Behavior-related												
Former smoker‡,¶	—	—	—	—	1.54	0.93	2.53	.093	—	—	—	—
Current smoker‡,¶	—	—	—	—	0.66	0.40	1.10	.110	—	—	—	—
Alcohol consumption‡	0.87	0.51	1.49	.617	—	—	—	—	—	—	—	—
Interaction effects												
GSES: Years of education	—	—	—	—	—	—	—	—	—	—	—	—
GSES: Work status	—	—	—	—	—	—	—	—	1.08	1.07	1.10	<.001†
GSES: Age at SCI	0.996	0.994	0.998	<.001†	0.997	0.995	0.999	.001†	0.997	0.995	0.999	.001†
GSES: Paraplegia, complete	—	—	—	—	—	—	—	—	—	—	—	—
GSES: Tetraplegia, incomplete	—	—	—	—	—	—	—	—	—	—	—	—
GSES: Tetraplegia, complete	—	—	—	—	—	—	—	—	—	—	—	—
GSES: Cause of injury	—	—	—	—	—	—	—	—	1.13	1.11	1.16	<.001†
GSES: Time since SCI	—	—	—	—	—	—	—	—	—	—	—	—

GSE = general self-efficacy; GSES = General Self-Efficacy Scale; PU = pressure ulcer; SCI = spinal cord injury; OR = odds ratio; 95% CI = 95% confidence interval; SCIM-SR 9 = self-reported Spinal Cord Injury Independence Measure item no. 9.

* The following variables were also included in the basic regression model but were not selected for the final models by the stepwise selection algorithm because they had no influence on the effect estimates: sex, time since SCI, and financial hardship. Mobility in bed (SCIM-SR 9), alcohol consumption, and time since injury were also analyzed after several transformations (quadratic, cubic, to the power of 4) but the transformed variables did not reveal any significant association with PU prevention behavior and therefore are not shown in the tables.

† Statistically significant at alpha level of .0025 after Bonferroni correction.

‡ This variable was selected only for some of the 5 skin-care items by the statistical selection algorithm.

§ Reference group: persons with incomplete paraplegia.

¶ Reference group: nonsmokers.

lesion (Tables 7 and 8). In addition, participants with complete tetraplegia more frequently reported to perform daily skin checks (item 2, $P < .001$). Similar positive associations with PU prevention behavior were revealed for participants who received formal or informal support at home regarding skin-care items 2, 3, and 5, irrespective of interaction terms (Tables 5-8).

Concerning all other potential influencing factors including gender, age at SCI, time since SCI, work status, years of education, social support and financial hardship, no statistically significant associations with any of the 5 skin-care PU prevention items were observed. Also, participants with a history of PUs in the previous 3 months showed only a tendency to perform prevention behavior more often than subjects without previous PUs ($P = .002$) and this difference was restricted to PU prevention during night (item 1).

Interestingly, after we added potentially relevant interaction terms including GSES to the final regression models, slight but statistically significant associations between GSE and PU prevention were revealed for items 1 to 3 (odds ratios: 1.09-1.17, $P < .001$) (Table 7). Furthermore, a statistically significant interaction effect appeared between GSE and age at SCI, indicating a stronger association between GSE and PU prevention behavior in persons who sustained their SCI at a younger age.

Besides that, 2 other significant interaction effects were restricted to skin-care item 3 (control of anti-pressure sore devices). For this item, the GSE score was positively associated with preventive behavior only in participants with a nontraumatic cause of SCI and in individuals who were employed at the time of the survey (both $P < .001$) (Table 7). For each of the PU prevention items 1-3, the results of the regression models both with and without interaction terms are displayed in Figures 1-3.

Table 8
Multivariate associations between GSE and PU prevention (items 4 and 5) in individuals with SCI based on proportional odds regression models including interaction terms

	Skin Care in Case of Skin Breakdown (n = 380)				Skin Care in Case of Incontinence (n = 368)			
Variables (measure)*	OR	CI Lower	CI Upper	*P* Value	OR	CI Lower	CI Upper	*P* Value
GSES	0.97	0.89	1.06	.479	1.01	0.95	1.06	.827
Sociodemographic								
Home support, yes	2.09	1.13	3.89	.019	3.23	1.70	6.14	<.001†
Lesion-related								
Age at SCI	0.98	0.97	1.00	.011	0.98	0.96	1.00	.958
Time since SCI‡	—	—	—	—	0.08	0.01	1.20	.067
Paraplegia, complete§	0.05	0.00	1.57	.089	3.00	1.54	5.80	.001†
Tetraplegia, incomplete§	1.77	0.04	71.59	.763	1.58	0.75	3.34	.232
Tetraplegia, complete§	1.38	0.01	218.55	.901	3.30	1.03	10.60	.045
PU last 3 months, yes‡	1.95	1.01	3.76	.046	—	—	—	—
Behavior-related								
Former smoker‡,¶	2.02	1.09	3.76	.026	—	—	—	—
Current smoker‡,¶	1.24	0.65	2.36	.507	—	—	—	—
Alcohol consumption‡	0.47	0.25	0.89	.021	—	—	—	—
Interaction effects								
GSES: Years of education	—	—	—	—	—	—	—	—
GSES: Work status	—	—	—	—	—	—	—	—
GSES: Age at SCI	—	—	—	—	—	—	—	—
GSES: Paraplegia, complete	1.13	1.01	1.27	.028	—	—	—	—
GSES: Tetraplegia, incomplete	0.98	0.87	1.10	.694	—	—	—	—
GSES: Tetraplegia, complete	1.02	0.86	1.22	.781	—	—	—	—
GSES: Cause of injury	—	—	—	—	—	—	—	—
GSES: Time since SCI	—	—	—	—	1.09	0.99	1.19	.073

GSE = general self-efficacy; GSES = General Self-Efficacy Scale; PU = pressure ulcer; SCI = spinal cord injury; OR = odds ratio; 95% CI = 95% confidence interval; SCIM-SR 9 = self-reported Spinal Cord Injury Independence Measure item no. 9.

* The following variables were also included in the basic regression model but were not selected for the final models by the stepwise selection algorithm because they had no influence on the effect estimates: sex, financial hardship, years of education, work status, social support, cause of Injury, and mobility in bed (SCIM-SR 9). Alcohol consumption and time since SCI were also analyzed after several transformations (quadratic, cubic, to the power of 4) but did not reveal any significant association with PU prevention behavior and therefore are not shown in the tables.

† Statistically significant at alpha level of .0025 after Bonferroni correction.

‡ This variable was selected only for some of the 5 skin-care items by the statistical selection algorithm.

§ Reference group: persons with incomplete paraplegia.

¶ Reference group: nonsmokers.

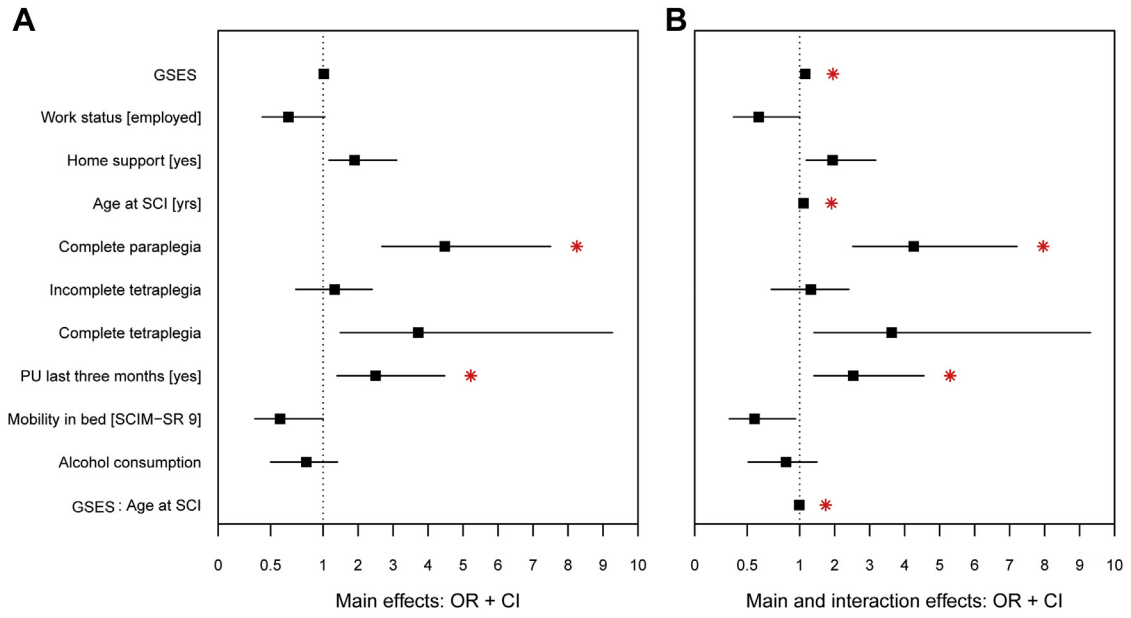

Figure 1. Associations between GSE and PU prevention during night (prevention item 1) after we controlled for potential confounders. Results of the multivariate regression models (A) without interaction terms and (B) with interaction terms. ORs and 95% CIs are shown. *$P < .0025$. CI, confidence interval; GSE, general self-efficacy; GSES, General Self-Efficacy Scale; OR, odds ratio; PU, pressure ulcer; SCI, spinal cord injury; SCIM-SR 9, self-reported Spinal Cord Independence Measure item no. 9.

Discussion

Contrary to our research hypothesis, GSE generally was not associated with the performance of skin care strategies for PU prevention among persons with SCI in this sample of a nationwide survey in Switzerland according to the models without interaction terms. However, after we added several potential interaction terms to the multivariate regression model, some associations between GSE and the performance of PU prevention during night, daily skin checks, and control of antipressure sore devices became significant. Although the strength

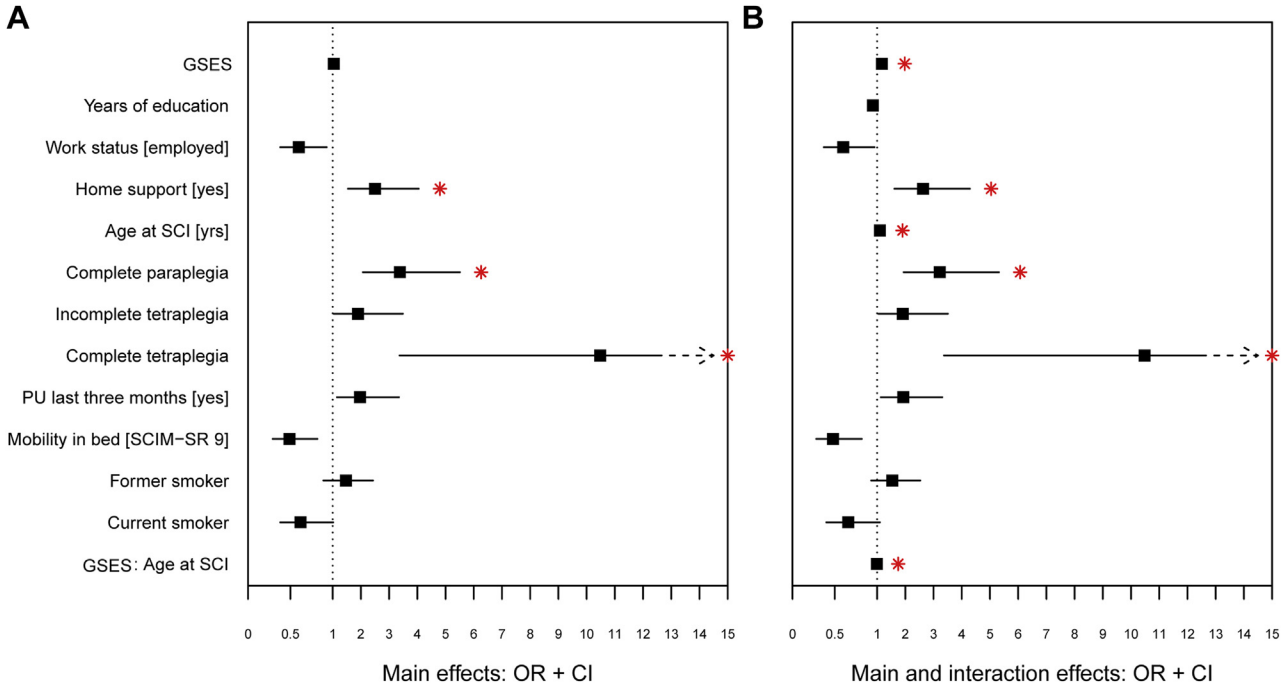

Figure 2. Associations between GSE and daily skin checks (prevention item 2) after we controlled for potential confounders. Results of the multivariate regression models (A) without interaction terms and (B) with interaction terms. ORs and 95% CI are shown. *$P < .0025$. CI, confidence interval; GSE, general self-efficacy; GSES, General Self-Efficacy Scale; OR, odds ratio; PU, pressure ulcer; SCI, spinal cord injury; SCIM-SR 9, self-reported Spinal Cord Independence Measure item no. 9.

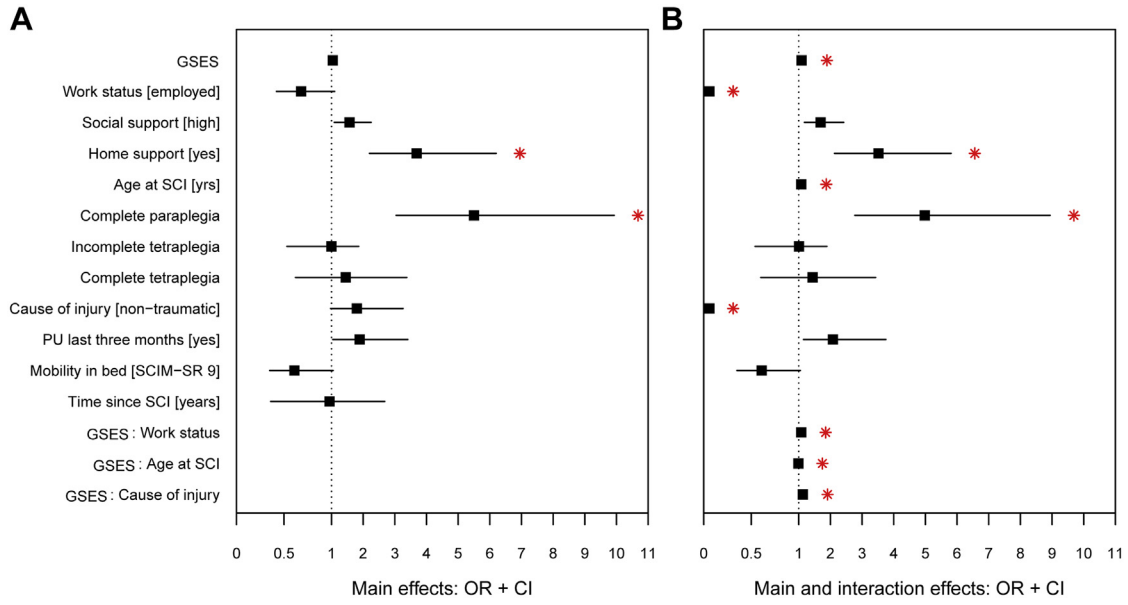

Figure 3. Associations between GSE and control of antipressure sore devices (prevention item 3) after we controlled for potential confounders. Results of the multivariate regression models (A) without interaction terms and (B) with interaction terms. OR and 95% CIs are shown. *$P < .0025$. CI, confidence interval; GSE, general self-efficacy; GSES, General Self-Efficacy Scale; OR, odds ratio; PU, pressure ulcer; SCI, spinal cord injury; SCIM-SR 9, self-reported Spinal Cord Independence Measure item no. 9.

of these associations was rather small, based on the models with interaction terms, greater levels of GSE seem to be supportive for regular PU prevention.

With regard to the interaction effects, it is conceivable that self-efficacy may be more important for preventive behavior in individuals who were younger at the onset of SCI. To the best of our knowledge, similar interaction effects have not yet been described in the literature regarding individuals with SCI or other chronic health conditions.

Self-Efficacy and PU Prevention Behavior

Concerning the impact of self-efficacy on the adherence to PU prevention items among persons with SCI, there is only little literature available and the results of these studies are ambiguous. One reason for the contradictory findings might be the application of different self-efficacy scales, also limiting the comparability of the results. In the present survey, the GSES scale assessing rather universal issues of self-efficacy was applied. In other investigations, more specific instruments such as the Self-Efficacy for Managing Chronic Disease 6-Item Scale [27,51] or self-developed self-efficacy scales [25] were applied. Moreover, there are other assessment tools such as the Moorong Self-Efficacy Scale [52] or the University of Washington Self-Efficacy Scale [18,53] focusing on specific challenges emerging after SCI. Possibly, a more specific self-efficacy scale would be a better predictor for skin care behavior in this population. Congruently with this suggestion, there are also different forms of self-efficacy mentioned by the HAPA model, with "task self-efficacy" defined as central for transforming intention into action [10].

Self-Efficacy and Health-Related Outcomes

However, the scientific evidence emphasizing self-efficacy as a relevant personal factor for improving health-related outcomes among persons with chronic health conditions is quite robust. Among individuals with SCI, self-efficacy has been shown to be positively associated with engagement in health behavior [14]. Moreover, in the large field of chronic diseases such as arthritis, chronic heart failure and back pain, a positive impact of self-efficacy in self-management programs has been observed [54-56].

Strengths and Limitations

The present sample was derived from the SwiSCI study, a nationwide survey of community-dwelling persons with long-standing SCI. In this large survey, a broad spectrum of lesion-related, personal, and environmental characteristics has been collected.

There are several limitations restricting the generalizability of our results. Because all data were self-reported, the statements concerning self-efficacy and PU prevention behavior could have been biased by social desirability and the real values might be somewhat lower than indicated. However, as both variables would have been influenced by this bias in the same direction, it is not expected to have an impact on the association between GSE and PU prevention behavior. Moreover, a selection bias is

conceivable as a consequence of excluding 55 participants from the analyses because of item nonresponse for GSE (n = 3) or PU prevention behavior (n = 52). Participants with complete SCI lesions were overrepresented in our sample. This can also be seen by comparing the distribution of lesion severity with the basic SwiSCI survey data showing participant proportions of 36.2% with incomplete paraplegia, 32.7% with complete paraplegia, 20.1% with incomplete tetraplegia, and 11.0% with complete tetraplegia [31].

A reason for the item nonresponse concerning skin-care behavior may be that people with incomplete SCI lesions felt less threatened by PUs and therefore had a lower motivation to report on their skin-care behavior. This assumption is supported by the fact that the majority of these participants with missing skin-care information answered "not applicable" to the respective question and therefore had to be excluded (n = 46 of 52, corresponding to 88%). Because many persons with incomplete SCI lesions are able to walk and have well-preserved sensibility, this answer pattern is comprehensible. As the mean GSES score in the excluded groups was slightly greater and the frequency of skin-care PU prevention behavior probably lower, the inclusion of these participants would rather have weakened the association between GSE and prevention behavior in our analyses further.

As mentioned in the Methods section, missing data in all other variables were imputed for the first 3 prevention items but not for the 2 specific prevention items concerning only some of the participants, namely in case of previous PU or incontinence. Therefore, the sample sizes for the analyses with these 2 dependent variables were smaller than for the first 3 PU prevention items, which may diminish the generalizability of the results. Finally, given the cross-sectional approach of the SwiSCI survey, we were not able to investigate potential changes in GSE levels or PU prevention during the time course after SCI, and causality cannot be determined.

Conclusions

Taken together, in the present study GSE level was not associated with skin-care PU prevention behavior in persons with SCI. In further research, assessment tools based on self-efficacy concepts reflecting the specific circumstances of persons living with SCI might be of interest. Moreover, the availability of home support seems to be a modifiable factor that could be addressed by suitable interventions to facilitate sustainable prevention behavior in persons with SCI.

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Disclosure

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CME Question
The study authors found which group to be more compliant with performing pressure ulcer (PU) prevention regularly?

a. Complete paraplegia.
b. Incomplete paraplegia.
c. Complete tetraplegia.
d. Incomplete tetraplegia.

Answer online at me.aapmr.org