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The association of Type D personality with functional outcomes, quality of life and neuropathic pain in persons with spinal cord injury

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STUDY DESIGN: Cross-sectional study.
OBJECTIVES: This study aimed to investigate the association of Type D personality (TDP) with functional outcomes, health-related quality of life (HRQoL) and neuropathic pain in persons with spinal cord injury (SCI), using dichotomous and continuous analysis methods.
SETTING: Tertiary rehabilitation center.
METHODS: This study included 105 persons with SCI. Independence level was determined using the Functional Independence Measure (FIM)-motor subscale. The Short Form-36 questionnaire (SF-36) was used to assess HRQoL. TDP (combined existence of negative affectivity and social inhibition) was assessed using Type D Scale-14 (DS-14). Presence of chronic pain was questioned and the Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) Pain Scale was used to distinguish neuropathic pain from others.
RESULTS: In dichotomous method, the FIM-motor score was significantly lower in persons with TDP (41 persons, 39%) ($p = 0.025$). Persons with TDP had significantly lower scores in vitality, emotional role and mental health. There was no significant difference between the groups, regarding neuropathic pain and LANSS scores ($p > 0.05$ for all). Negative affectivity and total DS-14 scores had negative correlation with mental health and vitality. In continuous interaction method, TDP predicted mainly the mental health components of SF-36 (particularly, vitality and mental health). Negative affectivity was the driving factor. TDP was not associated with FIM-motor, VAS pain or LANSS scores.
CONCLUSIONS: Mental component of HRQoL is associated with Type D in persons with SCI in both analyses. Assessment of potential differences related with TDP may be beneficial to develop and apply person-specific goals in SCI rehabilitation.

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INTRODUCTION

Spinal cord injury (SCI) highly affects the level of independence and health-related quality of life (HRQoL) due to the loss of motor and sensory functions and other SCI-related problems such as bowel, bladder and sexual dysfunction, muscle spasms, neuropathic pain and psychological problems. The gain in the individuals' treatment are limited due to a combination of the abovementioned problems [1]. The objective of rehabilitation in SCI is to help the individuals enhance their independence in daily activities, improve HRQoL, participate in social activities and return to work [2].

Demographic factors and variables related to injury are considered while planning the rehabilitation program for persons with SCI. However, even in case where the considered factors are similar, the achieved functional outcomes and HRQoL measures may have differences between patients [2]. Previous studies have reported that psychological factors (cognition, mood and coping strategies) would explain the variance in HRQoL and functional independence between individuals with SCI [2]. Therefore, strengthening the person's coping capacity, improving health-related behaviors and psychological status may be beneficial to reach successful outcomes in clinical rehabilitation [3–5].

Type D (distressed) personality is described as joint existence of negative affectivity (NA) and social inhibition (SI). NA is the tendency to have negative emotions like anger, irritability, dysphoria, anxiety and depressed affect. SI is the anxiety about being criticized and rejected by others, and having difficulty in expressing oneself properly in social situations. Type D personality (TDP) was reported to be highly associated with anxiety and depression [6, 7]. Although it was previously reported to be stable, some recent studies reported that the course of TDP may change by time. Thus, some authors described it relatively stable and a state rather than a trait [8].

TDP has been previously linked to adverse health outcomes in several diseases. The negative impact of TDP on health was firstly reported and widely studied in coronary heart disease [9]. In those studies, it was reported that those with TDP had higher drop-out

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rates from cardiac rehabilitation, higher levels of depressive symptoms and higher rates of sedentary lifestyle [10, 11]. The negative outcomes of TDP has been also reported in sleep disturbance, vestibular and auditory diseases, multiple sclerosis, Parkinson's disease, ankylosing spondylitis, periodontal diseases, diabetes, ulcerative colitis, migraine, cancer, fibromyalgia and chronic pain. It was suggested that TDP might predispose the individual to have detrimental health-related behaviors (maladaptive avoidance coping strategies) [6, 12, 13]. Given that the characteristics of SCI cannot be modified, the aforementioned psychological factors (mood and coping strategies, in particular) may be susceptible to change [14]. Thus, those may be used as targets for interventions to enhance the functional outcomes.

People with TDP were reported to be more prone to develop depression and anxiety disorders compared to non-Type D ones. Depressive symptoms may be associated with getting higher scores on both subscales of the Type D Scale-14 (DS-14). Some authors stated that the association of TDP with depression would be an indicator of the disorder rather than a predictor [15]. Some behavioral pathways between Type D and depression were also suggested; Type D persons are prone to engage unhealthy lifestyle such as physical inactivity, which in turn may result in depression [16]. It was suggested that TDP was associated with depression via increased biomarkers of inflammation and endothelial dysfunction. Moreover, higher cortisol levels have been related to increased oxidative stress, TDP and depression [16]. Despite there are numerous studies to investigate the health related associations of TDP, there are also studies criticizing the conceptual, statistical and methodological issues regarding the Type D construct. Classifying the people into NA and SI groups by achieving high or low scores on a scale, may result in loss of information regarding individual differences. This categorization may lead to false or exaggerated comments that outcome of an effect needs to be similar for every person. Besides, some studies suggested that TDP was a reconceptualization of neuroticism and inverse extraversion, and some others suggested it to be only a reflection of depression [17]. Regarding statistical assessments, Paul Lodder reported that commonly used methods to assess TDP effect revealed exaggerated false positive rates in simulation scenarios. Thus, he recommended the use of continuous interaction method including the quadratic NA and SI effects [18]. In their longitudinal study, Loosman et al. found that TDP varies over time in dialysis patients and suggested that it is possibly more a state rather than a trait [8]. Despite these criticisms, TDP is considered a risk factor for adverse physical and psychological health outcomes in patients with chronic diseases.

The impact of psychological factors in SCI has been studied widely and was previously reported to affect the outcomes in SCI [2, 3]. However, the role of TDP and its relations have not been previously studied in persons with SCI. The hypotheses for the present study are as follows: (1) TDP would be associated with worse functional outcomes and lower HRQoL, (2) TDP would be associated with more severe and more frequent neuropathic pain. Thus, this study aimed to investigate, for the first time in literature, whether TDP had any associations with functional outcomes, HRQoL and neuropathic pain in persons with SCI.

METHODS

Participants

The study was carried out at the tertiary rehabilitation center affiliated with Afyonkarahisar Health Sciences University, Turkey. Consecutive persons who admitted to neurological rehabilitation program due to SCI in an inpatient or outpatient setting in 12-month period were recruited. The cross-sectional study was approved by the local ethics committee. All participants were informed about the study procedure and they gave their written consents prior to any data collection. The inclusion criteria were: (1) being between 18–70 years of age, (2) having SCI for at least 9 months in duration, (3) having no difficulties in communicative and cognitive functions. The exclusion criteria were having: (1) additional neurological diseases other than SCI (traumatic brain injury, stroke, multiple sclerosis), (2) rheumatoid arthritis, (3) systemic diseases associated with neuropathic pain or polyneuropathy (diabetes mellitus), (4) psychiatric disorders (schizophrenia, psychotic symptoms, untreated bipolar disorder) and (5) past or current history of major depressive disorder, panic disorder or post-traumatic stress disorder. Demographic data of the participants (age, sex, duration since injury) and data regarding any accompanying psychiatric disorders were recorded by self-report and using medical records.

All participants were examined by the same physician (S.E.) and the level (cervical, thoracic and lumbosacral) and the severity of injury (complete/incomplete) were determined according to the American Spinal Cord Injury Association (ASIA) Impairment Scale, in which ASIA A means complete injury and ASIA B-C-D reveals incomplete injury [19].

Measurements

The level of participants' independence in daily living activities was determined according to the Functional Independence Measure (FIM)-motor score. The FIM is an 18-item scale (13 items for motor and 5 items for cognitive functions) in which each of the items is graded 1 to 7 points (total assistance required (1 point)–completely independent (7 points)). FIM-motor subscale includes self care, sphincter control, transfer and locomotion categories (one can get 13 points minimum to 91 points maximum). The Turkish reliability and validity of FIM was performed previously by Kucukdeveci et al. [20].

The Short Form-36 questionnaire (SF-36) was used to assess HRQoL. SF-36 consists of 36 questions in 8 subscales (physical function, physical role, bodily pain, general health, vitality, social function, emotional role and mental health) and each is graded between 0–100 points. The greater score indicates higher quality of life [21].

TDP was assessed using the Turkish version of DS-14, which consists of two subscales; NA and SI. Each subscale consists of seven items, which are scored on a five-point Likert type scale ranging from 0 (false) to 4 (true). The participants with a score of 10 points or greater on both scales are accepted to have TDP [22, 23]. The Turkish reliability and validity of DS-14 was previously performed by Alçelik et al. [23].

The participants were questioned for presence of chronic pain (lasting more than 3 months) at and/or below the level of injury and other pain, if present, asked to rate the intensity of pain over the last week on a 0–100 cm visual analog scale (VAS) [24].

Each participant with chronic pain was evaluated using the Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) Pain Scale to distinguish neuropathic pain from the others. The cut-off value in the LANSS for inclusion of the participant in the neuropathic pain group was 12 and greater (total score 24). The Turkish reliability and validity of the LANSS was previously performed by Yucel et al. [25].

Statistical analysis

PASW Statistics 18 version 18.0.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Descriptive analysis on the demographic and clinical characteristics was performed. The Kolmogorov–Smirnov test was used to test the normality of distribution. The categorical variables were described as the number of cases and percentages. Normally distributed continuous data was presented as mean(standard deviation), unless stated otherwise. Chi-square test was used to compare the data regarding sex, severity and level of injury and the presence of neuropathic pain between Type D and non-type D groups.

We analyzed the data of this study using two methods. First, we used the dichotomous method in which the persons are classified as Type D according to the score achieved over 10 from both NA and SI. Student's *t* test was used to compare the data on age, duration from injury, FIM-motor, VAS chronic pain and LANSS scores and Short Form-36 subscales between Type D and non-type D groups. The Pearson's rank correlation test was performed to determine the relationships between duration from injury, VAS pain, LANSS, FIM-motor, SF-36 subscales and NA, SI and total DS-14 scores of the participants. p values <0.05 was regarded statistically significant.

Second, we also examined TDP as a continuous variable (NA, SI and their interactions) in regression analysis. Mean-centered continuous variables were used to form the models. Hierarchical linear regression analysis was performed in order to find out the predictor effect of DS-14 scores on FIM-motor, Short Form-36 subscales, VAS pain and LANSS scores. Type D effect was assessed with models [18]:

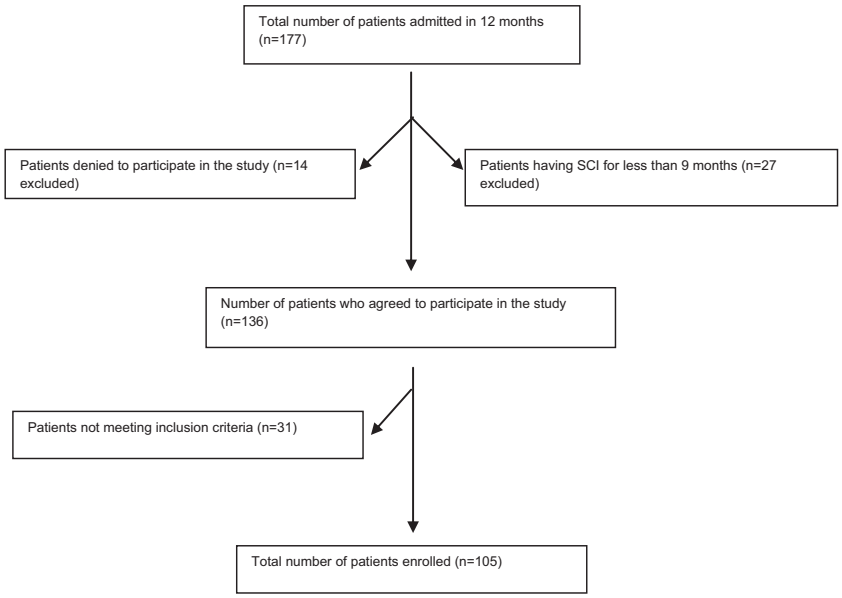

Fig. 1 Flow chart of study participant selection, describing the number of eligible and included participants as well as the reasons for exclusion. SCI spinal cord injury, *n* number of participants.

Model 1 (NA mean-centered + SI mean-centered) tests whether the personality traits NA and SI are related to the functional outcomes.

Model 2 (NA mean-centered + SI mean-centered + NA × SI) tests whether the interaction between NA and SI (the Type D effect) adds anything on top of the effects of the NA and SI main effects.

Model 3 (NA mean-centered + SI mean-centered + $NA^2 + SI^2 + NA \times SI$) tests whether the Type D effect as the interaction between NA and SI remains significant after adjusting it for the possible confounding influence of the NA and SI quadratic effects.

Model 4 (NA mean-centered + SI mean-centered + $NA^2 + SI^2$) excludes the interaction term but includes the NA and SI quadratic effects. This allows determining whether the quadratic effects or the interaction effect best explains the individual variation in functional outcomes.

RESULTS

A total of 177 consecutive patients admitting in 12 months were asked whether they wanted to participate in the study. Twenty-seven persons were excluded since they had SCI for <9 months, 14 denied to participate in the study and 31 were excluded because of comorbidities (diabetes mellitus; 13, accompanying traumatic brain injury; 3, stroke; 1, polyneuropathy; 2, rheumatoid arthritis; 1, major depressive disorder; 7 and post-traumatic stress disorder; 4). Finally, the study included 105 individuals with SCI (Fig. 1). The mean age of the participants was 33.8(13.4) years and the mean duration since injury was 38.6(26.6) months. The demographic data and clinical characteristics of the persons are summarized in Table 1.

Dichotomous method

Forty-one persons (39%) fulfilled the criteria for having TDP. The participants were grouped as Type D and non-Type D. There were no significant differences in terms of age, sex, duration since injury, severity and level of injury between Type D and non-Type D groups ($p > 0.05$ for all) (Table 2). However, the FIM-motor score of the Type D group was significantly lower than that of the non-Type D group ($p = 0.025$) (Table 2). There was no significant difference between the groups, regarding VAS pain scores, the presence of neuropathic pain, and the LANSS scores ($p > 0.05$ for all) (Table 2).

There were significantly lower values for the SF-36 subscale scores of vitality, emotional role and mental health in Type D group compared to non-Type D group ($p = 0.000$, 0.045, 0.000, respectively) (Table 3).

Table 1. Demographic and clinical characteristics of the study population ($n = 105$).

Variable	Mean (SD) or frequency (percentage)
Age (years)	33.8 (13.4)
Sex (male/female)	79 (75.2%)/26 (24.8%)
Duration since injury (months)	38.6 (26.6)
FIM-motor	58.1 (18.6)
Short Form-36 subscales	
Physical function	28.5 (19.0)
Physical role	32.8 (35.1)
Bodily pain	56.6 (28.1)
General health	51.5 (20.1)
Vitality	54.05 (21.1)
Social function	47.9 (25.8)
Emotional role	44.5 (29.0)
Mental health	66.2 (19.9)
Negative affectivity	9.2 (6.3)
Social inhibition	8.2 (5.4)
Total DS-14	17.5 (10.4)
VAS pain	42.0 (30.9)
Chronic pain, *n* (%)/neuropathic pain, *n* (%)	76 (72.3%)/59 (56.1%)

FIM Functional Independence Measurement, *Total DS-14* 14-item Type D scale, *VAS* visual analog scale.
Continuous variables are represented using mean (SD), categorical variables are represented using frequency and percentage (%).

Regarding overall persons with SCI: the NA scores of DS-14 had strong negative correlation with mental health, moderate correlation with vitality, and weak correlation with social function, emotional role and general health subscales of SF-36 and weak correlation with FIM-motor scores ($p < 0.05$ for all, $r = -0.615$, -0.565, -0.325, -0.297,-0.234 and -0.221, respectively).The SI scores of DS-14 had weak negative correlation with vitality and

Table 2. Demographic and clinical characteristics of the persons with spinal cord injury regarding the presence of Type D personality.

	Type D (n = 41)	Non-Type D (n = 64)	p
Age (years)	34.4 (15.4)	33.4 (12.1)	0.743
Duration from injury (months)	38.4 (27.8)	38.7 (26.0)	0.710
Sex (male/female)	28 (68.2%)/13 (31.7%)	51(79.7%)/13 (21.3%)	0.139
Severity of injury (ASIA)			0.725
A	15 (36.6%)	30 (46.9%)	
B	9 (22%)	12 (18.8%)	
C	12 (29.3%)	17 (26.6%)	
D	5 (12.2%)	5 (7.8%)	
Level of injury			0.287
Cervical	8 (19.5%)	14 (21.9%)	
Thoracic	28 (68.3%)	35 (54.7%)	
Lumbosacral	5 (12.2%)	15 (23.4%)	
FIM-motor score	54.1 (18.3)	60.7 (18.5)	**0.025**
VAS chronic pain	43.1 (31.8)	41.4 (30.5)	0.724
Neuropathic pain (n, %)	21 (51.2%)	38 (59.4%)	0.267
LANSS	7.7 (6)	9.2 (7.3)	0.204

Values are presented as numbers, *n*(%) or mean (SD); $p < 0.05$.
ASIA American Spinal Injury Association Impairment Scale, *FIM* Functional Independence Measurement, *LANSS* the Leeds assessment of neuropathic symptoms and signs, *VAS* visual analog scale.
Statistically significant *p* values are given in bold.

Table 3. Comparison of the quality of life measures according to Short Form-36 subscales regarding the presence of Type D personality in persons with SCI.

	Type D (*n* = 41)	Non-Type D (*n* = 64)	p
Physical function	10 (27.5)	20 (27.2)	0.160
Physical role	28.1 (31)	35 (37)	0.430
Bodily pain	59 (26)	55 (29.5)	0.610
General health	47.9 (20.7)	53.9 (19.5)	0.950
Vitality	44.0 (19.3)	60.4 (19.8)	**0.000**
Social function	44.0 (23.4)	50.4 (27.2)	0.220
Emotional role	38.3 (27.3)	44.5 (29)	**0.049**
Mental health	56.3 (18)	72.6 (17.9)	**0.000**

Values are presented as mean (SD); $p < 0.05$.
Statistically significant *p* values are given in bold.

mental health ($p < 0.05$ for all $r = -0.308$ and -0.270, respectively). The total DS-14 scores had moderate negative correlation with vitality, mental health and weak correlation with social function ($p < 0.05$ for all $r = -0.512$, -0.512 and -0.212, respectively) (Table 4).

Continuous interaction method

Unlike the dichotomous method, TDP was not a predictor for FIM-motor score when assessed as continuous variable, nor was a predictor for VAS pain and LANSS scores. However, in hierarchical regression, some models predicted the difference in bodily pain, general health, vitality, social function, emotional role and mental health with varying rates. Model 1 predicted the mental components of SF-36. NA had the main predictor effect in all those subgroups; for vitality ($\beta = -0.567$, $t = -5.678$, $p = 0.000$), for social function ($\beta = -0.457$, $t = -4.146$, $p = 0.000$), for emotional role ($\beta = -0.367$, $t = -3.232$, $p = 0.002$) and for mental health ($\beta = -0.668$, $t = -7.021$, $p = 0.000$). Moreover, Model 2 predicted bodily pain ($\beta = 0.212$, $t = 2.111$, $p = 0.037$), general health ($\beta = 0.208$, $t = 2.107$, $p = 0.038$) and vitality ($\beta = 0.176$, $t = 2.073$, $p = 0.041$). Model 3 predicted bodily pain with SI^2 driving the outcome ($\beta = -0.380$, $t = -2.820$, $p = 0.006$). Model 4 after exclusion of NA × SI effect also predicted bodily pain with NA^2 driving the outcome ($\beta = 0.294$, $t = 2.678$, $p = 0.009$) (Table 5).

DISCUSSION

This study investigated, for the first time, whether TDP has any associations with functional outcomes, HRQoL and neuropathic pain in persons with SCI. We found, in dichotomous method, that the individuals with TDP had significantly lower levels of functional motor independence and lower scores of HRQoL measures such as vitality, emotional role and mental health, compared to non-Type D ones. Among the persons who stated to have chronic pain related to SCI, VAS pain scores were similar between the Type D and non-Type D groups. There was no difference between the number of persons with neuropathic pain and the LANSS scores in both groups. Moreover, regarding overall persons with SCI, higher NA and total DS-14 scores were associated with lower vitality and mental health. In continuous interaction method, TDP predicted mainly the mental health components of SF-36. NA was a significant predictor of vitality and mental health, in particular. Type D was not a predictor of FIM-motor, VAS pain or LANSS scores.

In the present study, 39% of persons with SCI were found to have TDP. Previously, the frequency of TDP was reported 31.7% in general population, 27.7% in hemodialysis patients, 33% in persons with fibromyalgia and 56.8% in persons with multiple sclerosis in Turkey [26–28].

Individual differences in psychological factors may significantly affect the recovery period, functional outcomes and physical skills in SCI. Thus, evaluation of individual needs and providing proper psychological support may enhance functional independence and long-term HRQoL of persons with SCI. Since psychological factors (person's coping capacity, health-related behaviors and psychological status) can be modified, the physicians taking part throughout the rehabilitation process must consider those [2, 4, 10]. Kennedy et al. reported that the variance in FIM-motor scores in SCI was due to individual differences. Stressful situations which exceed the person's capacity might make him/her engage avoidant and passive coping strategies [2]. Since, this condition is more probable in Type D persons, TDP may predispose an individual to engage detrimental health-related behaviors including maladaptive avoidance coping strategies [10, 13]. Thus, the person may struggle less to contribute to the rehabilitation process [2].

SCI rehabilitation is a dynamic and interactive process. All stages of rehabilitation require intensive effort of the patient and compliance to the therapy. Although not significant in continuous interaction method, we found, in the dichotomous method, that among persons with SCI, the Type D ones had significantly lower levels of functional motor independence compared to the non-Type D ones. A possible explanation for the difference in functional outcomes would be that Type D persons might be less motivated and less eager to exercise and also less compliant to the therapy. Moreover, depressive symptoms which are frequent both in SCI and Type D may also influence individual motivation to participate in the rehabilitation process [2]. Cardiac patients with TDP were reported to have a sedentary life style; they exercise less, and have lower motivation to exercise and poorer self-management behaviors [9]. Further, Type D persons have higher rates of drop-out from cardiac

Table 4. Correlation between the scores of negative affectivity, social inhibition and total DS-14 and clinical and functional variables and health related quality of life in persons with SCI ($n = 105$).

	Negative affectivity		Social inhibition		Total DS-14	
	r	95% CI	*r*	95% CI	*r*	95% CI
Duration from injury (months)	−0.061	−0.250–0.132	−0.023	−0.214–0.169	−0.036	−0.226–0.157
VAS pain	0.009	−0.183–0.200	−0.017	−0.208–0.175	−0.005	−0.196–0.187
LANSS	−0.086	−0.273–0.107	−0.112	−0.297–0.081	−0.117	−0.302–0.076
FIM-motor	**−0.221**	**−0.396–0.031**	−0.072	−0.260–0.121	−0.166	−0.347–0.027
SF-36 subscales						
Physical function	−0.111	−0.296–0.082	−0.043	−0.233–0.150	−0.093	−0.280–0.100
Physical role	−0.158	−0.339–0.035	0.037	−0.339–0.035	−0.058	−0.247–0.135
Bodily pain	−0.075	−0.263–0.118	0.098	−0.095–0.284	−0.013	−0.204–0.179
General health	**−0.234**	**−0.407–−0.044**	−0.069	−0.257–0.124	−0.190	−0.368–0.002
Vitality	**−0.565**	**−0.683–−0.419**	**−0.308**	**−0.472–−0.124**	**−0.512**	**−0.641–−0.355**
Social function	**−0.325**	**−0.486–−0.142**	−0.035	−0.225–0.158	**−0.212**	**−0.388–−0.021**
Emotional role	**−0.297**	**−0.462–−0.112**	−0.021	−0.212–0.171	−0.187	−0.366–−0.005
Mental health	**−0.615**	**−0.722–−0.480**	**−0.270**	**−0.439–−0.083**	**−0.512**	**−0.641–−0.355**

r: Pearson's correlation coefficient, the values with $p < 0.05$ are given in bold. A correlation was considered weak at <0.3, moderate between 0.3 and 0.5 and strong at higher than 0.5.
VAS visual analog scale, *LANSS* the Leeds assessment of neuropathic symptoms and signs, *FIM* Functional Independence Measurement, *DS-14* 14-item Type D Scale.

rehabilitation program. TDP was reported to affect participation to cardiac rehabilitation independently [11]. Since our study has a cross-sectional design, we did not investigate if any person with SCI dropped out from rehabilitation. Besides, it is worth to keep in mind that the FIM score can be influenced by especially the participant's effort and the relationship between the rater and the person being rated. Psychological factors may have an impact on HRQoL measures, mental health in particular, more than the injury characteristics [14]. The measures used to assess HRQoL are based on individual perceptions. Previous studies reported that the effect of TDP on mental health was more prominent than that on physical health in persons with Parkinson's disease and multiple sclerosis [6, 27]. Mikula et al. found no relationship between TDP and the physical component of SF-36, but the mental component was significantly affected in persons with multiple sclerosis. They suggested that this was due to the more objective nature of physical health than mental health [4]. In keeping with the relevant literature, vitality, emotional role and mental health subscales, that constitute the mental component of SF-36, were lower in Type D persons with SCI in the present study. However, there was no difference in the physical health dimension. Further, higher scores of NA and total DS-14 were associated with lower vitality and mental health in overall persons with SCI. However, no such correlation was found regarding SI. In addition to these findings, TDP was a predictor for all mental component subscales of SF-36. NA was associated with mental health and vitality, in particular. It is likely that intense anxiety and distress experienced by persons with SCI induce NA. SI was not apparent, possibly because individuals with SCI need social support to perform activities in daily life. In a study conducted on general population, the main effect on physical symptoms and quality of life was associated with NA and it was the main component related to negative impacts in TDP [29]. On the other hand, Lee et al. reported that higher SI scores were related to higher rates of drop-out from rehabilitation in cardiac patients [11].

Neuropathic pain highly affects daily lives and the HRQoL of persons with SCI. Individual differences and personality may play a role in the emergence of neuropathic pain and psychological distress in persons with SCI [30]. Besides, neuropathic pain and psychological distress have a close relationship [24, 30]. Gruener et al. investigated the impact of psychological distress on neuropathic pain among patients with SCI with and without neuropathic pain. They reported that SCI patients with neuropathic pain had higher levels of distress, depression and anxiety compared to those without neuropathic pain. They also stated that pain was associated with psychological distress rather than the existence of SCI itself. Distress and the level of neuropathic pain were positively correlated [30]. Given that Type D persons frequently have depression and anxiety [9] and persons with SCI have increased levels of depression [30], we had hypothesized that Type D (distressed) persons would have higher levels of chronic pain. However, we could not detect any differences in the intensity of chronic pain, the number of participants with neuropathic pain and the LANSS scores between Type D and non-Type D groups. Moreover, Type D was not a predictor of FIM-motor, VAS pain and LANSS scores. The pathophysiology of neuropathic pain is quite complex and not fully elucidated yet. Although there are numerous psychological and biological factors in the emergence of neuropathic pain, we could not find any influence of TDP on neuropathic pain in SCI. Furthermore, medications and other modalities used by the participants were not considered in the present study.

Despite numerous studies on the health-related effects of TDP, debates still exist about the conceptual issues. Both neuroticism and TDP measures assess a variety of negative emotions. Since the items in the measures of neuroticism and TDP have considerable overlap, some authors stated that there is no true TDP effect and suggested that TDP is a reconceptualization of neuroticism [17]. Neuroticism has been reported to be highly similar to Type D in terms of negative feelings, and unfavorable social outcomes. Further, similar to TDP, neuroticism also has been reported to be relatively unstable and fluctuate over time [31].

To the best of our knowledge, the association between TDP and SCI has not been studied in the literature, but there are studies evaluating the effects of personality traits in patients with SCI. Personality features were linked with health behaviors, prognosis and even mortality in persons with SCI. Krause et al. suggested evaluation of the personality features in order to detect persons at risk for specific issues and to institute cause-specific interventions and prevention strategies [32]. Moreover, Scholten et al. stated that early assessment of postinjury psychological distress would

Table 5. Hierarchical regression analysis on FIM-motor, Short Form-36 subscales, VAS pain and LANSS scores according to models 1, 2, 3 and 4.

Variable	R^2 change	Significance of *F* change (*p*)
FIM-motor		
Model 1	0.028	0.235
Model 2	0.008	0.363
Model 3	0.014	0.484
Model 4	−0.022	0.134
Physical function		
Model 1	0.023	0.299
Model 2	0.005	0.490
Model 3	0.005	0.782
Model 4	−0.002	0.678
Physical role		
Model 1	0.048	0.082
Model 2	0.004	0.497
Model 3	0.005	0.774
Model 4	−0.002	0.652
Bodily pain		
Model 1	0.012	0.539
Model 2	**0.042**	**0.037**
Model 3	**0.078**	**0.014**
Model 4	**−0.041**	**0.032**
General health		
Model 1	0.043	0.109
Model 2	**0.040**	**0.038**
Model 3	0.003	0.860
Model 4	−0.018	0.164
Vitality		
Model 1	**0.298**	**0.000**
Model 2	**0.029**	**0.041**
Model 3	0.004	0.754
Model 4	−0.023	0.071
Social function		
Model 1	**0.145**	**0.000**
Model 2	0.000	0.823
Model 3	0.005	0.728
Model 4	−0.004	0.477
Emotional role		
Model 1	**0.093**	**0.007**
Model 2	0.001	0.687
Model 3	0.036	0.138
Model 4	−0.002	0.612
Mental health		
Model 1	**0.363**	**0.000**
Model 2	0.019	0.081
Model 3	0.005	0.685
Model 4	−0.019	0.085
VAS pain		
Model 1	0.000	0.991
Model 2	0.012	0.271
Model 3	0.020	0.355
Model 4	0.000	0.886
LANSS		
Model 1	0.010	0.593
Model 2	0.001	0.813
Model 3	0.032	0.193
Model 4	−0.001	0.776

VAS visual analog scale, *LANSS* the Leeds assessment of neuropathic symptoms and signs, *FIM* Functional Independence Measurement.
Statistically significant values are given in bold.

be important in predicting the distress at later stages in persons with SCI. They reported that later distress was highly associated with early postinjury distress, higher maladaptive coping and neuroticism. They suggested earlier screening of the persons with SCI to identify those at higher risk for psychological distress [33]. Given that distress and maladaptive coping is frequent in persons with TDP, screening of those would be useful in clinical practice.

Recently, there are debates about the statistical methods used in assessment of TDP. Lodder et al. reviewed 44 published studies that evaluated the Type D effect using both dichotomous and continuous approaches and reported that the dichotomous method revealed poor agreement with the continuous Type D effect. They suggested that around half of the published articles using the dichotomous method might have reported Type I errors, with only NA or SI mainly driving the outcome. Thus, they suggested to conceptualize and analyze TDP as a continuous construct. Although TDP was related with FIM-motor in the dichotomous method, it could not predict FIM-motor in continuous interaction method. However, the predictor effect of TDP was more evident for mental health and vitality. It was previously reported that categorical assessment of TDP would result in higher false positive rates and TDP would be better evaluated through continuous interaction method. By using this method, the individual effects of NA and SI, and the interaction between them can be elucidated [18, 34]. Similar to our findings, Stevenson and Williams found, using categorical analysis, that Type D was associated with lower quality of life and higher physical symptoms in general population. However, in continuous analysis, they could not find any association between Type D and quality of life and physical symptoms. They also reported that NA was the main component related to negative outcomes of TDP as identified in categorical analysis [29].

Limitations

The study population is young for a SCI sample. This might be due to the cross-sectional design of the study and the exclusion criteria (accompanying comorbidities excluded). The cross-sectional design of the study does not provide information about the course of the Type D persons over time. The low number of participants treated in the single-center might limit generalization of the results to overall SCI population. Collection of limited demographic variables is another limitation. A range of other demographic factors such as marital status, work status, religious attendance might influence the outcome measures under investigation. Thus, it is unclear that to what extent these unmeasured factors may have impacted the findings. Moreover, we did not investigate the individual impacts of anxiety, depression, coping strategies and the level of participation to rehabilitation. Thus, future studies of longitudinal design are needed to investigate the associations of TDP more comprehensively in SCI population.

CONCLUSIONS

This is the first study to investigate the association between Type D and functional outcomes, neuropathic pain and HRQoL in SCI,

using both the dichotomous and continuous methods of analyzing Type D. Functional independence and HRQoL (vitality, emotional role and mental health) were lower in Type D persons with SCI. Higher NA and total DS-14 scores were associated with lower vitality and mental health regarding overall persons with SCI. Using continuous interaction approach, TDP was mainly associated with mental health components of SF-36. We found that NA was the main driving factor in negative outcomes of Type D. The results of this study may emphasize the significance of assessment of TDP in individuals with SCI. The physicians taking part in SCI rehabilitation should consider potential differences regarding HRQoL of Type D persons. Further studies to develop and apply psychological interventions and follow person-specific goals may be of benefit.

DATA AVAILABILITY

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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AUTHOR CONTRIBUTIONS

SE conceptualized and designed the study, contributed data analysis, and manuscript preparation. SS contributed to extracting and analyzing data. ÜD oversaw the data analysis and contributed to manuscript preparation.

COMPETING INTERESTS

The authors declare no competing interests.

ETHICAL APPROVAL

This study protocol was approved by the Ethics Committee of Dumlupınar University, Kutahya, Turkey (reference number: 2016-5-40). We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

ADDITIONAL INFORMATION

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