

Roles of Changing Physical Function and Caregiver Burden on Quality of Life in Stroke

A Longitudinal Dyadic Analysis

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Background and Purpose—The purpose of this study was to examine changes in stroke survivor and caregiver quality of life (QOL) and to determine whether changes in survivor physical functioning and caregiver burden (ie, the impact of the physical, psychological, and social demands of caregiving) influence changes in QOL.

Methods—Longitudinal design with 226 stroke survivor–caregiver dyads enrolled at survivor discharge from rehabilitation hospitals. Data collection was performed over 12 months. We measured survivor physical functioning, caregiver burden, and QOL (physical, psychological, social, and environmental) in both survivor and caregiver. Multilevel modeling was used to control for the interdependence of the data.

Results—Survivors (50% male sex) and caregivers (66% female sex) were 70.8 (SD=11.9) and 52.4 (SD=13.1) years old, respectively. Over the 12 months, stroke survivor's physical ($\gamma=1.59$; $P<0.001$) and psychological ($\gamma=0.86$; $P<0.05$) QOL significantly improved; social and environmental QOL did not $P>0.05$. Caregiver QOL, on average, did not significantly change over time $P>0.05$. Improvements in survivor physical functioning were associated with increases in survivor and caregiver physical and psychological QOL and survivor environmental QOL. Decreases in caregiver burden were significantly associated with improvements in caregiver physical, psychological, and environmental QOL but not with survivor QOL.

Conclusions—QOL of stroke survivors and caregivers covaries and is greatly impacted by the physical function changes of the survivor. Dyadic approaches to stroke rehabilitation that acknowledge the interdependence of dyads are needed. (*Stroke*. 2017;48:733-739. DOI: 10.1161/STROKEAHA.116.014989.)

Key Words: caregiver ■ quality of life ■ rehabilitation ■ stroke ■ survivor

Research has shown that stroke has a significant impact on the stroke survivor's quality of life (QOL).^{1,2} Less well known is the negative impact on the stroke caregiver's QOL.³ Yet, poor QOL in caregivers is associated with rehospitalization of the stroke survivor and increased healthcare costs.⁴ Given the severe disability and limitations in activities of daily living present in stroke, caregivers have been found to experience high levels of burden (ie, the overall impact of the physical, psychological, and social demands of caregiving)⁵ and unpreparedness.⁵⁻⁸ Caregivers experiencing high levels of burden report lower QOL.⁹

Although research has found that QOL of survivors and their caregivers is interdependent in stroke,^{10,11} to our knowledge, only one study¹⁰ has used a statistical approach that controls for this interdependence within stroke dyads. The

majority of studies either have conducted separate analyses for survivor and caregiver¹² or have used traditional methods (eg, Pearson correlation) that greatly limit the ability to examine the transactional nature of the caregiving dyad.¹¹ Moreover, only 3 studies were found that examined QOL in stroke survivors and caregivers over time.¹¹⁻¹³ For example, Chuluunbaatar et al¹² conducted separate analyses of survivor and caregiver QOL over a year and found that although physical and overall QOL did not improve in stroke survivors, environmental QOL did. In caregivers, psychological and environmental QOL improved over time, whereas physical QOL decreased. Survivor physical functioning and caregiver burden may change over time, but patterns of these changes and their influence on the dyad's QOL are unknown.¹⁴

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As the first study to examine simultaneous change in survivor and caregiver QOL, we hypothesized that (1) survivors and caregivers will have similar patterns of change in QOL over time and (2) survivor and caregiver QOL will be significantly associated with changes in survivor physical functioning and caregiver burden. Finally, we posit that these time-varying associations within the caregiving dyad will remain when controlling for covariates known to influence survivor and caregiver QOL (ie, survivor age, survivor sex, educational status, stroke site, stroke type, cognitive function, survivor depression, caregiver depression, type of caregiver, and caregiver preparedness).^{10–13,15–18}

Methods

Design

We used a longitudinal prospective design. Details about the study protocol have been published elsewhere.¹⁹ In brief, we recruited stroke survivor–caregiver dyads at discharge from rehabilitation hospital and followed them up every 3 months for a year.

Participants and Procedures

Participants of this study consisted of stroke survivor and caregiver dyads enrolled at survivor discharge from 10 rehabilitation hospitals in several cities across Italy: Viterbo, Tivoli, Rome, Grottaferrata, Potenza, Guidonia, Cosenza, Ragusa, Naples, and Taranto. Stroke survivors' inclusion criteria were (1) diagnosis of stroke confirmed by computed tomographic imaging or magnetic resonance imaging; (2) discharge from a rehabilitation hospital to home; and (3) willingness to participate in the study. Stroke survivors' exclusion criteria were (1) severe preexisting physical and cognitive deficit (eg, previous stroke and dementia) and (2) cancer or severe organ failure known to impair QOL. Caregivers' inclusion criteria were (1) identification as the primary informal unpaid caregiver by the stroke survivor and (2) willingness to participate in the study.

Trained nurse research assistants identified potential survivor participants (who were asked to nominate a caregiver if one was available) and determined eligibility of both survivors and caregivers. A sample of 400 patients were enrolled in the study, but only 244 had a caregiver available and willing to participate in the study. Of the 244 dyads who participated, only 226 dyads had complete data at baseline. Baseline data were collected in person with follow-up data collection taking place during home visits at 3, 6, 9, and 12 months. The institutional review boards of each rehabilitation hospital where participants were enrolled approved the study.

Measures

Study measures have been described in detail in a previously published paper¹⁹ and are, thus, briefly described here. The study outcome, QOL, was measured using the 26-item WHOQOL-BREF (World Health Organization Quality of Life–BREF)²⁰ instrument that measures QOL in the following 4 dimensions: (1) physical (eg, the ability to perform activities of daily living); (2) psychological (eg, negative/positive feelings); (3) social (eg, personal relationships), and (4) environmental (eg, financial resources). Scores are transformed to a 0 to 100 scale, with higher scores indicating better QOL in each dimension. The WHOQOL-BREF has previously been used in stroke survivor²¹ and caregiver²² populations. Stroke survivor physical functioning was measured using the Barthel Index²³; caregiver burden was measured using the 24-item Caregiver Burden Inventory.²⁴

Baseline covariates included survivor and caregiver depression measured with the subscale of the Hospital Anxiety and Depression Scale,²⁵ survivor cognitive performance measured with the 7-item memory subscale of the Stroke Impact Scale 3.0,²⁶ and caregiver preparedness measured with the 8-item Caregiver Preparedness scale.²⁷ All measures have previously been validated in Italian samples.^{28–33}

Finally, sociodemographic characteristics of survivor and caregiver were also collected (eg, age, sex, educational status, employment status, coresidence, income and stroke survivor–caregiver relationship, site and type of stroke, and survivor comorbidities).

Statistical Analysis

Descriptive statistics were used to describe survivor and caregiver sociodemographic characteristics. Multilevel modeling was used to analyze data at the level of the stroke survivor and caregiver dyad to control for interdependencies in the data. The advantages of such models for the examination of dyadic data and time-varying covariates have been well described.^{34,35}

Three longitudinal dyad models were tested for each QOL domain (ie, physical, psychological, social, and environmental) using Hierarchical Linear Modeling v7 (Skokie, IL).³⁶ The first model was an unconditional (ie, no covariates included) linear model of QOL within dyads over time, which estimates the population averages of QOL for both survivors and caregivers (fixed effects), the interdependence between QOL of members of the survivor–caregiver dyad (tau correlations), and the variability around average trajectories of QOL for both members (random effects). Multiparameter omnibus testing, within hierarchical linear modeling, was used to test for differences between survivor and caregiver mean QOL and linear change over time. The second model included survivor physical functioning and caregiver burden as time-varying covariates for both survivor and caregiver QOL. These time-varying effects were decomposed into 2 parts: the effect of the variable that is changing or fluctuating (time-varying) and the aggregate effect of the variable (time-invariant).

Finally, preliminary analysis of potential baseline covariates identified in the literature was conducted to identify a comprehensive set of covariates associated with QOL ($P < 0.05$) but without collinearity concerns. Thus, our third model included survivor age, survivor sex, stroke site, stroke type, survivor educational status, survivor employment status, survivor cognition, survivor depression, caregiver type, caregiver educational status, caregiver employment status, caregiver depression, and caregiver preparedness.

Results

Description of the Sample

Only 244 stroke survivors who took part in the larger study ($n=400$) had a caregiver willing and available to participate, but only 226 had complete data at baseline. A baseline comparison between the survivors of the final sample of this study versus those of the larger study without a caregiver found no significant differences in terms of sociodemographic (eg, age), clinical characteristics (eg, stroke type), depression, and QOL scores ($P > 0.05$ in all comparisons). The only significant difference found between the 2 groups of survivors was, as expected, that survivors included in this study were less frequently single (7.5% versus 14%), divorced (3.5% versus 7%), and more frequently widowed (32% versus 20%) than survivors of the larger study ($\chi^2=11.37$; $df=3$; $P < 0.01$).

The average age of stroke survivors and their caregivers at baseline was 70.8 (SD=11.9) and 52.4 (SD=13.1), respectively. Fifty percent of stroke survivors were women, whereas 66% of caregivers were women. Just over a third of survivors and caregivers were married to each other, with half of the survivors cared for by an adult child (Table 1). Most stroke survivors had had an ischemic stroke ($n=183$), equally distributed in right and left hemisphere.

Patterns of Change in QOL

Multilevel modeling results for survivor and caregiver physical and psychological QOL are displayed in Tables 2 and 3;

Table 1. Survivor and Caregiver Baseline Characteristics (N=226 Dyads)

Characteristic	Survivors	Caregivers
Age, y, mean (\pm SD) (survivor age range: 34–90 y; caregiver age range: 17–80 y)	70.8 (\pm 11.9)	52.4 (\pm 13.1)
Female sex, n (%)	113 (50)	148 (66)
Employed, n (%)	38 (17)	109 (48)
More than middle school, n (%)	70 (31)	129 (57)
Stroke type (ischemic), n (%)	183 (81)	...
Stroke site (right hemisphere), n (%)	113 (50)	...
Spouse caregiver, n (%)	...	78 (35)
Adult child caregiver, n (%)	...	114 (50)
Other relative caregiver, n (%)	...	34 (15)
Time since stroke, d (range: 0–146 d)	17.4 (\pm 21.4)	...
Survivor comorbidities, mean (\pm SD)(range 0–10)	0.90 (\pm 1.1)	...
Survivor memory/cognition, mean (\pm SD) (range 0–100; higher scores, better cognitive performance)*	70.3 (\pm 24.9)	...
Depression, mean (\pm SD) (range 0–21; higher scores, greater depressive symptoms)†	9.6 (\pm 4.3)	7.1 (\pm 4.1)
Caregiver preparedness, mean (\pm SD) (range 0–4; higher scores, greater preparedness)	...	1.9 (\pm 0.9)

HADS indicates Hospital Anxiety and Depression Scale.

*Stroke Impact Scale memory/cognition subscale.

†HADS depression subscale.

social and environmental QOL results are displayed in Tables I and II in the [online-only Data Supplement](#). As can be seen from model 1 in each table, survivor QOL (physical, psychological, social, and environmental) was lower than caregiver QOL over time. A significant linear positive slope was found for survivor's physical ($\gamma=1.59$; $P<0.001$) and psychological ($\gamma=0.86$; $P<0.05$) QOL over the 12 months but not for social or environmental QOL; no significant linear slopes were found for caregivers. Multiparameter omnibus hypothesis tests revealed significant differences between average trajectories for survivors and caregivers on both physical ($\chi^2=203.07$; $df=2$; $P<0.001$) and psychological QOL ($\chi^2=120.57$; $df=2$; $P<0.001$) but not for social or environmental QOL. Thus, we found partial support for our hypothesis. Tau correlations ranged from 0.35 to 0.70 across QOL domains, indicating moderate-to-strong covariation within dyads. Finally, model 1 random effects in each table show that there was significant variability around average trajectories for both survivor and caregiver QOL in all 4 domains.

Impact of Changing Survivor Physical Functioning and Caregiver Burden on QOL

Model 2 in each table shows the associations between survivor physical functioning and caregiver burden and survivor and caregiver QOL. Mean survivor physical functioning was positively associated with both mean survivor and mean

caregiver QOL across all domains but not caregiver social QOL. Similarly, mean caregiver burden was negatively associated with both mean survivor and mean caregiver QOL across all domains. Higher survivor physical functioning and lower caregiver burden were associated with better survivor and caregiver QOL. But more importantly, improvements in survivor physical functioning were associated with significant increases in both survivor and caregiver physical (survivor: $\gamma=0.28$; $P<0.001$ and caregiver: $\gamma=0.09$; $P<0.01$) and psychological (survivor: $\gamma=0.29$; $P<0.001$; caregiver: $\gamma=0.09$; $P<0.01$) QOL and survivor environmental QOL ($\gamma=0.13$; $P<0.001$). Decreases in caregiver burden were only significantly associated with improvements in caregiver physical ($\gamma=-0.13$; $P<0.01$), psychological ($\gamma=-0.26$; $P<0.001$), and environmental ($\gamma=-0.16$; $P<0.001$) QOL, controlling for changes in survivor physical functioning; changes in caregiver burden were not significantly associated with changes in survivor QOL.

Finally, model 3 in each table shows results of adding known covariates of QOL to the model. As expected, significant associations regarding time-varying change in survivor physical functioning and caregiver burden, observed in model 2, remain. Survivor and caregiver depression were consistently associated with QOL.

Discussion

To our knowledge this is the first study that has examined QOL in the stroke survivor–caregiver dyad over a 12-month period with a statistical approach that controls for nonindependent data.

Consistent with previous research,³ QOL was significantly higher in caregivers than in survivors over the 12-month period, which was not surprising given the majority of caregivers in the sample were younger than survivors. In stroke survivors, we observed that physical and psychological QOL significantly improved over time, but social and environmental QOL did not. This lack of improvement in social QOL has previously been observed in the literature.^{37,38} After a stroke, relationships with friends and colleagues decline, resulting in stroke survivors living more isolated lives than before the stroke. Similarly, environmental QOL, which focuses on issues regarding living conditions, are unlikely to vary for most stroke survivors and may in fact be amplified because of the stroke. These findings are consistent with other Italian studies that have found, unfortunately, that physical barriers both inside and outside the stroke survivor's house represent a significant problem after the stroke.^{39,40}

In contrast, QOL in stroke caregivers did not significantly change, on average, over time in any of the 4 dimensions, which is consistent with the limited research in this area.⁴¹ However, we saw significant variability around average trajectories of QOL indicating some caregivers and survivors were experiencing improvements and others were experiencing declines over time, resulting in an average of no change. Survivor physical functioning and caregiver burden played important roles in explaining this variability.

A notable strength of the current longitudinal, dyadic study is the examination of both aggregate and time-varying effects

Table 2. Multilevel Models Predicting Survivor and Caregiver Physical QOL With Changes in Survivor Physical Functioning and Caregiver Burden Over Time

	Model 1		Model 2		Model 3	
	Survivor	Caregiver	Survivor	Caregiver	Survivor	Caregiver
	Parameter Estimate (SE)					
Fixed effects						
Intercept*	52.64 (0.99)†	68.27 (0.95)†	43.72 (1.77)†	74.94 (1.78)†	43.58 (2.77)†	70.96 (2.79)†
Survivor mean physical functioning‡			0.21 (0.04)†	0.10 (0.04)§	0.12 (0.04)¶	0.08 (0.04)§
Caregiver mean burden‡			-0.19 (0.06)¶	-0.27 (0.06)†	-0.05 (0.06)	-0.11 (0.07)
Survivor age					-0.08 (0.09)	-0.04 (0.07)
Survivor sex					0.11 (1.43)	3.49 (1.54)§
Survivor educational status (middle school or higher)					0.85 (1.50)	-2.32 (1.66)
Survivor employment status (working)					1.10 (2.01)	-3.30 (2.41)
Stroke site					1.40 (1.40)	1.21 (1.51)
Stroke type					3.21 (1.85)	2.17 (2.06)
Survivor SIS memory					0.05 (0.03)	-0.02 (0.04)
Survivor depression					-1.35 (0.19)†	-0.44 (0.22)§
Caregiver type (spouse)					0.53 (1.81)	-0.64 (1.95)
Caregiver educational status (middle school or higher)					-2.54 (1.48)	4.27 (1.63)§
Caregiver employment status (working)					-0.85 (1.59)	1.22 (1.79)
Caregiver depression					-0.57 (0.19)¶	-1.01 (0.26)†
Caregiver preparedness					1.23 (0.96)	1.75 (0.86)§
Linear slope¶	1.59 (0.40)†	0.59 (0.32)	0.50 (0.39)	0.11 (0.32)	0.54 (0.39)	0.26 (0.32)
Survivor physical functioning#			0.28 (0.03)†	0.09 (0.03)¶	0.27 (0.05)†	0.08 (0.03)§
Caregiver burden#			0.01 (0.05)	-0.13 (0.04)¶	0.01 (0.06)	-0.12 (0.05)§
Random effects						
Intercept	186.91†	160.54†	109.27†	126.65†	83.89†	99.32†
Linear slope	22.90†	7.17†	13.46†	6.38†	13.60†	6.58†
Estimated parameters	15		23		49	
Deviance statistic	11 931.74		10 232.58		10 086.67	
Model comparison χ^2 (df)			1699.16 (8)†		145.91 (26)†	

QOL indicates quality of life; and SIS, stroke impact scale.

*The intercept in the level 1 model has been coded to represent mean QOL over the 12-mo period.

† $P < 0.001$.

‡Mean survivor physical functioning and caregiver burden were created by averaging scores across 5 time points.

§ $P < 0.05$.

¶ $P < 0.01$.

¶¶The linear slope in the level 1 model represents rate of change per 3 mo in QOL over the 12-mo period.

#The time-varying covariates entered into the level 1 model were centered around their group mean.

of change in QOL. Stroke survivor physical functioning and caregiver burden had both aggregate and time-varying effects on physical, psychological, and environmental QOL, while primarily aggregate effects were found for social QOL. The aggregate (time-invariant) effects are consistent with previous cross-sectional research.^{42,43} However, the examination of time-varying effects adds new knowledge and expands our understanding of the fluctuating nature of the stroke context and the importance of such rapid changes on QOL for both members of the dyad. The time-varying effects indicate

that changes in the survivor's physical functioning and caregiver burden every 3 months are significantly associated with changes every 3 months in dyadic QOL. In other words, short-term improvements or declines in survivor's physical functioning and caregiver burden are associated with improvements and declines in QOL. For social QOL, we primarily observed an aggregate effect, emphasizing the enduring nature of this dimension. However, when controlling for known covariates, improvements in survivor physical functioning were significantly associated with improvements in survivor social QOL

Table 3. Multilevel Models Predicting Survivor and Caregiver Psychological QOL With Changes in Survivor Physical Functioning and Caregiver Burden Over Time

	Model 1		Model 2		Model 3	
	Survivor	Caregiver	Survivor	Caregiver	Survivor	Caregiver
	Parameter Estimate (SE)					
Fixed effects						
Intercept*	52.16 (1.10)†	62.47 (0.95)†	41.68 (1.76)†	71.33 (1.76)†	39.90 (2.51)†	68.15 (2.60)†
Survivor mean physical functioning‡			0.15 (0.04)†	0.12 (0.04)§	0.04 (0.04)	0.10 (0.04)§
Caregiver mean burden‡			-0.44 (0.06)†	-0.18 (0.06)§	-0.32 (0.06)†	0.03 (0.06)
Survivor age					-0.07 (0.07)	0.04 (0.07)
Survivor sex					1.11 (1.40)	1.25 (1.51)
Survivor educational status (middle school or higher)					1.05 (1.51)	1.18 (1.63)
Survivor employment status (working)					-1.20 (1.93)	-1.50 (2.08)
Stroke site					-0.31 (1.31)	-0.69 (1.41)
Stroke type					1.97 (1.78)	0.25 (1.92)
Survivor SIS memory					0.07 (0.03)¶	0.02 (0.03)
Survivor depression					-1.39 (0.19)†	-0.64 (0.20)§
Caregiver type (spouse)					3.59 (1.75)¶	-0.01 (1.90)
Caregiver educational status (middle school or higher)					-1.10 (1.49)	3.59 (1.61)¶
Caregiver employment status (working)					1.37 (1.55)	1.06 (1.67)
Caregiver depression					-0.24 (0.19)	-1.50 (0.20)†
Caregiver preparedness					1.56 (0.83)	0.15 (0.90)
Linear slope¶	0.86 (0.37)¶	-0.01 (0.30)	0.01 (0.38)	-0.44 (0.29)	0.04 (0.38)	-0.34 (0.29)
Survivor physical functioning#			0.29 (0.03)†	0.09 (0.03)§	0.27 (0.03)†	0.08 (0.03)§
Caregiver burden#			0.01 (0.05)	-0.26 (0.04)†	0.02 (0.05)	-0.25 (0.04)†
Random effects						
Intercept	235.42†	161.91†	121.86†	135.66†	90.61†	90.35†
Linear slope	15.74†	4.51¶	9.81†	2.91	10.16†	2.97
Estimated parameters	15		23		49	
Deviance statistic	11 994.36		10 278.35		10 109.67	
Model comparison χ^2 (df)			1716.01 (8)†		168.68 (26)†	

QOL indicates quality of life; and SIS, stroke impact scale.

*The intercept in the level 1 model has been coded to represent mean QOL over the 12-mo period.

† $P < 0.001$.

‡Mean survivor physical functioning and caregiver burden were created by averaging scores across 5 time points.

§ $P < 0.01$.

¶ $P < 0.05$.

¶¶The linear slope in the level 1 model represents rate of change per 3 mo in QOL over the 12-mo period.

#The time-varying covariates entered into the level 1 model were centered around their group mean.

(time-varying effect) but not caregiver QOL. Thus, we found partial support for our hypothesis.

Caregiver QOL was particularly sensitive to changes in stroke survivor physical functioning as the need for care increased or decreased. Greater physical disability has been shown to lead to increased care burden and consequently poorer caregiver QOL.⁴³ In contrast, stroke survivors were not significantly impacted by time-varying changes in caregiver burden, suggesting that survivors are more impacted by their own physical functioning rather than caregiver burden.

Finally and most importantly, we observed that significant associations regarding changes in stroke survivor's physical functioning and caregiver burden remain, even after controlling for covariates known to influence QOL. We also found that depression played an important role on stroke survivor and caregiver QOL. Even after controlling for the interdependent nature of data and the caregiver's own depression, survivor depression significantly influenced caregiver QOL (specifically, physical and psychological QOL), and caregiver depression significantly influenced survivor QOL (specifically,

physical QOL), controlling for their own depression. These results emphasize how important it is to treat depression both in stroke survivors and caregivers to guarantee caregiver well-being and survivor recovery from stroke.

Limitations

This study was conducted in only one European country, and this may reduce its generalizability. Also, we enrolled a convenience sample that included stroke survivors without major comorbidities, such as cancer, preexisting physical and cognitive deficits, or severe organ failure. Consequently, our results should be generalized with caution to survivors with more severe comorbidities.

Conclusions

This study is the first known study to demonstrate that short-term changes in physical functioning and caregiver burden have associated changes in QOL, making a strong argument for the need for early dyadic-level interventions to improve QOL for both members. This study also has important clinical implications for healthcare providers who need to be more cognizant that stroke survivors and caregivers are an interdependent unit. Our study confirms the importance of continued efforts to improve the physical functioning of the stroke survivor but makes a strong case for a dyadic approach to recovery so that even during rehabilitation caregivers must be an integral part of the rehabilitation process. Finding ways to address caregiver burden and depression will lead to better overall QOL for both survivor and caregiver.

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Disclosures

None.

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Roles of Changing Physical Function and Caregiver Burden on Quality of Life in Stroke: A Longitudinal Dyadic Analysis

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SUPPLEMENTAL MATERIAL

SUPPLEMENTAL TABLES I-II

Table I: Multilevel Models Predicting Survivor & Caregiver Social Quality of Life with Changes in Survivor Physical Functioning & Caregiver Burden

	Model 1		Model 2		Model 3	
	Survivor Parameter Estimate (SE)	Caregiver Parameter Estimate (SE)	Survivor Parameter Estimate (SE)	Caregiver Parameter Estimate (SE)	Survivor Parameter Estimate (SE)	Caregiver Parameter Estimate (SE)
Fixed effects						
Intercept*	60.09 (1.17)***	68.26 (1.02)***	58.17 (2.61)***	68.64 (2.45)***	56.93 (3.26)***	65.62 (2.94)***
Survivor mean physical functioning [†]			0.15 (0.05)**	0.04 (0.04)	0.08 (0.05)	0.07 (0.04)
Caregiver mean burden [‡]			-0.36 (0.07)***	-0.31 (0.07)***	-0.29 (0.08)***	-0.23 (0.07)***
Survivor age					-0.05 (0.09)	0.15 (0.07)*
Survivor gender					1.39 (1.89)	1.27 (1.61)
Stroke site					-1.68 (1.76)	-0.90 (1.50)
Stroke type					0.94 (2.39)	2.49 (2.05)
Survivor educational status (middle school or higher)					2.95 (2.03)	-0.52 (1.72)
Survivor employment status (working)					1.49 (2.60)	3.70 (2.21)
Survivor SIS memory					0.01 (0.04)	-0.02 (0.04)
Survivor depression					-0.74 (0.25)**	-0.22 (0.22)
Caregiver type (spouse)					3.71 (2.36)	-1.57 (1.99)
Caregiver educational status (middle school or higher)					-2.88 (2.01)	2.32 (1.70)
Caregiver employment status (working)					0.64 (2.09)	2.77 (1.78)
Caregiver depression					-0.31 (0.25)	-0.90 (0.21)***
Caregiver preparedness					1.61 (1.12)	0.49 (0.95)
Linear slope [§]	-0.24 (0.37)	-0.08 (0.39)	-0.83 (0.50)	-0.45 (0.40)	-0.88 (0.45)	-0.35 (0.40)
Survivor physical functioning [†]			0.08 (0.06)	0.05 (0.05)	0.08 (0.04)*	0.05 (0.04)
Caregiver burden [‡]			-0.09 (0.08)	-0.08 (0.08)	-0.08 (0.06)	-0.08 (0.05)
Random effects						
Intercept	264.95***	169.64***	190.23***	123.53***	161.49***	92.45***
Linear slope	15.65***	10.22*	14.38***	10.04***	14.41***	10.28
Estimated parameters	15		23		49	
Deviance statistic	12237.64		10684.85		10603.99	
Model comparison χ^2 (df)			1552.79 (8)***		80.86 (26)***	

Note. * The intercept in the Level 1 model has been coded to represent mean quality of life over the 12-month period. [†]Mean survivor physical functioning & caregiver burden were created by averaging scores across five time points. [§]The linear slope in the Level 1 model represents rate of change per 3 months in quality of life over the 12-month period. [‡]The time-varying covariates entered into the Level 1 model were centered around their group mean.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table II: Multilevel Models Predicting Survivor & Caregiver Environmental Quality of Life with Changes in Survivor Physical Functioning & Caregiver Burden

	Model 1		Model 2		Model 3	
	Survivor Parameter Estimate (SE)	Caregiver Parameter Estimate (SE)	Survivor Parameter Estimate (SE)	Caregiver Parameter Estimate (SE)	Survivor Parameter Estimate (SE)	Caregiver Parameter Estimate (SE)
Fixed effects						
Intercept*	53.29 (1.06)***	57.58 (0.97)***	48.34 (1.71)***	60.96 (1.70)***	44.90 (2.57)***	55.96 (2.63)***
Survivor mean physical functioning [†]			0.13 (0.04)***	0.11 (0.04)**	0.05 (0.04)	0.08 (0.04)*
Caregiver mean burden [‡]			-0.38 (0.06)***	-0.17 (0.06)**	-0.27 (0.06)***	-0.03 (0.06)
Survivor age					0.08 (0.07)	0.05 (0.07)
Survivor gender					-0.74 (1.50)	1.89 (1.54)
Stroke site					1.56 (1.40)	1.97 (1.44)
Stroke type					-1.13 (1.90)	-0.26 (1.95)
Survivor educational status (middle school or higher)					2.13 (1.62)	1.36 (1.66)
Survivor employment status (working)					1.61 (2.07)	-1.23 (2.13)
Survivor SIS memory					0.03 (0.03)	0.04 (0.03)
Survivor depression					-0.88 (0.20)***	-0.31 (0.21)
Caregiver type (spouse)					6.04 (1.88)**	3.36 (1.94)
Caregiver educational status (middle school or higher)					0.07 (1.60)	1.18 (1.65)
Caregiver employment status (working)					1.74 (1.66)	1.70 (1.71)
Caregiver depression					-0.15 (0.20)	-0.88 (0.21)***
Caregiver preparedness					2.08 (0.89)*	1.97 (0.91)*
Linear slope [§]	0.40 (0.30)	0.17 (0.30)	-0.25 (0.37)	-0.18 (0.32)	-0.26 (0.37)	-0.16 (0.32)
Survivor physical functioning [†]			0.13 (0.03)***	0.05 (0.03)	0.12 (0.03)***	0.05 (0.03)
Caregiver burden [‡]			-0.03 (0.05)	-0.16 (0.04)***	-0.02 (0.05)	-0.14 (0.04)***
Random effects						
Intercept	221.88***	171.10***	135.81***	140.21***	112.17***	117.71***
Linear slope	9.93***	5.54***	9.90***	4.88***	9.87***	4.96**
Estimated parameters	15		23		49	
Deviance statistic	11645.04		10153.04		10059.97	
Model comparison χ^2 (df)			1492.00 (8)***		93.07 (26)***	

Note. *The intercept in the Level 1 model has been coded to represent mean quality of life over the 12-month period. [†]Mean survivor physical functioning & caregiver burden were created by averaging scores across five time points. [§]The linear slope in the Level 1 model represents rate of change per 3 months in quality of life over the 12-month period. [‡]The time-varying covariates entered into the Level 1 model were centered around their group mean.

* $p < .05$. ** $p < .01$. *** $p < .001$.