Paraplegia

Long Term Prediction of Self-reported Problems Following Spinal Cord Injury

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Summary

Past studies of the long term consequences of spinal cord injury (SCI) have used both univariate and multivariate techniques to identify variables predictive of long term problems. Studies using multiple regression and discriminant analysis, while generating valuable data, have often used insufficient sample sizes and have rarely included cross-validation procedures. In the present study, completed questionnaires were obtained from 347 persons with SCI in 1985, 154 of whom also completed questionnaires in 1974. Factor analysis was first used to identify 3 underlying dimensions of self-reported problems including Emotional Distress, Dependency, and Health Problems. Scores on these 3 dimensions were then used as dependent variables with multiple regression. Three organic variables (age, duration of injury and injury level) and 5 adjustment variables (work status, activity level, medical stability, interpersonal satisfaction and economic satisfaction) were used as predictors. Regression equations were generated on the subjects completing only the 1985 questionnaire (N = 193) and cross-validated on persons completing both questionnaires (n = 154). The highest cross-validated squared multiple correlations were obtained for Dependency (SMC = 0.43), followed by Health Problems (SMC = 0.28) and Emotional Distress (SMC = 0.15). Adjustment variables proved to be the better predictors than organic variables, even though the organic variables were entered first. Organic predictors were somewhat useful in predicting Health Problems and Dependency, but of no value in predicting Emotional Distress. When the 1974 data was used to predict 1985 problems considerably smaller SMCs were noted (Dependence = 0.19; Health Problems = 0.11; Emotional Distress = 0.07), although all SMC's remained significant ($p < 0.01$). Implications for counsellors and other rehabilitation professionals are discussed.

Key words: Spinal cord injury; Adjustment; Prediction of psychological problems; Paraplegia.

Traumatic spinal cord injury (SCI) occurs suddenly and precipitates changes in nearly every aspect of life. Motor and sensory impairments frequently lead to long term health problems. Higher mortality rates are observed, especially among quadriplegics with complete lesions (Geisler *et al.*, 1983). Approximately 80% of persons with SCI report abnormal sensations following SCI, with pain occurring in nearly half of these cases (Nepomuceno *et al.*, 1979).

Rehabilitation professionals have often described psychological difficulties such as depression and loneliness (Siller, 1969), although the universality of these reactions following SCI has not been documented by recent research (Cook, 1979; Richards, 1986). Dependency in some form is unavoidable for persons with high level injuries. In addition, social isolation frequently occurs following rehabilitation (Cogswell, 1968). Family relations may become strained and marriages initiated prior to injury may show the detrimental effects of change and loss (Crewe *et al.*, 1978). Finances may become troublesome as persons frequently lose their ability to earn income and are burdened with medical expenses. Alcohol and drug abuse become of concern as persons with SCI are often injured in alcohol or drug-related accidents (O'Donnell *et al.*, 1981–1982). Lastly, environmental barriers exist as persons must deal with architectural barriers and prejudicial public attitudes (Siller *et al.*, 1967).

Different persons experience these problems in varying degrees. These differences may be related to demographic or injury related variables such as injury level or age (labelled organic variables by Trieschmann, 1978), characteristics of the environment or to characteristics of the persons themselves (personality or personal adjustment).

Univariate studies of differential adjustment

General outcomes

Several researchers have attempted to identify variables correlated with general outcomes such as adjustment, acceptance of disability, self-concept or activity patterns following SCI. Nickerson (1971) found persons with more education and higher socioeconomic status were more likely to be rated as having better in-hospital and out-of-hospital adjustment. Woodrich and Patterson (1983) also found educational level correlated with acceptance of SCI. Age and duration of disability were negatively correlated with acceptance, while women were found to be more accepting than men. Injury level, marital status and race were unrelated to acceptance.

In a study using the Tennessee Self-Concept Scale (TSCS), Green *et al.* (1984) found strong positive correlations between educational level and self-concept subscales. Significant negative correlations were obtained between current age and age at onset with a limited subset of TSCS scales. In a study of activity patterns, MacDonald and associates (MacDonald *et al.*, 1987) found non-depressed paraplegics in general to be more active than non-depressed quadriplegics, but that these differences disappeared when subjects were depressed. No differences were found as a function of gender, or completeness of injury.

Psychometric variables and long term outcomes

When psychometric measures of distress and depression are used (MMPI for example), the role of organic variables becomes less important. Cook (1979) found few relationships between Mini-Mult scores and several variables (age, gender, injury level, duration of injury or cause of injury), except that older persons scored higher on 5 scales (F,K,1,2,3) and paraplegics more likely to show denial and quadriplegics more likely to have anxiety reactions. Similarly, Frank and Elliot (1987) found that negative life events were highly correlated with measures of distress and depression, but time since injury was not.

Two studies identified variables during hospitalisation that were correlated with long term psychosocial and vocational outcomes. Goldberg and Freed (1982) correlated several measures of vocational development during rehabilitation with the amount of time spent working 8 years later. Several measures of vocational development including having specific and realistic vocational plans, educational level, intrinsic and consistent work values, high motivation to work and a positive rehabilitation outlook were all positively correlated with time working. None of the demographic or injury related variables including age, injury level, duration of disability or completeness of injury were significantly correlated with the outcome. Gordon *et al.* (1982) found that the presence of pressure sores during hospitalisation predicted 2 of 7 measures of psychosocial adjustment 1 to 4 years later.

Multivariate studies of differential adjustment*Productivity*

In 3 studies of productivity, multiple regression or discriminant analysis were used to identify the optimal set of predictor variables. Of 15 potential predictor variables, Kemp and Vash (1971) found that having many goals, reporting losses of activities as more important than losses of physical functioning, greater creativity and younger age predicted greater productivity among 50 persons with SCI (accounting for 71% of the variance in responding). They found that (age at onset, injury level, sex, race and duration of SCI failed to significantly add to the equation). DeJong *et al.* (1984) found that the 6 best of a possible 16 predictors of productivity ($n = 75$) were the absence of transportation barriers, absence of disincentives, higher educational level, higher Barthel scores, greater vocational rehabilitation services provided, and younger age. Variables such as gender, marital status, duration of injury and age at onset did not aid in prediction.

DeVivo and Fine (1982) used discriminate analysis to predict vocational status among 60 persons with SCI using 8 of an initial set of 18 variables. Age at injury (favouring those less than 24 at injury), race (being white), and having a better pre-injury work history were the best predictors of employment outcome. Results were cross-validated on a second sample of 34 persons with the percentage of persons who were correctly classified as unemployed remaining at approximately 83% (few false positives). However, the percentage of persons

correctly classified as employed dropped from 97% to 59% (therefore a large number of false negatives).

Short term health and activity related outcomes

Four studies used multiple regression to predict activity and health related outcomes. In the previously mentioned study by DeJong *et al.* (1984), marital status (being married), absence of transportation barriers, gender (female), older age at onset, less medical supervision, and fewer unmet OT needs all were predictive of ability to live in the least restrictive environment. Similarly, Malec and Niemeier (1983) found measures of psychological distress and depression predicted a substantial amount of variance in length of rehabilitation stay and measures of performance in skin and bladder care at discharge and follow-up for a small sample ($n = 28$) of persons with SCI.

In a study of the relationship between in-hospital and post-discharge behaviours of 14 SCI patients, Norris-Baker *et al.* (1981) used factor analysis (to reduce the number of behavioural predictors) and stepwise multiple regression (to identify the optimal set of predictors). The authors found a strong relationship between in-hospital and post-hospital behaviours. In a similar study, Rintala and Williams (1987) found that in-hospital behaviours of 39 SCI patients were generally better predictors of post-discharge outcomes than were demographic variables. Three sets of regression analyses were run on each of the 19 dependent measures (results with only 4 dependent variables were reported) using demographic predictors, behavioural predictors and a combination of behavioural and demographic predictors.

Long term general and health outcomes

In the previously cited study by Green *et al.* (1984) involving 71 subjects, several significant predictors of higher self-concept subscales were identified. These included: greater perceived independence with higher physical, personal, social and total scales; ability to drive with higher personal, social and total scores; the need for greater assistance with higher moral, ethical, social and total scores; and living with friends rather than in a residential care facility had higher personal self scores. Using path analysis with a SCI sample ($n = 85$). Dew and associates (1985) found that injury level was predictive of perceptions of health and need for assistance, and also predictive of perceptions of activity level, actual activity level, number of activities performed and the amount of weekly exercise; whereas having an active role in the injury and a higher education level were more predictive of occurrence, duration and perceptions of pain. The authors concluded that there was a correspondence between the best predictors and the outcome variable such that injury level was a good predictor of activity level (a physical outcome), while perceptions of pain (with a large psychological component) was best predicted by relatively more psychological predictors (educational level, role in injury). Lastly, Richards and associates (Richards *et al.*, 1980) used regression and discriminant analysis to predict 4 outcome measures of pain. The most consistent predictors of the 4 pain outcomes were age (older persons being more susceptible), verbal IQ (higher IQ indicating

more pain), work history, and measures of psychological distress (accounting for from 15% to 44% of the variance in responding). The sample sizes varied across analyses (from 41 to 55) and as many as 30 variables were entered.

Summary of past research

Collectively, the results of this past research suggests that organic variables (such as age and age at SCI onset) and educational variables (such as educational level and SES) are significantly related to the degree to which different individuals experience various problems such as low self-esteem, depression, pain or low productivity. However, when other variables are included which are more specific to that type of outcome used, these variables seem to take on a greater importance than the more basic organic variables. Examples include goals and perceived greatest loss to productivity (Kemp and Vash, 1971), specific vocational plans to time spent working (Goldberg and Freed, 1982), behaviour during rehabilitation with behaviour post-discharge (Rintala and Willems, 1987).

Unfortunately, while these studies based on regression add to our understanding of the influence of various factors predicting long term outcomes, many of the studies included a large number of predictors with a limited number of subjects (Norris-Baker *et al.*, 1981; Rintala and Willems, 1987). In order to produce stable equations using regression, the ratio of cases to predictor variables should be large and the results must be cross-validated on an independent subject sample. Only one study (DeVivo and Fine, 1982) used a cross-validation sample.

Current objectives

The purpose of the present study is twofold; to present descriptive data on self-rated problems following SCI and to identify variables predictive of these problems. The first objective was reached by generating descriptive data on self-rated problems following SCI. Responses to several likert-type items regarding the significance of different problems were obtained from a large sample of non-hospitalised persons with SCI. These items were compared as to their relative importance among persons with SCI and were then factor analysed to identify any underlying dimensions.

The second objective is to use multiple regression (meeting the accepted requirements for sample size, number of variables chosen and cross-validation procedures) to identify an optimal set of predictors for the resulting problem dimensions. Both organic (age, duration of disability and injury level) and adjustment related predictors (indices of activity level and medical adjustment, employment status, and economic and interpersonal satisfaction) were used, with the organic variables forced into the equation first. Results were cross-validated with a second group of subjects. Cross-validation was both concurrent (with predictor data obtained at the same time as the problem ratings) and long term (predictor data obtained 11 years prior to the problem ratings).

Methods

Subjects

Two samples of subjects were used in this study. Sample 1 consisted of all persons with traumatic SCI meeting age and duration requirements (at least 18 years old and 2 years post-injury) who had participated in the Renal Function Studies (RFS) at the University of Minnesota prior to 1974. Of the 301 persons initially contacted in 1974, 256 mailed back completed questionnaires. In 1985, questionnaires were again mailed to all the 1974 participants who could be located. Of the 256 respondents, 166 again returned questionnaires in 1985, 46 persons were known to be dead, 31 could not be located and 13 were non-respondents. Twelve subjects returned questionnaires, but were dropped due to large amounts of missing data (leaving a total of 154 subjects).

Sample 2 consisted of 266 persons who began participating in the RFS programme after the initiation of the 1974 study. Of these new subjects, 208 returned questionnaires, 58 did not return surveys, 7 failed to meet screening criteria (duration and age), and another 8 were dropped from analyses due to large amounts of missing data leaving a final sample of 193 new subjects.

Table I shows the basic organic and demographic data for Sample 1 in 1974 ($n = 154$), Sample 1 in 1985 ($n = 154$), Sample 2 in 1985 ($n = 193$) and for the combined samples in 1985 ($n = 347$). Overall, the characteristics of the two samples were relatively similar when responses were compared at the time of first contact (Sample 1 was first contacted in 1974 and Sample 2 in 1985). The 2 samples were nearly identical in terms of gender (Sample 1 = 81% male, Sample 2 = 80% male), with Sample 2 somewhat older at the onset of injury ($S1 = 22$, $S2 = 26$). A greater percentage of persons with cervical lesions were found in Sample 1 (Sample 1 = 62%, Sample 2 = 54%). Compared to Sample 1 in 1974, subjects in Sample 2 were similar in terms of duration of SCI ($S1 = 9$, $S2 = 9$) and age ($S1 = 32$, $S2 = 35$), with nearly identical percentages of persons single ($S1 = 57\%$, $S2 = 56\%$) and working ($S1 = 45\%$, $S2 = 44\%$). Following the 11-year period between questionnaires (in 1985), the characteristics of Sample 1 obviously changed. Subjects in Sample 1 were now considerably older (43 years), had been disabled longer (20 years), were less likely to be single (36%) and were more likely to be working (57%) than they were in 1974.

Procedures

In 1974, the Life Satisfaction Questionnaire (LSQ) was mailed to all subjects in Sample 1 and \$5 was offered for completed returns. A second LSQ was mailed to subjects who did not respond to the initial survey.

In 1985, revised questionnaires (LSQ-R) were sent to all Sample 1 respondents from 1974 and to all Sample 2 subjects. A second mailing was again initiated for all non-respondents. Many of the 1974 subjects did not list current addresses, so follow-up phone calls to their next of kin were made to locate as many subjects as possible. Subjects were offered a copy of the book *Employment Following Spinal Cord Injury* (Crewe *et al.*, 1978) as an inducement to participate in the study.

Table I Basic demographic information for Sample 1 in 1974 and 1985, for Sample 2 in 1985 and for the combined samples in 1985

Variable	Sample 1		Sample 2	Combined
	1974	1985	1985	1985
Number of respondents	154	154	193	347
Gender				
male	81%	81%	80%	80%
female	19%	19%	20%	20%
Injury level				
cervical	62%	62%	54%	57%
TLS*	38%	38%	46%	43%
Marital status				
single	57%	36%	56%	47%
married	33%	49%	28%	37%
SWD**	10%	15%	16%	16%
Work status				
employed	45%	57%	44%	50%
unemployed	55%	43%	56%	50%
Age	32 (11)	43 (11)	35 (12)	39 (12)
Duration of injury	9 (6)	21 (6)	9 (5)	14 (8)
Age at onset	22 (9)	22 (9)	26 (12)	24 (11)
Years of education	13 (3)	14 (3)	14 (2)	14 (3)

Standard deviations appear in parentheses for all continuous variables

* Thoracic, lumbar and sacral lesions

** Separated, widowed and divorced

Instruments

The LSQ elicits mostly objective information over a broad range of behaviours relevant to psychological, social, vocational and medical adjustment. Basic organic items include age, sex, age at injury, duration of injury and injury level. Items relevant to vocational adjustment include work and school status, years of education and job tenure. Objective information was also elicited relating to activity level (frequency of visitors and social outings, sitting tolerance) and medical adjustment (number of recent doctor visits, and number and duration of recent hospitalisations). In addition, the LSQ included 2 sets of self-ratings related to psychological adjustment. These variables included 6, 5-point, likert-type life satisfaction items (living arrangements, employment, finances, social life, sex life, and general health) and 2 items asking subjects to rate their overall present and predicted future adjustment on 10-point scales.

The revised LSQ was an expanded version of the original LSQ with an additional set of 15 likert-type items. Each item required subjects to rate on a scale of 1 to 5 the degree to which they have had problems with various aspects of their lives: loneliness, boredom, depression, alcohol and drugs, difficulty in making new friends, dependency, lack of control over their lives, family problems, conflicts with attendants, attitudes toward the disabled, pain, health problems, lack of transportation, lack of accessibility, and income. With the exception of these problem items which were not included in the original LSQ, all other items used in this study appeared on both the 1974 and 1985 questionnaires.

To reduce the number of single item variables to be used as regression predictors, 2 behavioural indices (activity level and medical adjustment) were

derived by combining related items. Each index was a linear combination of 3 behavioural items. The activity index includes sitting tolerance, frequency of visitors and frequency of social outings, while the medical index combines items on recent medical history (number of hospitalisations, days hospitalised and number of non-routine doctor visits within the 2 years prior to the survey). In addition, the number of life satisfaction items were reduced by means of factor analysis.

Analyses

In the descriptive phase of this study means and standard deviations were generated for all 15 problem items for the combined sample ($n = 347$). The SPSS version of principal axis factor analysis was then applied to the problem items to reduce the number of potential dependent variables and to identify the underlying dimensions of self-rated problems. Subjects with more than 30% missing problem items were eliminated from this analysis. For the remaining subjects, missing values were estimated for each item using the sample mean. Items were eliminated prior to factoring if a halo effect in responding was observed (70% or more of the subjects reported no problem). All factors with eigenvalues greater than 1.0 were retained (a total of 3 met the criteria). A varimax rotation was used to obtain orthogonal factors with maximal interpretation. The same procedure (principal axis factor analysis with varimax rotation) was applied to the 6 life satisfaction items to reduce the number of predictors in regression.

In the prediction phase, the resulting problem factors were then used as outcome variables for multiple regression. Eight variables were chosen as predictors based on their theoretical significance and appropriateness for use in regression. These included 3 organic variables (age, duration of disability and injury level) and 5 adjustment variables (work status, the 2 behavioural indices, and 2 life satisfaction factors). Other variables such as gender and educational level were also of theoretical significance, but they were not entered for statistical reasons (too few women in the sample; education level is highly correlated with other predictors such as age and employment status). Data from the new sample (Sample 2) was used to calculate the regression coefficients (regression sample), while responses of the original sample (Sample 1) were used for cross-validation (cross-validation sample). To ensure that the same sample was used for each regression procedure, all subjects with missing values on 1 or more predictor or outcome variables were dropped from all regression analyses.

In each of the regression analyses, the 3 organic predictors were forced to enter into the equation prior to entry of 5 adjustment predictors. The SPSS version of forward selection was used to determine the order of variable entry within each set of predictors. The organic variable with the largest correlation with the outcome was therefore entered first, followed sequentially by the remaining 2 organic variables. Following entry of the 3 organic variables, the adjustment variable with the highest partial correlation with the outcome was entered first. The procedure was repeated until the partial correlation of the best remaining adjustment predictor variable with the problem dimension failed to reach significance ($p < 0.05$). By forcing organic predictors into the equation first, the importance of the adjustment predictors (of more theoretical signifi-

cance) may be assessed following statistical control for the organic predictors (identical to analysis of covariance with organic variables as covariates). The advantage over ANCOVA is that the relative contribution of each organic variable to the prediction of the outcome may also be assessed.

In the first cross-validation procedure (concurrent prediction), the equations generated from the initial regression analyses with Sample 2, were applied to the 1985 survey data of the cross-validation sample (Sample 1). In the second cross-validation procedure (long term prediction), data on predictors taken in 1974 for Sample 1 were entered into the regression equation to predict 1985 survey outcomes. The squared multiple correlations (SMC) generated from the 2 cross-validation procedures were then compared to those of the initial regression sample. Comparison of the regression sample SMC with those of the concurrent validation sample assesses actual amount of variance accounted for by the predictors following shrinkage (due to use of the least squares procedure). Squared multiple correlations for the long term prediction were then compared to those in concurrent prediction to assess the loss of prediction power due to the passage of 11 years time.

Results

Problem areas

The overall pattern of response to the 15 items indicated that these subjects perceived themselves to have relatively few long term problems following SCI (Table II). Mean ratings exceeded 2.0 on only 6 of the 15 items. The most significant problem was lack of income (2.63) followed by pain (2.37), lack of accessibility and health problems (both 2.32), boredom (2.12) and dependency (2.11). The least significant problems were alcohol and drug abuse (1.26), conflicts with attendants (1.32), attitudes towards the disabled (1.51), and difficulty in making new friends (1.53).

Factor analysis

Twelve of the 15 problem areas were included for factor analysis. Three items (conflicts with attendants, attitudes toward the disabled, and alcohol or drug abuse) were dropped prior to analysis since the incidence of problems in the sample was too low to allow predictive analysis (at least 70% of all subjects reported no problem for these three items).

Three factors were subsequently derived with eigenvalues greater than 1.0 (Table III). The three factors accounted for 57.1% of the variance in subject responding. Table IV shows the factor loadings. Boredom (0.759), loneliness (0.763) and depression (0.669) load most heavily on the first factor (labelled Emotional Distress), while lack of control (0.425) and difficulty in making new friends (0.419) have moderate loadings. The items dependency (0.589), lack of control (0.558), difficulty with transportation (0.554), family conflicts (0.486) and lack of income (0.484) all have similar loadings on the second factor which is now labelled Dependency. Lastly, pain (0.652) and health problems (0.649)

Table II Means, standard deviations, sample size and response percentages on the 15 problem items for the combined sample (n = 347)

Variable	N	Mean	SD	1	2	3	4	5
Pain	343	2.37	1.30	36	22	21	14	8
Loneliness	344	1.84	1.09	53	21	17	5	2
Lack of control over life	343	1.98	1.21	48	27	13	6	7
Difficulty in making new friends	346	1.53	0.91	68	17	9	4	1
Lack of income	344	2.63	1.46	32	20	16	17	15
Boredom	342	2.12	1.24	43	23	18	9	6
Lack of transportation	344	1.66	1.16	68	13	8	6	5
Dependency	344	2.11	1.30	47	20	17	9	8
Health Problems	346	2.32	1.29	36	26	17	15	7
Depression	345	1.84	1.05	50	26	15	6	3
Family conflicts	344	1.63	1.02	63	22	8	5	3
Conflicts with attendants	322	1.32	0.79	77	15	5	2	1
Attitudes toward the disabled	344	1.51	0.89	70	16	10	4	1
Lack of accessibility	342	2.32	1.20	34	23	25	14	4
Alcohol or drug abuse	347	1.26	0.68	84	10	4	1	1

For response categories, 1 = no problem, 3 = small problem and 5 = major problem

Table III Eigenvalues, percentage of variance and cumulative percentage of variance accounted among the problem items following principal factor analysis

	Eigenvalue	% of variance	Cumulative % of variance
Factor 1 (Emotional distress)	4.41501	36.8	36.8
Factor 2 (Dependency)	1.37349	11.4	48.2
Factor 3 (Health problems)	0.06114	8.8	57.1

Table IV Factor loadings of individual problem items with problem factors following varimax rotation

	Emotional distress	Dependency	Health problems
Pain	0.127	0.111	0.652
Loneliness	0.763	0.171	0.088
Lack of control	0.425	0.558	0.266
Difficulty/new frnd	0.419	0.283	0.055
Income	0.191	0.484	0.172
Boredom	0.759	0.253	0.043
Transportation	0.213	0.554	0.004
Dependency	0.244	0.589	0.235
Health problems	0.079	0.327	0.649
Depression	0.669	0.230	0.342
Family conflicts	0.184	0.486	0.203
Accessibility	0.063	0.331	0.226

were the only items loading heavily on the third factor called Health Problems. The items lack of accessibility and difficulty in making new friends failed to load heavily on any factor, while lack of control had moderately heavy loadings on both Emotional Distress and Dependency.

Two factors were obtained from analysis of the 6 life satisfaction items common to both surveys which accounted for 62.7% of the variance (Table V). The first factor (Table VI), labelled Interpersonal Satisfaction, had its heaviest loadings from sex life (0.794) and social life items (0.630) with general health moderately loaded (0.489). Satisfaction with finances (0.848) and employment

Table V Eigenvalues, percentage of variance and cumulative percentage of variance accounted among the life satisfaction items following principal factor analysis

	Eigenvalue	% of variance	Cumulative % of variance
Factor 1 (Interpersonal satisfaction)	2.59604	43.3	43.3
Factor 2 (Economic satisfaction)	1.16695	19.4	62.7

Table VI Factor loadings of individual life satisfaction items with life satisfaction factors following varimax rotation

	Interpersonal satisfaction	Economic satisfaction
Living arrangements	0.339	0.360
Employment	0.144	0.682
Finances	0.189	0.848
Social life	0.630	0.218
Sex life	0.794	0.057
General health	0.489	0.225

(0.682) loaded heavily on the second factor called Economic Satisfaction. The living arrangements item failed to load heavily on either factor (0.339 with Interpersonal Satisfaction and 0.360 with Economic Satisfaction).

Regression: multiple correlations for regression and cross-validation samples

Table VII shows comparisons between the regression and cross-validation groups for each of the 3 outcome variables. As can be seen, the highest SMC between the predictors and outcome variable for the regression group is for Dependency (SMC = 0.44, $p < 0.001$) followed by Emotional Distress (SMC = 0.33, $p < 0.001$) and Health Problems ($R = 0.29$, $p < 0.001$). Following concurrent cross-validation, only trivial shrinkage was observed for Dependency (SMC = 0.44 to 0.43) and Health Problems (SMC = 0.29 to 0.28). The SMC for Emotional Distress showed considerable shrinkage following concurrent cross-validation (SMC = 0.33 to 0.15). When 1974 data are used as predictors, all 3 squared multiple correlations remained significant. Dependency still produced the highest SMC (SMC = 0.19, $p < 0.001$) again followed by Health Problems (SMC = 0.11) and Emotional Distress (SMC = 0.07).

Prediction of outcome variables: order of entry of demographic injury related and primary predictors

Tables VIII, IX and X show the order of entry and variables entered for the 3 outcome equations. In each of the 3 equations, the adjustment-related variables exceeded the amount of variance accounted for by the organic variables (even though the organic variables were entered first). The contribution of the 3 organic variables to the prediction equation reached significance for Dependency and Health Problems, but not for Emotional Distress. On each of the 2 analyses reaching significance, only 1 of the 3 organic predictors accounted for a significant portion of the variance. At least 2 adjustment-related predictors

Table VII Comparisons of multiple correlations, squared multiple correlations and statistical significance for regression and cross-validation groups on emotional distress, dependency and health problems

Factor	R	Regression			N	Concurrent		Cross-validation		
		R SQ	DF	F		R	R SQ	N	Long term R	R SQ
Emotional distress	0.58	0.33	6,152	12.74	127	0.38	0.15	96	0.27	0.07**
Dependency	0.66	0.44	6,152	19.66	127	0.65	0.43	96	0.43	0.19****
Health problems	0.54	0.29	5,153	12.47	127	0.53	0.28	96	0.33	0.11**

All initial regression and concurrent cross-validation multiple correlations are significant at $p < 0.001$

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.005$ **** $p < 0.001$

Table VIII Regression summary table for emotional distress including order of variable entry, F to enter, simple correlation, multiple correlation, SMC, change in SMC due to the last variable entered, and the overall F-ratio

Variable entered	F	Simple R	Mult R	SMC	Change	Overall F
1. Injury level	2.14	0.12	0.12	0.01	0.01	2.14
2. Duration	1.33	-0.08	0.15	0.02	0.01	1.74
3. Age	0.50	-0.09	0.16	0.02	0.00	1.32
4. Interpersonal satisfaction	48.27****	-0.48	0.51	0.26	0.23	13.60****
5. Work status	12.75****	-0.31	0.56	0.31	0.06	14.05****
6. Activity index	4.54*	-0.24	0.58	0.33	0.02	12.74****
7. Economic satisfaction						
8. Medical index						

Variables not significantly contributing to the SMC at $p < 0.05$ are listed following the last variable entered

Injury level has been dichotomized such that persons with cervical injuries fall in one group and persons with thoracic, lumbar and sacral injuries in the other. A positive correlation therefore means greater problems among persons with cervical injuries

Satisfaction scores have been reversed with higher scores indicating greater satisfaction. A negative correlation indicates greater problems among persons with lower satisfaction

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.005$ **** $p < 0.001$

Table IX Regression summary table for Dependency including order of variable entry, F to enter, simple correlation, multiple correlation, SMC, change in SMC due to the last variable entered, and the overall F-ratio

Variable entered	F	Simple R	Mult R	SMC	Change	Overall F
1. Injury level	8.06***	0.22	0.22	0.05	0.05	8.06***
2. Duration	1.14	-0.07	0.24	0.06	0.01	4.61*
3. Age	1.11	-0.07	0.24	0.06	0.00	3.09*
4. Economic satisfaction	77.56****	-0.59	0.61	0.37	0.32	22.88****
5. Interpersonal satisfaction	9.95***	-0.30	0.64	0.41	0.04	21.36****
6. Medical index	6.97**	-0.32	0.66	0.44	0.03	19.66****
7. Work status						
8. Activity index						

Variables not significantly contributing to the SMC at $p < 0.05$ are listed following the last variable entered

Injury level has been dichotomized such that persons with cervical injuries fall in one group and persons with thoracic, lumbar and sacral injuries in the other. A positive correlation therefore means greater problems among persons with cervical injuries

Satisfaction scores have been reversed with higher scores indicating greater satisfaction. A negative correlation indicates greater problems among persons with lower satisfaction

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.005$ **** $p < 0.001$

reached significance in every case with as many as 3 of these predictors contributing to the prediction equation (Dependency).

Table X Regression summary table for Health problems including order of variable entry, F to enter, simple correlation, multiple correlation, SMC, change in SMC due to the last variable entered, and the overall F-ratio

Variable entered	F	Simple R	Mult R	SMC	Change	Overall F
1. Age	9.19***	0.24	0.24	0.06	0.06	9.19***
2. Duration	2.06	-0.04	0.26	0.07	0.01	5.66***
3. Injury level	0.62	-0.02	0.27	0.07	0.00	3.97**
4. Medical index	40.75****	-0.49	0.52	0.27	0.19	13.93****
5. Interpersonal satisfaction	5.14*	-0.26	0.54	0.29	0.02	12.47****
6. Activity index						
7. Economic satisfaction						
8. Work status						

Variables not significantly contributing to the SMC at $p < 0.05$ are listed following the last variable entered

Injury level has been dichotomized such that persons with cervical injuries fall in one group and persons with thoracic, lumbar and sacral injuries in the other. A positive correlation therefore means greater problems among persons with cervical injuries

Satisfaction scores have been reversed with higher scores indicating greater satisfaction. A negative correlation indicates greater problems among persons with lower satisfaction

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.005$ **** $p < 0.001$

Six variables were entered for Emotional Distress and Dependency, while 5 predictors were included for Health Problems. Three variables (interpersonal satisfaction, work status, and the activity index) significantly contributed to the prediction of Emotional Distress (Table VIII). Persons showing greater interpersonal satisfaction, who were working and more active were less likely to report emotional problems.

Injury level, interpersonal satisfaction, economic satisfaction and the medical index were all significantly predictive of dependency (Table IX). Persons with lower lesions (thoracic and lower), who showed more interpersonal and economic satisfaction, who reported fewer medical problems were less likely to report problems with dependency.

Three variables significantly predicted Health Problems (Table X). These included age, medical adjustment and interpersonal satisfaction. Persons who were younger reported better medical adjustment and who showed greater interpersonal satisfaction reported fewer health problems.

Discussion

Past research has suggested that subjective distress is not overwhelming following SCI (Cook, 1979; Green *et al.*, 1984; Richards, 1986) and behaviour during rehabilitation is correlated with long term post-injury outcomes (Goldberg and Freed, 1982; Gordon *et al.*, 1982). Results of the present study support these observations finding that few individuals report major problems following SCI and that long term problems may be predicted to varying degrees, even over an 11-year period. In addition, this investigation extends those findings by presenting evidence that distinct factors underlie self-reported problems, these factors vary in predictability, and that measures of personal adjustment are better predictors of long term problems than are organic variables.

The present study adds to the mounting evidence (Cook, 1979; Green *et al.*, 1984; Richards, 1986) that the long term psychological consequences of SCI

are not as great as was once believed. Lack of income was the only item endorsed by more than 10% of the subjects as being a major problem. Less than 20% of all subjects rated difficulty in making new friends, lack of transportation, family conflicts, conflicts with attendants, attitudes toward the disabled or alcohol or drug abuse as even a small problem.

Results of factor analysis indicated that 3 distinct factors underlie subjects' self-perceived problems. These factors can be distinguished in the degree to which individuals are responding to objective problems brought about by the injury (health status) as opposed to subjective or psychological concomitants such as depression or loneliness. Furthermore, regression analysis indicated that these factors also differ in the degree to which they can be predicted from other variables both concurrently and long term. The types of variables that best predicted factor scores also differed among the 3 factors.

The first dimension obtained in factor analysis (Emotional Distress) appears to be the most subjective or psychological in nature (boredom, loneliness, and depression load most heavily on this factor) and the most difficult to predict. Cross-validated regression accounted for only 15% of the variance in subject responding and long term prediction accounted for an even smaller amount of variance (7%). Persons who report greater emotional distress are more likely to also have low interpersonal satisfaction, to be unemployed, and to have a less active lifestyle. None of the organic variables significantly contributed to the prediction of emotional distress providing further evidence of the psychological nature of this variable.

The second factor (Dependency) appears to be a more general dimension with the predominant theme a chronic inability to take control over one's life. Individual items loading heavily on this factor such as dependency, lack of control, transportation, family conflicts, and income are indications of the diversity of problems identified by this factor. Of the 3 dimensions identified, this was by far the most easily predicted both concurrently (cross-validated $SMC = 0.43$) and long term ($SMC = 0.19$ over the 11-year period) suggesting this factor is relatively stable over time. Persons with the greatest dependency problems are more likely to be quadriplegics, have low economic and interpersonal satisfaction, and require more medical attention. The nature of the predictors suggests that this factor possibly has both objective (injury level and medical index) and psychological components (the two satisfaction dimensions). In addition, the individual item lack of control also loaded moderately heavy on Emotional Distress indicating a likely psychological component.

The final dimension, Health Problems, is more medical and objective in nature. Neither of the items loading on this dimension (pain and health problems) correlated even moderately on the first psychological dimension. This factor had a moderate degree of predictability from the other variables both concurrently (cross-validated $SMC = 0.28$) and long term ($SMC = 0.11$ over the 11-year period). Older persons were more likely to state greater health problems, although the best predictor was clearly the medical index. Low interpersonal satisfaction also predicted perceived Health Problems, but it accounted for only 2% of the variance.

While past researchers have frequently used activity and productivity related outcomes rather than measures of long term problems, some interesting simi-

larities in results with those studies were obtained. As was the case in the present study, organic predictors have not been found to be good predictors of emotional distress in the past (Cook, 1979). Similarly, the importance of organic predictors diminished in past studies in contrast to more theoretically relevant variables such as number of goals (Kemp and Vash, 1971) or measures of vocational development (Goldberg and Freed, 1982). In the present study, measures of satisfaction, activity level, medical history and work status outperformed organic predictors. The present finding that age significantly predicted Health Problems is consistent with Richards and associates (1980) finding of age being the best predictor of pain. While psychosocial variables were of greater importance in the Richards *et al.* study, this is likely due to differences between studies in the number and type of medical and psychosocial predictors used. More psychosocial measures were included in the Richards study and the medical variables were injury and surgically related, rather than general as the medical index used in this study (recent medical history). Dew *et al.* (1984) also obtained somewhat contradictory results suggesting that pain had a large psychological component and was best predicted by psychosocial variables (role in injury, and educational level). In the present study, there was practically no evidence for a psychological component to self-rated pain or predictability from psychosocial variables.

The results of this study also strongly support the need to include a cross-validation sample in any study using multiple regression or discriminant analysis. Results of concurrent cross-validation showed that shrinkage following cross-validation may vary between outcome measures. The range of variance accounted for by the predictors between different outcome measures nearly doubled following concurrent cross-validation (regression group SMCs ranged from 0.29 to 0.44; cross-validated SMCs ranged from 0.15 to 0.43), even though a large sample and small number of predictors were used. When DeVivo and Fine (1982) cross-validated the results of their discriminant analysis, the percentage of persons correctly classified dropped from 90% to 71% with the percentage of persons correctly classified as working (of greatest interest) dropping from 97% to 59%. In studies using small samples with a large number of predictors, the equation would be less stable and many findings would likely be negated had a cross-validation sample been used. When using regression, researchers should limit the number of predictor and outcome variables by using factor analysis or principal components to reduce the number if necessary.

Several methodological points need to be considered when drawing generalisations to patient populations. First, all subjects were at least 2 years post-injury and would likely have attained some degree of life stability. The efficacy of using personal adjustment to predict long term problems for persons of less than 2 years duration cannot be gauged from this study. Secondly, while age and duration of injury were not linearly related to the long term problems (with the exception of age and Health Problems), it cannot be assumed that problems do not change systematically over time. A longitudinal design using repeated measures would be required to detect such changes, as non-linear relationships cannot be identified using this form of regression. Lastly, the demographics of the cross-validation sample were somewhat different than those of the regression sample in terms of average age and duration of disability (but not

variance). Since regression is a correlational technique based on least squares, these differences in level are likely inconsequential to estimates of SMC or the order of variable entry. If there is a difference in the SMC, it would be to reduce the concurrent cross-validated SMC where there are the largest differences in subject characteristics. Since the samples were similar at the point of first contact (sample 1 in 1974 compared with sample 2 in 1985), the long term prediction would likely be unaffected. While it would have been possible to randomly divide the full sample into regression and cross-validation samples (thus eliminating the demographic differences), approximately half of the subjects with 1974 data would have been in the regression group leaving an insufficient number of cases in the long term cross-validation group.

The results of this study have important implications for counsellors and other rehabilitation professionals. Perhaps the most apparent implication is that persons with SCI are not as likely to view their problems with the same degree of concern as rehabilitation professionals. Attempts to initiate a therapeutic intervention may meet with resistance when there is a discrepancy between rehabilitation professionals' and clients' assessments of the current problems. Such clients may be labelled as unmotivated or rebellious. Rehabilitation professionals must also be aware of the possible long term dependency issues, especially among persons with low life satisfaction and high-level injuries. Some persons may no longer believe they can gain control of their lives, even if feasible means of reducing the dependency are available. In these cases, counselling should focus on helping the individual find alternative ways of gaining control over their lives. When the physical, intellectual or emotional restraints are severe and dependency inevitable, counselling should then focus on helping individuals to accept their limitations and increase their life satisfaction regardless of any change in dependency. One final important point needs to be mentioned. If counsellors are to accurately predict the long term consequences of SCI, they must base their prediction on an accurate assessment of current adjustment rather than rely on organic data. Emotional distress is the least predictable and likely the least stable type of problem and must be acknowledged as such by the counsellor.

Continuing research efforts are needed to help understand the long term problems of persons of SCI. Future research should address such issues as the impact of time and cultural change on long term outcomes, the impact of aging on health and adjustment, personality determinants of adjustment and the influence of SCI on women. Researchers should continue to use diverse methodologies ranging from broad scale explorative studies with large subject samples to intensive investigations of specific behavioural issues using a small subject sample, as the use of both strategies has successfully advanced our understanding of outcomes following SCI. Researchers must continue efforts to uncover misunderstood aspects of post-injury adjustment. By working together with other professionals to improve rehabilitation services, the ultimate beneficiaries of these efforts are the persons with SCI themselves.

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