



# Linkage of Optimism With Depressive Symptoms Among the Stroke Survivor and Caregiver Dyads at 2 Years Post Stroke

## Dyadic Mediation Approach

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**Background:** Depressive symptoms are substantial among stroke survivors and their caregivers in poststroke management. Optimism and social support are known to protect against depressive symptoms. However, little is known about how optimism and social support contribute to depressive symptoms among stroke survivor–caregiver dyads. The study's purpose was to examine actor and partner effects of optimism on depressive symptoms through perceived social support among stroke survivors and caregiver dyads in the chronic stage of rehabilitation. **Methods:** Stroke survivors and caregivers (N = 105 dyads) completed the survey at 2 years of follow-up after the first stroke. Depressive symptoms, optimism, and perceived social support were assessed using the Center for Epidemiologic Studies–Depression, the Life Orientation Test, and the Interpersonal Support Evaluation List. The Actor-Partner Interdependence Model Extended to Mediation analysis was used to test the indirect effect of optimism on depressive symptoms through perceived social support. **Results:** Higher optimism was significantly associated with lower depressive symptoms for caregivers (direct actor effect,  $-0.6844$ ; 95% confidence interval [CI],  $-0.9844$  to  $-0.3844$ ) and stroke survivors (direct partner effect,  $-0.4189$ ; 95% CI,  $-0.0789$  to  $-0.0889$ ). Perceived social support availability significantly mediated the association between optimism and depressive symptoms for stroke survivors (indirect effect,  $-0.1957$ ; 95% CI,  $-0.3923$  to  $-0.0670$ ). Caregiver perceived social support availability was also a significant mediator between caregivers' optimism and stroke survivors' depressive symptoms (indirect effect,  $0.1658$ ; 95% CI,  $0.0559$ – $0.3128$ ). **Conclusions:** Intervention improving dyad members' optimism and social support would be beneficial to improve depressive symptoms of the stroke survivors and caregivers in chronic stroke management.

**KEY WORDS:** depressive symptoms, dyadic research, optimism, social support, stroke

Stroke is the fifth leading cause of disability and the second leading cause of death globally, because stroke causes more than 116.4 million people living with disabilities and more than 5.5 million deaths.<sup>1</sup>

Stroke incidence and prevalence are high in the United States. Annually, 610000 American adults experience a first stroke, 185000 have a recurrent attack, and more than 7.6 million are living with the sequelae of stroke.<sup>2</sup> Stroke is an unexpected life-changing event

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that substantially affects survivors and their families in acute and chronic poststroke phases.

Depressive symptoms are one of the adverse psychological distresses commonly reported by stroke survivors and their family caregivers. According to a meta-analysis of 50 studies, 33% of stroke survivors experience depressive symptoms at 6 months to 1 year post stroke and 25% at more than 1 year post stroke.<sup>3</sup> In another meta-analysis of 12 studies, 40% of caregivers caring for stroke survivors reported depressive symptoms.<sup>4</sup> This high prevalence of depressive symptoms is a cause for concern because it is closely linked to adverse health outcomes in dyads. For example, stroke survivors with depressive symptoms had a 59% increased risk of death<sup>5</sup> and more long-term disability than those without depressive symptoms.<sup>6</sup> Depressive symptoms are also identified as a critical factor increasing the risk of cardiovascular disease development and poor quality of life for caregivers.<sup>7</sup> This substantial impact of depressive symptoms on health outcomes has prompted healthcare providers and researchers to identify contributing factors of depressive symptoms and develop approaches to prevent or improve depressive symptoms.

Dispositional optimism is defined as the relatively stable and generalized expectation that positive outcomes will occur across important life domains.<sup>8</sup> Dispositional optimism is also considered to be an internal attribute related to personality.<sup>8</sup> Substantial evidence suggests that high optimism plays a protective role in preventing or decreasing depressive symptoms in survivors of stroke and other chronic diseases<sup>9–12</sup> and caregivers caring for patients with chronic illness.<sup>10,13</sup> Noticeably, most study authors analyzed the link of optimism with depressive symptoms in separate patients and caregiver groups. However, this individual approach may ignore interdependent relationships between patients and caregivers and underestimate the dynamics of interpersonal interaction that influence each other intentionally or unintentionally.

The associations among depressive symptoms, optimism, and health outcomes at the dyad level in stroke have been rarely investigated. Chung and her colleagues<sup>10</sup> recently investigated how optimism was associated with depressive symptoms in stroke survivors and caregiver dyads at the early stage of stroke rehabilitation (ie, 6–12 weeks of poststroke) using dyadic analysis, the actor partner interdependent model. They reported that individuals, either stroke survivors or caregivers, with high optimism levels had low depressive symptoms. They also found that stroke survivors whose spousal caregivers had high optimism levels were more likely to report low depressive symptoms. Given that such findings were investigated in the early acute rehabilitation phase, one of the remaining questions is whether this phenomenon happens in the chronic phase of stroke rehabilitation. Optimism is considered a stable trait across

time.<sup>14</sup> Few researchers have questioned the stability of optimism across the life span or reported that optimism could be changeable during a life transition, which is negative in nature.<sup>14,15</sup> Stroke survivors often rely on their family caregivers even in the chronic phase of stroke rehabilitation because of physical and cognitive impairment or function. Prolonged management or rehabilitation of stroke for 1 or 2 years may influence both dyad members' optimistic views and depressive symptoms. However, there is limited knowledge of the association in the chronic stage.

Researchers demonstrated that optimism plays a crucial role in promoting beneficial social relationships and networks.<sup>14,16</sup> Individuals who are optimistic about the future are more likely to engage in social networking with others, making that future more positive.<sup>14,17</sup> Optimistic persons also are more likely to have a dominant interpersonal style than pessimists.<sup>16</sup> On the other hand, researchers suggest a beneficial role of social support in buffering and reducing depressive symptoms and better health-related quality of life for stroke survivors.<sup>18</sup> Without support from caregivers, stroke survivors may find the management of stroke to be difficult. Caregivers also need continuous social support and maintenance of their social life to prevent burnout during chronic stroke care. One way to explain how optimism could affect depressive symptoms is through its influence on social support. Social support may link optimism to depressive symptoms. Although social support is vital for both dyad members, the mechanisms by which the availability of social support for each dyad member plays a protective role in decreasing depressive symptoms during the chronic phase of stroke management are rarely investigated.

For the past decade, researchers have explored the phenomena of the interdependent relationship of how each member of a dyad, patients with chronic illness and their family caregiver, influences one another and affects each other's outcomes.<sup>19</sup> Still, there is limited knowledge of such a phenomenon in dyads in the chronic phase of stroke management. No researcher has verified how social support contributes to the linkage of optimism with depressive symptoms within dyad members in the chronic management phase of stroke. Thus, the specific aim of this study was to examine whether individuals' level of optimism influences their depressive symptoms and their partner's depressive symptoms through perceived social support in stroke survivors and their family caregivers during the chronic management of stroke. In this study, 2 years of follow-up data after their first stroke represent chronic stroke management.

## Methods

### Study Design and Sample Selection

This study is a secondary analysis of an observational study in stroke survivors and their primary family

caregivers after a first stroke. The authors of the parent study collected data from acute hospitalization for 2 years post discharge at 5 rehabilitation centers in stroke survivors and caregivers (NIHR01NR02416). A detailed summary of the parent study and sample description eligibility were previously reported.<sup>20,21</sup> In summary, eligible stroke survivors were community-dwelling adults ( $\geq 21$  years old) who had a first stroke or minimal sequelae of a previous stroke without end-stage medical comorbidities. Their caregivers were informal caregivers identified by stroke survivors as the primary support person in the family who lived with the stroke survivor after discharge.

In the parent study, a total of 174 stroke survivor and caregiver dyads were recruited and followed up 4 times (ie, at hospitalization, 6–10 weeks post discharge, 1 year, and 2-year follow-up) after the institutional review boards of 6 hospitals approved the study. This secondary analysis of the cross-sectional study included 105 dyads (105 stroke survivors and 105 caregivers) who had a 2-year follow-up assessment data, including all main variables in this study. The rationale for selecting dyads with 2-year follow-up data was our focus on the chronic phase of stroke rehabilitation. Although there is no specific time frame for the chronic phase of stroke rehabilitation, 2 years post stroke is a reasonable time frame for the chronic phase.

## Measures

### Optimism

The Life Orientation Test was designed to assess dispositional optimism by asking general expectations of good and bad things in the future, not in a specific situation.<sup>8</sup> This scale consists of 8 items, including 4 negative and 4 positive items. After negative items were reverse coded, the total score was computed by summing all items. Higher scores indicate higher optimism levels. Convergence and discriminant validity were demonstrated, and reliability was appropriate with a Cronbach  $\alpha$  of 0.76 among undergraduates as reported by the developer.<sup>8</sup> This scale has been used to assess optimism and was validated by testing associations of optimism with various outcomes in various patient populations, including caregivers and patients with stroke, cancer, and Parkinson's disease.<sup>9,10,13</sup> In the current study, Cronbach  $\alpha$  at 2 years was 0.70 for stroke survivors and 0.76 for caregivers.

### Perceived Social Support

Perceived social support, a mediator in this study, was assessed using the Interpersonal Support Evaluation List<sup>22</sup> that measures an individual's perceived availability of social support. The 40 items of this scale have 4 social support dimensions, including tangible aid, belonging, appraisal, and self-esteem. All items were evaluated

as a true/false response, with a score of 1 for a supportive response and 0 for a nonsupportive response. The possible total score ranges from 0 to 40, and a higher score indicates higher levels of perceived social support. Internal consistency was reported as 0.77.<sup>22</sup> Cronbach  $\alpha$  was 0.82 for stroke survivors and 0.82 for caregivers at 2 years in this study.

### Depressive Symptoms

The outcome, depressive symptoms, was assessed by the Center for Epidemiologic Studies-Depression (CES-D) scale.<sup>23</sup> The CES-D is a 20-item scale that evaluated the frequency of depressive symptoms experienced in the past week. All items are rated on a 4-point scale ranging from 0 (less than 1 day) to 3 (5–7 days). The total score was calculated by summing 20 items, and the possible range of total scores was from 0 to 60, with higher scores indicating high levels of depressive symptoms. A score of 16 or greater indicates probable depression.<sup>23</sup> In the dyadic analysis, we reported the prevalence of depression using the recommended cut point of 16. Internal consistency has been reported to be 0.85 to 0.90.<sup>23</sup> In the current study, Cronbach  $\alpha$  of the CES-D at 2-year follow-up was 0.89 for stroke survivors and 0.90 for family caregivers.

### Sociodemographic and Clinical Characteristics

Sociodemographic characteristics were collected using structured questionnaires for both stroke survivors and caregivers. Clinical characteristics of stroke survivors were collected by medical record review at the baseline assessment (admission) in the parent study. Variables included in this analysis were gender, age, education level, employment status, family income, the relationship between stroke survivors and caregivers, history of stroke (a first stroke or not), and health service utilization. We also collected disability of stroke survivors at 2-year follow-up using the motor subscale of the Functional Independence Measure.<sup>24</sup> The 13 items of the Functional Independence Measure motor subscale rate function from maximum dependence (score, 1) to independent without assistance (score, 7). Possible score ranges from 13 to 91, and higher scores indicate better functional status. The Cronbach  $\alpha$  for the motor scale was 0.97 in this study.

### Data Analysis

Descriptive statistics (eg, mean, standard deviation, frequency, percentiles) were used to describe patient and primary caregiver characteristics. Paired *t* test,  $\chi^2$  tests, and correlations were used to describe differences or similarities of characteristics within 2 members in the dyad. To accomplish the specific aim, we conducted dyadic mediation analysis, using the Actor-Partner Interdependence Model Extended to Mediation (APIMeM) with the MEDYAD macro program (model 1) for SPSS

v26.<sup>25</sup> The Actor-Partner Interdependence Model examines the impact of a person's predictor variable on their outcome (actor effect) and another dyad member's outcome (partner effect). The APIMeM is an extended model of the actor-partner independent model, which allows the addition of a mediator.

With the APIMeM in this study, we examined 4 direct effects of optimism on depressive symptoms. Those direct effects included 2 direct actor effects indicating the impact of each individual's optimism on his/her depressive symptoms and 2 direct partner effects indicating the impact of each individual's optimism on his/her partner's depressive symptoms for each dyad member. Figure 1 presents direct actor effects ( $C'_1$  and  $C'_4$ ) and direct partner effects ( $C'_2$  and  $C'_3$ ). We also examined 8 indirect effects of optimism on depressive symptoms with perceived social support, a mediator, in the APIMeM, our primary purpose in this study. Eight indirect effects consisted of 4 indirect actor effects and 4 indirect partner effects. Indirect actor effects represent effects of individuals' optimism on their depressive symptoms, two through their perceived social support and the other two through their partner's perceived social support. Indirect partner effects represent effects of individuals' optimism on their partner's depressive symptoms, two through their own perceived social support and the other two through their partners' perceived social support. The total effect of optimism is the sum of the direct and indirect effects.

Significance of the direct, indirect, and total effects were determined with the lower and upper limits of 95% bootstrap confidence interval (CI) with 5000 bootstrap samples. When 95% bootstrap CI includes zero, effects are not significant. In the analysis, stroke survivors and their family caregivers are distinguishable dyads because they play different roles in the interaction. Although the main focus is the indirect effect (ie, mediator effect), not each path, in modern mediation analysis, we also report regression coefficients for each path between 2 variables (predictor and outcome) to better understand the

mediational relationships. Each path coefficient was obtained from the MEDYAD macro program.

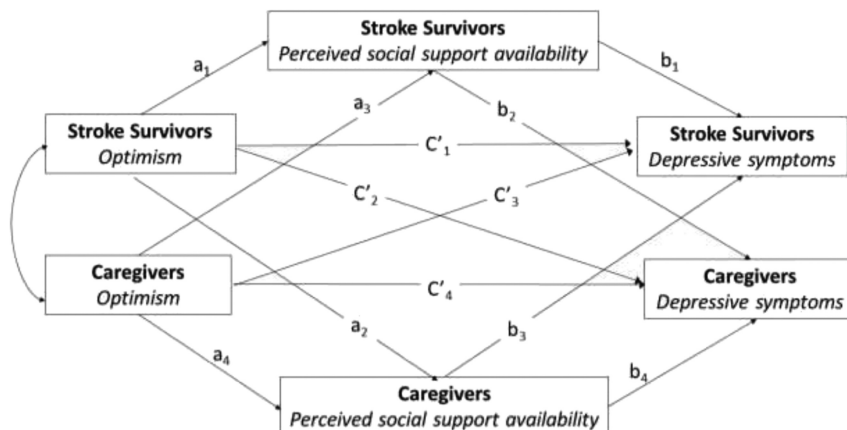
## Results

### Sample Characteristics

A total of 105 stroke survivors and 105 of their family caregivers completed questionnaires at 2 years post discharge (Table 1). Half of the stroke survivors (56%) were male, whereas 61% of caregivers were female. Stroke survivors were 2 years older than their caregivers (58.7 vs 56.8,  $P = .04$ ). Most caregivers (91.4%) were in a spousal relationship with stroke survivors. Other caregivers were children, siblings, or parents of stroke survivors. Most stroke survivors had experienced their first stroke ( $n = 95$ , 90.5%), and the rest had minimal sequelae of a previous stroke. At the 2-year follow-up, half of the stroke survivors ( $n = 59$ , 56.1%) used health services, and the most common service was therapy in clinics ( $n = 41$ , 39%), home healthcare ( $n = 10$ , 9.5%), and recreational service ( $n = 5$ , 4.8%). The mean motor score of the Functional Independence Measure (mean [SD], 78.8 [15.4]; range, 22–91) indicates that most were in modified independence; only 3 stroke survivors need moderate assistance.

Prevalence of depressive symptoms (CES-D  $\geq 16$ ) was 23.8% for stroke survivors and 25.7% for caregivers (Fisher exact test = 3.4,  $P = .071$ ). There was no statistical difference in the mean scores of depressive symptoms, optimism, and perceived social support within dyad members, indicating similar levels of depressive symptoms (Table 1). There were significant correlations in optimism ( $r = 0.267$ ,  $P < .001$ ), depressive symptoms ( $r = 0.224$ ,  $P < .05$ ), and perceived social support availability ( $r = 0.204$ ,  $P < .05$ ) between 2 dyad members (Table 2).

Table 3 presents unstandardized coefficients of each path based on a regression model with only a predictor



**FIGURE 1.** Dyadic mediation model of optimism on depressive symptoms through perceived social support.

**TABLE 1** Comparison of Characteristics Within Dyad Members

Characteristics	Stroke Survivors, n (%) or Mean ± SD	Caregivers, n (%) or Mean ± SD	Paired <i>t</i> Test or $\chi^2$ ( <i>P</i> )	Correlation <i>r</i> ( <i>P</i> )
Age, y	58.7 ± 12.7	56.8 ± 13.8	2.078 (.04)	0.734 (<.001)
Gender, male	59 (56.2)	41 (39.0)	86.2 (<.001)	N/A
Female	46 (43.8)	64 (61.0)		
Ethnicity (White)	80 (76.2)	82 (78.1)	94.2 (<.001)	N/A
Spousal caregivers (yes)	N/A	96 (91.4)	N/A	N/A
Education (high school or lower)	41 (39)	46 (43.8)	32.0 (<.001)	
Optimism	22.09 ± 4.44	21.36 ± 5.11	1.278 (.204)	0.267 (.006)
Perceived social support	33.73 ± 5.19	33.82 ± 5.16	-0.130 (.897)	0.204 (.036)
Depressive symptoms	9.28 ± 8.84	9.98 ± 8.30	-0.671 (.224)	0.224 (.022)
Presence of depressive symptoms (CES-D ≥ 16)	25 (23.8)	27 (25.7)	3.4 (.71)	N/A

Abbreviations: CES-D, Center for Epidemiologic Studies-Depression scale; n, frequency; N/A, not applicable or available values.

and an outcome. Each path indicator in Table 3 matches the path in Figure 1. Among the paths, individuals' optimism was associated positively with own perceived social support availability for stroke survivors ( $a_1$ ) and caregivers ( $a_4$ ). Stroke survivors' perceived social support availability was significantly negatively associated with survivor depressive symptoms ( $b_1$ ) and caregiver depressive symptoms ( $b_2$ ). Conversely, caregiver perceived social support availability was positively associated with stroke survivors' depressive symptoms ( $b_3$ ), indicating that stroke survivors reported higher depressive symptoms as caregivers had higher perceived social support availability. Caregivers' perceived social support availability was not associated with their depressive symptoms ( $b_4$ ). In the multiple regressions, all predictors (ie, each dyad member's optimism and perceived social support) explained 23.7% of the variance in stroke survivors' level of depressive symptoms ( $P < .001$ ) and 28.5% of the variance in caregivers' level of depressive symptoms ( $P < .001$ ).

### Direct Actor and Partner Effects of Optimism on Depressive Symptoms

Table 4 presents the results of the APIMeM, and Figure 2 shows the visualized effects in the APIMeM. Stroke survivor optimism had no significant direct actor and partner effects on depressive symptoms. In contrast, there were significant direct actor effect of

caregiver optimism on their depressive symptoms ( $C_4 = -0.6844$ ; 95% CI,  $-0.9844$  to  $-0.3844$ ) and direct partner effect on stroke survivor depressive symptoms ( $C_3 = -0.4189$ ; 95% CI,  $-7.89$  to  $-0.0889$ ). The significant direct actor effect means that caregivers who reported higher levels of optimism were more likely to have lower levels of depressive symptoms. Every 1-unit increase in caregiver optimism was associated with a 0.6844-unit decrease in their depressive symptoms. The significant direct partner effect of caregiver optimism indicates that stroke survivors whose family caregivers had higher levels of optimism were more likely to have lower levels of depressive symptoms. Every 1-unit increase in caregiver optimism was associated with a 0.4189-unit decrease in depressive symptoms for stroke survivors.

### Indirect Actor and Partner Effects of Optimism on Depressive Symptoms

Among 8 indirect effects, only 2 indirect effects were significant (Table 4). The first significant indirect effect was the indirect actor effect of stroke survivors' optimism on their depressive symptoms through their perceived social support ( $a_1b_1 = -0.1957$ ; 95% CI,  $-0.3923$  to  $-0.0670$ ). Stroke survivors who had higher levels of optimism were more likely to have higher levels of perceived social support availability associated with lower levels of depressive symptoms. Every 1-unit increase in stroke

**TABLE 2** Correlations Among Optimism, Perceived Social Support, and Depressive Symptoms in Dyads

Variables	1	2	3	4	5
1. Stroke survivor's optimism					
2. Stroke caregiver's optimism	0.267 <sup>a</sup>				
3. Stroke survivor's perceived social support	0.303 <sup>a</sup>	0.111			
4. Stroke caregiver's perceived social support	0.043	0.330 <sup>b</sup>	0.204 <sup>b</sup>		
5. Stroke survivor's depressive symptoms	-0.279 <sup>a</sup>	-0.220 <sup>b</sup>	-0.342 <sup>b</sup>	0.125	
6. Stroke caregiver's depressive symptoms	-0.204 <sup>b</sup>	-0.480 <sup>a</sup>	-0.271 <sup>a</sup>	-0.269 <sup>b</sup>	0.224 <sup>b</sup>

<sup>a</sup> $P < .001$ .

<sup>b</sup> $P < .05$ .

**TABLE 3 Path Coefficients Among Optimism, Perceived Social Support Availability, and Depressive Symptoms**

Predictor	Outcomes	Path	B	SE	$\beta$	P	95% CI	
							Lower	Upper
Optimism-SS	→ Perceived social support availability-SS	a <sub>1</sub>	0.3443	0.1145	3.0075	.0033	0.1172	0.5713
Optimism-SS	→ Perceived social support availability-CG	a <sub>2</sub>	-0.0571	0.1127	-0.5070	.6133	-0.2805	0.1663
Optimism-CG	→ Perceived social support availability-SS	a <sub>3</sub>	0.0330	0.0995	0.3317	.7408	-0.1643	0.2303
Optimism-CG	→ Perceived social support availability-CG	a <sub>4</sub>	0.3471	0.0979	3.5463	.0006	0.1530	0.5413
Perceived social support availability-SS	→ Depressive symptoms-SS	b <sub>1</sub>	-0.5685	0.1594	-3.5668	.0006	-0.8847	-0.2523
Perceived social support availability-SS	→ Depressive symptoms-CG	b <sub>2</sub>	-0.3168	0.1449	-2.1868	.0311	-0.6042	-0.0294
Perceived social support availability-CG	→ Depressive symptoms-SS	b <sub>3</sub>	0.4777	0.1620	2.9489	.0040	0.1563	0.7990
Perceived social support availability-CG	→ Depressive symptoms-CG	b <sub>4</sub>	-0.1416	0.1472	-0.9594	.3397	-0.4334	0.1509
Optimism-SS	→ Depressive symptoms-SS	C <sub>1</sub> '	-0.2483	0.1894	-1.3112	.1928	-0.6241	0.1274
Optimism-SS	→ Depressive symptoms-CG	C <sub>2</sub> '	-0.0512	0.1722	-0.2971	.7670	-0.3927	0.2904
Optimism-CG	→ Depressive symptoms-SS	C <sub>3</sub> '	-0.4189	0.1663	-2.5183	.0134	-0.7489	-0.0889
Optimism-CG	→ Depressive symptoms-CG	C <sub>4</sub> '	-0.6844	0.1512	-4.5266	<.0001	-0.9844	-0.3844

Abbreviations: CG, caregiver; CI, confidence interval; SS, stroke survivor. Path is illustrated in Figure 1.

survivor optimism was associated with a 0.1957-unit decrease in depressive symptoms for stroke survivors through perceived social support.

The second was the indirect partner effect of caregivers' optimism on stroke survivor depressive symptoms through caregiver perceived social support (a<sub>3</sub>b<sub>2</sub> = 0.1658; 95% CI, 0.0559–0.3128). Higher levels of caregiver optimism were

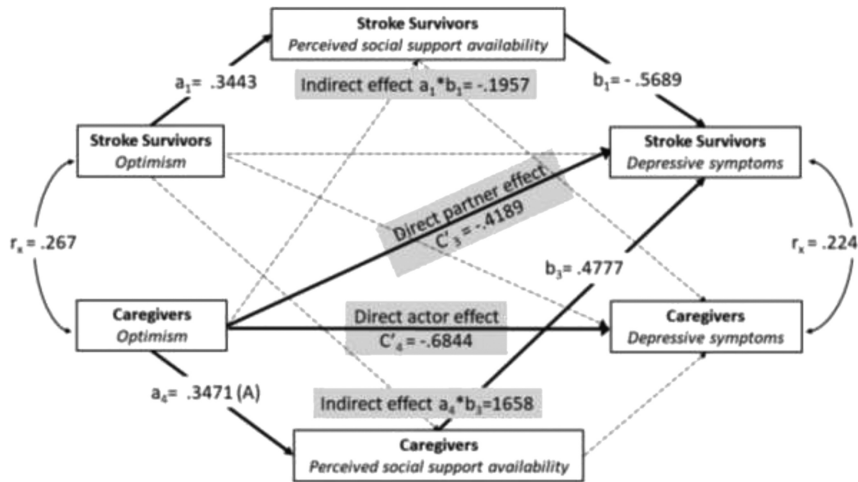
associated with a higher level of stroke survivor depressive symptoms through caregivers' perceived social support levels. Every 1-unit increase in caregiver optimism was associated with a 0.1658-unit increase in depressive symptoms for stroke survivors through caregiver perceived social support. When direct (-0.4189) and indirect (0.1658) effects of caregivers' optimism on stroke

**TABLE 4 Total, Direct, and Indirect Effects of Optimism on Depressive Symptoms in the Actor-Partner Interdependence Model Extended to Mediation (N = 105 Dyads)**

Effects	Path	Effect	SE	P	95% CI	
					Lower	Upper
Effects of optimism-SS						
Total actor effect on depressive symptoms-SS		-0.4713	0.1940	.0169	-0.8562	-0.0865
Total partner effect on depressive symptoms-CG		-0.2718	0.1686	.1100	-0.6063	0.0626
Direct actor effect on depressive symptoms-SS	C <sub>1</sub> '	-0.2483	0.1894	.1928	-0.6241	0.1274
Direct partner effect on depressive symptoms-CG	C <sub>2</sub> '	-0.0512	0.1722	.7670	-0.3927	0.2904
Indirect actor effect on depressive symptoms-SS through PSSA-SS	a <sub>1</sub> * b <sub>1</sub>	-0.1957	0.0829	—	-0.3923	-0.0670
Indirect actor effect on depressive symptoms-SS through PSSA-CG	a <sub>2</sub> * b <sub>3</sub>	-0.0273	0.0557	—	-0.1487	0.0784
Indirect partner effect on depressive symptoms-CG through PSSA-SS	a <sub>1</sub> * b <sub>2</sub>	-0.1091	0.0762	—	-0.2855	0.0175
Indirect partner effect on depressive symptoms-CG through PSSA-CG	a <sub>2</sub> * b <sub>4</sub>	0.0081	0.0275	—	-0.0333	0.0827
Effects of optimism-CG						
Total actor effect on depressive symptoms-CG		-0.7439	0.1459	<.0001	-1.0333	-0.4545
Total partner effect on depressive symptoms-SS		-0.1522	0.1679	-.9063	-0.4852	0.1808
Direct actor effect on depressive symptoms-CG	C <sub>4</sub> '	-0.6844	0.1512	<.0001	-0.9844	-0.3844
Direct partner effect on depressive symptoms-SS	C <sub>3</sub> '	-0.4189	0.1663	.0134	-0.7489	-0.0889
Indirect actor effect on depressive symptoms-CG through PSSA-CG	a <sub>4</sub> * b <sub>4</sub>	-0.0490	0.0643	—	-0.1880	0.0697
Indirect actor effect on depressive symptoms-CG through PSSA-SS	a <sub>3</sub> * b <sub>2</sub>	-0.0105	0.0350	—	-0.0834	0.0665
Indirect partner effect on depressive symptoms-SS through PSSA-CG	a <sub>4</sub> * b <sub>3</sub>	0.1658	0.0661	—	0.0559	0.3128
Indirect partner effect on depressive symptoms-SS through PSSA-SS	a <sub>3</sub> * b <sub>1</sub>	-0.0188	0.0569	—	-0.1247	0.1019

Abbreviations: CG, caregivers; CI, confidence interval; PSSA, perceived social support availability; SS, stroke survivors.

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**FIGURE 2.** Significant direct and indirect actor and partner effects of optimism on depressive symptoms.

survivor depressive symptoms were compared, direct effect was 2.5 times higher than the indirect effects.

## Discussion

We aimed to explore whether optimism plays a protective role in decreasing depressive symptoms through high perceived social support availability (mediator) among the stroke survivor–caregiver dyads in the chronic phase of poststroke management. First of all, we found that depressive symptoms were substantial in stroke survivors and family caregivers in the chronic phase of stroke management because 1 in every 4 stroke survivors and caregivers experienced depressive symptoms. These high rates were generally consistent with the rates of 2 meta-analyses for stroke survivors and stroke caregivers.<sup>3,4</sup>

This dyadic mediation analysis found no definite evidence that stroke survivors' optimism was directly associated with their depressive symptoms. Still, their optimism indirectly influenced depressive symptoms through their perceived social support availability. These results support our proposed testing mediation path that maintenance of high optimism and social network promotion may be beneficial in reducing depressive symptoms in stroke survivors during chronic stroke management. In contrast, among caregivers, optimism directly influenced reducing their depressive symptoms, not indirectly through perceived social support availability. No mediation effect of perceived social support availability on depressive symptoms and nonsignificant association of social support with depressive symptoms in caregivers may raise a question about the quality of support or types of social support caregivers received from the interaction with their support resources. According to Bolger et al,<sup>26</sup> invisible support occurs when the recipients do not become aware of actual support transactions that are beneficial or when the recipients do not code the available support

transactions as enacted support. Support resource attempts to give support may be miscarried, fail to deliver, or be ineffective in buffering depressive symptoms for caregivers.

The most compelling findings in this study were significant direct and indirect partner effects of caregivers' optimism on stroke survivor depressive symptoms. In contrast, there was no direct partner effect of stroke survivors' optimism on caregivers' depressive symptoms. The findings indicate that caregivers' optimistic views and perceived social support are vital for stroke survivors. Caregivers' high optimism was directly associated with low stroke survivors' depressive symptoms, consistent with previous research.<sup>10</sup>

Notably, the direct and indirect partner effects of caregiver optimism on stroke survivor depressive symptoms were the opposite sign. Caregivers' high optimism was directly associated with decreasing stroke survivors' depressive symptoms. Unexpectedly, caregivers' perceived social support availability had opposite effects by increasing stroke survivor depressive symptoms. The comparison of the strength between direct and indirect partner effects indicated that caregivers' optimism strongly influenced the decreasing of stroke survivors' depressive symptoms. However, caregivers' adverse indirect effects of optimism should not be ignored because the strength of caregiver optimism's opposite effect was similar to the indirect effect of stroke survivors' optimism on stroke survivors' depressive symptoms.

This unforeseen phenomenon may be explained in several ways. It is plausible that patients may not receive solid support from caregivers' social support resources. Suppose caregivers have exclusive support from their network only for themselves, not stroke survivors. In that case, stroke survivors may have negative perceptions about not receiving support from caregivers' social support networks, which may increase their depressive symptoms. Stroke survivors may also

### What's New and Important

- Stroke survivor optimism is associated with increasing their perceived social support availability that leads to decreased depressive symptoms.
- Caregiver optimism is vital for stroke survivors. Caregivers' high optimism contributes to decreasing stroke survivors' depressive symptoms, despite an adverse mediation effect of caregivers' perceived social support on their partner's depressive symptoms.
- The interdependent relationship between stroke survivors and family caregivers influences the mental health outcomes of both dyad members in chronic stroke management.

feel relative deprivation or social isolation when they cannot join caregivers' social network activities because of their limited physical condition.

Further research is needed to support these plausible explanations. Paradoxical effects of social support may be another explanation of this phenomenon.<sup>27</sup> It is conceivable that patients may experience challenging or harmful interactions with caregivers' social networks. Stroke survivors may perceive their supportive behaviors and communications as hassle or nagging. Such negative interaction may provide sources of strain or tension for stroke survivors, thereby unintentionally drawing their attention toward rather than away from their depressed mood.

The findings provided evidence of the interdependent relationship between stroke survivors and family caregivers when they were in the chronic phase of stroke management. The dyadic mediation analysis findings guide the development of dyadic intervention programs focusing on maintaining an optimistic view and reinforcing support systems. The unexpected opposite partner effect also suggests the need to develop strategies to prevent and resolve this adverse effect of the perceived social support availability. Developing strategies should be based on assessing each member's perception of his/her partner's social network, and the quality or types of social support received from his/her own and his/her partner's social network.

There are several limitations in this study. Because most caregivers were White and spousal caregivers and caring for stroke survivors, generalizing the findings may be limited with other ethnicity or caregivers in nonspousal relationships (ie, adult-children or relatives) or caring for reoccurrence in patients who had stroke. Most patients had experienced their first stroke and had a modified level of independence. Thus, these results may be limited in generalizability for stroke survivors with severe disabilities (ie, maximal assistance or total assistance) or who have experienced multiple strokes. In addition, there were no data on caregivers' tasks or time spent on caregiving for the survivors and the quality of support for both dyad members at 2-year follow-up.

Another limitation could be that potential confounding factors such as disability level at the assessment were not controlled in the analysis. Authors of future studies should extend the dyadic mediation approach by including potential confounding factors to improve our understanding of optimism linkage with depressive symptoms.

Despite these limitations, a strength of this study is that we used an advanced dyadic statistical analysis, the APIMeM, in exploring how an optimistic view influences depressive symptoms by interpersonal interaction in stroke survivor and caregiver dyads. Stroke survivors and their family caregivers are involved in a relationship of mutual influence. When data are collected from 2 individuals in such an interdependent relationship, traditional statistical techniques such as regression violate the statistical assumption of independencies in the measurement in dyadic data analysis. Although the dyadic analysis was introduced over the past few decades, conducting dyadic research and collecting dyadic data is rare in cardiovascular diseases, including stroke.<sup>28</sup> Mediation analysis is a common approach in exploring causal relationships or mechanisms in social and behavioral science. However, it is also rare to conduct mediation analysis using dyadic data in stroke. This study expanded our understanding of how dyadic processes operate in stroke survivors and caregivers. We found mixed results of significant direct and indirect effects of optimism in the dyad level. In a mediation analysis, the main focus is testing the indirect effect, not direct effect, and the statistically significant indirect effect cannot prove a definitive cause-and-effect relationship. However, the findings in this study could suggest that social support is deemed to play a mediator role in the association of optimism with depressive symptoms in dyads and the potential causal effect of optimism on depressive symptoms through perceived social support availability that we tested.

In conclusion, optimism and perception of the social support available from close others have a critical role in reducing depressive symptoms for stroke survivors and caregivers in the chronic phase of stroke management. The development of dyadic intervention and strategies to resolve the adverse effect of low levels of optimism is needed to prevent and decrease depressive symptoms in dyads in the chronic management phase of stroke.

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