



# The impact of loneliness and relationship quality on life satisfaction: A longitudinal dyadic analysis in persons with physical disabilities and their partners

Hannah Tough<sup>a,b,\*</sup>, Martin W.G. Brinkhof<sup>a,b</sup>, Johannes Siegrist<sup>c</sup>, Christine Fekete<sup>a</sup>

<sup>a</sup> Swiss Paraplegic Research, Nottwil, Switzerland

<sup>b</sup> Department of Health Sciences and Health Policy, University of Lucerne, Lucerne, Switzerland

<sup>c</sup> Faculty of Medicine, University of Düsseldorf, Life-Science-Center, Düsseldorf, Germany

## ARTICLE INFO

### Keywords:

Caregiving  
Disability  
Loneliness  
Longitudinal  
Relationship quality  
Life satisfaction

## ABSTRACT

**Objective:** Persons with physical disabilities and their caregiving partners are at an increased risk of experiencing reduced life satisfaction. One potential explanation for this trend may be the potentially harmful effects of loneliness and poor relationship quality which this population often experience. To date, little is known about how the perceptions of loneliness and relationship quality affect life satisfaction in the disability and caregiving setting, furthermore the directionality of effect is not well understood. In this study, we investigate the actor and partner effects, and the reciprocal effects of loneliness and relationship quality on life satisfaction.

**Methods:** The analyses are based on longitudinal dyadic data from a Swiss community survey of persons with spinal cord injury (SCI) and their partners ( $n = 246$ ). We employed mixed effects modelling to explore standardized ( $\beta$ ) and unstandardized ( $B$ ) actor and partner effects, and used cross-lagged path analysis to explore reciprocal effects.

**Results:** Loneliness was more prevalent in persons with SCI than in their caregiving partners. In caregiving partners, we found significant negative actor effects of loneliness ( $\beta = -0.20$  ( $-0.31, -0.10$ )) and positive actor effects of relationship quality ( $\beta = 0.15$  ( $0.04, 0.26$ )) on life satisfaction, and significant partner effects of relationship quality on wellbeing. In persons with SCI, only the negative actor effect of loneliness was significant ( $\beta = -0.30$  ( $-0.41, -0.18$ )). Over time, loneliness demonstrated reciprocal associations with life satisfaction.

**Conclusion:** The findings of our study highlight the importance of reducing loneliness and strengthening relationship quality to improve life satisfaction in partnerships of persons coping with disability.

## 1. Introduction

Persons with physical disabilities and their caregiving partners are at greater risk from poor wellbeing than the general population [1–5]. One potential explanation for this trend may be the unfavorable experiences of loneliness and poor relationship quality which persons with disabilities and their caregiving partners face due to the limitations, strain and burden often associated with coping with disability [6–10]. Loneliness and relationship quality have both been identified as playing a crucial role in determining health and wellbeing [11–14]. The concept of loneliness is commonly defined as the subjective perception of social isolation [15]. Loneliness is, however, not synonymous with isolation, meaning that it may be experienced by individuals who are in long-term partnerships and embedded within social networks [15,16]. Persons coping with disability may become emotionally isolated from

their existing social circle, especially if they feel that they are no longer understood or accepted [6,17]. Relationship quality is a similarly subjective evaluation which assesses the depth, the purpose, and the availability of emotional support in partner relationships. Couples coping with disability may be at risk of poor relationship quality as the effort of caregiving becomes an implicit part of the relationship, meaning that the relationship is no longer balanced, roles within the relationship may change and the stress often associated with caregiving seeps into the intimate bond between partners [18,19].

To date little research has explored the associations between loneliness, relationship quality and life satisfaction in the disability context using longitudinal, dyadic data. While cross-sectional associations of loneliness and relationship quality with life satisfaction are robust in the general population, longitudinal research has identified that the nature of the relationship is often complex and bidirectional. Poorer life

\* Corresponding author at: Guido A. Zäch Strasse 4, 6207 Nottwil, Switzerland.  
E-mail address: [hannah.tough@paraplegie.ch](mailto:hannah.tough@paraplegie.ch) (H. Tough).

satisfaction has also been found to elicit perceptions of loneliness and low relationship quality, by causing individuals to withdraw from their social networks, and by instigating conflict within relationships [20–25]. Evidence from populations affected by chronic disease and disability has mainly focused on the positive association between relationship quality and life satisfaction, omitting other relevant constructs such as loneliness [26]. As we are not only interested in persons with disabilities, but also in their caregiving partners the availability of dyadic data is vital. Dyadic data not only enables the understanding how couples cope with disability, but also provides a comparison population, and enables the exploration of partner effects [27]. Evidence shows that relationships may be perceived differently by the actor and the partner, and that this may have differential effects on both the individuals' and their partners' life satisfaction [27–30].

Here we use spinal cord injury (SCI) as an informative case in point to investigate the impact of loneliness and relationship quality on life satisfaction in the context of physical disability, using longitudinal, dyadic data. SCI has a far-reaching impact on an individual's functioning, as affected persons sustain a complete or partial loss of sensory and motor function below the lesion level [31]. The functional limitations associated with SCI may have dramatic consequences on social participation and an individuals engagement in their social environment [32]. There is also evidence suggesting that assuming the role of caregiver to a person with SCI has a profound emotional impact on the individual and results in a change in relationship dynamics [33]. The aims are to 1) assess the actor and partner effects of loneliness and relationship quality on life satisfaction; and 2) evaluate the reciprocal effects of loneliness and relationship quality on life satisfaction in persons with SCI and their caregiving partners. We hypothesise that individuals who experience poor relationship quality and higher levels of loneliness are at greater risk of experiencing poor life satisfaction. Furthermore, we hypothesise that both the individuals' and the partners' experience of loneliness and relationship quality have an impact on individual life satisfaction, and that the association of loneliness and relationship quality with life satisfaction is reciprocal.

## 2. Methods

### 2.1. Sampling frame and participants

Participants for the pro-WELL study ('The social production of wellbeing in disability: a longitudinal study of persons with spinal cord injury and their caregivers') were recruited from the larger community survey of the Swiss Spinal Cord Injury Cohort Study (SwiSCI) [34]. The SwiSCI survey included persons with traumatic or non-traumatic SCI aged over 16 years living in Switzerland, and excluded persons with congenital conditions leading to SCI, new SCI in the context of palliative care, neurodegenerative disorders, and Guillain-Barré syndrome. Details of the study design, recruitment outcomes and participation rates of the SwiSCI survey are reported elsewhere [35,36]. The first wave of the SwiSCI community survey (September 2011–March 2013;  $n = 1922$ ) served as the sampling frame for the pro-WELL recruitment. All persons aged 30–65 at the time of the pro-WELL recruitment and who spoke German or French were contacted simultaneously by mail in order to determine eligibility and willingness to participate ( $n = 1108$ ). Those who were willing to participate and those who did not react to the written invitation were then contacted by telephone for further eligibility screening and to obtain consent for participation from both the person with SCI and their partner who was involved in informal caregiving. See [34] for details of the screening procedure. In total, 676 persons with SCI were eligible and 133 persons with SCI and their partners were recruited at baseline (total  $n = 266$ ). A total of 123 couples ( $n = 246$ ) completed at least two waves of data collection and were thus available for longitudinal analysis. Although the baseline response rate was restrained at 19.7% (refusal  $n = 373$ ; no contact  $n = 170$ ), a comprehensive non-response analysis demonstrated good

representation of the source population of persons with SCI with insignificant selection bias regarding sociodemographic and lesion characteristics [34].

### 2.2. Study design of pro-WELL

This paper uses data from pro-WELL, a longitudinal community-based survey with three measurement waves spaced over a 12 month period (t0: baseline; t1: month 6; t2: month 12). Data were collected using standardized telephone interviews and questionnaires (paper-pencil or online). Baseline data collection was effectuated between May and December 2015, and follow-up waves using a six month interval were then individually scheduled with reference to the previous data collection date. The study protocol was approved by the Ethical Committee of Northwest and Central Switzerland (document EKNZ 2014-285). We strictly observed all regulations concerning informed consent and data protection. A more detailed description of the study design is provided in the cohort profile of the pro-WELL study [34].

### 2.3. Measures

*Loneliness* was assessed using 3 items from the Revised UCLA loneliness scale which capture subjective feelings of loneliness, with a score ranging from 0 to 6, with high scores representing higher levels of loneliness [37]. This scale has recently been validated in an SCI population and showed adequate metric properties [38]. The Cronbach's alpha was 0.79, demonstrating satisfactory internal consistency in our sample.

*Relationship quality* was assessed using 8 items from the social support and depth subscales of the Quality of Relationship Inventory (QRI), assessing the meaningfulness and the positive role of the partnership, along with the extent to which one could turn to one's partner for support, and the responsibility or need one felt for their partner. The items were rated on a 4-point Likert scale, resulting in a sum score ranging from 0 to 24, with higher scores representing higher quality [39]. The Cronbach's alpha across all 8 items was 0.82, demonstrating satisfactory internal consistency in our sample.

*Life satisfaction* was assessed with the five-item Satisfaction with Life Scale (SWLS), designed to measure global cognitive judgments of satisfaction with one's life [40]. The SWLS has been used in previous SCI research [41]. The items were rated on a 5-point Likert scale ranging from "strongly disagree" (scored 0) to "strongly agree" (scored 4) [42]. A sum score ranging from 0 to 20 was calculated, with higher scores indicating higher wellbeing. The Cronbach's alpha across all 5 items was 0.83, demonstrating satisfactory internal consistency in our sample.

### 2.4. Potential confounders

To identify potential confounding variables, a preliminary analysis on associations between socio-demographics, socio-economic, loneliness, relationship quality and life satisfaction was performed. Financial hardship and stressful life events were the variables that were significantly related to the independent (loneliness, relationship quality) and the dependent variables (life satisfaction) and were thus included as confounders in multivariable models. Financial hardship was measured with a single item on participants ability to manage with their available financial resources. Response options included 'very scarce; scarce; just lasts; lasts good; lasts very good'. Stressful life events were assessed with a single item identifying whether the individual had suffered from a stressful event in the last 6 months. The variable was binary indicating individuals who had experienced a stressful event in the 12 months of data collection and those who had not. Age, sex, lesion characteristics (SCI only) and hours of caregiving (caregiving partners only) were also included in multivariable models due to evidence suggesting their confounding effects [16,43–45].

2.5. Data analysis

Analyses were conducted using STATA version 14.2 for Windows (College Station, TX, USA). We first describe the distribution of loneliness, relationship quality and life satisfaction in persons with SCI and their partners, using *t*-tests in comparative analysis. Cross-sectional and longitudinal correlations were computed to gain a crude understanding of the associations between loneliness, relationship quality and life satisfaction and to assess their stability over time.

The Actor Partner Interdependence Model (APIM) was used to inform our dyadic analysis [29,30]. In order to assess the actor and partner effects of relationship quality and loneliness on life satisfaction, we stratified the analysis to persons with SCI and caregiving partners, and used a two-level mixed model with random effects for persons (level 2) and repeated measures (level 1). A mixed model was used to control for interdependencies in the data. Models were adjusted for age, sex, stressful life events, financial hardship, lesion characteristics (SCI only) and hours of caregiving (caregiving partners only). Likelihood ratio tests were performed on models with and without random effects to establish whether random effects should be included in the model. Robust standard errors were calculated to account for non-normally distributed dependent variables [46]. Multilevel analysis has been shown to be very robust in handling missing data, therefore no missing data was imputed to account for item non-response [47,48]. Selection bias due to unit non-response has been shown to be negligible [34]. We report standardized and unstandardized regression coefficients and 95% confidence intervals. A post-hoc analysis (results not shown) was conducted in order to determine if the effects of loneliness and relationship quality on life satisfaction were modified depending on the person's role i.e. whether the effect was statistically different for persons with SCI compared to their caregiving partners, and interaction terms were entered into the model.

To evaluate the reciprocal effects of relationship quality and loneliness on life satisfaction, a path analysis was conducted, which involved the testing of cross-lagged relationships between relationship quality, loneliness and life satisfaction. This method has the advantage of simultaneously exploring reciprocal influences between variables to assess the directionality of effects. Here we also stratified the analysis to persons with SCI and caregiving partners and the models were adjusted for age, sex, stressful life events, financial hardship, lesion characteristics (SCI only) and hours of caregiving (caregiving partners only). The analyses are based on the assumption that variation in the study variables remains stable over time [23]. These assumptions were modelled by including equality constraints on the autoregressive and cross-lagged paths, thereby enforcing “stationarity” on relationship quality, loneliness and life satisfaction. Model fit was assessed by  $\chi^2$  test (vulnerable to sample size), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA). We report standardized regression coefficients and 95% confidence intervals. Although our sample size is restricted, it is above the minimal recommended sample size [49]. Missing data were not imputed and all analysis was conducted using full information maximum likelihood estimation. This method does not impute data but instead “borrows” information from the observed data [50].

3. Results

Basic baseline characteristics of the pro-WELL sample are displayed in Table 1. The majority of persons with SCI were male and the majority of caregiving partners were female. Mean age was 51.7 years in persons with SCI and 50.6 years in caregiving partners, 54.5% of persons with SCI and 64.2% of partners were in paid employment and the majority of couples had formed their relationship after SCI had occurred. > 30% of participants reported financial hardship and between 26.4% and 29.9% of participants experienced a stressful life event within the 12 months of data collection. On average, the partners provided 1.8 h a day of care

**Table 1**  
Baseline sociodemographic and clinical characteristics of persons with SCI and their caregiving partners from the pro-WELL study.

	Persons with SCI	Caregiving partners	P difference SCI caregiving partners <sup>a</sup>
Total	123 (100)	123 (100)	
[Missing values: SCI; partner]			
<b>Categorical variables</b>	<b>N (%)</b>	<b>N (%)</b>	
<i>Sociodemographic characteristics</i>			
Male [0;0]	91 (74.0)	32 (26.0)	< 0.001
Paid employment [0;0]	67 (54.5)	79 (64.2)	0.01
Partnership before SCI [7;7]	50 (43.1)	50 (43.1)	
Financial hardship [4;5]	38 (31.9)	41 (34.1)	0.85
Negative life event [2;6]	32 (26.4)	35 (29.9)	0.55
<i>Lesion characteristics</i>			
Lesion severity [2]			
Complete paraplegia	39 (32.2)	N/A	
Incomplete paraplegia	47 (38.8)	N/A	
Complete tetraplegia	23 (19.0)	N/A	
Incomplete tetraplegia	12 (9.9)	N/A	
<b>Continuous variables</b>			
	<b>Mean (SD)</b>	<b>Mean (SD)</b>	
Age in years [1;6]	51.7 (9.4)	50.6 (10.1)	0.11
Years of education [2;7]	13.9 (3.2)	14.0 (3.1)	0.51
Household income in Swiss Francs [18;16]	4629.0 (1470.9)	4443.8 (1525.7)	0.23
Years since injury [5]	24.5 (11.6)	N/A	
Hours of caregiving [12]	N/A	1.8 (3.3)	
<i>Study variables</i>			
Loneliness, UCLA-SF (0–6) [2;3]	1.05 (1.38)	0.80 (1.35)	< 0.001
Relationship quality, QRI (0–24) [2;3]	21.00 (2.84)	20.24 (3.50)	0.04
Life satisfaction, SWLS (0–20) [3;2]	12.25 (3.80)	13.79 (3.94)	< 0.001

Abbreviations: CI: Confidence interval; SCI: Spinal cord injury; SD: Standard deviation; SWLS: Satisfaction With Life Scale; QRI: Quality of Relationship Inventory; UCLA-SF: UCLA Loneliness Scale-Short Form.

<sup>a</sup> P from  $\chi^2$  test for dichotomous variables; from Mann–Whitney *U* test for the comparison of mean.

for the person with SCI. Persons with SCI experienced a higher level of both loneliness and relationship quality, and a more adverse experience of life satisfaction. 55.0% of persons with SCI experienced loneliness during the 12 months of data collection, in comparison to 47.1% of caregiving partners. Zero-order cross-sectional and longitudinal correlations between study variables can be found in Appendix 1.

3.1. Actor and partner effects of loneliness and relationship quality on life satisfaction

Table 2 presents the results of the multi-level analysis including standardized ( $\beta$ ) and unstandardized (*B*) actor and partner effects of loneliness and relationship quality on wellbeing. Loneliness demonstrated strong actor effects on life satisfaction in both persons with SCI and their caregiving partners ( $\beta = -0.30$ ;  $p < 0.001$  SCI,  $\beta = -0.20$ ;  $p < 0.001$  caregiving partner), whereby persons who experienced higher levels of loneliness reported reduced life satisfaction. In contrast, we found no evidence for a partner effect of loneliness on life satisfaction, indicating that the partners' feelings of loneliness were not related to the individuals' level of life satisfaction. Relationship quality had no effect on life satisfaction in persons with SCI but demonstrated significant actor and partner effects on life satisfaction in caregiving partners ( $\beta = 0.15$ ;  $p < 0.01$  actor effect,  $\beta = 0.21$ ;  $p < 0.01$  partner effect). The results of the post-hoc analysis found no evidence of effect modification due to the persons' role in the association of loneliness and relationship quality with life satisfaction.

**Table 2**

Actor and partner effects of loneliness and relationship quality on life satisfaction: Two-level mixed effects model with nested random effects showing standardized and unstandardized coefficients and 95% confidence intervals (CI).

Effect size	Life satisfaction (0–20)			
	Person with SCI		Caregiving partners	
	B coefficients (95% CI)	β coefficients (95% CI)	B coefficients (95% CI)	β coefficients (95% CI)
<b>Actor effects</b>				
Loneliness, UCLA-SF (0–6)	−0.81 (−1.12, −0.50)***	−0.30 (−0.41, −0.18)***	−0.56 (−0.84, −0.27)***	−0.20 (−0.31, −0.10)***
Relationship quality, QRI (0–24)	0.08 (−0.04, 0.21)	0.07 (−0.03, 0.17)	0.18 (0.05, 0.31)**	0.15 (0.04, 0.26)**
<b>Partner effects</b>				
Partner's loneliness, UCLA-SF (0–6)	−0.05 (−0.32, 0.23)*	−0.02 (−0.12, 0.08)	−0.21 (−0.48, 0.06)	−0.07 (−0.17, 0.02)
Partner's relationship quality, QRI (0–24)	0.01 (−0.11, 0.12)	0.01 (−0.09, 0.10)	0.26 (0.12, 0.39)***	0.21 (0.10, 0.32)***
Level 1 ΔR <sup>2</sup>	0.27		0.36	
Level 2 ΔR <sup>2</sup>	0.35		0.44	

Abbreviations: β: Standardized coefficients; B: Unstandardized coefficients; QRI: Quality of Relationship Inventory; SCI: Spinal cord injury; UCLA-SF: UCLA Loneliness Scale-Short Form.

Adjusted for age, sex, financial hardship, negative life events, lesion characteristics (SCI only), hours of caregiving (caregiving partners only).

\* p ≤ 0.05.

\*\* p ≤ 0.01.

\*\*\* p ≤ 0.001.

**3.2. Reciprocal effects of loneliness and relationship quality on life satisfaction**

Figs. 1 and 2 show that the significant stationary autoregressive effects of loneliness, relationship quality and life satisfaction are moderate, highlighting the stability of the constructs over time in both populations. Figs. 1 and 2 also demonstrate that loneliness was reciprocally related to life satisfaction in both persons with SCI and in their caregiving partners, even after controlling for relevant confounders and the autoregressive effects of the study variables themselves. Much like the previous dyadic analysis we find that the effect of relationship quality on life satisfaction is only evident in caregiving partners, but that higher life satisfaction led to better relationship quality in both groups (β = −0.14; p < 0.001 SCI, β = −0.15; p < 0.001 caregiving partner).

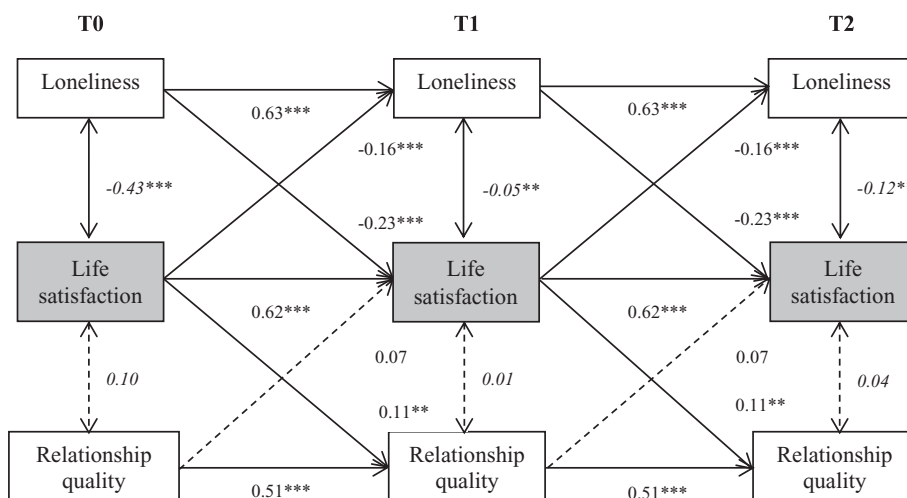
**4. Discussion**

This is the first study in the disability setting that assesses the actor and partner effects of loneliness and relationship quality on life satisfaction, and furthermore investigates the directionality of associations between these constructs. Our study has demonstrated that the individuals' perception of loneliness consistently predicts life satisfaction in both persons with SCI and in their caregiving partners, a finding

in support of our research hypothesis. It also indicates that loneliness is more prevalent in persons with SCI than in their caregiving partners, and that its' negative effect on life satisfaction is more profound in this population. In comparison and in contrast to our research hypothesis, the positive effect of relationship quality was only evident in caregiving partners and not in persons with SCI. Moreover, loneliness and relationship quality were both affected by previous levels of life satisfaction, in that higher levels of life satisfaction predicted reduced perceptions of loneliness and enhanced relationship quality in both persons with SCI and in their caregiving partners. Although the reciprocal association of loneliness and relationship quality with life satisfaction which we hypothesized, only held true for loneliness with life satisfaction.

**4.1. Loneliness and life satisfaction**

The actor effect of loneliness was found to consistently predict life satisfaction in both persons with SCI and their caregiving partners. Meaning that one's own perception of loneliness impacts on one's own life satisfaction. This is in contrast to the partner effects of loneliness on one's own life satisfaction which were small and insignificant in both groups, suggesting that the perception of loneliness is a profoundly personal experience which can have a dramatic effect on an individuals' life satisfaction, but not on their partners'. To date, there has been no



**Fig. 1.** Reciprocal effects of loneliness and relationship quality on life satisfaction in persons with spinal cord injury: A path analysis showing standardized coefficients.

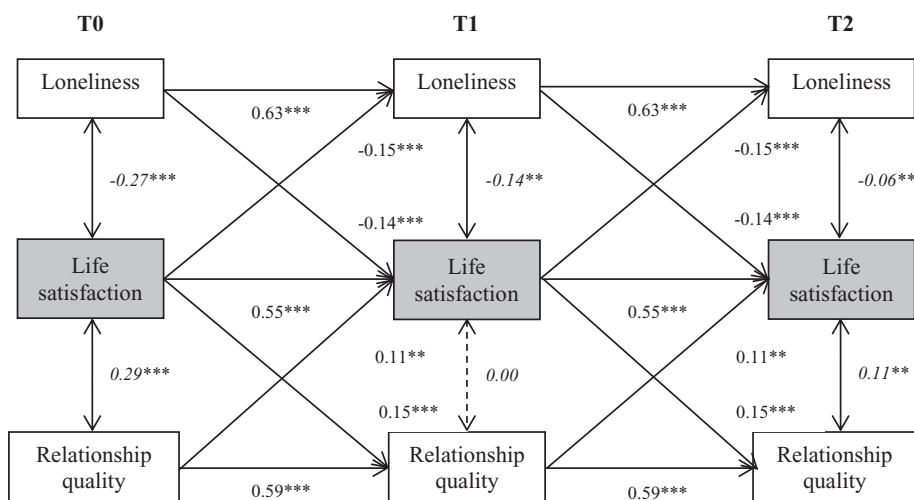
The dashed lines represent hypothesized but not significant paths, and solid lines represent the significant paths. Double-sided arrows represent co-variances between constructs. Italicized coefficient represents time-varying co-variances.

Adjusted for age at baseline, sex, financial hardship, negative life events and lesion characteristics. Model fit: X<sup>2</sup>:40.42, p-value:0.23, CFI:0.99, RMSEA:0.05 (0.04–0.07).

\*p ≤ 0.05; \*\*p ≤ 0.01; \*\*\*p ≤ 0.001.

R<sup>2</sup> Wellbeing T2 = 0.58; R<sup>2</sup> Wellbeing T1 = 0.52; R<sup>2</sup> Wellbeing T0 = 0.11.





**Fig. 2.** Reciprocal effects of loneliness and relationship quality on life satisfaction in caregiving partners: A path analysis showing standardized coefficients.

The dashed lines represent hypothesized but not significant paths, and solid lines represent the significant paths. Double-sided arrows represent covariances between constructs. Italicized coefficient represents time-varying co-variances.

Adjusted for age at baseline, sex, financial hardship, negative life events and hours of caregiving. Model fit:  $\chi^2:70.9$ ,  $p$ -value:  $< 0.001$ , CFI:0.95, RMSEA:0.09 (0.06–0.09).

\* $p \leq 0.05$ ; \*\* $p \leq 0.01$ ; \*\*\* $p \leq 0.001$ .  $R^2$  Wellbeing T2 = 0.54;  $R^2$  Wellbeing T1 = 0.58;  $R^2$  Wellbeing T0 = 0.18.

comparable dyadic analysis on the effects of loneliness on life satisfaction, however the harmful actor effects of loneliness are widely established in the general population [15,16], and to a lesser extent in the disability and caregiving setting [38,51]. The dramatic impact of loneliness has become a prominent public health issue, with mounting pressure on public health authorities to take action [52]. The prevalence of loneliness in persons with SCI was notably higher than in their caregiving partners, and also higher than in the Swiss general population [10]. The higher prevalence of loneliness and the stronger effect it had on life satisfaction in persons with SCI may to some extent account for the poorer life satisfaction experienced by this group, and also highlights the social exclusion still experienced by many persons with physical disabilities in society [53]. Social isolation may be experienced both by persons with SCI and their caregiving partners due to limited mobility, participation restrictions, and problems with bodily control and autonomy [7,31,32]. In particular, restrictions in social participation often attributable to the environment, such as participation restrictions in recreational and productive activities, may contribute to problems with social inclusion for persons with SCI [7,54]. Loneliness often affects an individual's social cognition and can lead to depressive mood, meaning that persons experiencing loneliness are generally more negative and suspicious towards others [23]. This subsequently inhibits their social inclusion and their ability to foster close social relationships, further exacerbating the problem of social exclusion in this population [16]. Chronic loneliness may lead an individual to react more profoundly to stressful situations or limit the ability of the individual to experience positive emotions [15,16]. This accompanied with the type of passive coping often associated with loneliness accumulates to cause a physiological stress response [12]. Cumulative stress as a result of chronic loneliness increases the body's allostatic load. This exerts itself through a maladaptive response from the hypothalamic-pituitary-adrenal axis, the autonomic nervous system and the immune system, which leads to a deterioration in physical and mental health. One example of this may be the onset of depressive symptoms [23]. This ultimately has a harmful effects on life satisfaction and wellbeing [55].

In both persons with SCI and their caregiving partners we see that over time poorer life satisfaction also leads to an increase in loneliness, implying a dangerous negative cycle, a finding in line with evidence from the general population [20,21]. This suggests that persons experiencing low levels of life satisfaction are less likely to actively participate in social interaction, and more likely to withdraw from social roles or to experience their social relationships as less fulfilling [20,21].

#### 4.2. Relationship quality and life satisfaction

Considerable actor and partner effects of relationship quality on life satisfaction were evident in caregiving partners but, in contrast to earlier findings, not in persons with SCI [26]. Previous research has corroborated the importance of relationship quality and marital satisfaction in the caregiving context, but to date there is no evidence on partner effects [18]. A persons' perception of relationship quality may directly effect their wellbeing by eliciting positive emotions or by buffering the potentially harmful effects of other external stressors. Moreover, it may affect their partners' wellbeing, as we see in caregiving partners, by impacting upon the way they interact with their partner. Persons who are dissatisfied with their relationship may react negatively to their partner by initiating conflict or by withdrawing support [56]. The finding that relationship quality has no influence on wellbeing in persons with SCI is surprising, and contradicts previous evidence [26,56]. The relative insignificance of relationship quality's influence on life satisfaction in persons with SCI may be due to the many other factors, such as bodily capacity and functional independence, which determine life satisfaction in this population [41]. In comparison the insignificant partner effects of relationship quality observed in our study mirror those observed in research. For example, Carr et al. found no association between spouse's marital appraisal and one's own wellbeing in a population whereby persons with disabilities were oversampled [57]. This research did however find that spouse's marital satisfaction improved the protective effect of one's own marital satisfaction on wellbeing, indicating the potential moderating role of the partners' relationship quality. The fact that we do not observe the partner effects of relationship quality in persons with SCI may be due to the caregiving relationship. Caregivers may not react to the same extent to their negative feelings and may be less likely to withdraw social support for fear of unbalancing the caregiver role, meaning that persons with SCI are affected to a lesser extent by their partner's perception of relationship quality [58].

Although the effects of relationship quality were only apparent in caregiving partners, both persons with SCI and their partners experienced changes in relationship quality predicted by prior levels of wellbeing. Our findings are consistent with previous research and in support of the stress-generating model, which posits a bidirectional relationship between relationship quality and wellbeing [24,59]. The model gives a theoretical explanation by proposing that individual's expressing depressive symptoms or reduced wellbeing cause stressful interactions with their partners which in turn leads to more depressive symptoms or reduced wellbeing [60].

### 4.3. Implications

Our results may suggest potential avenues for future research which seek to develop approaches aimed at enhancing life satisfaction in the disability setting. It is clear from our results that tackling loneliness would have a positive impact upon life satisfaction in our population. Potential approaches to reduce loneliness may include the strengthening of existing relationships by the offering of counselling services or by enabling individuals to overcome functional limitations in order to keep in contact with friends and family; the opportunity to make new connections through group-based or peer-to-peer activities; or psychological approaches which aim to address maladaptive social cognition through cognitive behavioural therapy (CBT) [52,61].

### 4.4. Strengths and limitations

This is one of the first studies in the disability setting to use a longitudinal dyadic design, so that both the directionality of effect, but also the actor and partner effects of loneliness and relationship quality on life satisfaction can be explored. The study utilized validated measures to assess relevant constructs and applied multivariable statistical methods, controlling for relevant confounders. There are however several limitations to this study which are important to consider when interpreting the study findings. Firstly, as the sample size is small, a more complex analysis was prohibited and the level of power was restricted. Secondly, although longitudinal data was utilized in our analysis, dynamic prediction rather than causality can be inferred. Furthermore, the optimal time lag in data collection for our research question may not have been employed. Another intricacy to utilizing longitudinal data is the issue of measurement error and whether real

change is measured or if variation is merely due to measurement differences at different time points. Thirdly, as our study only included couples, it may be implied that only couples in which relationship quality was high were willing to participate, meaning that data on less satisfying relationships are not available. Finally, this study focuses on a population which may be restricted in their social participation due to disability and caregiving characteristics. In order to find out how much these factors modify the association between loneliness, relationship quality and wellbeing, a comparison to the general population would have to be undertaken.

### 5. Conclusion

We conclude that the reduction of feelings of loneliness as well as the strengthening of partner relationship quality are of high importance for life satisfaction in couples coping with disability. The added importance of involving both persons with disabilities and their caregiving partners in interventions to enhance life satisfaction will furthermore nurture the caregiving relationship.

### Acknowledgements

We are grateful to all the participants of the pro-WELL study for their time and effort spent in responding to our questions and to the research assistants for their great work in recruitment and data collection. This study has been financially supported by the Swiss National Science Foundation (SNF; Grant Number 100017\_153256/1; to MB and CF) and by the Swiss Paraplegic Foundation, Nottwil, Switzerland. We also acknowledge the support from the Steering Committee of the SwiSCI cohort study.

### Appendix 1. Zero-order correlations between study variables

		Loneliness			Relationship quality			Life satisfaction		
		T0	T1	T2	T0	T1	T2	T0	T1	T2
Loneliness	T0	–								
	T1	<b>0.69</b>	–							
	T2	<b>0.69</b>	<b>0.74</b>	–						
Relationship quality	T0	–0.33	–0.36	–0.34	–					
	T1	–0.24	–0.30	–0.30	<b>0.72</b>	–				
	T2	–0.26	–0.31	–0.29	<b>0.79</b>	<b>0.72</b>	–			
Life satisfaction	T0	–0.46	–0.46	–0.41	0.27	0.24	0.29	–		
	T1	–0.48	– <b>0.54</b>	–0.47	0.32	0.26	0.34	<b>0.72</b>	–	
	T2	– <b>0.54</b>	–0.52	– <b>0.55</b>	0.37	0.30	0.41	<b>0.62</b>	<b>0.70</b>	–

All correlations are significant at the < 0.001 level. In bold: correlations ≥0.50.

### References

[1] M.W. Post, C.M. Van Leeuwen, Psychosocial issues in spinal cord injury: a review, *Spinal Cord* 50 (5) (2012) 382–389.  
 [2] V.A. Freedman, et al., Disability, participation, and subjective wellbeing among older couples, *Soc. Sci. Med.* 74 (4) (2012) 588–596.  
 [3] R.E. Lucas, Long-term disability is associated with lasting changes in subjective well-being: evidence from two nationally representative longitudinal studies, *J. Pers. Soc. Psychol.* 92 (4) (2007) 717–730.  
 [4] R.A. Cummins, The subjective well-being of people caring for a family member with a severe disability at home: a review, *J. Intellect. Dev. Disabil.* 26 (1) (2001) 83–100.  
 [5] R. Schulz, P.R. Sherwood, Physical and mental health effects of family caregiving, *J. Soc. Work. Educ.* 44 (sup3) (2008) 105–113.  
 [6] M. Korporaal, M.I.B. van Groenou, T.G. van Tilburg, Effects of own and spousal disability on loneliness among older adults, *J. Aging Health* 20 (3) (2008) 306–325.  
 [7] P. Fougereyrollas, L. Noreau, Long-term consequences of spinal cord injury on social participation: the occurrence of handicap situations, *Disabil. Rehabil.* 22 (4) (2000) 170–180.

[8] D.E. Taub, P.A. McLorg, A.K. Bartnick, Physical and social barriers to social relationships: voices of rural disabled women in the USA, *Disabil. Soc.* 24 (2) (2009) 201–215.  
 [9] R.A. Beeson, Loneliness and depression in spousal caregivers of those with Alzheimer's disease versus non-caregiving spouses, *Arch. Psychiatr. Nurs.* 17 (3) (2003) 135–143.  
 [10] A. Richard, et al., Loneliness is adversely associated with physical and mental health and lifestyle factors: results from a Swiss national survey, *PLoS One* 12 (7) (2017) e0181442.  
 [11] E.Y. Cornwell, L.J. Waite, Social disconnectedness, perceived isolation, and health among older adults, *J. Health Soc. Behav.* 50 (1) (2009) 31–48.  
 [12] J.T. Cacioppo, et al., Loneliness and health: potential mechanisms, *Psychosom. Med.* 64 (3) (2002) 407–417.  
 [13] J. Holt-Lunstad, T.B. Smith, J.B. Layton, Social relationships and mortality risk: a meta-analytic review, *PLoS Med.* 7 (7) (2010).  
 [14] J. Holt-Lunstad, et al., Loneliness and social isolation as risk factors for mortality: a meta-analytic review, *Perspect. Psychol. Sci.* 10 (2) (2015) 227–237.  
 [15] L.C. Hawkey, J.T. Cacioppo, Loneliness matters: a theoretical and empirical review of consequences and mechanisms, *Ann. Behav. Med.* 40 (2) (2010) 218–227.  
 [16] J.T. Cacioppo, W. Patrick, Loneliness: Human Nature and the Need for Social

- Connection, WW Norton & Company, 2008.
- [17] C. UK, State of Caring Survey 2014, Carers UK, 2014.
- [18] C. Quinn, L. Clare, B. Woods, The impact of the quality of relationship on the experiences and wellbeing of caregivers of people with dementia: a systematic review, *Aging Mental Health* 13 (2) (2009) 143–154.
- [19] N. Spruytte, et al., The quality of the caregiving relationship in informal care for older adults with dementia and chronic psychiatric patients, *Psychol. Psychother. Theory Res. Pract.* 75 (3) (2002) 295–311.
- [20] A. Shankar, S.B. Rafnsson, A. Steptoe, Longitudinal associations between social connections and subjective wellbeing in the English Longitudinal Study of Ageing, *Psychol. Health* 30 (6) (2015) 686–698.
- [21] T.J. VanderWeele, L.C. Hawkey, J.T. Cacioppo, On the reciprocal association between loneliness and subjective well-being, *Am. J. Epidemiol.* 176 (9) (2012) 777–784.
- [22] J.T. Cacioppo, et al., Loneliness as a specific risk factor for depressive symptoms: cross-sectional and longitudinal analyses, *Psychol. Aging* 21 (1) (2006) 140.
- [23] J.T. Cacioppo, L.C. Hawkey, R.A. Thisted, Perceived social isolation makes me sad: 5-year cross-lagged analyses of loneliness and depressive symptomatology in the Chicago Health, Aging, and Social Relations study, *Psychol. Aging* 25 (2) (2010) 453.
- [24] P.N.E. Roberson, et al., A longitudinal examination of the directional effects between relationship quality and well-being for a National Sample of U.S. Men and Women, *Sex Roles* 78 (1–2) (2018) 67–80 (January).
- [25] C.M. Proulx, H.M. Helms, C. Buehler, Marital quality and personal well-being: a meta-analysis, *J. Marriage Fam.* 69 (3) (2007) 576–593.
- [26] R. Pruchno, M. Wilson-Genderson, F.P. Cartwright, Depressive symptoms and marital satisfaction in the context of chronic disease: a longitudinal dyadic analysis, *J. Fam. Psychol.* 23 (4) (2009) 573.
- [27] R.G. Reed, E.A. Butler, D.A. Kenny, Dyadic models for the study of health, *Soc. Personal. Psychol. Compass* 7 (4) (2013) 228–245.
- [28] H. Tough, et al., Vitality and mental health in disability: associations with social relationships in persons with spinal cord injury and their partners, *Disabil. Health J.* 10 (2) (2017) 294–302.
- [29] D.A. Kenny, et al., *Dyadic Data Analysis (Methodology in the Social Sciences)*, Guilford, New York, NY, 2006.
- [30] W.L. Cook, D.A. Kenny, The actor–partner interdependence model: a model of bi-directional effects in developmental studies, *Int. J. Behav. Dev.* 29 (2) (2005) 101–109.
- [31] WHO, J. Bickenbach, et al. (Ed.), *International Perspectives on Spinal Cord Injury*, WHO, Geneva, 2013.
- [32] A. Craig, et al., Adjustment following chronic spinal cord injury: determining factors that contribute to social participation, *Br. J. Health Psychol.* 20 (4) (2015) 807–823.
- [33] A. Dickson, et al., The impact of assuming the primary caregiver role following traumatic spinal cord injury: an interpretative phenomenological analysis of the spouse's experience, *Psychol. Health* 25 (9) (2010) 1101–1120.
- [34] C. Fekete, M.W.G. Brinkhof, H. Tough, et al., Longitudinal study of social participation and well-being among persons with spinal cord injury and their partners (pro-WELL), *BMJ Open* 7 (2017) e011597, <http://dx.doi.org/10.1136/bmjopen-2016-011597>.
- [35] M.W. Brinkhof, et al., Swiss national community survey of functioning after spinal cord injury: protocol, characteristics of participants and determinants of non-response, *J. Rehabil. Med.* 48 (2) (2016) 120–130.
- [36] C. Fekete, et al., Participation rates, response bias and response behaviours in the community survey of the Swiss Spinal Cord Injury Cohort Study (SwiSCI), *BMC Med. Res. Methodol.* 15 (80) (2015).
- [37] M.E. Hughes, et al., A short scale for measuring loneliness in large surveys results from two population-based studies, *Res. Aging* 26 (6) (2004) 655–672.
- [38] S. Robinson-Whelen, et al., Loneliness among people with spinal cord injury: exploring the psychometric properties of the 3-item loneliness scale, *Arch. Phys. Med. Rehabil.* 97 (10) (2016) 1728–1734.
- [39] I. Reiner, et al., Validating the German version of the Quality of Relationship Inventory: confirming the three-factor structure and report of psychometric properties, *PLoS One* 7 (5) (2012) e37380.
- [40] E. Diener, et al., The satisfaction with life scale, *J. Pers. Assess.* 49 (1) (1985) 71–75.
- [41] M.P. Dijkers, Correlates of life satisfaction among persons with spinal cord injury, *Arch. Phys. Med. Rehabil.* 80 (8) (1999) 867–876.
- [42] R. Kobau, et al., Well-being assessment: an evaluation of well-being scales for public health and population estimates of well-being among US adults, *Appl. Psychol.* 2 (3) (2010) 272–297.
- [43] G. Kaufman, H. Taniguchi, Gender and marital happiness in later life, *J. Fam. Issues* 27 (6) (2006) 735–757.
- [44] M. Pinquart, S. Sörensen, Gender differences in self-concept and psychological well-being in old age: a meta-analysis, *J. Gerontol. Ser. B Psychol. Sci. Soc. Sci.* 56 (4) (2001) P195–P213.
- [45] M. Pinquart, S. Sorensen, Risk factors for loneliness in adulthood and old age—A meta-analysis, in: S.P. Shohov (Ed.), *Advances in Psychology Research*, 19 Nova Science, NY, 2003.
- [46] S.L. Zeger, K.-Y. Liang, Longitudinal data analysis for discrete and continuous outcomes, *Biometrics* (1986) 121–130.
- [47] J. Twisk, W. de Vente, Attrition in longitudinal studies: how to deal with missing data, *J. Clin. Epidemiol.* 55 (4) (2002) 329–337.
- [48] J.W. Twisk, *Applied Longitudinal Data Analysis for Epidemiology: A Practical Guide*, Cambridge University Press, 2013.
- [49] R. Weston, et al., An introduction to using structural equation models in rehabilitation psychology, *Rehabil. Psychol.* 53 (3) (2008) 340.
- [50] C.K. Enders, D.L. Bandalos, The relative performance of full information maximum likelihood estimation for missing data in structural equation models, *Struct. Equ. Model.* 8 (3) (2001) 430–457.
- [51] K. Vasileiou, et al., Experiences of loneliness associated with being an informal caregiver: a qualitative investigation, *Front. Psychol.* 8 (2017).
- [52] M. Bolton, et al., Loneliness—the state we're in. A report of evidence compiled for the Campaign to End Loneliness, Age UK Oxfordshire, 2012 Available at: <http://www.ageuk.org.uk/brandpartnerglobal/oxfordshirevpp/documents/loneliness%20the%20state%20we%20are%20in>.
- [53] G. Whiteneck, et al., Environmental factors and their role in participation and life satisfaction after spinal cord injury, *Arch. Phys. Med. Rehabil.* 85 (11) (2004) 1793–1803.
- [54] L. Noreau, P. Fougereyrollas, K. Boschen, Perceived influence of the environment on social participation among individuals with spinal cord injury, *Top. Spinal Cord Injury Rehabil.* 7 (3) (2002) 56–72.
- [55] B.S. McEwen, Stress, adaptation, and disease: Allostasis and allostatic load, *Ann. N. Y. Acad. Sci.* 840 (1) (1998) 33–44.
- [56] M.A. Whisman, L.A. Uebelacker, L.M. Weinstock, Psychopathology and marital satisfaction: the importance of evaluating both partners, *J. Consult. Clin. Psychol.* 72 (5) (2004) 830.
- [57] D. Carr, et al., Happy marriage, happy life? Marital quality and subjective well-being in later life, *J. Marriage Fam.* 76 (5) (2014) 930–948.
- [58] G. Luong, S.T. Charles, K.L. Fingerman, Better with age: social relationships across adulthood, *J. Soc. Pers. Relat.* 28 (1) (2011) 9–23.
- [59] C. Hammen, Generation of stress in the course of unipolar depression, *J. Abnorm. Psychol.* 100 (4) (1991) 555.
- [60] J. Davila, et al., Marital functioning and depressive symptoms: evidence for a stress generation model, *J. Pers. Soc. Psychol.* 73 (4) (1997) 849.
- [61] C.M. Masi, et al., A meta-analysis of interventions to reduce loneliness, *Personal. Soc. Psychol. Rev.* 15 (3) (2011) 219–266.