A cross-sectional study of personality traits on depressive symptoms in persons with SCI

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Summary

Spinal cord injury can cause severe disability and influence mental health. A considerable group of persons develop a depression after the injury. Contrary to the literature in the general population, research on the personality traits that could influence the development of depression in this population is sparse. Therefore, several correlations between personality traits and depressive symptoms have been conducted. Afterwards, a multiple regression and a hierarchical regression were conducted to see if personality traits were predictors of depressive symptoms when injury characteristics are controlled. Neuroticism and Self-Esteem are significantly correlated with depressive symptoms. In the regression analyses, Neuroticism was found to be a significant predictor of variance in the development of depressive symptoms. These findings suggest that personality traits are potentially attractive means of identifying individuals at risk and facilitate preventive interventions. Further research is needed to assess the complex relationship between personality and depressive symptoms.

Spinal cord injury (SCI) is a complex condition that is characterized by a paralysis below the level of the spinal lesion and severe disability (Rohe & Krause, 1999). The causes of a spinal cord injury can be traumatic, for example from an accident (Cripps et al., 2011) as well as non-traumatic, for example from an illness (New et al., 2014). The number of non-traumatic spinal cord injuries is estimated in the Netherlands to be roughly the same as the number of traumatic lesions, based on the data from rehabilitation centers (Van Asbeck & Van Nes, 2016; Post et al., 2017). The reported incidents are around 14 per million per year (Nijendijk et al., 2014; Post et al., 2017). Although SCI is a relatively low incidence phenomenon, it results in significant financial, physical, and psychological costs (Dijkers, 2005; White et al., 2010). Since SCI is such a life-changing event, it demands a multidisciplinary rehabilitation process (Galvis Aparicio et al., 2020). In the Netherlands, through the project "Psychosocial Care for Major Somatic Diseases", each person with SCI receives a psychological screening at the start of inpatient rehabilitation (Center of Excellence for Rehabilitation Medicine, 2019). The screening appeared to contribute positively to timely recognition or confirmation of psychological problems. This is of major importance because research has shown that after SCI, the prevalence of depression ranges from 18.7-26.3% (Williams, & Murray, 2015).

Depressive symptoms

As diagnoses of depression are time consuming and costly, access to quick and inexpensive instruments to assess the severity of depressive symptoms to determine the need of additional evaluation has been invaluable (Sakakibara et al., 2009). Approximately one third of SCI persons have reported moderate depressive symptoms (Jörgensen et al., 2017). In the SCI population, depressive symptoms have the characteristics of sadness and distress that are in many cases caused by people trying to adapt to the consequences of the spinal cord injury (Van Diemen & Van Leeuwen, 2016). They will have to cope with the loss of their

bodily functions but also to the loss of some of the social roles they fulfilled. Depressive symptoms have been associated with increased stays in the hospital, fewer improvements in SCI rehabilitation and increased mortality and morbidity (Kennedy & Rogers, 2000).

Personality

Personality traits are defined as relatively enduring, automatic patterns of thoughts, feelings, and behaviors that characterize individuals' typical ways of responding to different situations (Hudson and Roberts, 2014). Personality traits have been shown to be consistently associated with psychological adjustment and well-being (Magee & Biesanz, 2019). Emotional stability and Extraversion have exhibited the strongest associations with well-being. Individuals who are more emotionally stable and extraverted report higher levels of life satisfaction, positive affect, and self-esteem, and lower levels of negative affect and depressive symptoms (Magee, & Biesanz, 2019). Generally, lower levels of neuroticism and higher levels of extraversion were associated with more favorable therapeutic outcomes (Bucher et al., 2019). So, to clarify how persons with SCI experience their problems and how they deal with their daily frustrations, it is important to look at their personality traits (Snellen, 2018).

Personality in the SCI population

If personality traits reflect pre-injury risk factors or post-injury change remains unanswered (Hollick et al., 2001). However, studies that have used validated measures of personality have found certain traits to occur with greater frequency among people with SCI in comparison with normative samples. People with spinal cord injury are elevated in extraversion or in traits commonly associated with extraversion such as sensation seeking, risk taking, and high activity levels (De Carvalho et al., 1998; Krause & Rohe, 1998; Nagumo, 2000). When looking at which personality traits predict better adjustment to SCI, studies found that the most consistent predictors of adjustment have been low neuroticism and

high extraversion (De Carvalho, et al., 1998; Krause & Rohe, 1998; Nagumo, 2000). In particular, high scores of the individual traits of sociability and positive affectivity (extraversion) and low scores on stress, anxiety and negative affectivity (neuroticism) predicted better adjustment to SCI (Krause & Rohe 1998; Thompson, et al., 2003; Van Leeuwen et al., 2012). Other personality traits were not found to be related with adjustment to SCI (Krause & Rohe 1998; Thompson, et al., 2003; Van Leeuwen et al., 2012).

Personality traits in previous SCI research are for the most part assessed with the NEO Five-Factor Inventory (NEO–FFI; Costa & McCrae, 1992) or the NEO Personality Inventory (NEO-PI; Costa & McCrae, 1992). In the Netherlands, there is insufficient norm validity in the norm groups for both scales (COTAN, 2020), and in our knowledge, these questionnaires are not used in the Dutch rehabilitation setting. Luckily, there is a personality questionnaire that is used in the rehabilitation setting with high construct validity with the NEO-FFI and NEO-PI on these traits, the Dutch Personality Questionnaire (DPQ; Luteijn et al., 2000). The traits Neuroticism and Extraversion are named Inadequacy (or Neuroticism) and Social Anxiety respectively.

Relationship between Personality Traits and Depressive Symptoms

In general, the majority of established risk factors for depressive disorders are either immutable, for example, demographic characteristics, family history or predict onset only in the short term for example, stressful life events (Klein et al., 2011). However, research in non-medical samples has shown that personality is at least somewhat malleable, but may forecast the onset of depressive symptoms years in advance, which makes personality traits a potentially attractive means of identifying individuals at risk (Klein et al., 2011). Therefore, further research on the nature of personality-depression relations can significantly facilitate development of preventive interventions. Another advantage of traits is that they can be assessed relatively easily and efficiently and thus are ideal for screening. In particular, traits

can predict response to treatment (Klein et al., 2011). However, in the SCI population, there are a few studies conducting research for the relationship between personality and SCI. In addition, there is no study yet that investigates the effect that personality could have on depressive symptoms in this population.

Injury Characteristics

Following the incidence of a spinal cord injury, an individual is likely to experience varying degrees of permanent physical impairment (Nizeyimana et al., 2020). Depending on the damage to the spinal cord nerves, the result is considered a complete or an incomplete lesion. Important functions such as mobility (motor functions) or sensation (sensory functions) fail below the lesion. If the lesion occurs primarily in the trunk and legs it is stated that the individual has paraplegia. In comparison, if the lesion is also in the person's hands and partially on the arms it is stated that the individual has tetraplegia (Van Asbeck & Van Nes, 2016). The exact assessment of the injury, the person's sustained sensory and motor functions, the injury level and the degree of lesion – all of which help to forecast the possible impact on the person's daily living (Kakulas, 2004).

The existing data on depressive symptoms after SCI indicate that the prevalence of depression after SCI is substantially greater than in other populations (Williams & Murray, 2015). Variability in the medical characteristics of these samples, such as completeness of injury, may further explain the wide variation in depressive symptoms prevalence estimates. Nevertheless, there is inconsistency in research results if injury factors caused by SCI are associated with depressive symptoms. Some studies have shown that complete injury is more likely to be linked to depressive symptomatology (Dryden et al., 2005, Lim et al., 2017) and some studies do not demonstrate an association between depressive symptoms and injury characteristics (De Carvalho, 1998; Bombardier et al., 2004). In a meta-analysis, it is shown that injury characteristics are heavily underpowered because of missing data so there is no

clear relationship between those two concepts (Williams & Murray, 2015). Thus, including injury characteristics (complete vs incomplete injury) as possible variables in current research is necessary.

Purpose of the Present Study

The aim of this study was to explore the relationship between personality traits and depressive scores. The first hypothesis was that there would be a significant positive correlation between Neuroticism and depressive scores. The second hypothesis was that there would be a significant negative correlation between Extraversion and depressive scores. Because of lack of empirical evidence, it was expected that the other five personality factors would not be significantly related with depressive scores.

Another goal of this study was to investigate the relationship between personality traits and injury characteristics on depressive scores. The main hypothesis would be that Neuroticism would explain the most variance in depressive scores, followed by Extraversion. Lastly, when complete injury would be added as a control variable, Neuroticism and Extraversion would still predict variance in depressive scores.

Method

Design

The study consisted of a cross-sectional analysis of collected data. The Medical Ethics Committee of the University Medical Center Utrecht declared that this study did not need approval according to the Dutch Law on Medical Research (protocol number 15–617/C). Permission to execute the study was granted by the board of the Rehabilitation Center de Hoogstraat. All applicable institutional and governmental regulations concerning the ethical use of human volunteers during the course of this research were warranted.

Procedure

A brief psychological screening has been a part of the standard psychological intake with every individual with a recent SCI in the Hoogstraat Rehabilitation Centre (Knowledge Center of Rehabilitation Medicine Utrecht, 2019). These individuals completed questionnaires shortly after admission to first inpatient rehabilitation after onset of the condition. The questionnaire included measures to assess depression (Hospital Anxiety and Depression Scale; HADS) and personality measures (Dutch Personality Questionnaire; DPQ). ASIA scores has been a standard measurement in the rehabilitation process to measure complete vs. incomplete injury and level of injury. Inclusion criteria were: (1) Inpatient rehabilitation because of a recently acquired SCI (2) No serious cognitive or intellectual problems that have such an effect on answering the screening questions (3) No signs of psychiatric comorbidity or brain injury that would make the screening ineffective. Psychological screenings that were performed in March 2016 until November 2017 were retrieved from medical files by the treating psychologist.

Participants

Respondents were 82 persons with SCI (50 men, 32 women) with a mean age of 60 years (SD = 17.24). Of these persons, 70 (85.4 %) had incomplete lesions to the spinal cord, 10 (12.2 %) had complete lesions, and 2 (2.4 %) were unknown. At the time of assessment, the average time since injury was 2 months.

Instruments

Hospital Anxiety and Depression Scale

Depression was measured with the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983). The HADS consists of 14 statements about the past week with a 4-point response scale (score 0–3). These 14 statements are split up into 7 anxiety indicators and 7

depression indicators. An example of an anxiety statement would be “I feel tense” and a depressive statement would be “I look forward to things to come”. For each scale, a maximum score of 21 can be obtained, indicating a high probability of anxiety and or depression. Scores of 0–7 indicate 'non-(clinical) cases', 8-10 'possible/ doubtful cases', and ≥11 'clinical/ definite cases'. For this study, the depression subscale was used to measure depressive symptoms. The HADS has proven to be a valid and reliable measure of depressive symptoms in individuals with SCI (Sakakibara et al., 2009).

Personality measures

In this study, the Dutch Personality Questionnaire (DPQ) was used (Luteijn et al., 2000). It has been the most frequently used Dutch personality questionnaire in many practical settings, like selection, counseling and clinical psychology (Barelds and Luteijn, 2002). The DPQ consists of 140 items, answered on a three-point scale (True–?–False), that are non-overlapping keyed in seven scales, measuring the following personality aspects: Neuroticism, Social Anxiety (Extraversion), Rigidity, Hostility, Egoism, Dominance, and Self-Esteem. Examples include: “Life is often difficult for me” (Neuroticism), “I feel uncomfortable talking to strangers” (Social Anxiety/Extraversion), “I want everything to be in a standard place at home” (Rigidity), “People often fail to keep their promise” (Hostility), “I often empathize with others” (Egoism), “I like to give orders” (Dominance) and “I can solve my problems myself” (Self-Esteem). The reliability and validity of the DPQ are satisfactory (COTAN, 2020).

ASIA Scores

The ASIA scoring system is currently the most widely accepted and employed clinical scoring system for SCI (Alizadeh, Dyck, & Karimi-Abdolrezaee, 2019). In this system, sensory function is scored from 0–2 and motor function from 0 to 5. The ASIA impairment score (AIS) ranges from complete loss of sensation and movement (AIS = A), to incomplete

loss of sensory or motor function (AIS=B, C or D) to normal neurological function (AIS = E). For more details about the ASIA scoring see Figure 1 in the Appendix. ASIA classification combines the assessments of motor, sensory and sacral functions. The validity and reproducibility of the ASIA system combined with its accuracy in prediction of persons' outcome have made it the most accepted and reliable clinical scoring system utilized for neurological classification of SCI (Alizadeh, Dyck, & Karimi- Abdolrezaee, 2019*).* Table 1 provides frequencies of the ASIA scores.

Table 1.

Frequency table of ASIA scores.

Variables	**Frequency**	**Percentage**
	(n)	**(%)**
ASIA scores		
A	10	12.2
B	4	4.9
C	13	15.9
D	53	64.6
Missing	2	2.4
Total	82	100

Data analysis

Statistical analyses were performed using SPSS, version 26 (IBM Corp, 2019). First, descriptive statistics were used to describe the study population and outcome variables. The scores on the DPQ were compared with the general norming groups of DPQ. The personality variables were not normally distributed and thereby Spearman correlations were conducted. Sizes of the values of the correlation coefficients were interpreted with the guidelines of Cohen (Cohen, 1988). Besides that, the assumptions of regression were checked. Neuroticism, Self-Esteem and Social Anxiety were square root transformed, because the Kurtosis and Skewness were outside the normal range of scores. A dummy variable (ASIA complete

injury) was created from the variable ASIA scores. After that, a standard multiple regression was conducted with the personality traits that significantly correlated with depressive scores to examine which variable is the best predictor to explain variance in depressive scores. Lastly, a hierarchical regression was conducted to examine the ability of significant personality traits to predict depressive scores, after controlling for complete injury.

Results

In this sample, the depressive scores on the HADS (n = 82, M = 6.37, SD = 4.82) were as follows: 49 (59.8%) scored as non-clinical cases, 10 (12.2%) as possible cases, 21 (25.6%) scored as clinical cases and 2 (2.24%) were missing. Table 2 provides descriptive information about the scores on the subscales of DPQ in this study and in the general norming group of DPQ. Table 3 provides an overview of percentages of DPQ scores in the SCI group according to the norming tables.

Table 2.

Descriptive statistics of the scores on DPQ subscales in this sample and in general norming group.

Variables	M	SD	Minimum	Maximum	Skewness	Kurtosis
SCI Sample						
Neuroticism	10.51	9.95	0	40	1.41	1.49
Social Anxiety	8.58	8.93	0	35	1.51	1.76
Rigidity	25.67	8.93	6	39	-.29	-.10
Hostility	11.04	8.58	0	30	.70	-.48
Egoism	7.37	5.30	0	22	.84	.22
Dominance	26.30	7.84	2	40	-.64	.50
Self-Esteem	31.66	6.99	11	40	-1.12	.82
General norming group						
Neuroticism	12.00	9.80	-	-	-	-
Social Anxiety	14.10	9.80	-	-	-	-
Rigidity	27.00	7.30	-	-	-	-
Hostility	16.00	8.10	-	-	-	-
Egoism	9.90	5.80	-	-	-	-
Dominance	23.00	8.20	-	-	-	-
Self-Esteem	30.50	7.00	-	-	-	-

Table 3.

An overview of DPQ scores in the SCI sample according to the norming group (percentages).

Variables	Very Low	Low	Below average	Average	Above average	High	Very High
	(%)	(%)	(%)	(%)	(%)	(%)	(%)
DPQ subscales							
Neuroticism	-	17	23.1	21.9	9.7	2.4	7.3
Social Anxiety	-	32.9	24.5	12	4.8	2.4	4.8
Rigidity	2.4	10.9	18.3	25.6	8.5	15.8	6.1
Hostility	12.2	23.2	14.6	15.7	3.6	8.4	3.7
Egoism	3.7	18.4	20.7	25.6	1.2	9.7	2.4
Dominance	2.4	2.4	8.5	20.8	15.9	20.6	11
Self Esteem	3.6	9.7	4.8	18.3	12.3	25.7	7.3

Participants scored low on the subscales Neuroticism and Social Anxiety and high on the Dominance and Self-Esteem subscales in comparison with the general norming group. In addition, there was a large variance of scores on the subscales of Rigidity, Hostility and Egoism.

To explore the relationship between personality traits and depressive scores several Spearman correlations were conducted. There was a medium, positive correlation between the two variables, $r = .43$, $n = 67$, $p < 0.01$, with high levels of Neuroticism associated with high levels of depressive symptoms. The relationship between Social Anxiety and depressive scores was also investigated with Spearman product moment correlation coefficient. Contrary to the hypothesis, there was no significant correlation between these two variables. A finding was that there was a small negative correlation between Self-Esteem and depressive scores, $r = -.28$, $n = 67$, $p < 0.01$, with high levels of Self-Esteem associated with lower levels of depressive symptoms (see Table 4). The remaining personality traits were not

associated with depressive symptoms. Post hoc analyses revealed that with the sample of 67 partcipants there was .99 power which is high (Faul et al., 2009).

Table 4.

Spearman correlations between HADS depressive scores and DPQ scores.

Scale	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. Depression	-							
2. Neuroticism	.40**	-						
3. Social Anxiety	.21	.51**	-					
4. Rigidity	.15	.17	.19	-				
5. Hostility	.13	.30*	.30*	.15	-			
6. Egoism	.02	.19	.47**	-.03	.65	-		
7. Dominance	-.12	-.30*	-.42**	.06	.24*	-.00	-	
8. Self-Esteem	-.28*	-.63**	-.58**	-.04	-.03	-.09	.55**	-

Notes. * $p < .05$ (2-tailed); ** $p < .01$ (2-tailed)

Another goal of this study was to investigate the relationship between personality traits and injury characteristics on depressive scores. The main hypothesis would be that Neuroticism would explain the most variance in depressive scores, followed by Extraversion. However, Extraversion (Social Anxiety) did not significantly correlated with depressive scores so it was omitted from the analysis. Instead, Self-Esteem was added. Lastly, complete injury would be a confounding predictor of variance in depressive scores

Standard multiple regression was used to assess the ability of two personality traits (Neuroticism, Self Esteem) to predict depressive symptoms. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity, and homoscedasticity. The total variance explained by the model as a whole was 17, 3 %, F (2, 64) = 6.704, p = .002. Neuroticism was a significant predictor, see Table 5. Post hoc analysis revealed that there was a power of .96, which is high (Faul et al., 2009).

Table 5.

Regression Coefficients of Neuroticism, Self-Esteem on depressive scores.

Variables	***B***	***SE B***	***t***	**β**	**95% CI**
Constant	2.77	1.2	2.29		[.36, 5.19]
Neuroticism	1.19	.40	2.19	.416**	[.37, 2.00]
Self-Esteem	-.00	.50	-.00	-.001	[-1.00, .99]

Notes. CI= Confidence Interval. ** $p < .01$

Hierarchical multiple regression was used to assess the ability of two personality traits (Neuroticism and Self-Esteem) to predict depressive scores, after controlling for the influence of severity of injury (ASIA complete injury). Preliminary analyses were conducted to ensure no violation of the assumptions normality, linearity, multicollinearity, and homoscedasticity. Complete injury were entered at Step 1, explaining 1.3% of the variance in depressive scores. After entry of Neuroticism and Self-Esteem at Step 2 the total variance explained by the model as a whole was 21.3 %, F (3, 61) = 5.49, p = .001. The two controlling measures explained an additional 19.9 % of the variance in depressive scores, after controlling for complete injury, R squared change = .199, F change (2, 61) = 7.72, p = .001. In the final model, Neuroticism was statistically significant (see Table 6). Post hoc analyses revealed that there was a power of .81, which is adequate (Faul et al., 2009).

Table 6.

Hierarchical regression analyses of Neuroticism, Self-Esteem and complete injury on depressive scores.

Variables	***B***	**95% CI**		***SE B***	**β**	***R²***	**Δ*R²***
		LL	**UL**				
Step 1						.013	.013
Constant	6.16	4.88	7.44	.64			
ASIA scores	1.67	-1.95	5.30	1.81	.11		
Step 2						.213	.199**
Constant	1.51	-1.68	4.71	1.60			
ASIA scores	2.91	-.46	6.29	1.69	.20		
Neuroticism	1.21	.32	2.10	.44	.39**		
Self-Esteem	.36	-.89	1.63	.63	.08		

Notes. CI= Confidence Interval. ** $p < .01$

Discussion

Main Findings

The purpose of this study is to gain a better understanding of the relationship between personality traits and depressive scores. The first hypothesis, that there is a significant positive correlation between Neuroticism and depressive scores was confirmed. Nevertheless, in the second hypothesis, that there is a significant negative correlation between Extraversion and depressive scores was not confirmed. Unexpectedly, there was a significant negative correlation between Self-Esteem and depressive scores. In further regression analyses, only the significant variables from the correlations were included (Neuroticism and Self-Esteem). The main hypothesis would be that Neuroticism would explain the most variance in depressive scores, followed by Self-Esteem. Lastly, when complete injury would be added as

a control variable, Neuroticism and Self-Esteem would still predict variance in depressive scores. The results showed that Neuroticism is a significant predictor in both analyses.

Neuroticism is accompanied with feelings of insecurity, loneliness and helplessness (Luteijn et al., 2000). Neuroticism is a known predictor for depressive symptoms and is related to depressive disorder in the general population (Yoon et al., 2013). In the SCI population, adjustment to the consequences of the injury is more difficult when people score high on Neuroticism (De Carvalho et al., 1998; Krause & Rohe, 1998; Nagumo, 2000). This finding supports the notion that Neuroticism is related and can possibly predict depressive scores in the SCI population.

Extraversion is extensively studied in SCI personality research (Berry et al., 2007). It is rather surprising that Extraversion is not found to have a negative relationship with depressive symptoms because in other variables, like overall quality of life, extraversion is a positive significant predictor (Van Leeuwen, 2012). One possibility could be that Extraversion does not influence depressive symptoms directly, but rather indirectly, for example through social support (De la Vega et al., 2019). Another possible explanation would be that in most SCI studies on psychological resources (where personality traits are a part of) have been conducted in the community but not in the clinical setting (Peter et al., 2012). The screening that is used in this current study is taken during the rehabilitation phase, and that could possibly reflect short term personality changes.

Self-Esteem is an interesting outcome in this study because in most SCI literature it is studied as a way of self-perception after SCI but not as a personality trait (Craig et al., 1994). Self-esteem is a relatively stable, but by no means immutable, trait (Orth & Robins, 2014). Persons with SCI frequently perceived self-esteem as compromised by SCI (Peter et al., 2012). However, the same research showed that Self-Esteem does not consistently differ from general or other clinical populations. In this sample, the scores on Self-Esteem were high in

comparison with the general population. It could be hypothesized that Self-Esteem is a trait that supports the affected people during rehabilitation. Nevertheless, it remains unclear whether Self-Esteem is more important in the short or long term (Peter et al., 2012).

An additional finding is that Self-Esteem is correlated negatively with Neuroticism and positively with Extraversion. This is an interesting finding because it is shown that high Self-Esteem individuals also score highly on Extraversion and low on Neuroticism in the general population (Robins et al., 2001). A hypothesis could be that the combination of those personality traits are a potential pattern of individuals that resemble resilience (Catalano et al., 2011; Oshio et al., 2018). Personality types and resilient behaviors provide protection from the experience of depression, and resilience can increase the risk of not being depressed (Edward, 2005). This finding makes personality traits a potentially attractive means for clinical attention and research.

Personality traits could contribute to an individual's susceptibility to developing depression, and a combination of high Neuroticism and low Extraversion has been associated with a higher risk of depression (Allen et al., 2017). Further research on the nature of personality-depression relations can significantly facilitate development of preventive interventions through risk assessment (Klein et al., 2011). In addition, personality traits can be used to make interventions tailored to the individual. An example of this is resources activation (Flückiger & Grosse Holtforth, 2008), where personal strengths are used in therapy. Effective therapeutic relationships can be formed through the discussion of positive personal characteristics and experiences (Rashid, 2015). Research showed that Cognitive Behaviour Therapy (CBT) to client's relative strengths led to better outcome than CBT personalized to client's relative deficits (Flückiger & Grosse Holtforth, 2008).

Limitations

The present study represents a first attempt to address the relationship between depressive symptoms and personality in a SCI sample. One limitation of this study is that there was a small sample, meaning that the current results are difficult to generalize. On the original sample of $n = 82$, only 67 participants had filled in the DPQ. A sample size reduces the power of the study and increases the margin of error, which can render the study meaningless (Button et al., 2013). Nevertheless, the post-hoc analyses revealed that there was adequate to high power in the conducted analyses. A second potential limitation is that HADS is a screening instrument, so it can't diagnose depression but only measures if depressive symptoms are present. The HADS is not based on the DSM criteria on which clinical diagnoses are based (Sakakibara et al., 2009). Hence, future research should add a diagnostic interview after the screening to investigate if people who score high on the screening on depressive scores, Social Anxiety and Neuroticism and low on Self-Esteem would have increased risk of developing a depressive disorder. In this way, it can be determined if personality traits play a role in the development of depression. An additional explanation for these findings warrants comment. Researchers have suggested that resilience and coping are important factors in explaining the complicated relationship between personality traits and depressive symptoms (Galvin & Godfrey, 2001). Unfortunately, it was beyond the scope of this study to examine those measures and therefore not included.

Implications

Despite these limitations, the results of this study suggest several theoretical and practical implications. In this sample, 25.6 % scored high on depressive scores which is a prevalence found in earlier studies (Williams & Murray, 2015). This is the first research that examines the relationship between personality traits and depressive scores in a SCI sample in the Netherlands. In addition, it is the first study that shows that people who score high on

Neuroticism have elevated depressive symptoms confirming previous literature on adjustment (De Carvalho et al., 1998; Krause & Rohe, 1998; Nagumo, 2000). Also, Extraversion is higher than the general population conform previous literature (De Carvalho et al., 1998; Krause & Rohe, 1998; Nagumo, 2000). This personality trait could be a possible protective factor for depressive symptoms. Current findings of depressive scores show that these scores are a slightly higher than in the general population. However, SCI is seen as an impactful event that is life changing (Galvis Aparicio et al., 2020). So keeping that in mind, the percentage of depressive score is conform previous research (Williams & Murray, 2015). A hypothesis could be that high Extraversion could play a potential role in this through social support (De la Vega et al., 2019). Last implication would be that injury characteristics were included as a control variable in this study which in previous studies was neglected (Williams & Murray, 2015). The results preliminary support the notion that injury does not influence depressive symptoms, conform to previous research (De Carvalho, 1998; Bombardier et al., 2004).

Conclusion

SCI is a life changing event with serious mental health consequences. The prevalence of depression is 25% and more research is needed to disentangle the factors that influence the development of depression in this population. In this study, personality traits were examined and there is a possibility that Neuroticism, Social Anxiety and Self-Esteem are important factors that should be taken into account. Injury characteristics are interesting factors too, but more research is needed to assess their role in this complex phenomenon. Further research should focus on other variables, like resilience and coping to explore the relationship between personality and depression. This would be of great importance to apply in individualized treatment. The main conclusion would be that personality research is lacking in this population,

and the literature is outdated. A collaboration of research and clinical practice would be a meaningful contribution to this problem.

References

Alizadeh, A., Dyck, S. M., & Karimi-Abdolrezaee, S. (2019). Traumatic spinal cord injury: an overview of pathophysiology, models and acute injury mechanisms. *Frontiers in Neurology*, *10*, 282. https://doi.org/10.3389/fneur.2019.00282

Allen, T. A., Carey, B. E., McBride, C., Bagby, R. M., DeYoung, C. G., & Quilty, L. C. (2018). Big Five aspects of personality interact to predict depression. *Journal of Personality*, *86*(4), 714-725. https://doi-org.proxy.library.uu.nl/10.1111/jopy.12352

Barelds, D. P., & Luteijn, F. (2002). Measuring personality: a comparison of three personality questionnaires in the Netherlands. *Personality and Individual Differences*, *33*(4), 499-510. https://doi.org/10.1016/S0191-8869(01)00169-6

Berry, J. W., Elliott, T. R., & Rivera, P. (2007). Resilient, undercontrolled, and overcontrolled personality prototypes among persons with spinal cord injury. *Journal of Personality Assessment*, *89*(3), 292-302. https://doi-org.proxy.library.uu.nl/10.1080/00223890701629813

Bombardier, C. H., Richards, J. S., Krause, J. S., Tulsky, D., & Tate, D. G. (2004). Symptoms of major depression in people with spinal cord injury: implications for screening. *Archives of Physical Medicine and Rehabilitation*, *85*(11), 1749-1756. https://doi.org/10.1016/j.apmr.2004.07.348

Bucher, M. A., Suzuki, T., & Samuel, D. B. (2019). A meta-analytic review of personality traits and their associations with mental health treatment outcomes. *Clinical Psychology Review*, *70*, 51-63. https://doi.org/10.1016/j.cpr.2019.04.002

Button, K. S., Ioannidis, J. P., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S., & Munafò, M. R. (2013). Power failure: why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience*, *14*(5), 365-376. https://doi-org.proxy.library.uu.nl/10.1038/nrn3475

Catalano, D., Chan, F., Wilson, L., Chiu, C.-Y., & Muller, V. R. (2011). The buffering effect of resilience on depression among individuals with spinal cord injury: A structural equation model. *Rehabilitation Psychology, 56*(3), 200–211. https://doi-org.proxy.library.uu.nl/10.1037/a0024571

Center of Excellence for Rehabilitation Medicine. (2019*). Implementation of a psychological screening for people with spinal cord injury*. https://www.kcrutrecht.nl/project/psychologische-screening-voor-revalidanten-met-een-dwarslaesie

Cohen, J. W (1988). *Statistical power analysis for the behavioral sciences (2nd edition).* Lawrence Erlbaum Associates.

Costa, PT., Jr; McCrae, RR. (1992*). Revised NEO Personality Inventory (NEO–PI–R) and NEO Five-Factor Inventory (NEO–FFI) professional manual*. Psychological Assessment Resources.

COTAN (2020). *NEO Persoonlijkheidsvragenlijst, NEO PI-R.* https://www.cotan.documentatie.nl/beoordelingen/b/13953/neo-persoonlijkheidsvragenlijsten/

COTAN (2020). *NEO Persoonlijkheidsvragenlijst, NEOFFI.* https://www. cotandocumentatie.nl/beoordelingen/b/13955/neo-persoonlijkheidsvragenlijsten/

COTAN (2020). *Verkorte Nederlandse Persoonlijkheidsvragenlijst*. https://www.cotandocumentatie.nl/ beoordelingen/b/15686/verkorte-nederlandse-persoonlijkheidsvragenlijst/

Craig, A. R., Hancock, K., & Chang, E. (1994). The influence of spinal cord injury on coping styles and self-perceptions two years after the injury. *Australian and New Zealand Journal of Psychiatry, 28*(2), 307-312. https://doi.org/10.1080/00048679409075644

Cripps, R. A., Lee, B. B., Wing, P., Weerts, E., Mackay, J., & Brown, D. (2011). A global map for traumatic spinal cord injury epidemiology: towards a living data repository

for injury prevention. *Spinal Cord*, *49*(4), 493-501. https://doi.org/10.1038/sc.2010.146

De Carvalho, S. A. D., Andrade, M. J., Tavares, M. A., & de Freitas, J. L. S. (1998). Spinal cord injury and psychological response. *General Hospital Psychiatry*, *20*(6), 353-359.

De la Vega, R., Molton, I. R., Miró, J., Smith, A. E., & Jensen, M. P. (2019). Changes in perceived social support predict changes in depressive symptoms in adults with physical disability. *Disability and Health Journal*, *12*(2), 214-219. https://doi.org/10.1016/j.dhjo.2018.09.005

Dijkers, M. P. J. M. (2005). Quality of life of individuals with spinal cord injury: a review of conceptualization, measurement, and research findings. *Journal of Rehabilitation Research and Development*, *42*(3), 87. https://doi.org/10.1682/jrrd.2004.08.0100

Dryden, D. M., Saunders, L. D., Rowe, B. H., May, L. A., Yiannakoulias, N., Svenson, L. W., Schopflocher, D.P., & Voaklander, D. C. (2005). Depression following traumatic spinal cord injury. *Neuroepidemiology*, *25*(2), 55. https://doi.org/10.1159/000086284

Edward, K. L. (2005). Resilience: A protector from depression. *Journal of the American Psychiatric Nurses Association*, *11*(4), 241-243. https://doi-org.proxy.library.uu.nl/10.1177/1078390305281177

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*, 1149-1160. https://doi.org/10.3758/BRM.41.4.1149

Flückiger, C., & Grosse Holtforth, M. (2008). Focusing the therapist's attention on the patient's strengths: A preliminary study to foster a mechanism of change in outpatient psychotherapy. *Journal of Clinical Psychology*, *64*(7), 876-890. https://doi-org.proxy.library.uu.nl/10.1002/jclp.20493

Galvin, L. R., & Godfrey, H. P. D. (2001). The impact of coping on emotional adjustment to spinal cord injury (SCI): review of the literature and application of a stress appraisal and coping formulation. *Spinal Cord*, *39*(12), 615-627. https://doi.org/10.1038/sj.sc.3101221

Galvis Aparicio, M., Carrard, V., Morselli, D., Post, M., Peter, C., & SwiSCI Study Group (2020). Profiles of Psychological Adaptation Outcomes at Discharge From Spinal Cord Injury Inpatient Rehabilitation. *Archives of Physical Medicine and Rehabilitation*, *101*(3), 401–411. https://doi.org/10.1016/j.apmr.2019.08.481

Hollick, C., Radnitz, C. L., Silverman, J., Tirch, D., Birstein, S., & Bauman, W. A. (2001). Does spinal cord injury affect personality? A study of monozygotic twins. *Rehabilitation Psychology*, *46*(1), 58. https://doi.org/10.1037/0090-5550.46.1.58 https://doi.org/10.1016/S0163-8343(98)00047-4

Hudson, N. W., & Roberts, B. W. (2014). Goals to change personality traits: Concurrent links between personality traits, daily behavior, and goals to change oneself. *Journal of Research in Personality*, *53*, 68-83. https://doi.org/10.1016/j.jrp.2014.08.008

IBM Corporation (2019). IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corporation.

Jörgensen, S., Ginis, K. A., Iwarsson, S., & Lexell, J. (2017). Depressive symptoms among older adults with long-term spinal cord injury: Associations with secondary health conditions, sense of coherence, coping strategies and physical activity. *Journal of Rehabilitation Medicine*, *49*(8), 644-651. https://doi.org/10.2340/16501977-2241

Kakulas, B. A. (2004). Neuropathology: the foundation for new treatments in spinal cord injury. *Spinal Cord*, *42*(10), 549-563. https://doi.org/10.1038/sj.sc.3101670.

Kennedy, P., & Rogers, B. A. (2000). Anxiety and depression after spinal cord injury: a longitudinal analysis. *Archives of Physical Medicine and Rehabilitation*, *81*(7), 932-937. https://doi.org/10.1053/apmr.2000.5580

Klein, D. N., Kotov, R., & Bufferd, S. J. (2011). Personality and depression: explanatory models and review of the evidence. *Annual Review of Clinical Psychology*, *7*, 269. https://doi.org/10.1146/annurev-clinpsy-032210-104540

Krause, J. S., & Rohe, D. E. (1998). Personality and life adjustment after spinal cord injury: An exploratory study. *Rehabilitation Psychology*, *43*(2), 118. https://doi-org.proxy.library.uu.nl/10.1037/0090-5550.43.2.118

Lim, S. W., Shiue, Y. L., Ho, C. H., Yu, S. C., Kao, P. H., Wang, J. J., & Kuo, J. R. (2017). Anxiety and depression in patients with traumatic spinal cord injury: a nationwide population-based cohort study. *PLoS One*, *12*(1). https://doi.org/10.1371/journal.pone.0169623

Luteijn, F., Starren, J., & Van Dijk, H. (2000). *DPQ; Dutch Personality Questionnaire, manual (revised edition).* Boom Psychologie.

Magee, C., & Biesanz, J. C. (2019). Toward understanding the relationship between personality and well-being states and traits. *Journal of Personality*, *87*(2), 276-294. https://doi-org.proxy.library.uu.nl/10.1111/jopy.12389

Nagumo, N. (2000). Relationships between low-grade chronic depression, pain and personality traits among community-dwelling persons with traumatic spinal cord injury. *Japanese Journal of Psychology*, *1*(3), 205–210. https://doi-org.proxy.library.uu.nl/10.4992/jjpsy.71.205

New, P. W., Cripps, R. A., & Lee, B. B. (2014). Global maps of non-traumatic spinal cord injury epidemiology: towards a living data repository. *Spinal Cord*, *52*(2), 97-109. https://doi.org/10.1038/sc.2012.165

Nijendijk, J. H., Post, M. W., & Van Asbeck, F. W. (2014). Epidemiology of traumatic spinal cord injuries in The Netherlands in 2010. *Spinal Cord, 52*(4), 258-263. https://doi.org/10.1038/sc.2013.180

Nizeyimana, E., Joseph, C., & Phillips, J. (2020). Quality of life after traumatic spinal cord injury in a developing context: the influence of contextual factors and injury characteristics. *Disability and Rehabilitation, 42*, 1-7. https://doi-org.proxy.library.uu.nl/10.1080/09638288.2020.1827051

Orth, U., & Robins, R. W. (2014). The development of self-esteem. *Current Directions in Psychological Science*, *23*(5), 381-387. https://doi.org/10.1177/0963721414547414

Oshio, A., Taku, K., Hirano, M., & Saeed, G. (2018). Resilience and Big Five personality traits: A meta-analysis. *Personality and Individual Differences, 127*, 54-60. https://doi.org/10.1016/j.paid.2018.01.048

Peter, C., Müller, R., Cieza, A., & Geyh, S. (2012). Psychological resources in spinal cord injury: a systematic literature review. *Spinal Cord, 50*(3), 188-201. https://doi-org.proxy.library.uu.nl/10.1038/sc.2011.125

Post, M. W., Nooijen, C. F., Postma, K., Dekkers, J., Penninx, F., van den Berg-Emons, R. J., & Stam, H. J. (2017). People with spinal cord injury in the Netherlands. *American Journal of Physical Medicine & Rehabilitation, 96*(2), 93-95. https://doi.org/10.1097/PHM.0000000000000619

Rashid, T. (2015). Positive psychotherapy: A strength-based approach. *The Journal of Positive Psychology*, *10*(1), 25-40. https://doi-org.proxy.library.uu.nl/10.1080/17439760.2014.920411

Robins, R. W., Tracy, J. L., Trzesniewski, K., Potter, J., & Gosling, S. D. (2001). Personality correlates of self-esteem. *Journal of Research in Personality*, *35*(4), 463-482. https://doi.org/10.1006/jrpe.2001.2324

Rohe, D. E., & Krause, J. S. (1999). The five-factor model of personality: findings in males with spinal cord injury. *Assessment*, *6*(3), 203-213. https://doi-org.proxy.library.uu.nl/10.1177/107319119900600301

Sakakibara, B. M., Miller, W. C., Orenczuk, S. G., & Wolfe, D. L. (2009). A systematic review of depression and anxiety measures used with individuals with spinal cord injury. *Spinal Cord*, *47*(12), 841-851. https://doi.org/10.1038/sc.2009.93

Snellen, W. M. (2018). *Personality diagnostics in the clinical practice*. Bohn Stafleu van Loghum.

Thompson, N. J., Coker, J., Krause, J. S., & Henry, E. (2003). Purpose in life as a mediator of adjustment after spinal cord injury. *Rehabilitation Psychology*, *48*(2), 100–108. https://doi-org.proxy.library.uu.nl/10.1037/0090-5550.48.2.100

Van Asbeck, F. W. A., & Van Nes, I.J.W. (2016). *Handboek dwarslaesierevalidatie, de basis.* Koningklijke van Gorcum.

Van Diemen, T., & Van Leeuwen, C. M. C. (2016). Psychosociale aspecten. In Van Asbeck, F. W. A., & Van Nes, I.J.W. (Ed.), *Handboek dwarslaesierevalidatie, de basis.* (pp. 267-275). Koningklijke van Gorcum.

Van Leeuwen, C. M. C., Kraaijeveld, S., Lindeman, E., & Post, M. W. M. (2012). Associations between psychological factors and quality of life ratings in persons with spinal cord injury: a systematic review. *Spinal Cord*, *50*(3), 174-187. https://doi.org/10.1038/sc.2011.120

Van Leeuwen, C. M., Post, M. W., Westers, P., Van Der Woude, L. H., De Groot, S., Sluis, T., Slootman, H., & Lindeman, E. (2012). Relationships between activities, participation, personal factors, mental health, and life satisfaction in persons with spinal cord injury. *Archives of Physical Medicine and Rehabilitation*, *93*(1). https://doi.org/82-89.10.1016/j.apmr.2011.07.203

White, B., Driver, S., & Warren, A. M. (2010). Resilience and indicators of adjustment during rehabilitation from a spinal cord injury. *Rehabilitation Psychology*, *55*(1), 23–32. https://doi.org/10.1037/a0018451

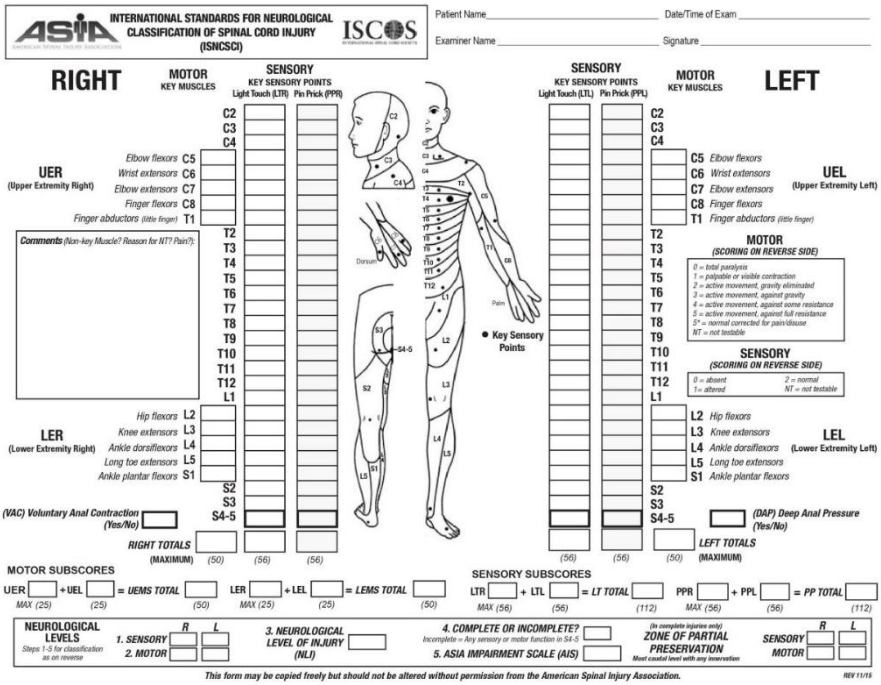
Williams, R., & Murray, A. (2015). Prevalence of depression after spinal cord injury: a meta-analysis. *Archives of Physical Medicine and Rehabilitation*, *96*(1), 133-140. https://doi.org/10.1016/j.apmr.2014.08.016

Yoon, K. L., Maltby, J., & Joormann, J. (2013). A pathway from neuroticism to depression: examining the role of emotion regulation. *Anxiety, Stress & Coping*, *26*(5), 558-572. https://doi.org/10.1080/10615806.2012.734810

Zigmond, A. S., & Snaith, R. P., (1983). The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavica*, *67*(6), 361-370. https://doi.org/10.1111/j.1600-0447.1983.tb09716.x

Appendix

Figure 1. ASIA scoring for the neurological classification of the SCI. A sample scoring sheet.



INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY (ISNCSCI)

ISCOS

Patient Name _____ Date/Time of Exam _____

Examiner Name _____ Signature _____

RIGHT

MOTOR KEY MUSCLES

SENSORY KEY SENSORY POINTS Light Touch (LTR) Pin Prick (PPR)

UER (Upper Extremity Right)

Elbow flexors C5
Wrist extensors C6
Elbow extensors C7
Finger flexors C8
Finger abductors (little finger) T1

Comments (Non-key Muscle? Reason for NT? Pain?):

LER (Lower Extremity Right)

Hip flexors L2
Knee extensors L3
Ankle dorsiflexors L4
Long toe extensors L5
Ankle plantar flexors S1

(VAC) Voluntary Anal Contraction (Yes/No)

RIGHT TOTALS (MAXIMUM) (50) (56) (56)

LEFT

SENSORY KEY SENSORY POINTS Light Touch (LTL) Pin Prick (PPL)

MOTOR KEY MUSCLES

C5 Elbow flexors
C6 Wrist extensors
C7 Elbow extensors
C8 Finger flexors
T1 Finger abductors (little finger)

UEL (Upper Extremity Left)

MOTOR (SCORING ON REVERSE SIDE)

0 = total paralysis
1 = palpable or visible contraction
2 = active movement, gravity eliminated
3 = active movement, against gravity
4 = active movement, against some resistance
5 = active movement, against full resistance
5* = normal corrected for pain/disuse
NT = not testable

SENSORY (SCORING ON REVERSE SIDE)

0 = absent 2 = normal
1 = altered NT = not testable

L2 Hip flexors
L3 Knee extensors
L4 Ankle dorsiflexors
L5 Long toe extensors
S1 Ankle plantar flexors

LEL (Lower Extremity Left)

(DAP) Deep Anal Pressure (Yes/No)

LEFT TOTALS (MAXIMUM) (50) (56) (56)

● Key Sensory Points

MOTOR SUBSCORES

UER + UEL = UEMS TOTAL MAX (25) (25) (50)

LER + LEL = LEMS TOTAL MAX (25) (25) (50)

SENSORY SUBSCORES

LTR + LTL = LT TOTAL MAX (56) (56) (112)

PPR + PPL = PP TOTAL MAX (56) (56) (112)

NEUROLOGICAL LEVELS Steps 1-5 for classification as on reverse

1. SENSORY R L
2. MOTOR R L

3. NEUROLOGICAL LEVEL OF INJURY (NLI)

4. COMPLETE OR INCOMPLETE? Incomplete = Any sensory or motor function in S4-5

5. ASIA IMPAIRMENT SCALE (AIS)

(In complete injuries only) ZONE OF PARTIAL PRESERVATION Most caudal level with any innervation

SENSORY R L
MOTOR R L

This form may be copied freely but should not be altered without permission from the American Spinal Injury Association.

REV 11/15

Muscle Function Grading

0 = total paralysis
1 = palpable or visible contraction
2 = active movement, full range of motion (ROM) with gravity eliminated
3 = active movement, full ROM against gravity
4 = active movement, full ROM against gravity and moderate resistance in a muscle specific position
5 = (normal) active movement, full ROM against gravity and full resistance in a functional muscle position expected from an otherwise unimpaired person
5* = (normal) active movement, full ROM against gravity and sufficient resistance to be considered normal if identified inhibiting factors (i.e. pain, disuse) were not present
NT = not testable (i.e. due to immobilization, severe pain such that the patient cannot be graded, amputation of limb, or contracture of > 50% of the normal ROM)

Sensory Grading

0 = Absent
1 = Altered, either decreased/impaired sensation or hypersensitivity
2 = Normal
NT = Not testable

When to Test Non-Key Muscles:

In a patient with an apparent AIS B classification, non-key muscle functions more than 3 levels below the motor level on each side should be tested to most accurately classify the injury (differentiate between AIS B and C).

Movement	Root level
Shoulder: Flexion, extension, abduction, adduction, internal and external rotation **Elbow:** Supination	C5
Elbow: Pronation **Wrist:** Flexion	C6
Finger: Flexion at proximal joint, extension. **Thumb:** Flexion, extension and abduction in plane of thumb	C7
Finger: Flexion at MCP joint **Thumb:** Opposition, adduction and abduction perpendicular to palm	C8
Finger: Abduction of the index finger	T1
Hip: Adduction	L2
Hip: External rotation	L3
Hip: Extension, abduction, internal rotation **Knee:** Flexion **Ankle:** Inversion and eversion **Toe:** MP and IP extension	L4
Hallux and Toe: DIP and PIP flexion and abduction	L5
Hallux: Adduction	S1

ASIA Impairment Scale (AIS)

A = Complete. No sensory or motor function is preserved in the sacral segments S4-5.

B = Sensory Incomplete. Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-5 (light touch or pin prick at S4-5 or deep anal pressure) AND no motor function is preserved more than three levels below the motor level on either side of the body.

C = Motor Incomplete. Motor function is preserved at the most caudal sacral segments for voluntary anal contraction (VAC) OR the patient meets the criteria for sensory incomplete status (sensory function preserved at the most caudal sacral segments (S4-S5) by LT, PP or DAP), and has some sparing of motor function more than three levels below the ipsilateral motor level on either side of the body. (This includes key or non-key muscle functions to determine motor incomplete status.) For AIS C – less than half of key muscle functions below the single NLI have a muscle grade ≥ 3.

D = Motor Incomplete. Motor incomplete status as defined above, with at least half (half or more) of key muscle functions below the single NLI having a muscle grade ≥ 3.

E = Normal. If sensation and motor function as tested with the ISNCSCI are graded as normal in all segments, and the patient had prior deficits, then the AIS grade is E. Someone without an initial SCI does not receive an AIS grade.

Using ND: To document the sensory, motor and NLI levels, the ASIA Impairment Scale grade, and/or the zone of partial preservation (ZPP) when they are unable to be determined based on the examination results.

INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

ISCOS

Steps in Classification

The following order is recommended for determining the classification of individuals with SCI.

1. Determine sensory levels for right and left sides.
The sensory level is the most caudal, intact dermatome for both pin prick and light touch sensation.

2. Determine motor levels for right and left sides.
Defined by the lowest key muscle function that has a grade of at least 3 (on supine testing), providing the key muscle functions represented by segments above that level are judged to be intact (graded as a 5).
Note: in regions where there is no myotome to test, the motor level is presumed to be the same as the sensory level, if testable motor function above that level is also normal.

3. Determine the neurological level of injury (NLI)
This refers to the most caudal segment of the cord with intact sensation and antigravity (3 or more) muscle function strength, provided that there is normal (intact) sensory and motor function rostrally respectively.
The NLI is the most cephalad of the sensory and motor levels determined in steps 1 and 2.

4. Determine whether the injury is Complete or Incomplete.
(i.e. absence or presence of sacral sparing)
*If voluntary anal contraction = **No** AND all S4-5 sensory scores = **0** AND deep anal pressure = **No**, then injury is **Complete**.*
*Otherwise, injury is **Incomplete**.*

5. Determine ASIA Impairment Scale (AIS) Grade:

Is injury Complete? **If YES, AIS=A** and can record ZPP (lowest dermatome or myotome on each side with some preservation)

NO ↓

Is injury Motor Complete? If YES, AIS=B

NO ↓ (No=voluntary anal contraction OR motor function more than three levels below the motor level on a given side, if the patient has sensory incomplete classification)

Are at least half (half or more) of the key muscles below the neurological level of injury graded 3 or better?

NO ↓ AIS=C YES ↓ AIS=D

If sensation and motor function is normal in all segments, AIS=E
Note: AIS E is used in follow-up testing when an individual with a documented SCI has recovered normal function. If at initial testing no deficits are found, the individual is neurologically intact; the ASIA Impairment Scale does not apply.