Environmental Factors and Their Role in Participation and Life Satisfaction After Spinal Cord Injury

Gale Whiteneck, PhD, Michelle A. Meade, PhD, Marcel Dijkers, PhD, Denise G. Tate, PhD, Tamara Bushnik, PhD, Martin B. Forchheimer, MPP

ABSTRACT. Whiteneck G, Meade MA, Dijkers M, Tate DG, Bushnik T, Forchheimer MB. Environmental factors and their role in participation and life satisfaction after spinal cord injury. Arch Phys Med Rehabil 2004;85:1793-803.

Objectives: To investigate environmental barriers reported by people with spinal cord injury (SCI), and to determine the relative impact of environmental barriers compared with demographic and injury characteristics and activity limitations in predicting variation in participation and life satisfaction.

Design: Cross-sectional, follow-up survey.

Setting: Individuals rehabilitated at 16 federally designated Model Spinal Cord Injury Systems of care, now living in the community.

Participants: People with SCI (N=2726) who completed routine follow-up research interviews between 2000 and 2002.

Interventions: Not applicable.

Main Outcome Measures: The Craig Hospital Inventory of Environmental Factors–Short Form (CHIEF-SF), the Craig Handicap Assessment and Reporting Technique–Short Form, and the Satisfaction With Life Scale.

Results: The top 5 environmental barriers reported by subjects with SCI, in descending order of importance, were the natural environment, transportation, need for help in the home, availability of health care, and governmental policies. The CHIEF-SF subscales accounted for only 4% or less of the variation in participation; they accounted for 10% of the variation in life satisfaction.

Conclusions: The inclusion of environmental factors in models of disability was supported, but were found to be more strongly related to life satisfaction than to societal participation.

Key Words: Environment; Outcome assessment (health care); Rehabilitation; Spinal cord injuries.

THE SEVERITY OF A spinal cord injury (SCI) is not the best predictor of most long-term outcomes. Researchers have found that while the level and extent of neurologic preservation does predict independence in activities of daily living (ADLs),[1,2] certain medical complications,[3,4] and mortality,[5] they do not strongly predict such postinjury outcomes as perceived stress,[6-8] emotional distress,[9] marital stability,[10,11] long-term job and employment stability,[12] productivity,[13,14] life satisfaction, perceived well-being, or quality of life (QOL).[15,16] Instead, these outcomes are influenced by such diverse factors as family support, adjustment and coping, productivity, self-esteem, financial stability, education, and the physical and social environment.[6-16] Although our understanding of SCI outcomes and the importance of noninjury-related factors has been advanced by this research, more multivariate investigations of SCI outcomes are needed. Such research should be grounded in current theories of disability, a sound conceptualization of the domains of disability, and the many factors that influence them.

In the last 2 decades of the twentieth century, dramatic progress was made in the conceptualization of disability. Two World Health Organization (WHO) international classification systems serve as bookends to this period.[17,18] The WHO *International Classification of Impairments, Disabilities and Handicaps*[17] (ICIDH), published in 1980, suggested conceptual distinctions among 3 levels of disablement-affected performance—impairment at the organ level, disability at the person level, and handicap at the societal level. The ICIDH scheme sparked controversy, however, because the societal level included the term "handicap" and the model failed to incorporate environmental factors. In 2002, a revision of the ICIDH was published as the WHO *International Classification of Functioning, Disability and Health*[18] (ICF). The newer model replaced the designation for the 3 dimensions with more appropriate labels: body structure and function/impairment at the organ level, activity/activity limitation at the person level, and participation/participation restriction at the societal level. Although the ICF combined the categorization system for activities and participation, it maintained a conceptual distinction between the 2 dimensions. The ICF also offered a modified conceptual scheme of the links between these 3 aspects of disability, which for the first time explicitly showed the role of environmental factors. Last, the ICF added a categorization system for environmental factors that covers the physical, social, and attitudinal environment.

During this 1980 to 2002 period, several advances were made in the United States that articulated the significant role of the environment in the lives of people with disabilities. From a policy and legislative perspective, the Americans with Disabilities Act[19] established full participation as the societal goal for all people with disabilities, and ensured their right to reasonable accommodation to achieve that goal. The National Institute on Disability and Rehabilitation Research[20] (NIDRR) articulated the "New Paradigm of Disability" as the basis of its research agenda, and focused attention on the imperative of environmental modifications to improve the lives of people with disabilities. The Institute of Medicine released its report, *Enabling America*,[21] which stressed the importance of environmental factors in the lives of people with disabilities. In response to these statements by federal agencies and institutes,

From Craig Hospital, Englewood, CO (Whiteneck); Virginia Commonwealth University, Richmond, VA (Meade); Mount Sinai School of Medicine, New York, NY (Dijkers); University of Michigan, Ann Arbor, MI (Tate, Forchheimer); and Santa Clara Valley Medical Center, Santa Clara, CA (Bushnik).

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Correspondence to Gale Whiteneck, PhD, Craig Hospital, 3425 S Clarkson St, Englewood, CO 80113, e-mail: *gale@craig-hospital.org*. Reprints are not available from the author.

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researchers focused their attention on developing instruments with which to measure societal participation and environmental barriers. Their efforts produced the Craig Handicap Assessment and Reporting Technique[22] (CHART), the Community Integration Questionnaire,[23] and the Craig Hospital Inventory of Environmental Factors[24] (CHIEF), among other measures.

Likewise, there was a growing international interest in disability issues and the importance of environmental factors. The United Nations (UN) focused attention on disability with its Disability Year[25] and the Disability Decade and such efforts as the World Programme of Action Concerning Disabled Persons.[26] The UN and Disabled Persons International have advanced the international disability rights movement. The Assessment of Life Habits[27] and the Measure of the Quality of the Environment[28] emerged from the Quebec Model of the Disability Creation Process,[29] and the London Handicap Scale[30] has focused on the subjective perception of participation.

Although the importance of environmental factors was included in the (revised) models of disability, there is little empirical evidence that supports the conceptualization. Research into participation by people with SCI has linked physical impairment and disability to societal participation, but has found that while severity of impairment was strongly related to the performance of ADLs, neither impairment nor disability measures were strongly related to participation.[31,32] A meta-analysis[33] concluded that participation was more strongly related to subjective QOL than either impairment or disability. Environmental factors were absent from the conceptual schema underlying these investigations. Therefore, measures were needed with which to appropriately assess environmental factors such as physical, attitudinal, and policy barriers in SCI research.

Such measures as the ones cited above are currently being used in SCI research,[24,34,35] in physical disability research,[36] and in population-based disability research.[8] The results of this research support the role of environmental factors in the lives of people with disabilities. These investigations have not systematically examined the impact of environmental factors on outcomes other than those in the physical functioning realm, however.

Few studies have examined the role of the environment in life satisfaction after SCI. "Life satisfaction" is a subjective component of QOL, including the self-assessment of a person's functioning and circumstances.[37] Diener et al[38] have described different aspects of subjective well-being: emotional aspects such as positive and negative affect, and a cognitive-judgmental one, that is life satisfaction. The judgment of one's life satisfaction is based on comparisons with a standard that is unique to the individual. Duggan and Dijkers[39] speak of personal expectations rather than standards. The valuation of one's experience in light of personal expectations is then one's appraisal of QOL. Disability models also suggest that environmental factors, as well as societal participation, will influence disability outcomes, including life satisfaction. Previous research has documented that life satisfaction is greater for those who are involved in productive activities such as work, education, and recreation.[40] In fact, life satisfaction appears to be related to measures of disability and handicap but not to physical impairment.[33]

The complexity of this research should not be underestimated. Because the word "disability" describes the outcome of the interaction between a health condition and the context (environmental, personal) in which a person with the condition finds her-/himself, cultural factors can play a critical moderating role with respect to influencing the exact pattern of these interactions.[41] Cultural traditions, language differences, and physical barriers can thus shape both society's concept of disability within this context and the perception of personal outcomes such as life satisfaction.

It is beyond the scope of this study to investigate the role of cultural differences, but this study does offer a first attempt at identifying environmental factors that influence outcomes after SCI. The study focuses on environmental barriers rather than on environmental facilitators. Although neither the disability models nor previous research were adequate to suggest specific hypotheses involving the role of the environment, our research was guided by 2 basic questions: (1) What is the nature and extent of environmental barriers as perceived and reported by people with SCI, and do they differ among various subgroups of SCI survivors? (2) What is the relative impact of environmental barriers, compared with demographic and injury characteristics and activity limitations, in predicting variation in participation and life satisfaction among people with SCI?

METHODS

Participants

The sample was composed of subjects with SCI who met the criteria for participation in the Model Spinal Cord Injury Systems (MSCIS) program, an ongoing multicenter research effort funded by NIDRR. Eligible for participation were those who: (1) sustained a traumatic SCI, (2) were admitted to 1 of 16 affiliated MSCIS in the United States, (3) consented to participate in the MSCIS ongoing data collection effort, (4) participated in follow-up data collection in their 1st, 5th, 10th, 15th, 20th, or 25th anniversary of injury between January 1, 2000, and December 31, 2002, and (5) completed the Craig Hospital Inventory of Environmental Factors–Short Form[24] (CHIEF-SF) as part of the follow-up data collection.

A total of 2762 people met these criteria and provided the data analyzed for this report. The sample's demographic and injury characteristics are presented in the first 2 columns of table 1. In the same time period, 1317 additional people met all the criteria but did not complete the CHIEF-SF, and 3739 others were lost to follow-up.

Data Collection

All data in this study were taken from the National Spinal Cord Injury Database (NSCID) in May 2003. Demographic and injury-related information was derived from the Initial Hospitalization and Rehabilitation Form I (originally abstracted from medical records) and all outcome information was taken from the Follow-up Form II (collected through in-person or telephone interviews). Variables included in the study were grouped into the following 6 categories:

1. Demographic and Personal Factors, including gender and ethnicity; marital, educational, and occupational statuses as well as age at injury; and years postinjury at follow-up.
2. Impairment and Injury-Related Factors, including the etiology of injury and the neurologic classification at inpatient rehabilitation discharge. Neurologic classification was based on the level of injury and the extent of neurologic preservation summarized into 4 groups: (1) people with functionally complete tetraplegia (American Spinal Injury Association [ASIA] grade A, B, or C) at a high cervical level (C1-4); (2) people with functionally complete tetraplegia at a low cervical level (C5-8); (3) people with functionally complete paraplegia; and (4) people at all levels of injury with functional preservation (ASIA grade D), typically allowing ambulation.[42]
3. Activity Limitations, as measured by the motor subscale of the FIM instrument[43] at follow-up.

Table 1: Average CHIEF-SF Scores by Demographics, Impairments, and Activity Limitations

Variables	N %	CHIEF Total	Physical and Structural	Services and Assistance	Work and School*	Attitudinal and Support	Policy
Demographic							
Age at injury (y)	2762						
<20	19%	**.65**	**0.98**	0.70	.25	**.50**	**.56**
20–29	35%	**.74**	**1.05**	0.76	.26	**.54**	**.70**
30–39	21%	**.89**	**1.30**	0.89	.26	**.64**	**.82**
40–49	14%	**.85**	**1.39**	0.85	.33	**.59**	**.65**
50+	11%	**.64**	**0.88**	0.73	.30	**.41**	**.50**
Gender	2762						
Male	78%	**.73**	1.09	**0.75**	.27	**.52**	**.65**
Female	22%	**.88**	1.24	**0.93**	.25	**.67**	**.76**
Ethnicity	2752						
White	73%	**.72**	1.12	**0.71**	.25	.52	.67
Minority	27%	**.87**	1.12	**0.99**	.35	.63	.68
Married at injury	2759						
Not married	66%	**.79**	1.13	**0.83**	.28	**.58**	**.71**
Married	34%	**.70**	1.10	**0.69**	.24	**.48**	**.61**
Education at injury	2687						
<HS grad	27%	.74	**1.04**	**0.84**	.25	.55	**.55**
HS grad	58%	.77	**1.14**	**0.79**	.25	.54	**.71**
>HS grad	15%	.71	**1.12**	**0.62**	.30	.55	**.75**
Occup at injury	2742						
Work	65%	.76	1.14	**0.77**	**.25**	.52	.68
School	17%	.64	0.92	**0.65**	**.32**	.53	.60
Other	18%	.88	1.22	**0.96**	**.21**	.65	.71
Years postinjury	2762						
1 Year	30%	**.95**	**1.33**	**1.05**	.30	**.64**	**.75**
5 Years	20%	**.73**	**1.18**	**0.75**	.26	**.53**	**.54**
10 Years	15%	**.77**	**1.18**	**0.72**	.36	**.58**	**.81**
15 Years	13%	**.73**	**1.05**	**0.72**	.33	**.57**	**.71**
20 Years	13%	**.59**	**0.81**	**0.62**	.14	**.43**	**.61**
25 Years	10%	**.50**	**0.77**	**0.47**	.19	**.38**	**.52**
Impairment							
Etiology	2761						
Vehicular	51%	**.76**	1.10	**0.79**	.27	**.57**	**.66**
Violence	14%	**.84**	1.12	**0.95**	.24	**.59**	**.72**
Sports	12%	**.73**	1.13	**0.73**	.28	**.50**	**.73**
Fall/falling	20%	**.68**	1.08	**0.65**	.28	**.45**	**.65**
Other	3%	**.98**	1.48	**1.03**	.25	**.81**	**.67**
Neurologic group (ASIA grade)	2686						
C1-4 ABC	13%	**.90**	**1.22**	**0.95**	.43	**.64**	**.86**
C5-8 ABC	25%	**.78**	**1.16**	**0.80**	.25	**.58**	**.71**
Para ABC	41%	**.76**	**1.07**	**0.80**	.26	**.56**	**.67**
ASIA D	20%	**.63**	**1.09**	**0.65**	.21	**.39**	**.50**
Activity Limitation							
Motor FIM	2507						
Low quartile	25%	**.95**	**1.20**	**1.04**	**.39**	**.69**	**.90**
2nd quartile	24%	**.94**	**1.31**	**1.02**	**.29**	**.63**	**.84**
3rd quartile	25%	**.64**	**1.02**	**0.62**	**.24**	**.50**	**.56**
Top quartile	26%	**.55**	**0.99**	**0.51**	**.19**	**.40**	**.46**

NOTE. Bold values indicate significant differences on a Kruskal-Wallis test at the .05 level. Percentages do not = 100 due to a rounding error.
Abbreviations: ASIA, American Spinal Injury Association; HS, high school; Occup, occupation; Para, paraplegia.
*Sample size for the work/school subscale is 35% of that for other subscales because only 35% of sample were working or in school at follow-up.

4. Environmental Factors, as measured by the CHIEF-SF[24] at follow-up.
5. Societal Participation, as measured by the Craig Handicap and Reporting Technique–Short Form[44] (CHART-SF) at follow-up.
6. Life satisfaction, as measured by the Diener Satisfaction With Life Scale[38] (SWLS) at follow-up.

Instruments

Craig Hospital Inventory of Environmental Factors. The CHIEF[24] is a 25-item instrument designed to quantify the frequency, magnitude, and overall impact of perceived environmental barriers. As conceptualized in the development of this measure, environmental barriers are barriers that keep people with disabilities from functioning within the household and community and from doing what they need or want to do. These include social, attitudinal, and policy barriers, as well physical and architectural barriers. Respondents are asked to provide information about the frequency of their encounters with each type of barrier listed (daily, weekly, monthly, less than monthly, never) and the magnitude of the problem when it occurs (big or little).

Scores for each of the 25 items are calculated by multiplying the frequency score (range: never, 0; daily, 4) by the magnitude score (range: little problem, 1; big problem, 2) to yield a product or overall "impact" score. Items relating to work or school, when the respondent is neither working nor in school, are considered "not applicable" and are not scored.[24] Scores on each of the CHIEF's 5 subscales are calculated based on the mean of all the nonmissing questions comprising that subscale. The 5 subscales—physical and structural barriers, attitudinal and support barriers, barriers to services and assistance, policy barriers, and barriers at work and school—were identified through factor analysis, account for 48% of the cumulative variance, and contain from 3 to 7 questions each. The total CHIEF score is the mean of up to 25 overall impact scores.

Content validity of the CHIEF is demonstrated by the consensus of 4 panels of experts charged with developing an instrument to measure the impact of environmental barriers on people with disabilities. The expert panels created 4 separate instruments with considerable overlap, which were then synthesized into one.

The CHIEF appears to have acceptable test-retest reliability over a 2-week period. The intraclass correlation coefficients (ICC) for the total CHIEF impact score across a sample of 103 people with a range of disabilities (46 with SCI, 44 with traumatic brain injury [TBI], 13 with other impairments) were greater than .90, and subscale ICCs ranged from .77 to .89. The CHIEF differentiates between people with and without disabilities and among people with different types of severe disabilities or impairments.[24] In a convenience sample of 409 people with severe disabilities (124 with SCI, 120 with TBI, 165 with other severe disabilities), clear differences were found among the impairment groups.

We used the CHIEF-SF in this study. This is a 12-item version of the CHIEF composed of those items with the greatest conceptual clarity and discriminant validity.[24]

Craig Handicap Assessment and Reporting Technique. The CHART[44] is an assessment measure with which to examine handicap or level of participation across 6 domains: physical independence, cognitive independence, mobility, occupation, social integration, and economic self-sufficiency. Its development was based on WHO's 1980 disablement model.[17] The CHART quantifies the extent to which people fulfill various social roles, focusing on observable criteria rather than on subjective interpretation.[44]

Scoring is based on degree of participation, with higher scores reflecting greater participation and less handicap. Each domain is scored from 0 to 100. The maximum score of 100 represents the participation level of most people without disabilities and who would be expected to have no handicap. Scores of less than 100 indicate less than full participation in society. The CHART total score results from the addition of each of the 6 scores for a maximum of 600 points.

For this report, we used the CHART-SF, a 20-item shortened version of CHART, to provide an overall quantification of societal participation subsequent to community reentry. Additionally, we used the CHART-SF subscales to measure physical and cognitive independence, productivity, economic self-sufficiency, social integration, and community mobility.

FIM instrument. The FIM[43] quantifies severity of activity limitation by assessing performance in 6 areas: self-care, locomotion, mobility, sphincter control, communication, and social cognition. Participants are rated on a 7-point scale based on the degree of assistance or supervision received with each of 18 tasks. Total FIM scores may range from 18 to 126 points, and subscores can be obtained in each of the 6 life-care areas and within the broad domains of motor and cognitive independence. The MSCIS currently collects only FIM scores related to motor independence.

The FIM has good interrater reliability and high face and construct validity. It is sensitive to changes in independence over time and accurately predicts burden of care.[45] Moreover, its reliability has been established for both in-person observation and telephone survey formats.[46]

Satisfaction With Life Scale. The SWLS[38] was designed to measure overall life satisfaction. Five items are rated on a 7-point Likert-type scale, with responses ranging from "strongly disagree" to "strongly agree." Higher scores reflect greater life satisfaction. Internal consistency is good ($\alpha \geq .80$)[38,47,48] and test-retest reliability is acceptable, especially over shorter time spans.[38]

Statistical Analyses

Data analysis included the use of descriptive statistics to examine the frequency and magnitude of reported barriers. Kruskal-Wallis tests determined the statistical significance of differences in CHIEF-SF scores between various subgroups, and multivariate logistic regression with the Nagelkerke pseudo R^2 was used to assess the relative impact of demographic, impairment, activity, and environmental variables (within and across categories) on participation and life satisfaction. These nonparametric statistical tests were selected because of the skewed distribution on the CHIEF-SF, CHART-SF total and subscale scores, and the SWLS. These variables were dichotomized for use in logistic regression. A score of 1 was the cut point for CHIEF-SF variables (separating those reporting no barriers or only infrequent small barriers, from those reporting more substantial barriers), and a score of 75 was used as the cut point for CHART-SF subscales and 375 for the CHART-SF total score (separating those with no or mild participation restrictions from those with substantial participation restrictions).

Although the study eligibility criteria ensured that there would be no missing data on the CHIEF-SF (except for the work/school subscale, which is not applicable to people who are neither working nor in school), many other variables had some missing data as indicated in table 1. For the regression analyses, the work/school subscale of the CHIEF-SF and the economic self-sufficiency subscale of the CHART-SF were excluded because of the high percentage of missing data, and a subset of 2103 study participants with no missing data in any of the other variables was utilized. The CHART-SF total score used in the regression analyses was the sum of the 5 CHART-SF subscales that had no missing data, and the CHIEF-SF total score was the average of all nonmissing items, as described in the CHIEF manual.[24]

RESULTS

Frequency and Magnitude of Environmental Barriers

Figure 1 graphs the average scores of each of the 12 items in the CHIEF-SF, indicating not only the average final product scores, but also the average frequency and magnitude scores. The top 5 environmental barriers reported by people with SCI

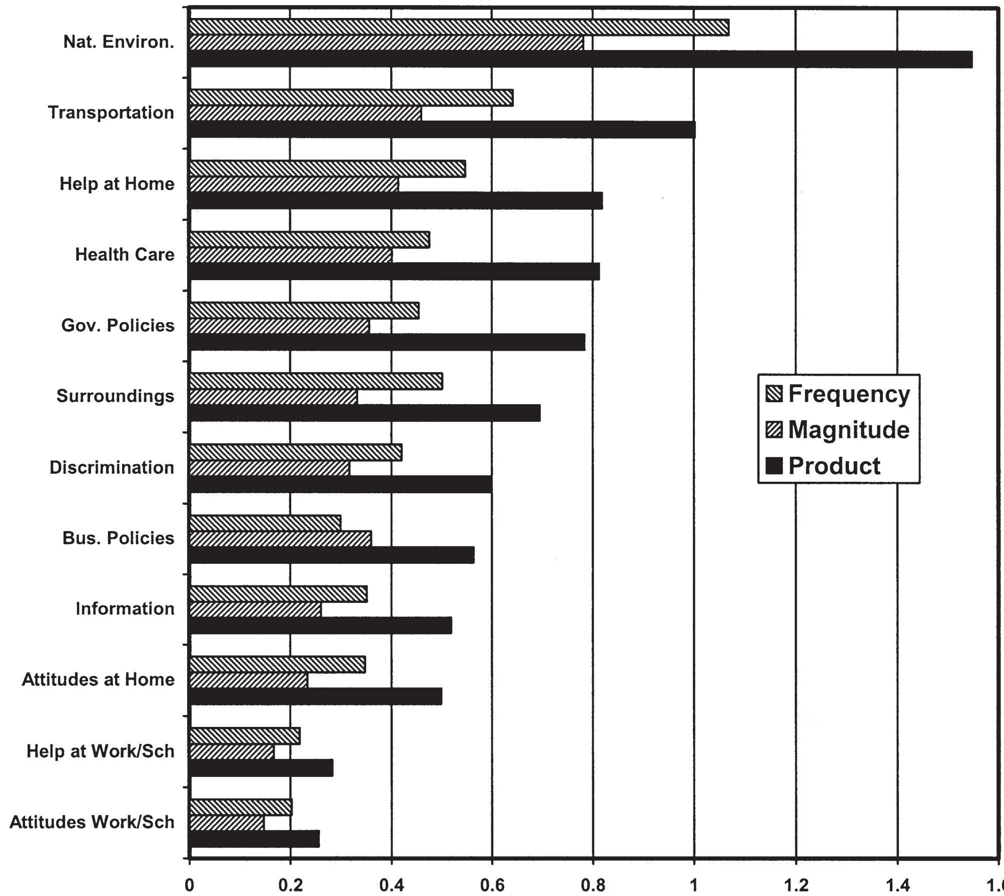

Fig 1. CHIEF item frequency, magnitude, and product scores in descending product score order. Abbreviations: Bus, Business; Gov, Government; Nat environ, Natural environment; Sch, School.

(in descending order of product scores) are barriers in the natural environment, transportation, help at home, health care, and government policy. Barriers in one's surroundings, which has the sixth highest product score, ranks fourth on the frequency score, indicating that barriers in one's immediate surroundings are relatively frequent but not very problematic. On the other hand, business policies ranked higher on the magnitude scale than on the frequency scale, indicating barriers resulting from business policy were relatively more problematic, though infrequent. With these 2 exceptions, all frequency, magnitude, and product scores followed the same pattern. Discrimination, business policies, information availability, and attitudes at home posed less severe environmental barriers. Help and attitudes at work or school received the lowest scores.

Figure 2 graphs the average CHIEF-SF subscores. People with SCI reported that barriers in the natural environment and surroundings (the physical/structural subscale) were the most problematic, followed by barriers in transportation, help at home, health care, and information availability (which make up the services/assistance subscale), barriers in business and government (the policies subscale), attitudes at home and discrimination (attitudes/support subscale), and help and attitudes at work or school (work/school subscale).

Figure 3 shows the frequency distribution of the total CHIEF-SF scores in the sample. Although only 20% reported no barriers (score of 0), the distribution was skewed with 75% of the cases scoring less than 1, and the remaining 25% spread across the rest of the scale with a maximum score of 8.

Subgroup Differences in CHIEF-SF Scores

Table 1 indicates average CHIEF-SF total and subscale scores across various subgroups, as defined by demographic,

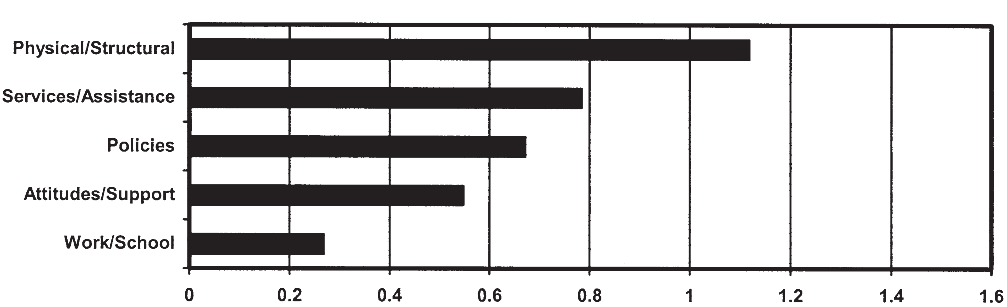

Fig 2. CHIEF subscale scores in descending product score order.

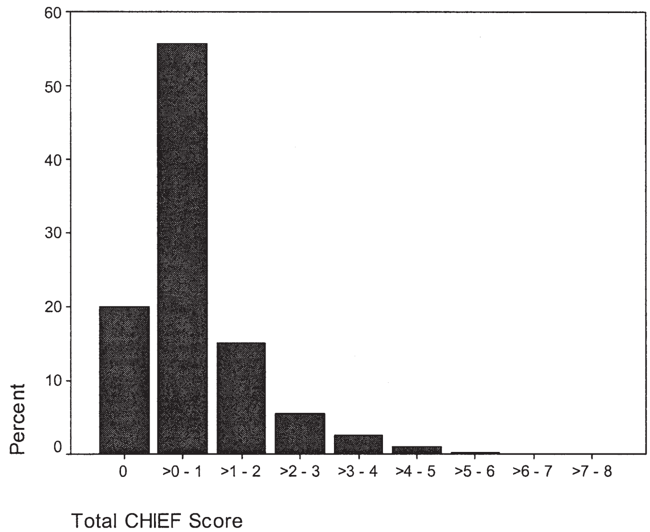

Fig 3. Distribution of CHIEF-SF total scores.

impairment, and activity limitations variables. Statistically significant differences at the .05 level (using Kruskal-Wallis tests) across the categories of an independent variable are indicated by average scores in boldface. There were significant differences in CHIEF-SF total scores by age at injury (oldest and youngest age groups reported the least barriers), by gender (women reported more barriers), by ethnicity (minorities reported more barriers), by marital status at injury (unmarried people reported more barriers), and by years postinjury (barriers lessened over time). There were also significant differences in CHIEF-SF total scores by etiology (subjects injured by a fall or falling object reported the fewest barriers, those in the "other" category reported the most barriers), by neurologic group (the more severely injured reported higher barrier levels), and by FIM scores (subjects with more activity limitations reported more barriers). Similar trends were generally found across the CHIEF-SF subscales, with the services/assistance scale and the attitudes/support scale showing the most significant differences that were consistent with the total score results.

Predictors of Participation and Life Satisfaction

Tables 2 and 3 report the results of the regression analyses to assess the relation of demographic, injury-related, activity, and environmental variables to participation and life satisfaction. First, separate regressions were performed within each independent variable category (table 2); next, variables in all categories were considered together (table 3). Both tables report the Nagelkerke pseudo R^2 value for each logistic regression, which is similar to a linear regression R^2. It indicates the predictive power or fit of the model to the data, in a manner similar to linear regression indicating the percentage of variance in the dependent variable predicted by the combination of the independent variables in the regression equation. The independent variables included in the regressions are listed in the first column with the odds ratio (OR) for each of the variables listed in the other columns. For each independent variable, a reference group has been identified, and the OR for the other group(s) of that variable is provided relative to the reference group. The OR indicates the likelihood of the selected category of the dependent variable occurring in the selected independent group, relative to its occurring in the reference group, after controlling for all other variables in the regression equation. An OR of 2.0 indicates that the dependent variable is twice as likely to occur in the selected group as in the reference group; an OR of 0.5 indicates it is only half as likely to occur as in the reference group. If the OR is statistically significant at the .05 level, then the confidence interval of the OR does not include 1.0 and the OR is in boldface.

As a group, the demographic variables were comparable to predicting 20% of the variance in the CHART-SF total score (table 2). People 50 years and older at injury were 6.43 times more likely to have a CHART-SF total score below 375 (indicating low participation) than the reference group of people less than 20 years old at injury. People in the 40 to 49 age group were 3.94 times more likely to report low participation than the reference group of people under age 20; those in the 30 to 39 age group were 1.93 times more likely to do so, but those in the 20 to 29 age group were not significantly more likely than the under 20 age group to have low participation. People who were 5 or more years postinjury were significantly less likely to report low participation than the reference group of people 1-year postinjury. Members of minority groups were 2.33 times more likely to have CHART-SF total scores below 375 than were whites. High school graduates were only .71 times as likely to have low CHART-SF scores as were those who did not finish high school, and those with more than a high school education were only .26 times as likely to report low CHART-SF scores compared with those with less than a high school education at injury. People in school when injured were only .62 times as likely to show low participation as those in the occupation reference group of "other," and those married at injury were only .67 times as likely to have participation deficits compared with those not married when injured.

Variables in the injury-related category were comparable to predicting 14% of the variance in CHART-SF total scores (above and below 375). People with higher level injuries were more likely to report lower participation, and subjects injured by violence or falls also had higher probabilities of having lower participation. The FIM motor score, the only variable in the activity limitations category, was comparable to predicting 20% of the variance in the CHART-SF total score, with more severe activity limitations being associated with less participation. Finally, while 3 CHIEF-SF subscales (physical/structural, services/assistance, attitudes/support) had significant ORs, indicating that more barriers were associated with less participation, the ORs were only 1.30 to 1.85; and taken together, the CHIEF-SF subscales were only comparable to predicting 4% of the variability in CHART-SF scores.

The second column of table 3 shows that all the demographic, injury-related, activity, and environmental variables combined were comparable to predicting 40% of the variance in the CHART-SF total score, with those having a motor FIM score in the lowest quartile and those more than 50 years old at injury reporting lower participation. The CHIEF-SF subscales, however, were not significant predictors in this model that included variables from all categories.

Among the CHART-SF subscales, physical independence (with a total comparable to 38% of its variance explained) had significant ORs for activity limitations, impairment, and demographic variables. Cognitive independence (with a total comparable to 30% of explained variance) had significant ORs for activity limitations, impairment, demographics, and CHIEF-SF attitudes and support. Mobility (with a total comparable to 32% of explained variance) had significant ORs for activity limitations, demographics, and the CHIEF-SF services/assistance subscale. Occupation (with a total comparable to 25% of explained variance) had significant ORs for activity limitations

Table 2: Logistic Regression Models Within Variable Categories for Participation and Life Satisfaction (N=2103 cases with no missing data) Indicating Nagelkerke R^2 and ORs for Variables

Independent Variable Categories and Variables Included in Regressions	CHART 5 Subscale Total (<375)	CHART Subscales					Life Satisfaction (SWLS) (<20)
		Physical Indep (<75)	Cognitive Indep (<75)	Mobility (<75)	Occupation (<75)	Social Integration (<75)	
Demographic	**R^2=.20**	**R^2=.10**	**R^2=.17**	**R^2=.13**	**R^2=.15**	**R^2=.12**	**R^2=.11**
Age at injury (y) (referent, <20)							
20–29	1.10	0.78	**1.98**	1.31	0.93	**1.64**	0.95
30–39	**1.93**	0.97	**2.21**	**2.50**	**1.53**	**2.30**	**1.55**
40–49	**3.94**	1.22	**4.04**	**3.39**	**2.99**	**4.03**	**1.81**
50+	**6.43**	**1.68**	**4.05**	**4.56**	**4.27**	**4.32**	1.31
Years postinjury (referent, 1y)							
5	**0.69**	**0.73**	**0.45**	0.84	.77	0.97	**0.48**
10	**0.58**	1.07	**0.58**	**0.70**	**.64**	**0.62**	**0.64**
15	**0.71**	**0.68**	**0.34**	1.00	.81	1.28	**0.46**
20	**0.66**	**0.43**	**0.19**	1.22	**.63**	**1.89**	**0.35**
25	**0.47**	**0.27**	**0.05**	**1.14**	**.70**	1.25	**0.33**
Gender (referent, male)							
Female	0.88	1.01	0.92	1.20	**0.65**	0.81	**0.78**
Ethnicity (referent, nonminor)							
Minority	**2.33**	**1.81**	**1.81**	**1.88**	**1.81**	**1.81**	**1.43**
Education at injury (referent, <HS)							
HS graduate	**0.71**	**0.74**	**0.67**	**0.70**	**0.79**	**0.73**	1.01
>HS	**0.26**	**0.61**	**0.35**	**0.32**	**0.42**	**0.24**	0.82
Occupation at injury (referent, other)							
Working	0.94	0.79	**0.63**	0.84	1.02	**0.73**	0.98
In school	**0.62**	0.70	0.89	**0.50**	**0.54**	**0.40**	**0.61**
Marital status at injury (referent, not married)							
Married	**0.67**	0.92	1.02	0.85	**0.71**	**0.49**	**0.73**
Injury related	**R^2=.14**	**R^2=.19**	**R^2=.05**	**R^2=.10**	**R^2=.07**	**R^2=.03**	**R^2=.03**
Etiology (referent, vehicular)							
Violence	**2.37**	**2.14**	**1.53**	**1.67**	**2.00**	**2.08**	**1.63**
Sports	**0.43**	0.83	**0.59**	**0.41**	**0.57**	**0.43**	**0.59**
Fall/falling object	**1.73**	**1.38**	**1.58**	**1.37**	**1.63**	1.09	1.11
Other	1.49	1.05	1.63	**1.79**	1.40	0.92	1.30
Neurologic group (referent, ASIA grade D)							
C1-4 ABC	**5.47**	**11.75**	**3.37**	**5.29**	**2.86**	1.21	**1.59**
C5-8 ABC	**2.52**	**3.92**	**1.62**	**2.66**	**1.77**	1.22	**1.56**
Para ABC	0.83	1.08	0.87	1.20	0.88	0.83	1.10
Activity Limitations	**R^2=.20**	**R^2=.24**	**R^2=.11**	**R^2=.18**	**R^2=.09**	**R^2=.01**	**R^2=.03**
FIM motor total (referent, 4th quartile)							
Lowest quartile	**7.17**	**12.91**	**5.03**	**7.76**	**3.50**	**1.40**	**1.66**
2nd quartile	**4.53**	**6.06**	**3.50**	**4.91**	**2.66**	**1.65**	**1.91**
3rd quartile	0.99	1.08	0.66	**1.43**	1.12	1.00	0.97
Environmental factors	**R^2=.04**	**R^2=.03**	**R^2=.03**	**R^2=.04**	**R^2=.02**	**R^2=.01**	**R^2=.10**
CHIEF physical/structural (referent, 0–1)							
>1	**1.30**	**1.40**	1.20	**1.31**	**1.30**	1.15	**1.94**
CHIEF services/assistance (referent 0–1)							
>1	**1.85**	**1.52**	**1.52**	**1.91**	**1.59**	**1.39**	**1.95**
CHIEF attitudinal/support (referent, 0–1)							
>1	**1.33**	**1.38**	**1.90**	1.02	1.10	1.21	**1.77**
CHIEF policy (referent, 0–1)							
>1	0.89	1.11	0.92	0.98	0.86	0.81	0.96
Participation							**R^2=.15**
CHART physical independence (referent, 75–100)							
<75							**1.38**
CHART cognitive independence (referent, 75–100)							
<75							1.26
CHART mobility (referent, 75–100)							
<75							**1.51**
CHART occupation (referent, 75–100)							
<75							**2.41**
CHART social integration (referent, 75–100)							
<75							**2.14**

NOTE. Bold indicates that the Nagelkerke R^2 or OR is significant at the .05 level.
Abbreviation: Indep, independence.

Table 3: Final Logistic Regression Models Across Variable Domains for Participation and Life Satisfaction (N=2103 cases with no missing data) Indicating Nagelkerke R^2 and ORs for Variables

Independent Variable Categories and Variables Included in Regressions	CHART 5 Subscale Total (<375)	CHART Subscales					Life Satisfaction (SWLS) (<20)
		Physical Indep (<75)	Cognitive Indep (<75)	Mobility (<75)	Occupation (<75)	Social Integration (<75)	
Demographic	**R^2=.40**	**R^2=.38**	**R^2=.30**	**R^2=.32**	**R^2=.25**	**R^2=.14**	**R^2=.26**
Age at Injury (y) (referent, <20)							
20–29	1.05	0.70	**1.89**	1.30	0.89	**1.69**	0.84
30–39	**1.70**	0.69	1.58	**2.34**	1.35	**2.34**	1.13
40–49	**4.03**	1.03	**3.05**	**3.17**	**2.64**	**4.15**	1.07
50+	**7.02**	1.55	**2.87**	**4.92**	**3.86**	**4.64**	0.81
Years postinjury (referent, 1y)							
5	**0.65**	**0.64**	**0.39**	0.85	0.77	1.00	**0.52**
10	**0.54**	1.15	**0.57**	**0.70**	**0.61**	**0.63**	**0.74**
15	**0.56**	**0.51**	**0.25**	0.92	**0.72**	1.28	**0.45**
20	**0.52**	**0.28**	**0.14**	1.19	**0.56**	**2.04**	**0.36**
25	**0.41**	**0.20**	**0.03**	1.25	**0.68**	1.32	**0.37**
Gender (referent, male)							
Female	0.86	1.19	0.93	1.19	**0.63**	0.76	**0.75**
Ethnicity (referent, white)							
Minority	**2.38**	**2.17**	**1.94**	**1.84**	**1.65**	**1.51**	1.06
Education at Injury (referent, <HS)							
HS graduate	**0.74**	**0.75**	**0.67**	**0.73**	**0.83**	0.76	1.15
>HS	**0.26**	**0.68**	**0.37**	**0.35**	**0.49**	**0.26**	1.32
Occupation at Injury (referent, other)							
Working	1.03	0.79	**0.61**	0.89	1.11	0.78	1.14
In school	**0.54**	**0.49**	0.71	**0.44**	**0.52**	**0.47**	**0.87**
Marital status at Injury (referent, not married)							
Married	**0.63**	0.93	1.02	0.83	**0.72**	**0.50**	0.92
Injury related							
Etiology (referent, vehicle)							
Violence	**1.70**	1.37	1.04	1.28	**1.49**	**1.49**	1.22
Sports	**0.61**	1.23	1.00	**0.54**	**0.72**	**0.54**	0.78
Fall/falling object	**1.47**	1.30	1.48	1.14	1.29	0.89	0.94
Other	0.97	0.80	1.33	1.24	1.05	0.72	1.22
Neurologic group (referent, all ASIA grade D)							
C1-4 ABC	**1.74**	**3.68**	0.75	1.57	1.20	1.03	0.95
C5-8 ABC	1.13	**1.67**	**0.55**	1.06	1.03	1.01	1.32
Para ABC	0.77	0.96	0.76	1.10	0.85	0.80	1.20
Activity limitations							
FIM motor total (referent, 4th quartile)							
Lowest quartile	**10.27**	**9.82**	**10.47**	**9.44**	**4.40**	1.36	1.10
2nd quartile	**4.85**	**4.76**	**3.74**	**4.63**	**2.65**	**1.54**	1.09
3rd quartile	1.37	1.16	0.87	**1.64**	**1.45**	0.91	0.89
Environmental factors							
CHIEF physical/structural (referent, 0–1)							
>1	1.19	1.30	1.04	1.27	1.18	1.15	**1.73**
CHIEF services/assistance (referent, 0–1)							
>1	1.24	1.07	**0.93**	**1.35**	1.20	1.07	**1.57**
CHIEF attitudinal/support (referent, 0–1)							
>1	1.33	1.31	**1.87**	0.94	1.08	1.18	**1.81**
CHIEF policy (referent, 0–1)							
>1	**0.83**	**0.96**	**0.85**	**0.96**	**0.85**	**0.91**	**0.99**
Participation							
CHART physical independence (referent, 75–100)							
<75							**1.13**
CHART cognitive independence (referent, 75–100)							
<75							**0.96**
CHART mobility (referent, 75–100)							
<75							**1.39**
CHART occupation (referent, 75–100)							
<75							**2.17**
CHART social integration (referent, 75–100)							
<75							**2.27**

NOTE. Bold Indicates that the Nagelkerke R^2 or OR is significant at the .05 level.

and demographics. Social integration (with a total only comparable to 14% of explained variance) had significant ORs for demographics and activity limitations.

We found a somewhat different pattern of relationships for life satisfaction. A total comparable to 26% of the variance in life satisfaction scores (above or below 20 on the SWLS) was predicted by a combination of variables from all categories. Variables in the injury-related and activity limitations categories explained only 3% of the variance each (table 2), whereas the demographic category explained 11% of the variance, environmental factors explained 10%, and participation explained 15%. When all categories were considered simultaneously (table 3), the only variables with significant ORs were 3 CHIEF-SF subscales (physical/structural, services/assistance, attitudes/support), 3 CHART-SF subscales (mobility, occupation, social integration), and years postinjury. Subjects reporting high CHIEF-SF subscale scores (>1) and/or low participation subscale scores (<75) were more likely also to report low SWLS scores (<20). People who were more years postinjury were less likely to report low level of life satisfaction.

DISCUSSION

We used the NSCID to identify environmental barriers reported in the years after injury, and to determine how the reports of environmental barriers differed among groups defined by demographic and injury characteristics and activity limitations. We also assessed the relative impact of environmental barriers compared with personal factors, impairment, and activity limitations on societal participation and life satisfaction.

Twenty percent of our participants reported that none of the 12 environmental areas assessed by the CHIEF-SF were ever barriers for doing what they wanted or needed to do; the other 80% reported encountering barriers, ranging from infrequent small problems to large problems encountered daily. The 5 top barriers, in descending order, were the natural environment, transportation, help at home, health care, and government policies. These barriers are consistent with environmental issues discussed in SCI literature and they appear to be related to the physical impairments, activity limitations, and participation restrictions common to SCI. Although the scores on the top 5 barriers were relatively low (0.78–1.55) compared with the possible scale range of 0 to 8, the CHIEF-SF scores were dramatically higher for the SCI sample than for nondisabled general population norms. The top 4 SCI barriers all had product scores more than twice those of people without disability, whereas the fifth barrier was 30% higher in the study sample.[24]

The total CHIEF-SF score and many of the CHIEF-SF subscale scores differed significantly by several demographic and injury characteristics. Groups reporting more environmental barriers included middle-aged subjects, women, minorities, those not married at the time of injury, those injured more recently, those with higher levels of injury, and those with greater activity limitations. It seems possible that women and minorities may have experienced added social exclusion and that those with higher levels of injury and greater activity limitations may have encountered more physical barriers.

Contrary to the current conceptual models and theories of disability, environmental factors (as measured by the CHIEF-SF) did not have a major effect on participation (as measured by the CHART-SF), particularly when considered in conjunction with the influences of personal factors, impairment, and activity limitations. Although 3 of the CHIEF-SF subscales (physical/structural, services/assistance, attitudes/support) were significant predictors of the total CHART-SF and several of its subscales, these CHIEF-SF subscales only explained less than 5% of the variance in participation. Furthermore, when considered with other variable categories, the environmental factors rarely added any significant explanatory value beyond that of personal factors, impairment, and activity limitations.

However, environmental factors were major predictors of life satisfaction, with the CHIEF-SF subscales predicting 10% of the variance. When considered with other categories, environmental factors, participation, years postinjury, and gender were the only significant predictors of life satisfaction.

Limitations and Future Research

The generalizability of our results is limited by the high proportion of cases lost to follow-up or who did not complete the CHIEF-SF. The reasons for nonparticipation are likely not random and may be influenced by the key variables studied—environmental factors. Furthermore, substantial information was lost in the regression analyses because CHIEF-SF, CHART-SF, and SWLS scores were dichotomized as a way to address their skewed distributions.

The instruments we used also have limitations. They do not fully assess the conceptual domains they represent. For example, the demographics include only rudimentary individual characteristics. Most of the domains were measured by only 1 instrument.

The CHIEF-SF, while covering representative content of environmental factors, only assesses the negative aspects of environmental factors—barriers—and does not measure the theoretically important extent to which aspects of the environment facilitate participation. The CHIEF-SF scores were relatively low and skewed, which required dichotomizing the measure and may have resulted in some loss of information. The fact that CHIEF-SF scores reflect the average of multiplicative terms may weaken its measurement properties, despite the common practice. More important, CHIEF-SF only assesses a person's subjective perceptions. The relation between perceived and actual barriers is not known.[49] Insurmountable barriers that are always systematically avoided may not be reported in the CHIEF-SF. Conversely, some respondents may not perceive as barriers environmental factors that can be overcome. Environmental barriers that prevent people from working or going to school are systematically excluded within the CHIEF-SF, because the 2 short-form items dealing with this area are considered not applicable if the person is neither working nor in school. This may account for the finding that work/school barriers have the lowest scores of any of the CHIEF-SF subscales. That subscale only measures the barriers reported by people who are working or in school and who may not report many barriers, but there may be substantial unreported barriers that prevent people from working or going to school. The high proportion of missing data on the subscale made it unusable in the regression analyses.

Considering the above study limitations, the finding that environmental factors are not critical determinants of societal participation (compared with personal factors, impairments, and activity limitations) may reflect methodologic weaknesses rather than positive evidence that such factors add little to the prediction of societal participation of people with SCI. A central tenet of the social model of disability is that environmental factors are major influences and moderators of participation. Rather than calling this conceptual relationship into question, our findings may reflect the inadequacy of environmental measurement (assessing barriers but not facilitators, assessing subjective perceptions rather than more objective criteria, and the dichotomization of the scale).

Three types of future research are needed to adequately address this issue. Improved measures of environmental factors may reveal stronger relationships between the environment and participation than we identified. Examining the relationship of specific environmental barriers to selected types of participation may be a more fruitful research strategy than our general approach in this study. Ultimately, interventional research systematically modifying environmental factors will be necessary to test for causal relationships between environmental barriers and participation.

CONCLUSIONS

This study supports previous research findings that life satisfaction is more strongly related to participation than to impairment or activity limitations.[33] It also suggests that environmental factors are substantial contributors to life satisfaction. Interestingly, the reporting of environmental barriers was more strongly related to life satisfaction than to participation. This potentially indicates that people facing barriers may, with added difficulty, be able to overcome them, but that the experience of encountering barriers may reduce life satisfaction. It raises the question whether the observed strength of the relation between environmental factors and life satisfaction is due to barriers being assessed through subjective self-reports rather than more objectively.[49] Is life satisfaction more closely related to perceived barriers than to objective environmental assessments? Can or should environmental factors be assessed independently from the person with a disability? Many conceptual and empirical questions remain. Substantially more research is needed to adequately assess the role of environmental factors in the lives of people with SCI.

References

1. Consortium for Spinal Cord Medicine. Outcomes following traumatic spinal cord injury: clinical guidelines for health care professionals. Washington (DC): Paralyzed Veterans of America; 1999.
2. Gerhart K, Bergstrom E, Charlifue S, Menter R, Whiteneck G. Long-term spinal cord injury: functional changes over time. Arch Phys Med Rehabil 1993;74:1030-4.
3. Chen D, Apple D, Hudson L, Bode R. Medical complications during acute rehabilitation following spinal cord injury—current experience of the Model Systems. Arch Phys Med Rehabil 1999; 80:1397-401.
4. McKinley W, Jackson A, Cardenas D, DeVivo M. Long-term medical complications after traumatic spinal cord injury: a regional Model Systems analysis. Arch Phys Med Rehabil 1999;80: 1402-10.
5. DeVivo M, Krause J, Lammertse D. Recent trends in mortality and causes of death among persons with spinal cord injury. Arch Phys Med Rehabil 1999;80:1411-9.
6. Gerhart K, Weitzenkamp D, Kennedy P, Glass C, Charlifue S. Correlates of stress in long-term spinal injury. Spinal Cord 1999; 37:183-90.
7. Rintala D, Hart K, Fuhrer M. Perceived stress in individuals with spinal cord injury. In: Women with physical disabilities: achieving and maintaining health and well-being. Baltimore: PH Brookes; 1997. p 223-42.
8. Fuhrer M, Rintala D, Hart K. Interrelationships among psychological stress and the components of disablement for people with spinal cord injury. IRMA VIII: the 8th World Congress of the International Rehabilitation Medicine Association. Bologna (Italy): Monduzzi Editore SpA; 1997. p 693-7.
9. Krause JS, Crewe NM. Long-term prediction of self-reported problems following spinal cord injury. Paraplegia 1990;28:186-202.
10. El Ghatit AZ, Hanson RW. Marriage and divorce after spinal cord injury. Arch Phys Med Rehabil 1976;57:470-2.
11. El Ghatit AZ, Hanson RW. Outcome of marriages existing at the time of a male's spinal cord injury. J Chronic Dis 1975;28:383-8.
12. El Ghatit AZ. Variables associated with obtaining and sustaining employment among spinal cord injured males: a follow-up of 760 veterans. J Chronic Dis 1987;31:363-9.
13. Kemp BJ, Vash CJ. Productivity after injury in a sample of spinal cord injured persons: a pilot study. J Chronic Dis 1971;24:259-75.
14. DeVivo M, Fine P. Employment status of spinal cord injured patients three years after injury. Arch Phys Med Rehabil 1982; 65:66-73.
15. Creek G, Moore M, Oliver M, Salisbury V, Silver J, Zarb G. Personal and social implications of spinal cord injury: a retrospective study. London: Thames Polytechnic; 1987.
16. Whiteneck G, Charlifue SW, Frankel HL, et al. Mortality, morbidity, and psychosocial outcomes of persons spinal cord injured more than 20 years ago. Paraplegia 1992;30:616-30.
17. World Health Organization. International classification of impairments, disabilities and handicaps: a manual of classification relating to the consequences of disease. Geneva: WHO; 1980.
18. World Health Organization. International classification of functioning, disability and health. Geneva: WHO; 2002.
19. Americans with Disabilities Act. Pub L No. 101-336 (1990). Available at: http://www.usdoj.gov/crt/ada/pubs/ada.txt. Accessed October 20, 2003.
20. National Institute on Disability and Rehabilitation Research. National Institute on Disability and Rehabilitation Research (NIDRR) long range plan for fiscal years 1999-2003. Available at: http://www.ncddr.org/new/announcements/nidrr_lrp/index.html. Accessed October 20, 2003.
21. Brandt E, Pope A. Enabling America: assessing the role of rehabilitation science and engineering. Washington (DC): Natl Acad Pr; 1997.
22. Whiteneck G, Brooks C, Charlifue S, et al. Guide for use of CHART: Craig Hospital Assessment and Reporting Technique. Englewood (CO): Craig Hospital; 1992.
23. Willer B, Rosenthal M, Kreutzer J, Gordan W, Rempel R. Assessment of community integration following rehabilitation for traumatic brain injury. J Head Trauma Rehabil 1993;8(2):75-87.
24. Craig Hospital Research Department. Craig Hospital Inventory of Environmental Factors (CHIEF) manual, version 3.0. Englewood (CO): Craig Hospital; 2001.
25. UN GA Res 31/123, 31 Sess, Supp No 39, UN Doc A/31/39 (1976).
26. UN GA Res 37/52, 31 Sess, Supp No 51, UN Doc A/37/51 (1982).
27. Noreau L, Fougeyrollas P. Profile of social consequences of long-standing spinal cord injury: the occurrence of handicap situations. Disabil Rehabil 2000;22(4):170-80.
28. Fougeyrollas P, Noreau L, St. Michael G. Measure of the Quality of the Environment–version 1.0. Lac St. Charles (QC): Classification internationale des déficiences, incapacités et handicaps; 1997.
29. Fougeyrollas P, Noreau L, Bergeron H, Cloutier R, Dion SA, St Michel G. Social consequences of long-term impairments and disabilities: conceptual approach and assessment of handicap. Int J Rehabil Res 1998;21:127-41.
30. Harwood RH, Rogers A, Dickinson E, Ebrahim S. Measuring handicap: the London Handicap Scale, a new outcome measure for chronic disease. Quality Health Care 1994;3:11-6.
31. Whiteneck G. Outcome analysis in spinal cord injury rehabilitation. In: Fuhrer MJ, editor. Rehabilitation outcomes: analysis and measurement. Baltimore: PH Brookes; 1987. p 221-31.
32. Whiteneck G. Outcome evaluation and spinal cord injury. Neurorehabilitation 1992;2:31-41.
33. Dijkers M. Quality of life after spinal cord injury: a meta analysis of the effects of disablement components. Spinal Cord 1997;35: 829-40.
34. Noreau L, Fougeyrollas P, Boschen K. The perceived influence of the environment on social participation among individuals with spinal cord injury. Top Spinal Cord Inj Rehabil 2002;7(6):56-76.
35. Fougeyrollas P, Noreau L, Boschen K. Interaction of environment with individual characteristics and social participation: theoretical perspectives and applications in persons with spinal cord injury. Top Spinal Cord Inj Rehabil 2002;7(6):1-16.
36. Gray D, Gould M, Bickenbach J. Environmental barriers and disability. J Architect Plann Res 2003;20:29-37.

37. Richards JS, Bombardier CH, Tate D, et al. Access to the environment and life satisfaction after spinal cord injury. Arch Phys Med Rehabil 1999;80:1501-13.
38. Diener E, Emmons RA, Larson RJ, Griffin S. The satisfaction with life scale. J Pers Assess 1985;49:71-4.
39. Duggan C, Dijkers M. Quality of life after spinal cord injury: a qualitative study. Rehabil Psychol 2001;46:3-27.
40. Post MW, van Dijk AJ, van Asbeck FW, Schrijvers AJ. Life satisfaction of persons with spinal cord injury. Arch Phys Med Rehabil 1998;78:395-401.
41. Schneidert M, Hurst R, Miller J, Ustun B. The role of the environment in the International Classification of Functioning, Disability and Health (ICF). Disabil Rehabil 2003;25:588-95.
42. American Spinal Cord Injury Association. International standards for neurological classification of spinal cord injury, revised 2002. Chicago: ASIA; 2002.
43. Uniform Data System for Medical Rehabilitation. Guide for the Uniform Data Set for Medical Rehabilitation (Adult FIM), version 4. Buffalo: UB Foundation Activities; 1993.
44. Whiteneck GG, Charlifue SW, Gerhart KA, Overholser JD, Richardson GN. Quantifying handicap: a new measure of long-term rehabilitation outcomes. Arch Phys Med Rehabil 1992;73:519-26.
45. Granger CV, Fiedler RC. The measurement of disability. In: Fuhrer MJ, editor. Assessing medical rehabilitation practices: the promise of outcome research. Baltimore: PH Brookes; 1997. p 103-26.
46. Smith M, Illig SB, Fielder RC, Hamilton BB, Ottenbacher KJ. Intermodal agreement of follow-up telephone functional assessment using the Functional Independence Measure in patients with stroke. Arch Phys Med Rehabil 1996;77:431-5.
47. Pavot W, Diener E, Colvin CR, Sandvik E. Further validation of the Satisfaction with Life Scale: evidence for the cross-method convergence of well-being measures. J Pers Assess 1991;57:149-61.
48. Yardley JK, Rice RW. The relationship between mood and subjective well-being. Soc Indicators Res 1991;57:149-61.
49. Dijkers MP, Yavuzer G, Ergin S, Weitzenkamp D, Whiteneck GG. A tale of two countries: environmental impacts on social participation after spinal cord injury. Spinal Cord 2002;40:351-62.