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Factors Associated with Health-Related Quality of Life in Chronic Spinal Cord Injury

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Abstract

Objective—An important goal of rehabilitation and treatment after spinal cord injury (SCI) is to improve function and enhance health-related quality of life (HRQoL). However, previous assessments are limited by use of HRQoL instruments not specific to SCI. Although respiratory dysfunction is common in SCI, it has not been possible to assess the association of comorbid medical conditions, including respiratory symptoms and pulmonary function, to HRQoL. Therefore, we assessed whether these factors were associated with HRQoL in SCI using an SCI-specific HRQoL questionnaire.

Design—In our cross-sectional study, 356 participants ≥ 1 yr post-SCI completed a 23-item SCI-specific HRQoL questionnaire and a detailed health questionnaire, and underwent pulmonary function testing and a neurological exam at VA Boston between 1998 and June 2003.

Results—In a multivariate regression model, age, employment status, motor level and completeness of injury, and ambulatory mode (use of hand-propelled or motorized wheelchair, use of crutches or canes, or walking independently) were independently associated with HRQoL. After adjusting for these factors, chronic cough, chronic phlegm, persistent wheeze, dyspnea with activities of daily living, and lower forced expiratory volume in 1 sec and forced vital capacity were each associated with a lower HRQoL.

Conclusions—These results provide evidence for the clinical validity of our SCI-specific HRQoL instrument. We also identify potentially modifiable factors that, if addressed, may lead to HRQoL improvement in SCI.

Keywords

Quality Of Life; Spinal Cord Injuries; Pulmonary Function Tests; Comorbidity

Survival of individuals with chronic spinal cord injury (SCI) has improved, and coping with long-term permanent disability along with aging is an important part of day-to-day living for many injured persons. As a result, the goals of rehabilitation and treatment in SCI are to improve function and enhance health-related quality of life (HRQoL).[1–6] Although specific definitions vary, HRQoL is a patient-centered outcome that relates to the physical, social, and psychological aspects of an individual's well-being that may be affected by the burden of

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disease, disability, and related treatment.[7] When assessed accurately, HRQoL measures are reliable, valid, and responsive to important clinical changes.[8–11] It is essential to identify determinants of HRQoL in SCI so that potentially modifiable factors can be identified and specific interventions to improve HRQoL can be assessed.

Previous reports on HRQoL in SCI are limited by lack of accurate measurement of HRQoL, because instruments designed for the able-bodied or medical conditions unrelated to SCI were used.[12–18] These instruments fail to consider the physical, social, and psychological burden that results from SCI. In addition, although a few previous reports have considered sociodemographics, severity of injury, time since injury, selected psychosocial variables, and ambulatory mode as factors that may be independently associated with HRQoL,[12,15] most studies have not assessed these factors together. Respiratory dysfunction is common in SCI.[19–22] However, the association of respiratory symptoms and pulmonary function with HRQoL has never been investigated.

There is no SCI-specific HRQoL instrument accepted for use in a clinical setting, nor has an instrument been administered systematically to a large numbers of persons with the goal of determining clinical factors potentially related to HRQoL in SCI. As part of a large cohort study assessing respiratory function in chronic SCI conducted at VA Boston,[23] we used a 23-item SCI-specific HRQoL questionnaire (SCI QL-23), an HRQoL instrument developed by a Swedish group led by Sullivan.[24] This instrument was specifically designed for people with SCI and includes questions addressing physical limitations (functioning domain); the perception of distress and depressive feelings (mood domain); perception of problems related to injury, such as bladder and bowel function (injury problem domain); and global quality of life. In this report, we assess the cross-sectional association of these HRQoL domains with objective measures of respiratory function and respiratory symptoms/comorbid illnesses. We also consider other important SCI characteristics such as severity of injury, time since injury, ambulatory mode, and sociodemographic factors.

MATERIALS AND METHODS

Patient Population

Since 1994, we have been assessing respiratory function in a chronic SCI cohort recruited from the VA Boston SCI Service and from the greater Boston area by advertisement, as described previously.[25] A recruitment criterion of ≥ 1 yr post-SCI was selected to include participants who had survived acute injury and related complications. Participants requiring mechanical ventilation or having a tracheostomy were not assessed. At study entry, participants had to be free of acute illness. They completed a detailed general and respiratory health questionnaire and underwent pulmonary function testing and a neurological exam. From 1998 onwards, an assessment of HRQoL was introduced into our study, longitudinal follow-up began, and recruitment continued.

Participants (n = 391) completing a health assessment that included the HRQoL questionnaire between 1998 and June 2003 were included, and the first assessment was used in this study. We excluded from the analysis participants with a history of other neurological disorders such as polio, multiple sclerosis, and stroke (n = 25), one participant with a tracheostomy, and those with missing data on HRQoL (n = 9). The final dataset for analysis included 356 participants (262 [74%] veterans and 94 nonveterans). One person tested at 0.9 yrs after injury was retained in the cohort because there was no a priori basis to exclude him. The study was approved by the institutional review boards at VA Boston Healthcare System, Brigham and Women's Hospital, and Harvard Medical School, and informed consent was obtained from each participant.

HRQoL Questionnaire

Each participant was asked to self-complete the SCI QL-23 at the time of pulmonary function testing.[24] Few participants completed the questionnaire over the phone (n = 33; 9.3%). The phone tests were conducted if not enough time was available after completion of pulmonary function testing or if a participant was unable to travel. The SCI QL-23 was designed in a comprehensive Swedish research program and is reported to have high reliability and validity according to standard psychometric methodology.[24,26,27] Cronbach's alpha, a test for reliability, was 0.85–0.86 on various domains of the questionnaire (coefficients above 0.70 are considered satisfactory internal consistency[28]). The SCI QL-23 reached content validity according to a conceptual model that includes condition-specific aspects as well as generic aspects of physical and psychosocial functioning and well-being, and overall HRQoL. Unidimensionality of the three composite scales of SCI QL-23 was tested using principal component factor analysis, where factor loadings above 0.40 were considered. The clinical validity was checked through correlation analyses in subgroups representing individuals with tetraplegia and paraplegia, and individuals with complete and incomplete lesion, respectively. Another previously published cross-national comparison also has supported the validity of this instrument.[29] We chose the SCI QL-23 questionnaire because it is SCI specific, short and easy to complete, even in a clinical setting, and yet comprehensive in eliciting possible items that are important to measure HRQoL in SCI.

The SCI QL-23 has four domains: functioning (ten items assessing physical and social limitations), mood (six items concerning distress and depressive feelings), SCI-related problems (six items regarding difficulty with loss of independence and other issues relating to injury, such as bladder and bowel function), and global HRQoL (assessed using a visual analog scale). HRQoL scores are generated individually for each of the four domains comprising three composite scale scores and one single-item score. Detailed information on response options, scoring instructions, handling of missing responses, and transformation to a 0–100 scale score can be obtained from the SCI QL-23 manual.[30]

Neurological Exam, Stature, and Weight

The assessment of motor level and completeness of injury was based on American Spinal Injury Association (ASIA) guidelines.[31] Level and completeness of injury were determined by examination in all but two participants, whose level and completeness were determined by medical record review. Participants were a priori grouped into one of seven motor injury level and severity groups. These groups included motor complete SCI (cervical, high thoracic [T1–T6], and other lower levels). Participants with motor incomplete SCI (ASIA C: the majority of key muscles below the neurological level grade < 3/5; or ASIA D: most muscles grade ≥ 3/5) were grouped into cervical C, other C, cervical D, and other D. Participants (n = 49) with motor complete SCI but evidence of some preservation of neurologic function below the neurologic level (more than two neurologic levels) were grouped with ASIA C participants. Weight and height were either self-reported or measured using previously described methodology.[32]

Health Questionnaire

The health questionnaire was based on the American Thoracic Society respiratory health questionnaire (ATS DLD-78)[33] with supplemental questions. These supplemental questions elicit information on concurrent medical conditions such as heart disease and diabetes, and current and past employment. To assess mobility, participants were asked, "How you usually get around?" and were given the following options: motorized wheelchair more than half the time, hand-propelled wheelchair more than half the time, walk with aid more than half the time, or walk without assistance more than half the time. Using a series of structured questions, participants were asked to report activities of daily living that resulted in breathlessness.

Participants were then asked to respond "yes" or "no" to the following questions: (A) Are you usually too breathless to leave the house or breathless while dressing or undressing? (B) Are you usually breathless while talking for more than a few minutes? (C) Are you usually breathless while eating? If the answer to one or more of the above questions was "yes," the participant was classified as having dyspnea during activities of daily living. Chronic cough was defined as cough on most days for three consecutive months of the year, and chronic phlegm was defined similarly. Persistent wheeze was defined as wheeze reported on most days or nights, or with a cold and occasionally apart from colds.

Pulmonary Function Tests

Spirometry was based on American Thoracic Society standards[34] modified for use in SCI, as described previously.[35,36] Testing was done using a 10-liter water-seal spirometer, except in 31 participants where a water-seal portable spirometer was used (DSII or Survey III, Collins Pulmonary Diagnostics, Ferraris Respiratory, Louisville, CO). Predicted values for forced expiratory volume in 1 sec (FEV_1) and forced vital capacity (FVC) were calculated using Hankinson et al.'s[37] equations for Caucasians and African Americans. Some participants (n = 42) had missing information on FEV_1 and FVC because health and HRQoL assessments were made on the phone for participants unable to travel to our study center (n = 20), because spirometry was not performed in 17 participants, or because predicted equations were not available for participants of other races (n = 5). In the 314 remaining participants, the best FVC and FEV_1 were reported. Of these, 278 (86.1%) had at least three acceptable expiratory efforts with the best values of FEV_1 and FVC, each within 200 ml; 11 (3.1%) were able to produce at least two acceptable and reproducible values of FEV_1 and FVC; and two (0.6%) participants were only able to perform one acceptable effort. The remaining participants had two or three efforts that were acceptable but not reproducible.

Statistical Analysis

We examined cross-sectional determinants of each of the four domains of HRQoL using generalized linear models. Variables significant at the 0.10 level were subsequently assessed in multivariate models. Then, variables significant at the 0.05 level for any of the domains were included in the final model of baseline factors. The variables assessed for baseline model were sociodemographic characteristics including age, marital status, gender, race, years of schooling, and employment status; personal habits such as smoking status, and body mass index; SCI characteristics such as motor level and completeness of injury, years since injury, and age at injury; and mobility.

After the baseline model was determined, we assessed respiratory symptoms, comorbid medical conditions, and pulmonary function as possible predictors of HRQoL. A separate regression model was constructed for each of the symptom and pulmonary function variables by individually including each variable with the baseline model for each HRQoL domain. A sensitivity analysis was conducted by excluding participants who completed the questionnaires by telephone from final regression models. We performed statistical analysis using SAS for UNIX (version 9.0, SAS Institute Inc., Cary, NC).

RESULTS

Our cohort was well represented by participants of all age groups and varying severities of SCI (Table 1). A majority of participants were Caucasian (92.7%) and male (94.1%). The median time since injury was 18.2 yrs (range: 0.9, 57.9). Few participants reported physician-diagnosed respiratory illnesses (Table 2). However, the prevalence of chronic respiratory symptoms and heart disease treated in the last 10 yrs was more common.

In the baseline multivariate model, factors significantly associated with HRQoL included age, employment status, motor level and completeness of injury, and mobility (Table 3). Although age was significant only at the 0.10 level, it was retained a priori in the models because of its clinical significance. Interaction terms between variables in the baseline model were not statistically significant. The results suggest that older participants had a lower HRQoL compared with younger age groups on the functioning domain ($P < 0.05$). Conversely, HRQoL on the injury problem scale was higher in participants greater than 60 yrs of age, especially in the 61- to 70-yr age group, compared with participants in the younger age groups. HRQoL on the functioning domain was lowest in the cervical motor complete SCI group compared with other complete SCI groups, and it also was lower in the cervical C SCI group than in the other C group. Similar findings were noted for mood state but not for perception of injury problems or global HRQoL domains. Each of the four HRQoL domains was significantly related to mobility.

Adjusting for covariates in the baseline multivariate model, participants with chronic cough, chronic phlegm, persistent wheeze, and dyspnea while talking, eating, or dressing had a significantly lower HRQoL on most domains (Table 4). The results were similar after further controlling for smoking status (current, ex, and never) in the multivariate models (data not shown). Mean values on the functioning domain of HRQoL were significantly lower (by 11 points; $P < 0.01$) for participants who, in the year before questionnaire completion, had chest illnesses that had kept one at home, in bed, or out of work ($n = 109$; data not shown). Other comorbid illnesses, including physician-diagnosed asthma, chronic obstructive pulmonary disease, and heart disease treated in the last 10 yrs, were not significant predictors of HRQoL, possibly because fewer participants had these illnesses.

Adjusting for variables in the baseline multivariate model, percent predicted FEV_1 and FVC (in quartiles) were significantly associated with HRQoL (Table 5). As percent predicted FEV_1 and FVC (in quartiles) decreased, there was a decline in HRQoL. The results were similar after further adjusting for smoking status in the multivariate model (data not shown).

The results for all multivariate models were similar when participants who completed health and HRQoL questionnaires on the phone were excluded from the analysis (data not shown).

DISCUSSION

Previous studies have provided little guidance in identifying factors that are independently associated with HRQoL in SCI. In a large cross-sectional cohort of participants with SCI, we examined factors associated with HRQoL using an SCI-specific instrument. These factors included age, employment status, motor level and completeness of injury, and mobility. Respiratory symptoms and pulmonary function, the role of which has not been previously reported, were also associated with HRQoL in SCI.

The importance of improving HRQoL as one of the primary goals in SCI rehabilitation, as well as lack of appropriate assessment of HRQoL and factors influencing it, is well known and has been described in comprehensive reviews by Hallin et al.,[38] Tulsky and Rosenthal,[5] Hammell,[39] and Wood-Dauphinee et al.[6] The assessment of factors associated with HRQoL in SCI is a two-step process, neither of which have been adequately addressed in previous studies: first step is accurate measurement of HRQoL; second is to subsequently determine which factors independently influence HRQoL and consider them together in multivariate analysis. HRQoL is a construct that is specific to a particular disease, population, and treatment.[5] Therefore, traditional generic instruments meant for use in the able bodied cannot be solely used to assess physical and social limitations, perceptions regarding loss of independence, or other injury-specific issues that constitute HRQoL in individuals with SCI. In contrast to diseases in the

able bodied, where most investigators have recognized the importance of using disease-specific questionnaires to assess HRQoL,[40] only two SCI-specific questionnaires have been developed.[41] After HRQoL is accurately measured, factors that are potential determinants of HRQoL in a chronic disability such as SCI need to be considered and adjusted for. Among these possible determinants, we considered socio-demographics (age, marital status, education, and employment), injury-related factors (level and completeness of injury, years since injury, and age at injury), respiratory health (lung function, symptoms, and illnesses), other comorbidities, and functional status (the ability to get around, or mobility).

It is well established that the higher the level and the more complete the injury, the more likely it is that there will be loss of muscle function and strength, and functional disability in SCI. However, previous studies have reported conflicting results on the association between level and completeness of injury and HRQoL. Some studies have reported a significant association between higher-level and more complete injury and a lower HRQoL,[12,42–44] whereas others have found no such association.[2,45–47] In our study, HRQoL for the functioning domain was lowest in participants with the most severe SCI (cervical motor complete SCI) compared with others with complete SCI, and it was also lower in higher levels of incomplete injury (cervical C) compared with other incomplete injuries. These findings suggest that the SCI QL-23 questionnaire is sensitive to clinically relevant functional differences and severities of SCI and is, therefore, clinically valid. However, further work is needed to demonstrate the overall validity of the SCI QL-23 questionnaire, and its validity needs to be demonstrated in different SCI study populations. Similar findings were noted for the mood state domain but not for perception of injury problems or global HRQoL domains. This might be because the functioning domain of SCI QL-23, which, by design, measures HRQoL on the basis of perceived functional status is most sensitive to changes with varying severities of SCI.

Older participants in our study had a lower HRQoL than younger age groups on the functioning domain. This is consistent with the results of some, but not all, previous cross-sectional studies.[16,48–51] However, on the injury problem scale, HRQoL was better in older participants than in younger age-groups. It has been hypothesized that individuals with SCI adapt to their injury as they age, thereby leading to a better HRQoL on the injury problem scale. A longitudinal study is required to assess these observations further because it is likely that a cross-sectional study might underestimate the effect of aging on HRQoL with “healthier” participants surviving to be in our cohort. Those working in full- or part-time jobs had a better HRQoL on the functioning, mood, and global HRQoL domains. This relationship is similar to that described in some previous studies.[13,52]

Participants using crutches or canes, or those using hand-propelled or motorized wheelchairs to get around, had a significantly lower HRQoL than those getting around without an assistive device. Hence, a higher HRQoL was related with the ability to get around independently (as in participants walking without assistance). We also found that those who usually walked with crutches or canes had a similar or lower HRQoL on most domains compared with those using hand-propelled or motorized wheelchairs. Because most participants using crutches or canes had lower SCI levels and incomplete injuries, we expected them to have a significantly higher HRQoL than those using motorized or hand-propelled wheelchairs (who are weaker and have higher levels and more complete injuries). It is possible that participants using ambulatory aids reported a lower HRQoL than would have been expected because of the greater effort and energy costs associated with using crutches or cane[53] compared with hand-propelled or motorized wheelchairs. These cross-sectional results suggest that improving mobility or the ability to get around in an energy-efficient manner may improve HRQoL in SCI.

The increased prevalence of dyspnea in SCI has been reported previously.[22,25] We also have reported previously that participants using crutches or canes have increased prevalence of

dyspnea when performing activities of daily living compared with those using hand-propelled wheelchairs.[25] Our results from this previous study[25] and the current study imply that participants using crutches or canes to get around have not only a lower than expected HRQoL but also a higher than expected prevalence of dyspnea (which was associated with lower HRQoL in our study). Therefore, improving mobility may help reduce the prevalence of dyspnea and improve HRQoL.

Although respiratory dysfunction is common in SCI, the association of respiratory symptoms and comorbid illnesses with HRQoL has not been previously investigated. Because HRQoL was lower in participants reporting chronic respiratory symptoms and chest illnesses, therapy directed toward the recognition and treatment of these conditions may improve HRQoL in SCI. Our study is the first to report on the association of pulmonary function with HRQoL in SCI. People with reduced percent predicted FEV_1 and FVC had lower HRQoL on the functioning domain. Similar results have been reported from other able-bodied cohorts of participants with chronic obstructive lung disease.[8–11] It is possible that interventions that lead to improvements in FEV_1 and FVC or that lead to improvements in functional ability may improve HRQoL in SCI. Because we performed a cross-sectional analysis, it is not possible to assess whether reduced pulmonary function led to lower HRQoL on the functioning domain or whether greater functional disability (leading to lower HRQoL on the functioning domain) resulted in decreased pulmonary function. A longitudinal study would be needed to assess the direction of a causal relationship between functioning domain of HRQoL and pulmonary function.

Clinicians not familiar with HRQoL concepts may find it difficult to interpret a meaningful change in HRQoL score and its corresponding clinical relevance.[54] Our cross-sectional results can help guide the clinician about the health implications of a change in SCI QL-23 score. For instance, a seven-point improvement in HRQoL score (from 35 to 28) on the functioning domain was associated with an increase in mean percent predicted FEV_1 from 47.6% (quartile 1) to 70.3% (quartile 2). Similarly, a ten-point improvement on the functioning domain (difference of means between 37 and 27 points) was associated with the absence of dyspnea during activities of daily living. On average, an eight-point improvement on the mood scale was associated with participants being able to work full time compared with those not working because of disability or illness. These results can help one put into perspective the clinical relevance of changes in HRQoL scores when future interventions and their impact on HRQoL are assessed.

Although we identified factors significantly associated with HRQoL, overall, the variance (R^2) explained by the regression models was modest and varied by domain (range, 13.5–44%; Tables 3–5), suggesting that there are additional factors associated with HRQoL in this cohort. For example, our study did not include a detailed assessment of psychosocial and other social support factors that may influence HRQoL in SCI. Another limitation is the participation of few females and minorities in our study. Hence, factors specific to these populations may not have been accounted for in our analysis. Although disease specific instruments more accurately measure HRQoL than generic instruments (as described earlier), this approach may lead to colinearity between the independent and dependent variables when studying factors associated with HRQoL. For example, questions used to define HRQoL in SCI may include descriptions of specific functional and psychological limitations that also are used as independent (predictive) variables in a regression model.

In summary, our study identified age, employment status, motor level and completeness of injury, and mobility as independent factors associated with HRQoL in SCI. The association of respiratory symptoms and illnesses, and decreased FEV_1 and FVC, with a lower HRQoL not only demonstrates previously unreported factors influencing HRQoL; it also shows the sensitivity and clinical validity of the SCI QL-23 instrument. Our study reports several

modifiable factors that, if addressed by a clinician, could potentially lead to HRQoL improvement in individuals with SCI. Our results also can help the clinician understand the health implications of a change in HRQoL scores when future interventions to improve HRQoL, as measured by SCI QL-23, are reported.

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TABLE 1

Selected baseline characteristics of 356 participants with spinal cord injury

	***n* (%)**
Age, yrs	
≤40	74 (20.8)
41–50	96 (27.0)
51–60	72 (20.2)
61–70	60 (16.9)
> 70	54 (15.2)
Sex	
Male	335 (94.1)
Female	21 (5.9)
Race	
Caucasian	330 (92.7)
Other	26 (7.3)
Marital status	
Single	110 (30.9)
Married	160 (44.9)
Widowed/separated/divorced	86 (24.2)
Years of schooling	
≤12	138 (38.8)
13–16	168 (47.2)
> 16	50 (14.0)
Employment status	
Full-time job	67 (18.8)
Part-time job	40 (11.2)
Not working because of disability/illness	117 (32.9)
Retired/unemployed/student	132 (37.1)
Body mass index	
Normal (< 25)	129 (36.2)
Overweight (25–30)	137 (38.5)
Obese (≥30)	80 (22.5)
Missing	10 (2.8)
Smoking	
Current smoker	78 (21.9)
Past smoker	145 (40.7)
Never-smoker	133 (37.4)
Years postinjury*	18.2 (17.9)
Motor level and severity of injury	
Motor complete	
Cervical	68 (19.1)
High thoracic (T1–T6)	50 (14.0)
Other (low thoracic [T7–T12], lumbar, sacral)	55 (15.4)
Motor incomplete	
Cervical C	43 (12.1)
Other C (thoracic, lumbar, sacral)	40 (11.2)
Cervical D	59 (16.6)
Other D (thoracic, lumbar, sacral)	41 (11.5)
Mobility (more than half the time)	
Using motorized wheelchair	76 (21.3)
Using hand-propelled wheelchair	193 (54.2)
Walk with crutches or cane	47 (13.2)
Walk without assistance	40 (11.2)

* Median (interquartile range).

TABLE 2

Medical comorbidities and pulmonary function in participants with spinal cord injury

Characteristic	***n* (%)**
Medical comorbidities (n = 356)‡	
Physician-diagnosed chronic obstructive pulmonary disease	30 (8.4)
Physician-diagnosed asthma	33 (9.3)
Heart disease treated in last10 yrs	32 (9.0)
Chronic cough	61 (17.1)
Chronic phlegm	73 (20.5)
Persistent wheeze	72 (20.2)
Pulmonary function (n = 314)	**Mean (SD)**
Percent predicted FEV_1*	
Quartile 1	47.6 (10.4)
Quartile 2	70.3 (4.9)
Quartile 3	84.3 (3.4)
Quartile 4	99.9 (8.2)
Percent predicted FVC*	
Quartile 1	48.4 (10.9)
Quartile 2	70.2 (4.2)
Quartile 3	83.4 (3.5)
Quartile 4	99.2 (8.3)

FEV_1, forced expiratory volume in 1 sec; FVC, forced vital capacity.

‡Each row represents the number (%) of participants with a given comorbidity. Therefore, participants may be listed in several rows.

*Missing values for FEV_1 and FVC = 42.

TABLE 3

Adjusted mean scores for factors associated with health-related quality of life in 356 participants with spinal cord injury

		HRQoL Domains (Scale 0–100)			
Covariate	***n***	**Functioning, Mean ± SE**	**Mood State, Mean ± SE**	**Injury Problems, Mean ± SE**	**Global, Mean ± SE**
Baseline Multivariate model					
Age, yrs**					
≤40	74	22 ± 3	*	31 ± 2	*
41–50	96	27 ± 2	*	31 ± 2	*
51–60	72	28 ± 3	*	31 ± 2	*
61–70	60	28 ± 3	*	25 ± 2	*
> 70	54	34 ± 3	*	29 ± 2	*
Employment status‡					
Full-time job	67	20 ± 3	14 ± 2	*	83 ± 3
Part-time job	40	25 ± 4	16 ± 3	*	80 ± 3
Not working because of disability/illness	117	35 ± 2	22 ± 2	*	71 ± 2
Retired/unemployed/student	132	31 ± 2	19 ± 2	*	76 ± 2
Motor level and severity of injury†					
Motor complete					
Cervical	68	39 ± 3	19 ± 2	*	*
High thoracic (T1–T6)	50	23 ± 4	17 ± 3	*	*
Other (low thoracic [T7–T12], lumbar, sacral)	55	21 ± 4	14 ± 3	*	*
Motor incomplete					
Cervical C	43	29 ± 4	20 ± 3	*	*
Other C (thoracic, lumbar, sacral)	40	23 ± 4	13 ± 3	*	*
Cervical D	59	31 ± 3	22 ± 2	*	*
Other D (thoracic, lumbar, sacral)	41	28 ± 4	20 ± 3	*	*
Mobility (more than half the time)‡					
Using motorized wheelchair	76	50 ± 3	17 ± 2	33 ± 2	77 ± 3
Using hand propelled wheelchair	193	24 ± 2	17 ± 1	32 ± 1	78 ± 2
Walk with crutches or cane	47	25 ± 4	23 ± 3	35 ± 3	71 ± 3
Walk without assistance	40	12 ± 4	14 ± 3	17 ± 3	86 ± 4

SE, standard error.

* Variable not significant at the 0.05 level;

‡ $P < 0.05$ for all reported domains.

** $P = 0.09$ for functioning domain and $P = 0.07$ for injury problems domain for age.

† $P < 0.05$ for functioning domain and $P = 0.09$ for mood state domain for motor level and severity.

R^2 for baseline model: functioning = 44.0%; mood state = 14.9%; injury problems = 13.5%; global = 14.4%.

The higher the score on the functioning, mood state, and injury problems scales, the lower is the HRQoL on the respective scale. Higher scores on the global HRQoL scale represent a higher HRQoL.

TABLE 4

Adjusted mean scores for medical comorbiditiesassociated with health-related quality of life in 356 participants with spinal cord injury[a]

		HRQOL Domains (Scale 0–100)			
Covariate[b]	***n***	**Functioning**	**Mood State**	**Injury Problems**	**Global**
Chronic cough‡					
Yes	61	33 ± 3	25 ± 2	*	71 ± 3
No	295	27 ± 2	16 ± 1	*	79 ± 2
Chronic phlegm†					
Yes	73	34 ± 3	25 ± 2	33 ± 2	73 ± 3
No	283	26 ± 2	16 ± 1	29 ± 1	79 ± 2
Persistent wheeze‡					
Yes	72	*	23 ± 2	*	72 ± 3
No	284	*	16 ± 1	*	79 ± 2
Dyspnea while talking, eating, or dressing‡					
Yes	34	37 ± 4	*	*	69 ± 4
No	322	27 ± 2	*	*	78 ± 2

[a] Controlling for variables in the baseline multivariate model (Table 3).

[b] Each variable was added in separate regression models to the baseline multivariate model.

* Variable not significant at the 0.05 level.

‡ $P \leq 0.01$ for all reported domains, except for functioning domain of chronic cough, where $P = 0.06$.

† $P < 0.05$ for all four domains.

Range of variance (R^2) explained by each regression model: functioning = 44.5–45.2%; mood state = 17.5–20.1%; injury problems = 14.7%; global = 15.9–16.2%.

The higher the score on the functioning, mood state, and injury problems scales, the lower the HRQoL is on the respective scale. Higher scores on the global HRQoL scale represent higher HRQoL.

TABLE 5

Adjusted mean scores for association of FEV_1 and FVC with health-related quality of life in 314 participants with spinal cord injury[a]

	HRQoL Domain* (Scale 0–100)			
	Functioning			
Covariate[b]	**Quartile 1 (Lowest percent predicted FEV_1 or FVC)**	**Quartile 2**	**Quartile 3**	**Quartile 4 (Highest percent predicted FEV_1 or FVC)**
Percent predicted FEV_1 quartile‡	35 ± 3	28 ± 3	24 ± 3	23 ± 3
Percent predicted FVC quartile‡	35 ± 3	28 ± 3	22 ± 3	24 ± 3

FEV_1, forced expiratory volume in 1 sec; FVC, forced vital capacity.

[a] Controlling for variables in the baseline multivariate model (Table 3).

[b] Each variable was added in separate regression models to the baseline multivariate model.

‡ $P \leq 0.01$;

* mood state, injury problems, and global HRQoL domains were not significant.

The variance (R^2) explained by the regression model with FEV_1 = 47.2% and with FVC = 47.3%.

A higher score on the functioning scale reflects a lower HRQoL.