Adaptation During Spinal Cord Injury Rehabilitation: The Role of Appraisal and Coping

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Author Note

Abstract

Objective: to test the spinal cord injury adjustment model (SCIAM) by examining whether primary appraisals (threat or loss) and coping strategies (approach-oriented and denial) sequentially mediate the impact of functional independence, psychological resources, and social support on depressive and anxiety symptoms among individuals with spinal cord injury during inpatient rehabilitation. *Methods:* Path analyses of longitudinal data from a Swiss inception cohort study (N=207). Models were implemented separately for depressive and anxiety symptoms. *Results:* the initial models based on the SCIAM yielded poor fit and were re-specified. Different from the SCIAM's assumptions, psychological resources and threat appraisal showed direct effects on depressive symptoms ($\beta = -.28$, *SE* = .07, *p* <.001 and $\beta = .33$, *SE* = .07, *p* < .001 respectively), while social support and threat appraisal showed direct effects on anxiety symptoms ($\beta = -.23$, *SE* = .06, *p* <.001 and $\beta = .42$, *SE* = .06, *p* < .001 respectively). Primary appraisals and coping strategies partially mediated the effects of psychological resources on depressive symptoms and fully mediated their effect on anxiety symptoms. However, this did not only happen via the SCIAM's sequential double mediation, since indirect effects were also observed via threat appraisal only. The final models explained 40 and 30% of the variance of depressive and anxiety symptoms respectively. *Conclusions:* The findings only partially supported the SCIAM's sequential double mediation mechanism. Psychological resources, social support, and primary appraisals can have direct effects on psychological adaptation outcomes and may be suitable intervention targets during inpatient rehabilitation.

Keywords: coping behaviors, anxiety, depression, psychological adaptation, spinal cord injuries

Impact statement:

- This is the first longitudinal study testing the Spinal Cord Injury Adjustment Model (SCIAM) in the inpatient rehabilitation setting.

- Different from what is hypothesized in the SCIAM, psychological resources, social support, and cognitive appraisals were not only associated with the adaptation outcomes by influencing the way individuals cope with their SCI, but also by directly contributing to lower levels of depressive or anxiety symptoms. Thus, interventions targeting appraisals and psychological resources (e.g., self-efficacy, optimism, or purpose in life), and strengthening social support may be particularly promising to promote a better course of the psychological adaptation process during SCI rehabilitation.

- When testing adaptation models, considering other elements of the coping process beyond the use of specific coping strategies (e.g., coping flexibility) is needed to advance the understanding of the psychological adaptation process to SCI.

Adaptation During Spinal Cord Injury Rehabilitation: The Role of Appraisal and Coping

The onset of a spinal cord injury (SCI) is a life-changing event with profound consequences in all life domains. Although sustaining an SCI does not preclude the experience of happiness and satisfaction with life (Post & van Leeuwen, 2012), individuals with SCI have been found to have a higher probability to experience mental health issues compared to the general population (Le & Dorstyn, 2016; Williams & Murray, 2015). Moreover, the onset of an SCI demands a rehabilitation process which can be long, challenging, and emotionally overwhelming (Craig et al., 2017). In this context, understanding how individuals cope with and adapt to the different challenges posed by the injury is of special interest to provide prompt and appropriate care.

Psychological adaptation to SCI

Psychological adaptation to chronic illnesses and disabilities, such as the caused by an SCI, is a complex process and diverse models have been developed to explain how it unfolds and what its underlying mechanisms are (for a review see Livneh & Martz, 2012). One of these models is the SCI Adjustment Model (SCIAM) proposed by Middleton and Craig (2008), which incorporates elements of the Lazarus and Folkman's Transactional Model of Stress and Coping (1984), the Stress Appraisal and Coping Model (Galvin & Godfrey, 2001), and the Biopsychosocial Model (Engel, 1977). The SCIAM defines adaptation to SCI as a complex multidimensional and temporal process. This process comprises the dynamic interaction of multiple biomedical, psychological, and social factors (Craig et al., 2017), whose influence on the adaptation outcomes is mediated by primary appraisal and coping strategies. In this sense, the SCIAM proposes a sequential double mediation mechanism: when facing the stressors related to an SCI, biomedical, psychological, and social factors influence the way an individual appraises the situation (e.g., as a loss, a threat, or a challenge). Such appraisals influence which coping strategies the individual uses, and this leads to certain adaptation outcomes which can be more or less positive (e.g., experiencing positive affect or effective social participation, or experiencing depression or anxiety; Craig et al., 2017).

Appraisals, Coping, and Adaptation to SCI

Primary appraisals and coping strategies have a central role in the SCIAM as the mechanism underlying the adaptation process to SCI (Craig et al., 2017). The role of primary appraisals and coping has been largely studied in relation to adaptation outcomes following SCI (Post & van Leeuwen, 2012; van Leeuwen, Kraaijeveld, et al., 2012). Findings on the relationship between primary appraisals and adaptation outcomes suggest that challenge appraisal is associated with higher life satisfaction and lower symptoms of depression or anxiety (Bonanno et al., 2012; van Leeuwen, Kraaijeveld, et al., 2012), while threat and loss are related with higher levels of depression and anxiety (van Leeuwen, Kraaijeveld, et al., 2012). In regards to coping and psychological adaptation outcomes, several studies indicate that avoidance-oriented strategies such as denial and behavioral disengagement are associated with poorer adaptation outcomes (Martz et al., 2005; Pollard & Kennedy, 2007), while approach-oriented strategies such as acceptance, active coping, planning, and positive reinterpretation have been linked to better adaptation outcomes (Bonanno et al., 2012; van Leeuwen, Kraaijeveld, et al., 2012). However, a review indicates that the findings on the effects of coping strategies on psychological adaptation outcomes are rather inconsistent (van Leeuwen, Kraaijeveld, et al., 2012), warranting further research on their role in the adaptation process.

The study of the association between biopsychosocial factors and primary appraisals or coping strategies has received comparatively less attention. Yet, the evidence available indicates that, among individuals undergoing inpatient rehabilitation, higher functional independence, self-efficacy, purpose in life, and social support were associated with lower threat or loss appraisals (Kennedy et al., 2009; Kunz et al., 2020). Moreover, appraisals of threat, loss, and challenge assessed at 12 weeks after injury onset have been found to contribute to higher functional independence one year after SCI (Kennedy et al., 2011). Further, statistically significant associations have also been found between psychological resources such as self-efficacy and purpose in life and appraisals of threat and challenge among community-dwelling individuals with SCI (e.g., Peter et al., 2015).

A variety of coping strategies such as acceptance, fighting spirit, positive reinterpretation, behavioral disengagement or planning, on another hand, have not been found to correlate with measures of functional independence (Kennedy et al., 2009; Kennedy et al., 2016; Kennedy et al., 2011; Kennedy et al., 2000), but most of these studies have been limited to small sample sizes. Social support and psychological resources such as self-efficacy and purpose in life have been found to be associated with higher use of religious coping, venting emotions, or acceptance (Kennedy et al., 2000), with more use of approach-oriented strategies such as active coping, positive reframing, and planning, and with less use of denial and behavioral disengagement (Peter et al., 2015).

The sequential double mediation mechanism proposed by the SCIAM, despite its popularity, has not been extensively explored yet. In a series of studies, Peter and colleagues (2014; 2015) tested the effect of psychological resources and the mediational role of appraisal and coping with regards to life satisfaction and depression. Results differed depending on the specific outcome and did not fully support the hypothesized sequential double mediation mechanism of the SCIAM because psychological resources had both direct and indirect effects (via appraisals and/or coping). However, these studies focused on individuals living in the community who had sustained the injury for 17 years on average. Moreover, they were limited by the use of cross-sectional data and did not consider the effects of biological nor social factors on the analyzed outcomes.

In sum, longitudinal research, which also examines the proposed mechanism linking biomedical and social characteristics to adaption outcomes, is needed to gain a better understanding of the psychological adaptation process to SCI. Moreover, the challenges faced by individuals newly injured are very different from those faced by individuals who have sustained an SCI a long time ago. As such, the factors contributing to the psychological adaptation may also differ (Galvin & Godfrey, 2001) and therefore, the consideration of the rehabilitation setting is also indicated.

To tackle these research gaps, the present study aimed at testing the mediation mechanism proposed by the SCIAM using a longitudinal design and focusing on the inpatient rehabilitation. It thus tested the SCIAM's hypothesis that the effects of functional independence, psychological resources, and social support (measured at rehabilitation admission) on depressive and anxiety

symptoms (measured at rehabilitation discharge) are fully and sequentially mediated by primary appraisals and coping strategies (measured approximately 3 months after SCI diagnosis).

Methods

Design and Participants

This longitudinal study used data from the ongoing Inception cohort of the Swiss Spinal Cord Injury Cohort Study (SwiSCI). Previous findings on functional Independence, post-traumatic growth, and psychological adaptation outcomes at rehabilitation discharge using SwiSCI data have been published elsewhere (see Galvis Aparicio et al., 2020; Hodel et al., 2020; Kunz et al., 2017, 2018, 2019; Kunz et al., 2020).

SwiSCI includes individuals 16 years old or older with permanent residence in Switzerland, who have a new diagnosis of traumatic or non-traumatic SCI and undergo first inpatient rehabilitation in one of the four collaborating rehabilitation centers. Exclusion criteria are congenital conditions leading to paraplegia or tetraplegia, new SCI in the context of palliative care, and neurodegenerative disorders such as multiple sclerosis. SwiSCI has received the approval of the regional ethics committees of all involved Swiss cantons.

Following eligibility screening, individuals newly admitted for inpatient rehabilitation are approached by SwiSCI research assistants who inform them about the study aims and procedures, and provide them with written informed consent forms. Individuals who consent to participate in SwiSCI complete clinical assessments and questionnaires regarding biomedical, psychological, and social factors. SwiSCI data collection takes place at four time points during clinical rehabilitation (for a more detailed description of the inception cohort of SwiSCI, see Fekete et al., 2021). The present study focused on three of these assessment times: rehabilitation admission (T1; approximately one month after SCI diagnosis), three months after SCI diagnosis (T2), and rehabilitation discharge (T3). Discharge data is collected shortly before individuals leave the rehabilitation facilities. In total, 1377 individuals undergoing rehabilitation between May 2013 and September 2020 were considered eligible for the present study. Of these, 153 refused to participate in SwiSCI and 570 only consented the collection of information regarding clinical assessments. Further 447 individuals were excluded

because they had complete data missing in at least one of the considered assessment time points. The final sample size was composed of 207 individuals. Reasons for non-participation or exclusion from the present study are listed in Figure 1.

Measures

Sociodemographic and Injury-related Characteristics

Information regarding sex, age, time since injury diagnosis, etiology of the SCI, injury level, and injury completeness were retrieved from the patients' records.

Independent variables: Assessed at T1

Functional Independence. Health practitioners rated the performance of the participants using the *Spinal Cord Independence Measure* (SCIM) III (Catz et al., 2007; Itzkovich et al., 2007). The SCIM is composed of 19 items regarding basic everyday tasks in the domains of self-care, respiration, sphincter management, and mobility. The total sum score ranges between 0 and 100 with higher scores representing better performance or independence. The SCIM III is a validated measurement instrument showing satisfactory reliability (Itzkovich et al., 2007). Cronbach's α in the present study was .86.

Social support. Individuals rated the extent of support they receive from their partner, family, and friends separately on a scale from 0 (not at all) to 10 (very much) using three items on instrumental support and three items on emotional support taken from the Swiss Household Panel (Tillmann et al., 2016). An average score of all six items was calculated. For individuals who indicated not to have a partner, the average score was calculated using the remaining four items. Cronbach's α of the six items in the present study was .82.

Psychological resources. Three psychological resources were considered for the present study: general self-efficacy, purpose in life, and optimism. General self-efficacy was assessed using a modified 5-item version of the *General Self-efficacy Scale* (Schwartzer & Jerusalem, 1995), which has shown to have very good construct validity and reliability in a sample of individuals with SCI (Peter, Cieza, et al., 2014). Participants rated the strenght of their belief in their own ability to respond to new or difficult situations using a Likert scale from 1 (not at all) to 4 (completely). Higher total sum

scores indicate higher general self-efficacy. To assess purpose in life, the four items of the *Purpose in Life Test–Short Form* (Schulenberg et al., 2011) were used. Participants reported their perceived life purpose using a Likert scale from 1 (e.g., "utterly meaningless/ without purpose") to 7 (e.g., "very purposeful and meaningful"). Higher total sum scores indicate higher perceived purpose in life. This test has shown unidimensionality, as well as very good reliability among individuals with SCI (Peter et al., 2016). Optimism was assessed with a 6-item version of the *Life Orientation Test-Revised* (LOT-R; Scheier et al., 1994) modified to measure current state. Individuals rated statements regarding their optimism on a scale from 0 (strongly disagree) to 4 (strongly agree). Higher total sum scores indicate higher optimism. The LOT-R has shown acceptable psychometric properties in terms of reliability and convergent validity (Glaesmer et al., 2012). Cronbach's α of the *General Self-efficacy Scale,* the *Purpose in Life Test–Short Form*, and the *Life Orientation Test-Revised* in the present study were .80, .85, and .77, respectively.

To aid model parsimony, a composite score of psychological resources was created by averaging the standardized total scores of general self-efficacy, purpose in life, and optimism. This procedure was validated by conducting a confirmatory factor analysis using data of all participants who had completed the corresponding questionnaires (n = 456). A second order factor of psychological resources was defined by the factors general self-efficacy, purpose in life, and optimism, which were in turn defined by each of their corresponding items with residual correlations of the three LOT-R items refering to pessimism being estimated. The model was implemented using the robust maximum likelihood estimator (MLR) in Mplus 8 (Muthén & Muthén, 1998-2017) and showed good fit: χ^2 (84) = 138.65, p < .01; CFI = .97; RMSEA = 0.04, [90% CI = 0.02, 0.05].

Mediators: assessed at T2

Appraisals. Primary appraisals were assessed using the *Appraisal of Life Events Scale* (ALE; Ferguson et al., 1999). The ALE is composed of 16 adjectives, which refer to three dimensions: threat (six adjectives; e.g. frightening), loss (four adjectives; e.g. pitiful), and challenge (six adjectives; e.g. challenging). The present study focused on the first two dimensions because the items corresponding to challenge were included in the questionnaires at a later stage of SwiSCI, leading to

a significant rate of missing data in this specific dimension. Participants were asked to indicate to which extent their perception of their situation in regards to their spinal cord injury corresponded to the adjectives on a 6-point scale ranging from 0 (not at all) to 5 (very much so). Total scores range from 0 to 20 for loss and or 0 to 30 for threat. Among individuals with SCI, the ALE has shown good internal consistency (Peter et al., 2016). In the present sample, Cronbach's α was .91 for the threat subscale and .81 for the subscale loss. Considering that appraisals of threat and loss were highly correlated in the present sample ($r = .76$, $p <.001$) they were examined in separate path models to avoid issues related to strong multicollinearity.

   Coping. The *Brief COPE* (Carver, 1997) was used to assess how individuals were coping with their SCI. In the SwiSCI questionnaires, 12 out of 14 subscales were included, which correspond to the coping strategies self-distraction, active coping, denial, emotional support, instrumental support, behavioral disengagement, venting, positive reframing, planning, humor, acceptance, and self-blame (each one composed of two items). Participants were asked to rate every item on a Likert scale from 1 ("I have not been doing this at all") to 4 ("I have been doing this a lot"). A total score ranging from 2 to 8 can be calculated for each subscale and higher scores indicate more use of the specific coping strategy. Considering that different factor structures have been found for the Brief-COPE (Kapsou et al., 2010) and that the subscales substance use and religion were not assessed, the factorial structure of the measure was examined as a first step using principal components analysis with Promax rotation and parallel analysis in SPSS 25. Data from all individuals who answered to this scale was considered ($n = 424$). A solution with three components (40.96% explained variance) was selected because of its simple structure and the theoretical relevance of its components. The three identified components coincide with findings reported by Kapsou et al. (2010) and were labeled as "emotion and support coping" (emotional support, instrumental support, venting and one item of self-blame; α = .78), "approach-oriented coping" (active, planning, positive reframing, acceptance, and humor; α = .78), and "avoidance-oriented coping" (self-distraction, denial, and behavioral disengagement; α = .59). A composite score of each component was calculated by adding up the corresponding items. For the purpose of the path analyses, the component "emotion and support" was excluded due to its

conceptual overlap with social support. Additionally, the component avoidance-oriented coping was excluded because of its low reliability (α = .59). Instead the subscale denial was used as a proxy of avoidance-oriented coping, since it was the only original COPE subscale of this component showing acceptable reliability (α = .77).

Psychological adaptation outcomes: assessed at T3

Symptoms of anxiety and depression. Using the two subscales of the *Hospital Anxiety and Depression Scale* (HADS; Zigmond & Snaith, 1983), participants rated how they felt during the last week using items such as "I feel tense or 'wound up" (anxiety) or "I feel as if I am slowed down" (depression) on a scale from 0 (not at all) to 3 (most of the time). Sum scores of each subscale range from 0 to 21. Scores above 7 are regarded as indicative of clinically relevant symptoms (Stern, 2014). The HADS has been validated among individuals with SCI, showing unidimensionality for each of its subscales, as well as acceptable person reliability indices (Müller, Cieza, et al., 2012). In the present study, Cronbach's α was .82 for both, depressive symptoms and anxiety symptoms.

Data Analysis

Missing data

Missing data was handled with multiple imputation with chained equations (MICE), using the mice package in R (van Buuren & Groothuis-Oudshoorn, 2011). The data was imputed at the total score level for all variables included in the path analysis. Twenty imputed datasets were created. These datasets were then merged into a single one using the median of the imputed values. Information regarding age, sex, marital status, and injury-related characteristics (etiology, level, completeness, and time since SCI to discharge), as well as single items of the imputed scales were included as auxiliary variables in the imputation model. The distribution of the imputed values and their correlations did not show substantial differences to the observed values, suggesting convergence of the imputation algorithm (van Buuren & Groothuis-Oudshoorn, 2011).

Path Analysis

To test the sequential double mediation mechanism proposed by the SCIAM (Craig et al., 2017; Middleton & Craig, 2008), separate path models were implemented for the outcomes depressive

symptoms and anxiety symptoms in Mplus 8 (Muthén & Muthén, 1998-2017). The initial models

tested the SCIAM's assumptions that the effects of psychological resources, social support, and

functional independence on depressive symptoms or anxiety symptoms would be fully mediated by

threat (or loss) appraisal, and by denial coping and approach-oriented coping (see Figure 2A and 2B).

The indirect effects of each independent variable on the outcome variables via threat and

denial and via threat and approach-oriented coping were estimated using the product of coefficients

approach, which allows a formal test of significance of the mediated effects (MacKinnon et al., 2012).

The models were implemented using the MLR estimator, which is robust to non-normality and to

heteroscedasticity (Muthén et al., 2016). For the indirect effects, non-symetric bootstrap confidence

intervals were obtained based on 10.000 bootstrapped resamples (Muthén et al., 2016). For each

model, exploration of potentially influential outliers was conducted using the Cook's distance

influence measure. Cases whose Cook's distance values ≥1 were further investigated.

The goodness of fit of the initial models was assessed using the Chi-square (χ^2), comparative fit

index (CFI), root mean square error of approximation (RMSEA), and the standardized root mean

residual (SRMR). Good model fit is indicated by a nonsignificant χ^2, a CFI value above .95, and an

RMSEA value below 0.06 (Hu & Bentler, 1998). Moreover, SRMR values higher than .10 were

considered indicative of poor model fit (Kline, 2016). To assess models' local fit, standardized

residuals were examined. Since standardized residuals are approximate *z*-scores (Muthén & Muthén,

1998-2017), values higher than 2 suggest significant differences between the specified model and the

data.

In the event of poor fit, the initial models were re-specified by sequentially adding paths with

the largest standardized residuals, as long as such paths were supported by theoretical interpretation

and by previous research findings. The fit of nested models was compared using the Satorra-Bentler

scaled χ^2 difference test for the MLR estimator (Satorra & Bentler, 2010). A statistically significant χ^2

difference supports the retention of paths newly added to the model (Kline, 2016). No further

modifications were conducted when a model reached a good fit.

Results

Participants' Characteristics

Descriptive characteristics of the participants and the study variables are depicted in Table 1. The rate of missing data varied between 1.45% (depressive symptoms) and 7.73% (optimism). At discharge, 24.15% of participants reported clinically relevant symptoms of anxiety, while 23.04% reported clinically relevant symptoms of depression. Study participants were compared to non-participants with available data regarding demographic and injury-related characteristics. In general, participants were younger and stayed longer in the rehabilitation facilities. Additionally, there was a bigger proportion of males and individuals with traumatic etiologies among participants than among non-participants. However, these differences had small effect sizes (Cohen's *d* between 0.09 and 0.30; Cramer's V between .04 and .08). These results are depicted in Supplementary Table 1.

Path Analysis of Depressive Symptoms

The correlations among study variables are presented in Table 2 and fit information for each model is shown in Table 3 and 4. The initial model of depressive symptoms including threat appraisal, and denial and approach-oriented coping as sequential mediators yielded a poor fit (see Table 3). Standardized residuals suggested the inclusion of direct paths from (1) psychological resources to depressive symptoms, (2) psychological resources to approach-oriented coping, and (3) threat to depressive symptoms. The initial model was thus re-specified adding these paths one after the other. Each of these additions improved the model fit as indicated by statistically significant χ^2 difference tests. No paths were deleted. After the third modification, the model showed acceptable fit and no further modifications were added. The final model explained 40% of the variance of depressive symptoms (see Table 3). As shown in Figure 2C, psychological resources, threat, and approach-oriented coping had statistically significant direct effects on depressive symptoms. Additionally, psychological resources were indirectly associated with depressive symptoms via three pathways: (a) via threat and approach-oriented coping, (b) via approach-oriented coping only, and (c) via threat only. Finally, threat appraisal was also indirectly associated with depressive symptoms via approach-

oriented coping. Functional independence and social support did not show any significant indirect effect on depressive symptoms. These results are depicted in Table 3.

The same models of depressive symptoms were also implemented including loss instead of threat appraisal as mediator. This yielded similar results (see Supplementary Table 2 and Supplementary Figure 1A).

Path Analysis of Anxiety Symptoms

The initial model of anxiety symptoms yielded a poor fit (see Table 4). Standardized residuals suggested the inclusion of direct paths from (1) psychological resources to approach-oriented coping, (2) threat to anxiety symptoms, and (3) social support to anxiety symptoms. The initial model was then re-specified adding these paths one after the other. Each of these modifications improved the model fit as indicated by statistically significant χ^2 difference tests. No paths were deleted. After the third modification, the model showed good fit and no further modifications were added. The final model explained 33% of the variance of anxiety symptoms. As shown in Figure 2D, social support, threat appraisal, and denial coping had direct statistically significant effects on anxiety symptoms. Psychological resources were indirectly associated with anxiety symptoms via two pathways: (1) threat and denial coping, and (2) via threat only. Finally, threat appraisal was also indirectly associated with anxiety symptoms via denial coping. Functional independence did not show any significant direct nor indirect effect on anxiety symptoms (see Table 4).

The same models of anxiety symptoms were implemented including loss appraisal as mediator. Different from the models including threat appraisal, the direct effect of denial coping on anxiety symptoms was non-significant, as well as all the indirect effects following a path that included denial coping. These results are depicted in Supplementary Table 3 and in Supplementary Figure 1B.

Sensitivity Analyses

To check the robustness of the results, all path analyses were implemented with complete cases only (n = 178). Changes in the standardized beta coefficients were mainly small in all models:

the absolute difference in standardized estimates between the final models was on average .02 for both adaptation outcomes.

Finally, post-hoc power analyses were conducted using Monte Carlo simulations with the simsem package in R (Pornprasertmanit, Miller, & Schoemann, 2013). Average power to detect the observed statistically significant effects was .95 for the final model of depressive symptoms and .92 for the final model of anxiety symptoms.

Discussion

Using a longitudinal design and focusing on the inpatient rehabilitation following SCI, the present study aimed at examining whether primary appraisals and coping strategies sequentially and fully mediate the effects of functional independence, psychological resources, and social support on depressive and anxiety symptoms, as proposed by the SCIAM. Findings did not fully support the SCIAM's sequential double mediation mechanism. For depressive symptoms, threat or loss appraisals and coping strategies only partially mediated the effect of psychological resources. For anxiety symptoms, threat or loss appraisals and coping strategies fully mediated the effect of psychological resources, but not only via the sequential double mediation proposed by the model, as psychological resources also had indirect effects on anxiety symptoms via threat or loss appraisals only. Moreover, social support and functional independence were not found to be associated with threat appraisal nor with coping strategies.

The identified direct and indirect effects of psychological resources on the psychological adaptation outcomes are similar to what was found by Peter and colleagues (2014; 2015) in cross-sectional studies among community-dwelling individuals with SCI. In a series of studies testing the sequential double mediation mechanism proposed by the SCIAM, the authors also identified psychological resources such as general self-efficacy and purpose in life to be associated with lower levels of depressive symptoms and higher levels of life satisfaction by contributing to lower levels of loss or threat appraisal and avoidance coping, and higher levels of challenge appraisal, and humor and active coping. Purpose in life was additionally found to directly contribute to lower depression and higher life satisfaction. Moreover, similar to Peter and colleagues (2014; 2015) the present study

identified direct effects of threat and loss appraisals on both, depressive symptoms and anxiety symptoms. Associations between negative appraisals and worse psychological adaptation outcomes over and above injury characteristics and other biological factors have also been reported in previous studies focusing on acute phase or inpatient rehabilitation (Eaton et al., 2018; Kennedy et al., 2009). Additionally, other studies have identified appraisals at the beginning of inpatient rehabilitation to influence the development of adaptation indicators such as depression and anxiety up to two years after injury onset (Bonanno et al., 2012; Kennedy et al., 2012). These findings suggest that, although the challenges faced by individuals recently injured may differ from those faced by individuals who had sustained an SCI for years (Galvin & Godfrey, 2001), psychological resources and primary appraisals continue to exert an important influence along the continuum of the adaptation process and should be considered in interventions aiming at decreasing the severity of depressive or anxious symptomatology.

This study found that the contribution of coping strategies was rather weak and differed depending on the analyzed outcome, with approach-oriented coping contributing to lower levels of depressive symptoms and denial coping contributing to higher levels of anxiety symptoms. Moreover, the effects of both coping strategies became smaller after the inclusion of the direct paths from appraisals to the adaptation outcomes. This indicates a larger contribution of appraisals in the psychological adaptation process that was also observed by Kennedy et al. (2009). This, nevertheless, does not imply that coping strategies are not important in the adaptation process, but as suggested by Peter et al. (2015), instead of an exclusive focus on coping strategies, interventions aimed at improving depressive or anxious symptomatology after SCI should consider several factors conjointly. For instance, a recent study evaluating the effectiveness of a coping-oriented supportive program for individuals with SCI undergoing inpatient rehabilitation identified statistically significant effects in several outcomes such as depressive symptoms, anxiety symptoms, and life satisfaction (Li et al., 2020). Although it was called "coping-oriented", the intervention program covered cognitive appraisals, coping strategies, social support and social skills, as well as self-efficacy. Moreover, it was designed to address specific Chinese cultural issues, to be more suitable to the targeted population.

Alternatively, targeting appraisal and psychological resources may be more efficient than targeting coping strategies, as both, appraisals and psychological resources can directly influence not only the use of coping strategies but also the adaptation outcomes. Moreover, how flexibly individuals use different coping strategies in accordance to the specific situational demands may be more important for the efficacy of the coping process than the extent to which one or the other specific type of strategies are used (Bonanno & Burton, 2013). Indeed, there is evidence on the positive association between coping flexibility and different psychological adaptation outcomes such as depressive symptoms, anxiety symptoms, positive affect, or life satisfaction across different populations with and without chronic health conditions including individuals with SCI (Cheng et al., 2014; van Diemen et al 2018; van Lankveld, van Diemen & van Nes, 2011). Therefore, considering coping flexibility in psychological interventions could be more useful than merely training the use of specific coping strategies.

The indirect effects of functional independence and social support on the adaptation outcomes proposed by the SCIAM were not identified, and different from what expected, they were not (or only weakly) associated with the analyzed appraisals or coping strategies. Regarding functional independence, other studies have found it to be a significant determinant of life satisfaction or participation following SCI (Erosa et al., 2014; van Koppenhagen et al., 2009; van Leeuwen et al., 2011; van Leeuwen, Post, et al., 2012), but not of mental health (van Leeuwen, Post, et al., 2012), which coincides with the findings of this study. In regards to social support, it has been found to be associated with better mental health among individuals with SCI (Müller, Peter, et al., 2012), which is in line with its identified direct effect on anxiety symptoms in the present study. Yet, it is surprising that such an effect was not observed on depressive symptoms. One plausible explanation for this is that the associations between social support and depressive symptoms may be better explained by other mediation mechanisms, such as resilient characteristics (i.e., tenacity, personal strength, and dispositional optimism; Catalano et al., 2011) or self-concept (Huang et al., 2015), as it has been found in previous studies. Nevertheless, such studies were conducted among community-dwelling individuals with SCI. Thus, the mechanism underlying the influence of social

support on adaptation outcomes such as depressive symptoms during inpatient rehabilitation demands further study.

Limitations

The findings of the present study should be considered in light of its limitations, particularly regarding the SCIAM's operationalization. First, Challenge appraisal was not considered in the analyses. This kind of appraisal has been found to contribute to the adaptation process among individuals sustaining an SCI for several years (Peter, Müller, et al., 2014; Peter et al., 2015) and its role in the adaptation process shortly after injury onset should also be clarified. Thus, future studies aiming at testing the SCIAM in the rehabilitation context should analyze the contribution of challenge appraisal to the adaptation outcomes. Second, the psychological resources were operationalized as a composite score of three different constructs (general self-efficacy, purpose in life, and optimism) and therefore no assertions can be made regarding their specific role in the adaptation process. Nevertheless, together with hope and other core self-evaluation components (i.e. locus of control, emotional stability, and self-efficacy), these resources have been often found to contribute to better mental health (e.g., Peter et al., 2012; van Leeuwen, Kraaijeveld, et al., 2012). Third, the analyzed coping strategies were limited to the component of approach-oriented coping (active, planning, positive reframing, acceptance, and humor) and denial as a proxy of avoidance-oriented coping. Other avoidance-oriented strategies such as escape/avoidance, behavioral disengagement or mental disengagement have been also found to be associated with mental health and life satisfaction (van Leeuwen et al., 2012). Thus, a broader operationalization of this kind of strategies may reveal stronger effects on the adaptation outcomes. Additionally, the analyzed coping components were identified in an exploratory fashion, due to the lack of consensus on the factorial structure of the Brief-COPE (Kapsou et al., 2010). This limits the comparability of the current results on coping with previous research findings. Future studies aiming at testing models such as the SCIAM should consider the use of more overarching coping measures, with better stablished factorial structures, and which include less components, as this may not only aid model parsimony, but also results' comparability. Alternatively, as mentioned above, instead of focusing on specific coping strategies,

other elements of the coping process may be considered, such as how flexibly individuals use different coping strategies and how suitable these strategies are for the specific situational demands.

Model modifications conducted in the present study, although supported by previous research findings, were data-driven and involve the risk of capitalizing on chance. This may also hinder the generalizability of the results. Thus, further studies validating these findings are needed. Additionally, although this study adopted a longitudinal design, all variables were treated as time-invariant (assessed only at one specific time point). This does not account for the dynamic quality of the adaptation process in which outcomes at a certain time point can act as a "feedback" and influence the further development of the process in a next time point (Middleton & Craig, 2008). More dynamic models of the adaptation process comprising a longer time span and considering appraisal and reappraisal processes should be tested to gain a better understanding of its development. Further, this study lacks of sociodemographic information such as race or ethnicity, which can be considered indicators of exposure to risk factors and resources (Stanton et al., 2007). Thus, their influence on the psychological adaptation outcomes could not be analyzed.

Clinical Implications

The prevalence of clinically relevant levels of depression and anxiety among individuals with SCI has been estimated to be 22 and 27% respectively (Le & Dorstyn, 2016; Williams & Murray, 2015). In the present study, the rate of individuals showing clinically relevant symptoms of depression or anxiety at rehabilitation discharge was also within this range. Previous studies have suggested that the majority of individuals adapt well to the challenges posed by an SCI, following trajectories of stable low symptoms of depression or anxiety (Bombardier et al., 2016; Bonanno et al., 2012). Still, it has also been found that some individuals can show chronic elevated depression or worsening in symptoms up to two years after SCI onset and that signs of struggle among these individuals could already be observed during inpatient rehabilitation (Bonanno et al., 2012). This underscores the need for early identification of individuals at risk of poor mental health and the provision of prompt psychosocial support. The findings of the present study indicate that, in planning interventions aiming at reducing the severity of depressive or anxiety symptoms during first

rehabilitation, several factors should be considered conjointly, including psychological resources, primary appraisals, and social support.

In regards to psychological resources, the findings of this study suggest that they would aid the psychological adaptation process to SCI early after injury onset not only by contributing to lower levels of threat or loss appraisals and higher use of approach-oriented coping strategies, but also by directly contributing to lower the levels of depressive symptoms. Moreover, psychological resources were found to contribute to lower levels of anxiety symptoms by reducing the levels of threat appraisal, which in turn seemed to reduce the use of denial coping. Cognitive-behavioral techniques may be a suitable approach for interventions aiming at strengthening psychological resources such as self-efficacy, challenging negative appraisals of the injury, and enhancing effective coping, although their efficacy in long term still needs to be established (Dorstyn et al., 2011).

Regarding social support, the results of this study are not conclusive on how it would impact depressive symptoms, but suggest that higher social support could have a direct effect on lower levels of anxiety symptoms. Group-based interventions could aid strengthening the provision of social support, by offering individuals the opportunity to exchange about their experiences with others who face similar challenges (Li et al., 2017). Finally, concerning functional independence, no statistically significant direct nor indirect effects were identified on any of the analyzed adaptation outcomes. This supports previous findings indicating that functional independence is not a significant determinant of mental health (van Leeuwen, Post, et al., 2012). Yet, it may play an important role for other adaptation outcomes such as life satisfaction or participation (Erosa et al., 2014; van Leeuwen, Post, et al., 2012).

Conclusions

To the best of the authors' knowledge, this is the first longitudinal study testing the sequential double mediation mechanism proposed by the SCIAM during SCI inpatient rehabilitation. Taken together, the results of the present study and of those testing the SCIAM among community-dwelling individuals with SCI (Peter, Müller, et al., 2014; Peter et al., 2015) suggest that the proposed sequential double mediation mechanism is not sufficient to explain the associations of psychological

resources, social support, or functional independence with adaptation outcomes such as depressive symptoms, anxiety symptoms, or life satisfaction. Indeed, depending on the adaptation outcome under analysis, factors such as psychological resources or social support may have a more direct influence than what is hypothesized in the SCIAM, or their effects on the adaptation outcomes may be mediated by other mechanisms. Moreover, it may be important to consider other elements of the coping process beyond the use of specific coping strategies, as their effect on several adaptation outcomes has been found to be weak or inconsistent. Finally, the findings of the present study offer scientific ground for the design of psychosocial interventions that have the potential to lower anxiety and depressive symptoms and in turn enhance the psychological wellbeing of individuals living with an SCI. Special support was given to the role of psychological resources and primary appraisals in the development of the adaptation process during inpatient rehabilitation.

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Table 1

Descriptive Characteristics of the Participants and Study Variables (*N* = 207)

Variable	M	(SD)	Range Possible	Range observed	n	(%)	Missing n	Missing (%)	Skewness	Kurtosis
Demographic characteristics										
Age	51.88	16.77	≤ 16	17-81			0	0	-0.26	2.08
Years of education	14.20	3.39		4-23			82	39.61	-0.04	3.42
Sex (Male)					155	74.88	0	0		
Marital status (have a partner)					147	71.01	0	0		
Injury-related characteristics										
SCI Etiology (traumatic)					134	64.73	0	0		
Injury Level (paraplegia)					134	64.73	0	0		
Lesion Completeness (incomplete)					157	75.85	0	0		
Time since SCI to discharge[a]	6.10	2.23		2.47-20.20			0	0	1.84	10.59
Independent variables (T1)										
Functional Independence	36.49	19.53	0-100	0-100			0	0	0.86	3.48
General Self-efficacy	15.94	2.55	5-20	8-20			6	2.90	-0.38	3.12
Purpose in Life	23.14	3.94	4-28	8-28			6	2.90	-1.10	4.31
Optimism	17.53	4.58	0-24	4-24			16	7.73	-0.52	2.63
Average Social Support	8.44	1.80	0-10	0-10			8	3.86	-1.87	7.59
Mediators (T2)										
Denial coping	3.14	1.62	2-8	2-8			0	0.00	1.36	3.81
Approach-oriented coping	26.80	5.66	10-40	12-40			13	6.28	-0.08	2.74
Threat appraisal	9.77	8.38	0-30	0-30			11	5.31	0.70	2.43
Loss appraisal	6.43	5.11	0-20	0-20			4	1.93	0.65	2.68
Outcomes (T3)										
Depressive symptoms	4.80	3.68	0-21	0-19			3	1.45	0.84	3.45
Anxiety symptoms	4.85	3.85	0-21	0-18			0	0	0.82	3.19

Note. [a] In months.

Table 2

Correlations among Study Variables (*N* = 207)

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Depressive symptoms											
2. Anxiety symptoms	0.74***										
3. General self-efficacy	-0.32***	-0.33***									
4. Purpose in life	-0.32***	-0.27***	0.39***								
5. Optimism	-0.42***	-0.38***	0.40***	0.58***							
6. Psychological resources	-0.45***	-0.43***	0.75***	0.83***	0.82***						
7. Social support	-0.29***	-0.27***	0.18*	0.25***	0.25***	0.29***					
8. Functional independence	-0.15*	-0.09	0.08	0.07	0.09	0.11	-0.13				
9. Threat	0.47***	0.49***	-0.32***	-0.21**	-0.36***	-0.36***	-0.04	-0.06			
10. Loss	0.51***	0.54***	-0.33***	-0.31***	-0.41***	-0.43***	-0.15*	-0.16*	0.76***		
11. Denial coping	0.22**	0.35***	-0.25***	-0.21**	-0.32***	-0.32***	-0.07	-0.04	0.40***	0.43***	
12. Approach-oriented coping	-0.45***	-0.24***	0.39***	0.35***	0.35***	0.45***	0.15*	0.09	-0.42***	-0.39***	-0.21**

Note. *** *p* < .001*; ** *p* < .01; * *p* < .05.

Table 3

Fit Indices of the Models of Depressive symptoms and Estimated Direct and Indirect Effects for the Final Model

Model	n	χ²	df	p	SCF	RMSEA	90% CI	CFI	SRMR	Scaled χ² difference test of nested models χ²	df	p
Initial model[a]	206	75.93	11	<.001	1.20	0.17	[.13, .21]	0.67	0.11			
1. Psy. resources →Depressive symptoms	206	54.43	10	<.001	1.20	0.15	[.11, .19]	0.77	0.08	21.76	1	<.001
2. Psy. resources →Approach coping[a]	205	38.24	9	<.001	1.14	0.13	[.09, .17]	0.86	0.06	12.55	1	<.001
3. Threat →Depressive symptoms[b]	205	16.78	8	.03	1.17	0.07	[.02, .12]	0.96	0.04	25.99	1	<.001

Effect of	B	95% CI for B LL	UL	SE B	β	p	Effect of	B	95% CI for B LL	UL	SE B	β	p
Psychological resources							Functional independence						
Direct effect	-1.25	-1.87	-0.64	.31	-.28	<.001	Direct effect	-	-	-	-	-	-
via Threat - Approach	-0.11	-0.23	-0.03	.05	-.02	.03	via Threat - Approach	0.00	-0.02	0.01	.01	.00	.81
via Threat - Denial	0.03	-0.08	0.15	.05	.01	.64	via Threat - Denial	0.00	-0.01	0.01	.00	.00	.84
via Approach only	-0.35	-0.64	-0.13	.13	-.08	.01	via Threat only	-0.01	-0.09	0.06	.04	-.01	.82
via Threat only	-0.61	-0.96	-0.31	.16	-.14	<.001	Total indirect effect	-0.01	-0.10	0.07	.04	-.01	.82
Total indirect effect	-1.04	-1.42	-0.69	.19	-.23	<.001	Social support						
Threat							Direct effect	-	-	-	-	-	-
Direct effect	0.14	0.07	0.19	.03	.33	<.001	via Threat - Approach	0.01	-0.01	0.03	.01	.00	.60
via Approach	0.02	0.01	0.05	.01	.06	.02	via Threat - Denial	0.00	-0.02	0.01	.00	.00	.72
via Denial	-0.01	-0.03	0.02	.01	-.01	.64	via Threat only	0.03	-0.08	0.14	.05	.01	.57
Total indirect effect	0.02	-0.01	0.05	.02	.04	.22	Total indirect effect	0.03	-0.09	0.16	.06	.02	.58

Note. All models rely on imputed data. SCF = scaling correction factor for the Scaled χ2 difference test of nested models using the MLR estimator; RMSEA = root mean squared error of approximation; 90% CI = 90% confidence interval of RMSEA; CFI = comparative fit index. SRMR = Standardized Root Mean Residual. *B* = unstandardized estimated coefficients; β = Standardized coefficients; CI = Confidence interval; *LL* = Lower limit; *UL* = Upper limit.

[a]Model fit after exclusion of influential outliers. [b]Final model.

Table 4

Fit Indices of the Models of Anxiety symptoms and Estimated Direct and Indirect Effects for the Final Model

Model	n	χ^2	df	p	SCF	RMSEA	90% CI	CFI	SRMR	Scaled χ^2 difference test of nested models		
										χ^2	df	p
Initial model	207	78.14	11	<.001	1.18	.17	[.14, .21]	.63	.11			
1. Psy. resources →Approach coping[a]	206	57.71	10	<.001	1.17	.15	[.11, .19]	.75	.09	18.73	1	<.001
2. Threat →Anxiety symptoms	206	27.72	9	.001	1.16	.10	[.06, .14]	.90	.06	29.21	1	<.001
3. Social support →Anxiety symptoms[b]	206	13.69	8	.09	1.19	.06	[.00, .11]	.97	.04	17.17	1	<.001

Effect of	B	95% CI for B		SE B	β	p	Effect of	B	95% CI for B		SE B	β	p
		LL	UL						LL	UL			
Psychological resources							Functional independence						
Direct effect	-	-	-	-	-	-	Direct effect	-	-	-	-	-	-
Via threat - approach	0.00	-0.07	0.07	.04	.00	.97	Via threat - approach	0.00	-0.01	0.01	.00	.00	.97
Via threat - denial	-0.14	-0.28	-0.01	.07	-.03	.04	Via threat - denial	0.00	-0.02	0.02	.01	.00	.81
Via approach only	0.00	-0.22	0.21	.11	.00	.97	Via threat only	-0.01	-0.12	0.09	.05	-.01	.81
Via threat only	-0.86	-1.34	-0.48	.22	-.17	.00	Total indirect effect	-0.01	-0.14	0.10	.06	-.01	.81
Total indirect effect	-0.99	-1.47	-0.56	.24	-.20	.00	Social support						
Threat							Direct effect	-0.52	-0.75	-0.29	.11	-.23	<.001
Direct effect	0.19	0.12	0.26	.04	.42	<.001	Via threat - approach	0.00	-0.01	0.01	.00	.00	.97
Via approach	0.00	-0.02	0.02	.01	.00	.97	Via threat - denial	0.01	-0.02	0.04	.01	.00	.60
Via denial	0.03	0.001	0.06	.02	.07	.03	Via threat only	0.04	-0.11	0.21	.08	.02	.59
Total indirect effect	0.03	-0.001	0.06	.02	.07	.04	Total indirect effect	0.05	-0.12	0.24	.09	.02	.58

Note. All models rely on imputed data. SCF = scaling correction factor for the Scaled χ2 difference test of nested models using the MLR estimator; RMSEA =

root mean squared error of approximation; 90% CI = 90% confidence interval of RMSEA; CFI = comparative fit index. SRMR = Standardized Root Mean

Residual. *B* = unstandardized estimated coefficients; β = Standardized coefficients; CI = Confidence interval; *LL* = Lower limit; *UL* = Upper limit.

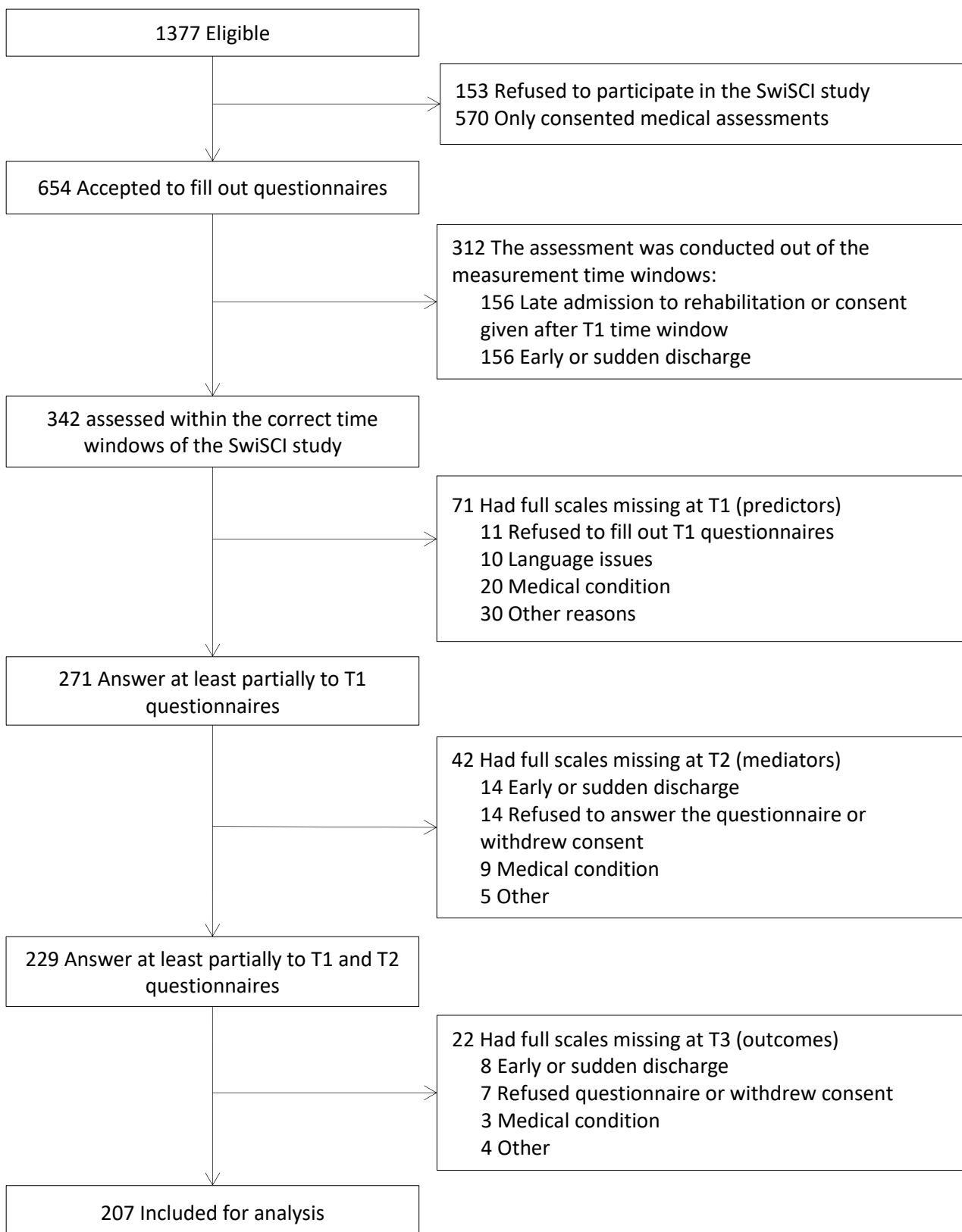[a]Model fit after exclusion of influential outliers. [b]Final model.

Figure 1

Participation Flow-chart


```
┌─────────────────────────────┐
│      1377 Eligible          │
└─────────────────────────────┘
              │
              │      ┌──────────────────────────────────────────────────┐
              ├─────►│ 153 Refused to participate in the SwiSCI study   │
              │      │ 570 Only consented medical assessments           │
              │      └──────────────────────────────────────────────────┘
              ▼
┌─────────────────────────────┐
│ 654 Accepted to fill out    │
│      questionnaires         │
└─────────────────────────────┘
              │
              │      ┌──────────────────────────────────────────────────┐
              │      │ 312 The assessment was conducted out of the      │
              ├─────►│ measurement time windows:                        │
              │      │     156 Late admission to rehabilitation or      │
              │      │     consent given after T1 time window           │
              │      │     156 Early or sudden discharge                │
              │      └──────────────────────────────────────────────────┘
              ▼
┌─────────────────────────────┐
│ 342 assessed within the     │
│ correct time windows of the │
│      SwiSCI study           │
└─────────────────────────────┘
              │
              │      ┌──────────────────────────────────────────────────┐
              │      │ 71 Had full scales missing at T1 (predictors)    │
              │      │     11 Refused to fill out T1 questionnaires     │
              ├─────►│     10 Language issues                           │
              │      │     20 Medical condition                         │
              │      │     30 Other reasons                             │
              │      └──────────────────────────────────────────────────┘
              ▼
┌─────────────────────────────┐
│ 271 Answer at least         │
│ partially to T1             │
│      questionnaires         │
└─────────────────────────────┘
              │
              │      ┌──────────────────────────────────────────────────┐
              │      │ 42 Had full scales missing at T2 (mediators)     │
              │      │     14 Early or sudden discharge                 │
              ├─────►│     14 Refused to answer the questionnaire or    │
              │      │     withdrew consent                             │
              │      │     9 Medical condition                          │
              │      │     5 Other                                      │
              │      └──────────────────────────────────────────────────┘
              ▼
┌─────────────────────────────┐
│ 229 Answer at least         │
│ partially to T1 and T2      │
│      questionnaires         │
└─────────────────────────────┘
              │
              │      ┌──────────────────────────────────────────────────┐
              │      │ 22 Had full scales missing at T3 (outcomes)      │
              │      │     8 Early or sudden discharge                  │
              ├─────►│     7 Refused questionnaire or withdrew consent  │
              │      │     3 Medical condition                          │
              │      │     4 Other                                      │
              │      └──────────────────────────────────────────────────┘
              ▼
┌─────────────────────────────┐
│ 207 Included for analysis   │
└─────────────────────────────┘
```

Figure 2

Path Diagrams Depicting the Initial and Final Implemented Models of Depressive Symptoms and Anxiety Symptoms after Exclusion of Outliers
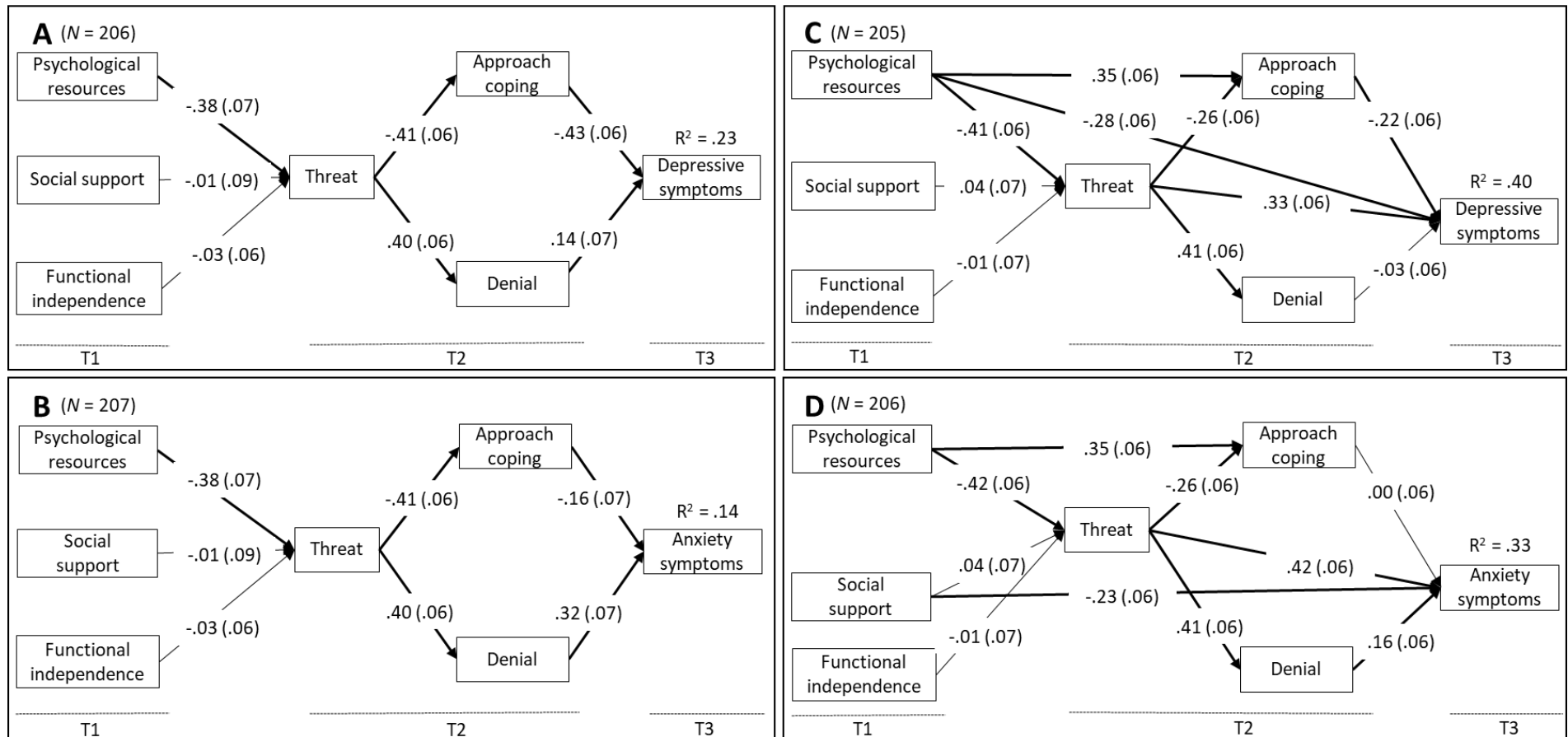
Note: The figures depict standardized estimates and standard errors. A and B = initial models. C and D = final models. Bold lines indicate statistically significant effects (*p* > .05). Correlations among independent variables are not depicted.