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Abstract

Objective: To determine average changes and individuals' patterns of change in depressive symptoms, anxiety symptoms, general distress, and life satisfaction between admission to spinal cord injury inpatient rehabilitation and discharge; and to identify factors associated with change. ***Methods:*** Longitudinal data collection as part of a national cohort study (N=281). Changes in the psychological adaptation outcomes were analyzed using latent change score models. Reliable change indexes were calculated for each outcome to identify individuals' patterns of change. Biopsychosocial factors were examined as covariates of change. ***Results:*** On average, depressive symptoms, anxiety symptoms, and general distress decreased between admission and discharge, while life satisfaction increased. According to the RCI, several adaptation patterns were identified. The proportion of individuals following each pattern varied depending on the analyzed outcome: resilience (absence of clinically relevant symptoms at admission and discharge) was the most common for symptoms of depression (61.57%) and anxiety (66.55%), while vulnerability (clinically relevant symptoms at both measurement times) was the most common for distress (57.32%). Improvement patterns (statistically significant decreases) were identified for 6.41%, 4.27%, and 7.83% of participants in depressive symptoms, anxiety symptoms and distress, respectively. For life satisfaction, improvement (statistically significant increases) was found for 8.54%. Male sex, tetraplegia, self-efficacy, optimism, and social support were associated with average changes in the psychological adaptation outcomes. ***Conclusions:*** On average, participants showed improvement in all analyzed outcomes. Still, there is substantial variability in change. Self-efficacy, social support, and optimism are potential intervention targets during inpatient rehabilitation to promote a favorable psychological adaptation process.

Keywords: psychological adaptation, spinal cord injuries, anxiety, depression, life satisfaction

Impact statement:

- Although the psychological adaptation process to an SCI may extend over years, improvements in mental health and life satisfaction can be observed at the group level during SCI inpatient rehabilitation. Still, at the individual level, different adaptation patterns such as improvement, resilience or vulnerability can be identified.. Clinicians should be aware that resilient responses in some adaptation outcomes may coexist with vulnerability in other outcomes.
- These findings highlight the importance of conducting screening processes during inpatient rehabilitation to early detect individuals at risk of poor adaptation outcomes, as well as the need for psychosocial support extending beyond the inpatient rehabilitation.
- Specific psychosocial factors can be targeted during inpatient rehabilitation to promote a more favorable psychological adaptation process across different outcomes with more general self-efficacy and social support contributing to improvement in depressive symptoms and optimism to improvements in distress and life satisfaction.

Longitudinal Changes in Psychological Adaptation Outcomes During Spinal Cord Injury Inpatient Rehabilitation

Experiencing a spinal cord injury (SCI) has profound consequences in all life domains. It often leads to serious disability and may have a wide range of medical complications (Nas et al., 2015). Moreover, sustaining an SCI can have adverse effects on individuals' social participation, financial situation, and quality of life (Crewe & Krause, 2009); therefore, it demands ongoing psychological adaptation.

Psychological Adaptation to Spinal Cord Injury

Diverse models have been developed to explain how the psychological adaptation to the onset of chronic health conditions and disability unfolds (see Livneh & Martz, 2012). In the field of SCI, Middleton and Craig (2008) have proposed the SCI Adjustment Model (SCIAM). Incorporating elements of the Lazarus & 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 multidimensional and temporal process that leads to more or less positive outcomes. Positive outcomes of the adaptation process include the experience of positive affect, effective social participation, and a good quality of life, while less positive outcomes would comprise the experience of depression or anxiety, and social isolation, among others (Craig, Tran, et al., 2017). These outcomes may change with time and are influenced by predisposing biological, psychological, and social factors and mediated by appraisal, and coping processes (Middleton & Craig, 2008).

According to the SCIAM, inpatient rehabilitation is a key element in the evolution of the adaptation process to SCI (Craig, Tran, et al., 2017). Yet, although increasing efforts have been made to understand the psychological impact of the injury shortly after its onset, the evolution of the psychological adaptation process during the inpatient rehabilitation remains underexplored. Studies analyzing average changes in adaptation outcomes have identified increases in life satisfaction between rehabilitation admission and discharge (van Koppenhagen et al., 2009; White et al., 2010) but inconsistent findings regarding mental health. Some studies have identified no average changes

in mental health (van Leeuwen et al., 2015); others have reported average decreases in depressive symptoms but not in anxiety symptoms (Kennedy et al., 2010), yet others have found average decreases in both depressive and anxiety symptoms during inpatient rehabilitation (van Diemen et al., 2017).

Nevertheless, substantial individual differences exist in how individuals adapt to a newly acquired SCI (Post & van Leeuwen, 2012) and these differences have been addressed in few studies. Moreover, focusing exclusively on sample's average changes provides little information on the prevalence of resilient or non-pathological responses to the onset of SCI (Bonanno et al., 2011). In response to such limitations, the study of trajectories of psychological adaptation outcomes has gained relevance. For instance, analyzing the course of depression or anxiety from inpatient rehabilitation admission to one or two years after injury, Bonanno et al. (2012) and Bombardier et al. (2016) identified several trajectories. These trajectories included a pattern of long-lasting elevated symptoms denoting vulnerability, a pattern of improvement, and a pattern of stable low symptoms labeled as resilience. The latter was displayed by the majority of participants in both studies. Regarding life satisfaction, van Leeuwen et al. (2011) also identified several trajectories between the beginning of inpatient rehabilitation and five years after discharge. In this study, most participants displayed a trajectory of intermediate scores at all measurement time points (31%), while a trajectory of high scores at all time points was displayed by 17% of participants.

Still, most of these studies have focused on single adaptation outcomes, thereby disregarding the multidimensionality of the psychological adaptation process. Indeed, critical life events do not equally affect all personal dimensions (Infurna & Luthar, 2017; Luhmann et al., 2012). Thus, a comprehensive description of how individuals adapt to an SCI requires the analysis of multiple indicators (Infurna & Luthar, 2017) and should include not only the presence or absence of psychiatric symptoms, but also measures of well-being such as positive affect or life satisfaction (Bonanno & Diminich, 2013; Seaton, 2009). One cross-sectional study applied this more comprehensive approach by analyzing the psychological impact of an SCI at rehabilitation discharge across four different indicators: life satisfaction, general distress, depressive symptoms, and anxiety

symptoms (Author, 2020). The study identified four different patterns of response with the majority of participants displaying moderate impact on the analyzed indicators. This approach was also taken in a longitudinal study by Quale and Schanke (2010) who analyzed trajectories of adaptation during inpatient rehabilitation among participants with severe injury using five indicators: symptoms of posttraumatic stress disorder, depression, anxiety, negative affect, and positive affect. Results showed that after severe injury, individuals followed one of three different trajectories between admission to and discharge from rehabilitation: resilient, recovery, and distress, with most participants showing resiliency. Yet, these results were limited to a small sample size (*N* = 80) from a single rehabilitation hospital and included not only individuals with SCI but also with multiple traumas. Thus, more studies acknowledging the multidimensionality of the psychological adaptation process longitudinally during SCI inpatient rehabilitation are needed.

Covariates of Change

How individuals respond to the onset of an SCI depends on the dynamic interaction of multiple biomedical (e.g. injury-related characteristics), psychological (e.g., personality traits, self-efficacy), and social factors (e.g., social support), which can act as resources or stressors (Middleton & Craig, 2008). The influence of these factors on change in psychological adaptation outcomes during inpatient rehabilitation has been scarcely studied. Moreover, most studies have focused either on biomedical or psychosocial covariates. In general, high functional independence and less pain seem to contribute to a better course of life satisfaction (van Koppenhagen et al., 2009; van Leeuwen et al., 2011), and general self-efficacy, purpose in life, appraisal, coping, and low pain have been found to contribute to a better course of mental health (e.g., depressive mood and anxiety; Bombardier et al., 2016; Bonanno et al., 2012; van Leeuwen et al., 2015; van Leeuwen et al., 2012). Identifying covariates of change in the context of inpatient rehabilitation is important not only to identify suitable intervention targets but also to detect those individuals most in need of such interventions (Stanton et al., 2007).

The Present Study

This study sought to expand previous efforts to understand the psychological adaptation process following SCI by focusing on the inpatient rehabilitation setting that is underexplored despite its importance for community reintegration (Craig, Tran, et al., 2017; Middleton & Craig, 2008). The present work strives also to acknowledge the multidimensionality of the adaptation process by analyzing the longitudinal evolution of several outcomes and investigating the predicting role of both biomedical and psychological covariates, as well as social support. Finally, this study goes a step further than the average observation perspective by exploring individual differences in the evolution of the psychological adaptation outcomes.

The specific aims of the present study were 1) to determine average changes, as well as individuals' patterns of change in depressive symptoms, anxiety symptoms, general distress, and life satisfaction between admission to SCI inpatient rehabilitation (T1) and discharge (T2); and 2) to identify factors associated with such changes. It was hypothesized that statistically significant average changes would be identified, namely decreases in depressive symptoms, anxiety symptoms, and general distress; and increases in life satisfaction. Additionally, it was expected to identify heterogeneous response patterns at the individual level, including 1) a pattern of statistically significant decreases, 2) a pattern of statistically significant increases, 3) a pattern without clinically relevant symptoms at T1 and T2 (denoting resilience), and 4) a pattern of clinically relevant symptoms at T1 and T2 (denoting vulnerability; Bonanno et al., 2012). Regarding covariates of change, statistically significant associations were expected between changes in the psychological adaptation outcomes and general self-efficacy, purpose in life, optimism, pain, functional independence, and social support (Bombardier et al., 2016; Bonanno et al., 2012; Quale & Schanke, 2010; van Leeuwen et al., 2011). Age, sex, etiology of the injury, lesion level, and lesion completeness were not expected to be associated with changes in the psychological adaptation outcomes (Bombardier et al., 2016; Bonanno et al., 2012; Chevalier et al., 2009).

Methods

Design and Participants

A longitudinal study was conducted as part of an ongoing National Inception Cohort Study (NICS – name changed for double-blind reviewing). Previous findings on functional Independence, post-traumatic growth, and psychological adaptation outcomes at rehabilitation discharge using NICS data have been published elsewhere (see Author, 2020; Author b, 2020; Author, 2017, 2018, 2019).

NICS is conducted in collaboration with the four major national specialized rehabilitation centers. It includes individuals 16 years old or older who permanently reside in the country, have a new diagnosis of traumatic or non-traumatic SCI, and undergo inpatient rehabilitation in one of the four collaborating centers (Author, 2011). NICS exclusion criteria are congenital conditions leading to paraplegia or tetraplegia, new SCI in the context of palliative care, and neurodegenerative disorders. NICS was approved by the regional ethics committees of all involved cantons.

After giving written informed consent, participants of the NICS complete clinical assessments and questionnaires regarding biomedical, psychological, and social factors. Data collection takes place at four time points during inpatient rehabilitation (Author, 2011). This study focused on rehabilitation admission (T1; approximately one month after SCI diagnosis) and discharge (T2; M = 5.59 months after SCI diagnosis, SD = 2.39) because these are the timepoints that are available for the majority of the NICS participants and at which all psychological adaptation outcomes are assessed. Discharge data is collected shortly before individuals leave the rehabilitation facilities. In total, 1071 eligible individuals undergoing rehabilitation between May 2013 and March 2018 were considered for analysis. Reasons for non-participation or exclusion are summarized in Figure 1. The final sample was composed of 281 participants.

Measures

Psychological Adaptation Outcomes: Assessed at T1 and T2

Life Satisfaction. Using one item from the International SCI Quality of Life Basic Data Set (Charlifue et al., 2012), participants rated how satisfied they were with their life as a whole in the past

four weeks on a scale from 0 (completely dissatisfied) to 10 (completely satisfied). This item has shown good convergent validity (Post et al., 2016).

General Distress. Using the single item of the Distress Thermometer (Roth et al., 1998), participants rated on a scale from 0 to 10 how much distress they were experiencing due to their SCI at the time of assessment. Distress corresponds to an unpleasant experience that may be psychological, social, spiritual, or physical in nature (Riba et al., 2019). Higher scores indicate higher distress, and values of 4 or higher are considered to indicate clinically relevant levels of general distress (Snowden et al., 2011). This item has acceptable sensitivity to detect psychosocial morbidity (Gil et al., 2005).

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). Each subscale is composed of seven items with a response scale ranging 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 subscale and acceptable person reliability indices (Müller, Cieza, et al., 2012).

Covariates of Change: Assessed at T1

Information regarding sex, age, time since injury diagnosis, etiology of the SCI (traumatic vs. non-traumatic), injury level (tetraplegia vs. paraplegia/intact), and injury completeness (complete vs. incomplete) were retrieved from the patients' records. Additionally, the following factors were included:

Functional Independence. Health practitioners rated the performance of the participants using the Spinal Cord Independence Measure III (SCIM III; Catz et al., 2007; Itzkovich et al., 2007). The total sum score of functioning 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).

Presence of Pain. Participants indicated whether they experienced pain during the last week using one self-reported binary (yes/no) item.

General Self-efficacy. Participants reported the strength of their belief in their own ability to respond to new or difficult situations on a scale from 1 (not at all) to 4 (completely) using a modified 5-item version of the General Self-efficacy Scale (Schwartzer & Jerusalem, 1995). Higher total sum scores indicate higher general self-efficacy. Rasch analysis on a sample of individuals with SCI indicated very good construct validity and reliability for this modified scale (Peter, Cieza, et al., 2014).

Purpose in Life. Participants reported their perceived meaning and life purpose with the Purpose in Life Test–Short Form (Schulenberg et al., 2011). It consists of four items rated on a scale from 1 to 7, with higher total sum scores indicating higher perceived purpose in life. Among individuals with SCI, this test has shown unidimensionality, supporting its construct validity, and has been found to have very good reliability (Peter et al., 2016).

Optimism. Individuals rated statements regarding their optimism on a scale from 0 (strongly disagree) to 4 (strongly agree) using a 6-item version of the Life Orientation Test-Revised (Scheier et al., 1994) modified to measure current state. 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).

Social Support. Individuals rated the extent of instrumental and emotional support they receive from their partner, family, and friends separately on a scale from 0 (not at all) to 10 (very much) using six items from the Swiss Household Panel Study (Tillmann et al., 2016). An average score of all six items was calculated. For individuals who indicated not having a partner, the average score was calculated using the remaining four items.

Data Analysis

Missing Data

Using the mice package in R (van Buuren & Groothuis-Oudshoorn, 2011), multiple imputation with chained equations was implemented for all variables, except for injury level and injury completeness, whose missing values were recovered from later assessment times (8 cases).

Information regarding age, sex, marital status, and injury-related characteristics (etiology, level, completeness, and time since SCI to discharge) were included as auxiliary variables in the imputation model. The HADS subscales were imputed at the item level to later test for longitudinal measurement invariance. For the remaining variables, the imputation was conducted at the sum/average score level, creating 20 imputed datasets. These datasets were finally merged into a single one using the median of the imputed values. To control for the quality of the imputation, the distribution of the imputed variables as well as their correlations were checked to identify differences to the complete cases. The results did not show substantial differences.

Analyzing Change and its Covariates

To identify whether changes in depressive symptoms and anxiety symptoms occur between the beginning of inpatient rehabilitation and discharge, latent change score models (LCSM; McArdle, 2009) were implemented in a Structural Equation Model framework using Mplus 8. This approach allows to model error-free constructs, overcoming the criticism of traditional difference scores (McArdle, 2009). These models were built following a stepwise procedure in which longitudinal measurement invariance was first tested. The HADS items were treated as ordered-categorical indicators to define the T1 and T2 depressive symptoms and anxiety symptoms latent factors and all models were implemented using the robust mean- and variance-adjusted Weighted Least Squares estimator (WLSMV) with theta parameterization in Mplus 8, following the recommendations of Liu et al. (2017). Model's goodness of fit was assessed using the Chi-square (χ^2), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA), as well as local fit statistics (residuals and modification indices). Typically, good model fit is indicated by a nonsignificant χ^2, a CFI value above .95, and an RMSEA value below .06 (Hu & Bentler, 1998). For the comparison of nested models, the DIFFTEST option available in Mplus 8 was used. It performs a robust chi-square difference testing for the WLSMV estimator (Asparouhov & Muthén, 2006). For a meaningful interpretation of change estimated with the LCSMs, at least partial strong invariance should be achieved (Gollwitzer et al., 2014).

The LCSMs were implemented using the finally selected invariance models. The T2 factors were regressed on the T1 factors with a structural weight of 1 and the change factors were defined by the T2 scores. Thus, the change factor represents the part of T2 that is not identical to T1 (McArdle, 2009). As such, the mean (μ_Δ) and variance (σ_Δ^2) of change, as well as the covariance between T1 scores and their change ($\sigma_{1\Delta}$) were estimated as model parameters (see Figure 2). A statistically significant and positive μ_Δ indicates increases over time, while a negative μ_Δ indicates decreases. A statistically significant σ_Δ^2 indicates significant inter-individual variability in change.

For general distress and life satisfaction, longitudinal measurement invariance could not be tested because they were measured with single items. Therefore, simplified LCSMs were implemented using the robust maximum likelihood estimator in Mplus 8 (see Figure 2). The observed scores at T1 and T2 were used to define the latent change factor, as it was done for depressive and anxiety symptoms. Note that although changes in life satisfaction and general distress are latent variables, they are not purged from measurement error (Castro-Schilo & Grimm, 2017). Moreover, the models are just-identified and therefore model fit cannot be interpreted (Kievit et al., 2018).

To describe individuals' patterns of change in the psychological adaptation outcomes, reliable change indexes (RCI; Jacobson & Truax, 1991) were calculated for each psychological adaptation outcome. This approach allows to identify how many individuals showed *statistically* significant increases or decreases in each outcome (i.e., RCIs above 1.96 or below -1.96, respectively), as well as for whom such changes could be considered *clinically* significant (i.e. additionally crossing the cut-off scores of the HADS or the Distress Thermometer). First, raw change scores were obtained for each participant subtracting the T1 scores from the T2 scores. Following Christensen and Mendoza (1986), the raw change scores were then divided by their corresponding standard error of the difference, which was calculated using the variances and standard deviations of the T1 and T2 scores, as well as the correlations between T1 and T2 scores.

Finally, to analyze which variables would influence the changes in the adaptation outcomes, the previously estimated LCSMs were extended by regressing each change factor on the covariates and on their respective T1 scores. The covariates were included in the models as observed variables

to reduce model complexity. All covariates were allowed to correlate with each other and with the T1 score of the analyzed psychological adaptation outcome. Potentially influential outliers were explored using scatter plots of the Cook's D against each psychological adaptation outcome. For life satisfaction and general distress, the log likelihood influence measure was also plotted. One influential outlier was identified and excluded from the analyses given its extreme value in time since SCI to discharge (about 20 months). Results of the LCSMs with covariates are reported without this observation.

Results

Participant's Characteristics and Preliminary Analyses

The rate of missing data in the study sample is depicted in Table 1 and the correlations among study variables are presented in Table 2. Compared to non-participants (n = 671), individuals included in this study were younger, spent longer time in rehabilitation, and reported higher distress. These differences had nevertheless small effect sizes (*d* between 0.12 and 0.22). These results are presented in Supplementary Table 1.

Changes in the Psychological Adaptation Outcomes

For the measure of depressive symptoms, a model with all factor loadings and thresholds constrained to be equal across time showed satisfactory model fit, indicating strong invariance, χ^2 (88) = 145.75, $p < .01$; CFI = .984; RMSEA = .046, RMSEA 90% CI [.034, .062]. This model was used as a basis for building the corresponding LCSM. For anxiety symptoms, the LCSM was built based on a model with all factor loadings equal across time and three freely estimated thresholds indicating partial strong invariance: χ^2 (85) = 117.15, $p = .01$; CFI = .989; RMSEA = .037, RMSEA 90% CI [.018, .052]. Results regarding longitudinal measurement invariance of the HADS subscales can be found in the supplementary Table 2.

The model fit of the LCSMs of depressive symptoms and anxiety symptoms was the same as the fit of the finally used invariance models. The results of the LCSMs indicate that, on average, participants showed statistically significant decreases in depressive symptoms (μ_Δ = -.46, *SE* = 0.10, p < .001), anxiety symptoms (μ_Δ = -.36, *SE* = 0.12, *p* = .003), and general distress (μ_Δ = -1.58, *SE* = 0.17, *p*

< .001), as well as increases in life satisfaction (μ_Δ = .96, *SE* = 0.14, *p* < .001). Still, there was significant variability in individuals' rate and pattern of change in all adaptation outcomes: σ_Δ^2 = 0.92, *SE* = 0.23, *p* < .001 for depressive symptoms, σ_Δ^2 = 1.62, *SE* = 0.44, *p* < .001 for anxiety symptoms, σ_Δ^2 = 8.04, *SE* = 0.79, *p* < .001 for general distress, and σ_Δ^2 = 5.67, *SE* = 0.58, *p* < .001 for life satisfaction (*NB* for change in depressive and anxiety symptoms μ_Δ and σ_Δ^2 are not given in the original scale of the HADS, because the HADS items were treated as ordered categorical).

Regarding individuals' patterns of change, most participants did not show clinically relevant symptoms of depression nor anxiety at T1 and T2 (61.57% and 66.55% respectively), which denotes resilience (see Figure 3). For general distress, conversely, most individuals scored above the clinical cutoff score at both time points (57.30%), which indicates vulnerability. According to the RCI, a change of at least 7 points in the scores of depressive symptoms and anxiety symptoms, 6 points in the Distress Thermometer or 5 points in the score of life satisfaction was needed to be considered *statistically* significant (RCI > 1.96 or < -1.96). Accordingly, an improvement pattern in symptoms of depression, anxiety, and general distress (i.e., *statistically* significant decreases) was identified for 6.41%, 4.27%, and 7.83% of participants respectively. Most of them additionally showed *clinically* significant change crossing the cutoff scores of the HADS or the Distress thermometer (See Figure 3). For life satisfaction, an improvement pattern (*statistically* significant increases) was identified for 8.54% of participants. Worsening patterns (*statistically* significant increases) were also identified for depressive symptoms (0.71%), anxiety symptoms (1.78%), and for general distress (2.14%). For life satisfaction, worsening (*statistically* significant decreases) was shown by 1.07% of participants.

Covariates of Change

The results of the extended LCSMs analyzing the association between several covariates and changes in the psychological adaptation outcomes during SCI inpatient rehabilitation are presented in Table 3. For all outcomes, their respective T1 score showed negative statistically significant associations with change. As change scores involve both magnitude (e.g., large, small) and direction of change (e.g., increase, decrease), these negative associations indicate that, for instance, individuals with higher scores in depressive symptoms at T1 displayed either larger decreases or

smaller increases in depression at T2. This applies similarly for anxiety symptoms, general distress, and life satisfaction. Moreover, the biopsychosocial covariates tested in this study explained some of the variance of change in psychological adaptation outcomes beyond the outcomes' T1 scores. Indeed, models including only the corresponding T1 scores as predictors explained 12.40%, 11.30%, 29.50%, and 37% of the variance of change in depressive symptoms, anxiety symptoms, general distress, and life satisfaction respectively. When all covariates were included, the proportion of explained variance increased to 23.70% (depressive symptoms), 23.10% (anxiety symptoms), 37.9% (general distress), and 41.9% (life satisfaction).

The effects of the covariates on change differed depending on the analyzed psychological adaptation outcome. Higher scores in general self-efficacy or social support at rehabilitation admission were associated with larger decreases or smaller increases in depressive symptoms between admission and discharge (β = -.19, p = .003 and β = -.21, p = .002 respectively). Sustaining tetraplegia was associated with larger increases or smaller decreases in anxiety symptoms (β = .19, p = .007). Male sex or higher scores in optimism at T1 were associated with larger decreases or smaller increases in general distress (β = -.17, p = .001 and β = -.15, p = .032 respectively). Finally, higher scores in optimism at T1 were associated with larger increases or smaller decreases in life satisfaction (β = .20, p = .005).

Sensitivity Analyses

To check the robustness of the results, the LCSMs with covariates were implemented with complete cases only (n = 228). Changes in the standardized beta coefficients were mainly small in all models: the difference in the estimates was on average .03. The biggest discrepancy was observed on the estimated effect of tetraplegia on changes in depressive symptoms; this standardized coefficient increased by .10 and became statistically significant.

Discussion

Analyzing data from a national cohort study, this study aimed at determining longitudinal changes in several psychological adaptation outcomes between admission to and discharge from SCI inpatient rehabilitation and discharge, and at identifying individuals' patterns of change. As

hypothesized, the results of the LCSMs indicate that, on average, depressive symptoms, anxiety symptoms, and general distress decreased during inpatient rehabilitation, while life satisfaction increased. Moreover, several subgroups of individuals were identified showing different change patterns that indicate improvement, resilience, or vulnerability. Yet, the hypothesized association between changes in the psychological adaptation outcomes and general self-efficacy, purpose in life, optimism, presence of pain, physical functioning, and social support was only partially supported. Not all of these covariates showed associations with change and their contribution was different depending on the specific psychological adaptation outcome analyzed.

Changes in psychological adaptation outcomes and inter-individual variability in change

The findings of the present study indicate that, at the group level, mental health and life satisfaction improve during SCI inpatient rehabilitation. Around one third of the participants started inpatient rehabilitation with elevated symptoms of depression or anxiety, but this proportion reduced to 21% by the time of discharge. Significant reductions in general distress were also observed, although the majority of participants still reported significant distress at the end of rehabilitation. Several studies have also identified average improvements in depressive symptoms (Craig, Guest, et al., 2017; Kennedy et al., 2010; van Diemen et al., 2017; White et al., 2010), anxiety symptoms (van Diemen et al., 2017), and life satisfaction (van Koppenhagen et al., 2009; White et al., 2010) during inpatient rehabilitation. Altogether, these findings indicate that, although the psychological adaptation process to a potentially traumatic event such as an SCI may extend over several years (Dijkers, 2005), individuals already show signs of positive adjustment shortly after injury.

Nevertheless, the results of the LCSMs also indicated statistically significant variability in change for all analyzed psychological adaptation outcomes and as hypothesized, several subgroups of individuals were identified as showing increases, decreases, or stability. These findings coincide with previous studies on the course of depression, anxiety, or life satisfaction following SCI, which have identified different trajectories such as chronic distress, recovery, or resilience; with the latter

showing a high prevalence (Bombardier et al., 2016; Bonanno et al., 2012; van Leeuwen et al., 2011). Yet, in the present study, the proportion of individuals showing each response pattern varied depending on the analyzed adaptation outcome. For instance, a pattern of non-clinical symptoms denoting resilience was the most common regarding depressive symptoms and anxiety symptoms. Most participants scored below the cutoff of the HADS subscales at both T1 and T2. Contrarily, for general distress, most individuals scored above the clinical cutoff score at admission and stayed above it at discharge, which would indicate a vulnerability pattern. Moreover, although direct comparisons were not conducted, the average life satisfaction of individuals in this study at rehabilitation admission (M = 5.56, SD = 2.63) and discharge (M = 6.56, SD = 2.23) was lower than the one of the general population (M = 8; SD = 0.02; Author c, 2020). Overall, this indicates that some individuals may not report clinically elevated symptoms of anxiety or depression, but still have a low life satisfaction or experience considerable general distress due to their SCI. This underscores the multidimensionality of the psychological adaptation process, as proposed in the SCIAM (Middleton & Craig, 2008); Moreover, it is in line with findings of Luhmann et al. (2012) or Infurna and Luthar (2017) indicating that critical life events may have a differential impact on different dimensions and that resilience in some adaptation outcomes may coexist with vulnerability in other outcomes.

The large proportion of individuals reporting significant general distress both at rehabilitation admission and at discharge could also be the consequence of a clinical cut-off score that is too low. Indeed, some studies have identified higher cutoff scores across different diagnostic groups (for a review, see Snowden et al., 2011). Nevertheless, the high distress levels of the study participants may be a reflection of the burden that accompanies the rehabilitation process, which can be challenging and emotionally overwhelming (Nas et al., 2015). Moreover, the discharge is a critical phase in the life course of individuals with SCI. It represents a transition from the structured clinical setting to the community environment in which individuals have to deal with more responsibility on their own recovery process, less availability of the health care professionals, and the uncertainty of the injury's effect on different life domains (e.g. family, work, leisure time; Bjoernshave et al., 2014; Nunnerley et al., 2013).

Although depressive symptoms, anxiety symptoms, and general distress showed average decreases and life satisfaction showed average increases between inpatient rehabilitation admission and discharge, improvement patterns (i.e., statistically significant changes according to the RCI) were identified for a small percentage of participants (6.41%, 4.27%, 7.83%, and 8.54% of the total sample respectively). Similarly, worsening was also identified for few participants (0.71%, 1.78%, 2.14%, and 1.07% for depressive symptoms, anxiety symptoms, general distress, and life satisfaction, respectively). This could be due to an intrinsic limitation in the calculation of the RCI. In this study, the RCI was used to describe individuals' patterns of change. For this, the T1 T2 correlations of each psychological adaptation outcome were used to calculate the standard error of the difference in the RCI formula (see Christensen & Mendoza, 1986). These correlations may weaken in the presence of actual individual differences in change in a measured construct (e.g., depressive symptoms) and therefore larger differences may be needed to detect statistically significant changes with the RCI (Martinovich et al., 1996). Indeed, in the present study, changes of at least 7 points in the scores of the HADS subscales, 6 points in the Distress thermometer or 5 points in the score of life satisfaction were needed to be considered statistically significant. This could have led to an underestimation of the number of individuals showing significant change. To overcome this limitation, some authors have suggested the use of the internal consistency reliability for the calculation of the RCI (e.g., Martinovich et al., 1996). Nevertheless, when using single item measures, as is the case in this study for general distress and life satisfaction, commonly used internal consistency indices such as Cronbach's alpha cannot be calculated (Lucas & Donellan, 2012).

An alternative explanation for the small number of individuals identified showing reliable change is that the measures used in the present study may not be sufficiently sensitive to detect change at the individual level. For instance, Post et al. (2019) analyzing the reproducibility of the international SCI Quality of Life Basic Data Set in a sample of community-dwelling adults with SCI, found that it was sensitive to small changes at the group level, but not at the individual level. Unfortunately, information regarding sensitivity to change of the outcome measures included in this study are lacking in the current literature regarding SCI inpatient rehabilitation. The results

concerning individuals' patterns of change identified in the present study should therefore be cautiously interpreted.

Covariates of Change in the Psychological Adaptation Outcomes

Negative associations were identified between changes in each psychological adaptation outcome and their corresponding T1 score. This indicates that those who had higher scores in depressive symptoms, anxiety symptoms, general distress, and life satisfaction at the beginning of the rehabilitation are more likely to show larger decreases over time, or smaller increases. These associations have been commonly reported in studies analyzing change in depression or post-traumatic stress disorder following potentially traumatic events, and have been deemed to represent an individual's natural trend to display improvements in mental health (e.g.,King et al., 2009). Nevertheless, regarding general distress and life satisfaction, since they were measured with single items and could not be defined as latent variables, regression towards the mean resulting from measurement error could also be an explanation for such negative associations.

The hypothesized association between changes in the psychological adaptation outcomes and general self-efficacy, purpose in life, optimism, presence of pain, physical functioning, and social support was only partially supported. Overall, findings of this study indicate that higher general self-efficacy and social support at the rehabilitation admission contribute to a better course of depressive symptoms during inpatient rehabilitation, while higher optimism is associated with a better course of general distress and life satisfaction. These findings coincide with previous studies, which have identified associations of general self-efficacy, optimism, and social support with better mental health and subjective well-being among individuals with SCI (Peter et al., 2012; Post & van Leeuwen, 2012; Quale & Schanke, 2010; van Leeuwen et al., 2015). Moreover, general self-efficacy, optimism, and social support seem to contribute to better physical functioning (Craig et al., 2013; Müller, Peter, et al., 2012) and participation, a key outcome of the rehabilitation process (Peter, Müller, et al., 2014). Thus, actively promoting general self-efficacy, optimism, and social support, during inpatient rehabilitation may facilitate community reintegration and contribute to better psychological and health-related outcomes.

Surprisingly, purpose in life, functional independence, and pain at the beginning of inpatient rehabilitation were not found to be associated with change in any psychological adaptation outcomes. This is in contrast to previous longitudinal research, which identified such effects in life satisfaction (van Koppenhagen et al., 2009; van Leeuwen et al., 2011) and mental health (Bombardier et al., 2016; Bonanno et al., 2012; van Leeuwen et al., 2015; van Leeuwen et al., 2012). This study may have failed to reproduce these findings because functional status, purpose in life, and pain were treated as time-invariant variables by considering only the scores at the beginning of inpatient rehabilitation. However, these factors may change during inpatient rehabilitation and such changes could be more pertinent to understand the development of the psychological adaptation outcomes. Thus, future studies should address the dynamic longitudinal interaction between these factors and psychological adaptation. Moreover, regarding pain, the findings of this study are limited to a self-report item indicating presence or absence of pain at the beginning of the inpatient rehabilitation. The severity, chronicity, and the interference that pain may cause in individuals' lives, as well as maladaptive pain-related beliefs may be more important to understand the evolution of the psychological adaptation outcomes (Bombardier et al., 2016; Hanley et al., 2008; Middleton et al., 2007). Therefore, they should be considered in future studies.

Also different from what was expected, being male was associated with a better course of general distress and tetraplegia seemed to contribute to a worse course of anxiety symptoms. Findings regarding sex and injury-related characteristics generally indicate that they are not accurate predictors of psychological adaptation outcomes (Chevalier et al., 2009; Tonack et al., 2008; van Leeuwen et al., 2011). Yet, some studies have found that males are more likely to show a low depressive mood trajectory or a profile of minimal psychological impact than females following the onset of a chronic health condition (Debnar et al., 2020) or SCI (Author, 2020). This may be related to the tendency for females to rate life events as more negative and uncontrollable than males (Matud, 2004). Thus, the present study indicates that females and individuals with tetraplegia may have special needs in terms of psychological support during rehabilitation, but these findings would need further confirmation.

Finally, it is interesting but not surprising that the contribution of the covariates to change differed depending on the specific psychological adaptation outcome analyzed. As stated by the SCIAM (Middleton & Craig, 2008) and other theoretical models, psychological adaptation is a complex process that implies the dynamic and longitudinal interaction of multiple biopsychosocial factors (Biesecker & Erby, 2008; Middleton & Craig, 2008). Nevertheless, altough in this study the analyzed covariates were allowed to correlate with each other, possible interactions among them were not specifically analyzed, and should be considered in future research. Moreover, it is possible that the effects of some of the covariates on change have been mediated by factors not included in this study (e.g., appraisal, coping strategies; Middleton & Craig, 2008), or by the levels of the psychological adaptation outcomes at admission. For instance, general self-efficacy, purpose in life, and optimism were correlated to the initial scores of all psychological adaptation outcomes. The latter would also indicate that the analyzed psychological factors together with social support could be buffering the initial impact of the injury on individual's mental health and life satisfaction (Thompson et al., 2003). Yet, this hypothesis needs further research.

Limitations

This study is subject to several limitations. As mentioned before, important covariates may be missing in the present study such as pain intensity or interference; or appraisal and coping processes. Moreover, important sociodemographic information such as race and ethnicity are not available in NICS and their influence in the adaptation process could not be analyzed. Additionally, this study lacks information on individuals' mental health history before SCI and on psychological treatment during rehabilitation. The history of psychiatric or psychological treatment before SCI has been found to predict risk of psychological disorders post injury (Craig et al., 2015) and the provision of psychological support during rehabilitation may have influenced the development of the psychological adaptation outcomes, and its effects could not be examined in this study. Finally, this study focused on two measurement times; therefore, only linear change could be modeled. Yet, models of adaptation such as the SCIAM (Middleton & Craig, 2008) indicate that this process may unfold in a non-linear way. Therefore, studies examining the course of adaptation outcomes during

rehabilitation across a bigger number of measurement time points are needed to gain a better understanding of the complexity of the adaptation process. Moreover, although the present study included several adaptation outcomes to gain a more comprehensive view on the development of the adaptation process, their change was analyzed separately and therefore, it does not offer information on how these outcomes evolve together. Future studies using alternative analytical methods that allow the analysis of change in several adaptation outcomes conjointly (i.e. latent transition analysis, bivariate latent change score models) may contribute to a better understanding on the multidimensionality of the psychological adaptation process.

Clinical Implications

Despite the average improvements in all analyzed adaptation outcomes, the findings of this study indicate that an important number of individuals may still feel highly distressed or be at risk of depression or anxiety at rehabilitation discharge. Since the prevalence of psychological disorders seems not to change up to 6 months after rehabilitation discharge (Craig et al., 2015), the findings of this study underscore the importance of identifying individuals at risk of poor mental health early in the clinical setting and providing psychological support during and after inpatient rehabilitation. This would demand a careful screening process that considers several adaptation outcomes to tailor any intervention to the individual's specific needs. Special attention should be also given to the transition from the rehabilitation to the community setting, which may confront the individuals with new challenges that demand ongoing coping efforts. Finally, the results of the present study indicate that general self-efficacy, social support, and optimism may be potential intervention targets to foster positive changes in depressive symptoms, anxiety symptoms, general distress, or life satisfaction. Such interventions are especially valuable, as it has been shown that improvements in depression and anxiety could have a beneficial impact on physical functioning (Lowe et al., 2008) and they might be easier to implement in an inpatient setting as individuals may be more easily reachable and accompanied than when they leave the rehabilitation facilities.

Conclusions

Changes in the psychological adaptation outcomes can be observed shortly after injury diagnosis. At the group level, the present study identified improvements in mental health and life satisfaction during SCI inpatient rehabilitation. Still, there is substantial variability in the pattern and rate of change at the individual level. Some individuals showed responses denoting resilience, while others improved, and others seemed to be vulnerable to mental health issues and low life satisfaction. Moreover, the proportion of individuals following each response pattern varied depending on the analyzed outcome, underlining the multidimensionality of the psychological adaptation process. The findings of the present study indicate that general self-efficacy, social support, and optimism may be potential intervention targets to foster positive changes in depressive symptoms, anxiety symptoms, general distress, or life satisfaction.

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Table 1

Descriptive Characteristics of the Participants (N = 281)

Variable	*M* (*SD*)	Range[a]	*n* (%)	Missing *n* (%)	Cronbach's *α*	Skewness	Kurtosis
Psychological adaptation outcomes							
T1 Depressive Symptoms	5.78 (4.18)	0-20	-	13 (4.63)	.82	0.80	3.13
T1 Anxiety Symptoms	5.40 (3.79)	0-18	-	8 (2.85)	.79	0.87	3.54
T1 Life Satisfaction	5.56 (2.63)	0-10	-	6 (2.14)	-	-0.16	2.27
T1 Distress	6.36 (2.77)	0-10	-	2 (0.71)	-	-0.51	2.42
T2 Depressive Symptoms	4.67 (3.78)	0-19	-	5 (1.78)	.83	0.99	3.57
T2 Anxiety Symptoms	4.70 (3.95)	0-19	-	1 (0.36)	.84	1.09	4.07
T2 Life Satisfaction	6.56 (2.23)	0-10	-	0	-	-0.64	3.11
T2 Distress	4.77 (2.68)	0-10	-	5 (1.78)	-	0.09	2.18
Covariates							
Sex (Male)	-	-	199 (70.82)	0	-	-	-
Age	54.01 (16.18)	17-84	-	0	-	-0.37	2.31
Time since SCI to discharge[b]	5.59 (2.39)	1.70-11.50	-	0	-	1.01	6.78
SCI Etiology (traumatic)	-	-	172 (61.21)	0	-	-	-
Injury Level (tetraplegia)	-	-	96 (34.16)	0	-	-	-
Injury Level (paraplegia)	-	-	181 (64.41)	0	-	-	-
Injury Level (intact)	-	-	1 (0.36)	0	-	-	-
Injury Level (UTD)	-	-	3 (1.07)	0	-	-	-
Lesion Completeness (incomplete)	-	-	222 (79.00)	0	-	-	-
Lesion Completeness (UTD)[c]	-	-	2 (0.71)	0	-	-	-
Pain (yes)	-	-	208 (74.29)	1 (0.36)	-	-	-
Functional Independence	40.12 (24.10)	0-100	-	3 (1.07)	.89	0.64	2.56
General Self-efficacy	15.80 (2.63)	7-20	-	19 (6.76)	.80	-0.46	3.10
Purpose in Life	23.06 (4.01)	8-28	-	18 (6.41)	.86	-1.11	4.31
Optimism	17.22 (4.36)	5-24	-	31 (11.03)	.73	-0.40	2.65
Social Support	8.34 (1.83)	0-10	-	18 (6.41)	.83	-1.63	6.20

Note. [a] Range corresponds to the actual range of responses reported by study participants. [b] In months. [c] UTD = Unable to determine.

Table 2

Correlations Between the Psychological Adaptation Outcomes and the Covariates (N = 281)

Variable	1	2	3	4	5	6	7	8
1 T1 Depressive symptoms	—							
2 T1 Anxiety symptoms	.57***	—						
3 T1 Life satisfaction	-.56***	-.51***	—					
4 T1 Distress	.42***	.43***	-.36***	—				
5 T2 Depressive symptoms	.67***	.51***	-.45***	.33***	—			
6 T2 Anxiety symptoms	.47***	.62***	-.39***	.27***	.72***	—		
7 T2 Life satisfaction	-.53***	-.49***	.53***	-.34***	-.66***	-.62***	—	
8 T2 Distress	.27***	.29***	-.23***	.46***	.47***	.46***	-.43***	—
9 General Self-efficacy	-.37***	-.39***	.37***	-.29***	-.38***	-.34***	.29***	-.13*
10 Purpose in life	-.54***	-.36***	.44***	-.22***	-.36***	-.32***	.32***	-.08
11 Optimism	-.57***	-.54***	.44***	-.34***	-.41***	-.39***	.40***	-.23***
12 Social support	-.21***	-.22***	.25***	-.06	-.30***	-.24***	.15**	-.10
13 Functional independence	-.14*	-.02	.08	-.04	-.16**	-.05	.13*	-.11
14 Time since SCI to discharge	.11	-.07	-.09	.07	.12*	.06	-.13*	.06
15 Age	.09	.01	.03	.01	.15**	-.03	-.03	.14*
16 Sex	-.04	-.12*	.09	-.12*	-.04	-.12*	.11	-.23***
17 SCI Etiology	-.06	-.06	-.09	-.02	-.03	.00	-.02	-.10
18 Tetraplegia	.04	-.09	.02	.06	.08	.10	-.04	.07
19 Complete SCI	.11	.09	-.09	.02	.09	.05	-.11	.00
20 Pain	.04	.08	-.18***	.12*	.07	.01	-.03	-.05

Note: $^{***}p \leq .001$. $^{**}p \leq .01$. $^{*}p \leq .05$.

Table 3

Fit Indices and Estimated Standardized Regression Coefficients of the Latent Difference Score Models Analyzing Covariates of Change (N = 280)

Model with Covariates	χ^2 (*df*)	CFI	RMSEA	90% CI RMSEA
Change in Depressive Symptoms	326.55** (232)	0.977	0.038	[.028, .047]
Change in Anxiety Symptoms	301.97** (229)	0.978	0.034	[.022, .044]
	Loglikelihood	AIC		BIC
Change in Distress	-6427.92	13093.85		13526.39
Change in Life Satisfaction	-6333.15	12904.31		13336.85

Covariate	Δ Depressive symptoms			Δ Anxiety symptoms			Δ Distress			Δ Life satisfaction		
	Estimate	*SE*	95% CI	Estimate	*SE*	95% CI	Estimate	*SE*	95% CI	Estimate	*SE*	95% CI
T1 level	-.33**	0.12	[-.56, -.10]	-.35***	0.10	[-.55, -.15]	-.58***	0.04	[-.66, -.51]	-.69***	0.04	[-.77, -.60]
General Self-efficacy	-.19***	0.06	[-.31, -.06]	-.07	0.07	[-.21, .07]	.05	0.06	[-.07, .16]	.04	0.06	[-.07, .15]
Purpose in Life	.19	0.10	[-.003, .38]	-.08	0.08	[-.23, .08]	.11	0.07	[-.03, .26]	-.03	0.08	[-.18, .12]
Optimism	.10	0.09	[-.07, .27]	.07	0.09	[-.11, .24]	-.15*	0.07	[-.28, -.01]	.20**	0.07	[.06, .33]
Social Support	-.21***	0.07	[-.34, -.08]	-.13	0.07	[-.26, .01]	-.09	0.05	[-.19, .01]	-.03	0.06	[-.14, .09]
Functional Independence	-.10	0.09	[-.27, .08]	.08	0.09	[-.09, .25]	-.08	0.07	[-.22, .07]	.04	0.06	[-.08, .16]
Time since SCI to discharge (months)	.04	0.09	[-.13, .20]	.15	0.11	[-.06, .36]	.08	0.07	[-.05, .21]	-.04	0.07	[-.17, .09]
Age	.11	0.08	[-.04, .27]	-.06	0.07	[-.19, .08]	.07	0.05	[-.03, .17]	.01	0.05	[-.10, .11]
Sex (Male)	-.03	0.08	[-.18, .12]	-.10	0.07	[-.24, .04]	-.17***	0.05	[-.26, -.07]	.06	0.05	[-.03, .15]
Traumatic SCI	.06	0.07	[-.08, .20]	.04	0.08	[-.11, .20]	-.05	0.06	[-.15, .06]	.03	0.05	[-.07, .12]
Tetraplegia	.04	0.07	[-.11, .18]	.19**	0.07	[.05, .32]	.03	0.06	[-.08, .15]	-.04	0.05	[-.14, .07]
Complete injury	-.01	0.08	[-.17, .15]	-.01	0.07	[-.14, .12]	-.002	0.05	[-.10, .10]	-.03	0.06	[-.14, .08]
Pain (yes)	.08	0.07	[-.06, .21]	-.12	0.07	[-.25, .02]	-.07	0.05	[-.17, .03]	.07	0.05	[-.02, .16]
R^2	.24	0.06		.23	0.07		.38	0.05		.42	0.04	

Note: Results after exclusion of one outlier. CFI = comparative fit index. RMSEA = root mean squared error of approximation. 90% CI RMSEA = 90% confidence interval of the RMSEA. T1 level = initial level of each psychological adaptation outcome. Δ = change from T1 to T2. 95% CI = 95% confidence interval for the estimated standardized regression coefficients. $^{***}p \leq .001$. $^{**}p \leq .01$. $^{*}p \leq .05$.

Figure 1

Participation Flow-Chart

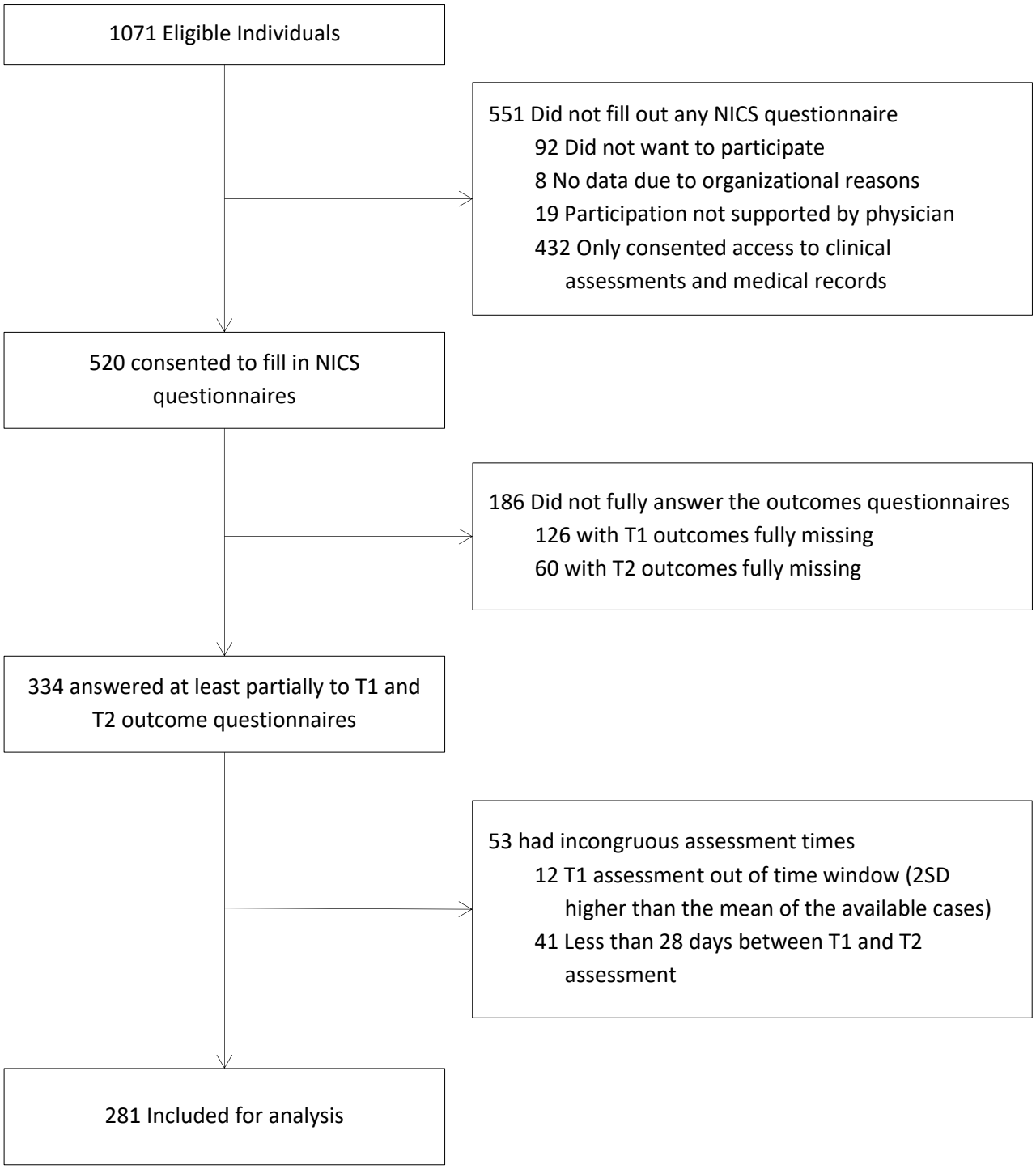
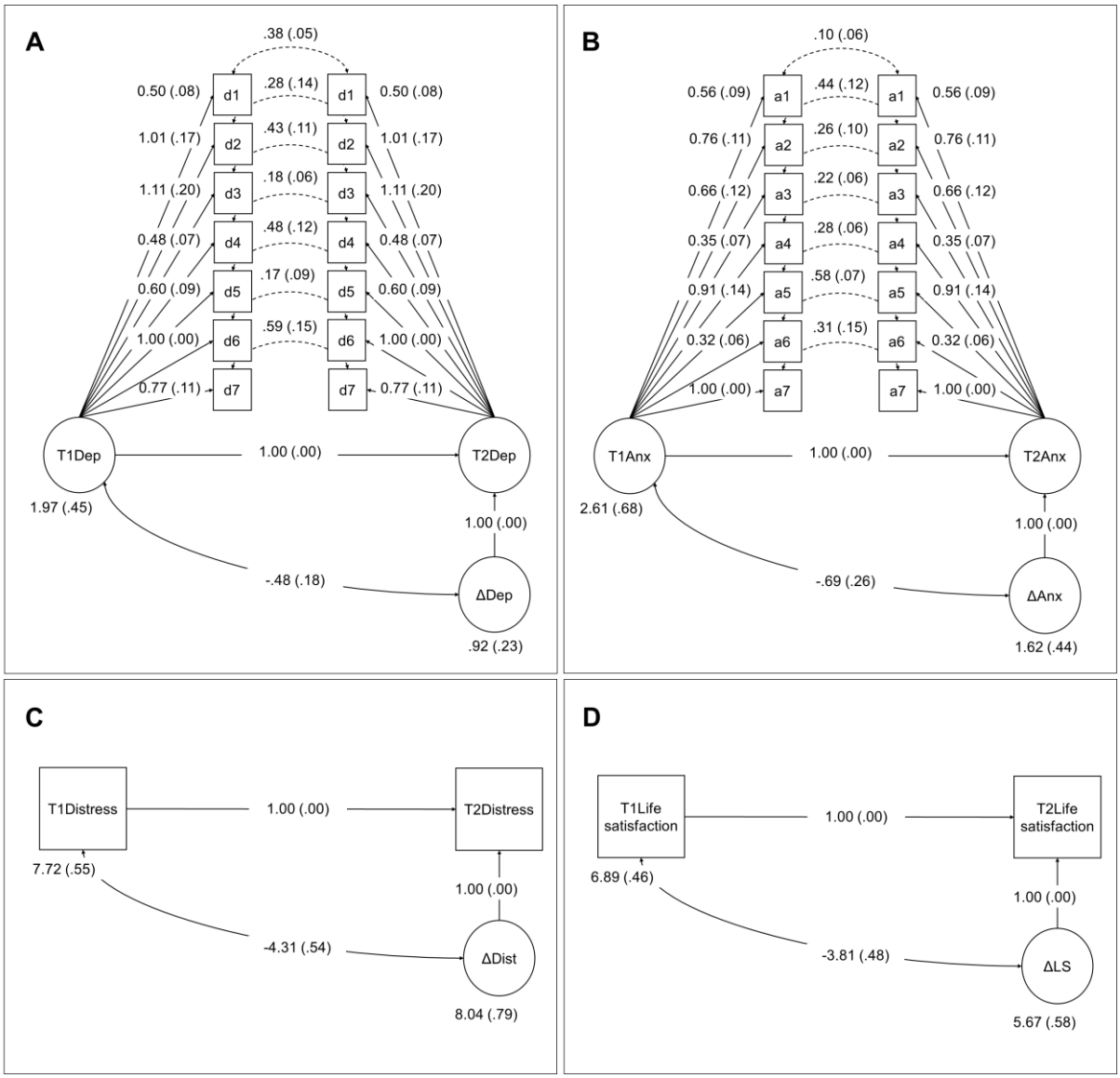


Figure 2

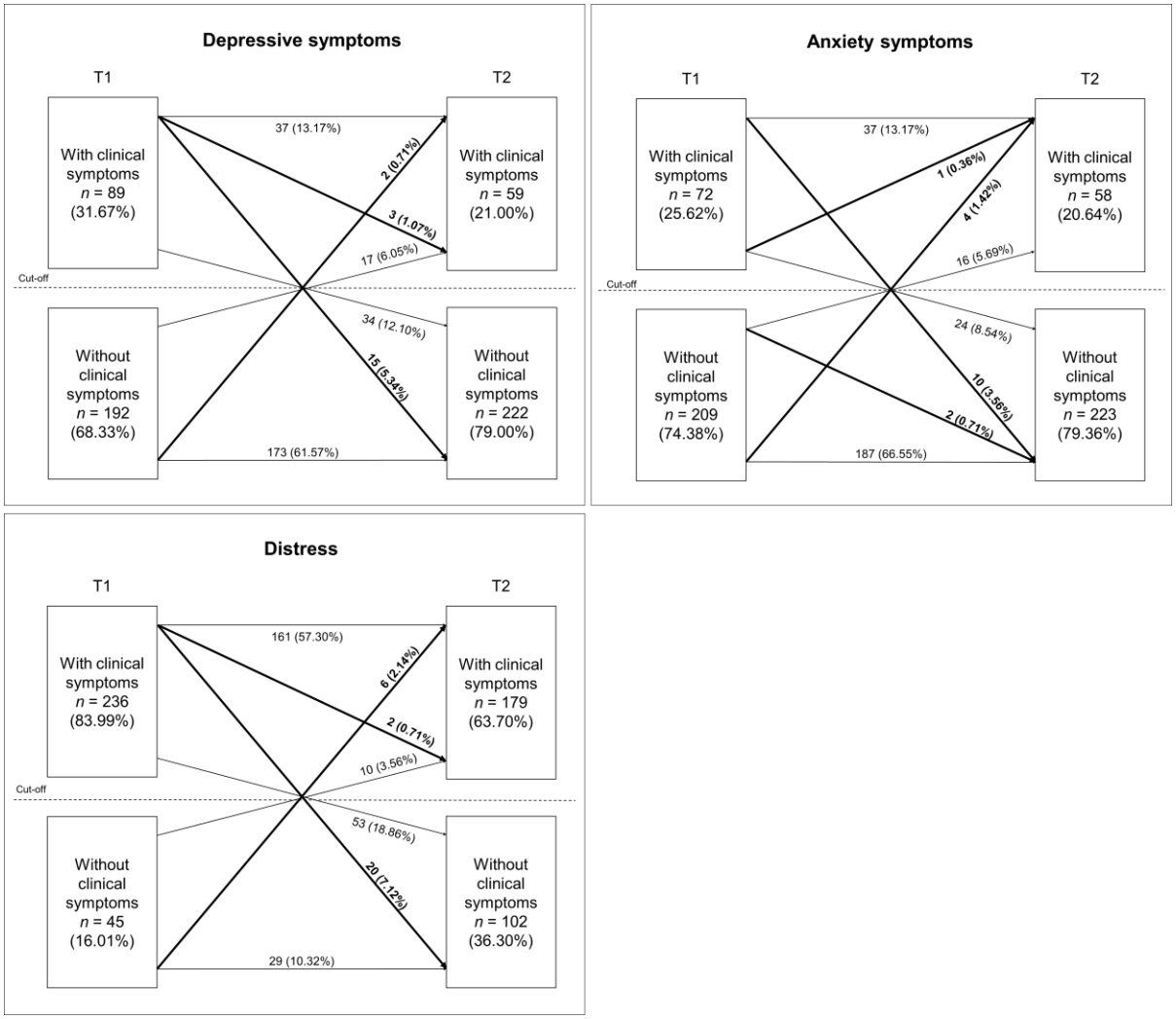
Path Diagrams Depicting the Implemented Latent Change Score Models



Note. The diagrams depict unstandardized estimates and standard errors. Single-headed arrows represent regressions. Double-headed arrows represent correlations. Models A and B were built on the retained threshold-invariant models for depressive symptoms and anxiety symptoms respectively. All thresholds of the HADS-Depression items were held equal across time. Two thresholds of item one and one threshold of item four of the HADS-Anxiety subscale were freely estimated. All other thresholds were held equal across time. For identification of models A and B, all unique variances at T1 were constrained to one, while all unique variances at T2 were freely estimated. d1-d7 = HADS-Depression items. a1-a7 = HADS-Anxiety items. Dep = Depressive symptoms. Anx = Anxiety symptoms. ΔDep = Change in depressive symptoms. ΔAnx = Change in anxiety symptoms. ΔDist = Change in General Distress. ΔLS = Change in Life Satisfaction.

Figure 3

Individuals' Changes in Depressive Symptoms, Anxiety Symptoms, and Distress According to their Scores in the Reliable Change Index



Note: Scores ≥ 8 for depressive and anxiety symptoms and ≥ 4 for distress were considered indicative of clinically relevant symptoms. Bold arrows indicate *statistically* significant changes according to the RCI. Bold arrows crossing the dotted lines of the cut-off scores indicate *clinically* significant changes. Gray arrows crossing the dotted lines indicate increases or decreases that crossed the cutoff scores but were not statistically significant according to the RCI. A change of at least 7 points in the scores of depressive symptoms and anxiety symptoms or 6 points in the Distress thermometer was needed to be considered statistically significant according to the RCI. Percentages are relative to the total study sample (*N* = 281).