Published in final edited form as:

Top Stroke Rehabil. 2013 ; 20(4): . doi:10.1310/tsr2004-369.

Spouses of Stroke Survivors May Be at Risk for Poor Cognitive Functioning: A Cross-sectional Population-Based Study

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Abstract

Background—Stroke often results in chronic disability and the need for long-term assistance, which is provided in large part by spouses. Stroke caregivers experience poorer health and well-being compared with non-caregivers, but less is known about the specific toll that caregiving may exact on cognitive functioning.

Objective—To investigate whether persons caring for a spouse who experienced a recent stroke may be at risk for poor cognitive functioning compared with non-caregivers.

Methods—Existing data from the United States' Health and Retirement Study (HRS) were used to identify 146 caregivers from among couples in which 1 individual reported surviving a recent stroke and experiencing functional limitations. This cross-sectional population-based analysis compared the stroke caregivers with 3,416 non-caregivers in time orientation, working memory, semantic memory, learning, and episodic memory.

Results—Overall, the caregiver group was considerably more disadvantaged than the non-caregiver group in terms of background characteristics, socioeconomic status, health, and well-being. Results of weighted Poisson regression models indicated that stroke caregivers were at risk for poorer performance than non-caregivers in working memory, semantic memory, learning, and episodic memory. The gap between stroke caregivers and non-caregivers in episodic memory remained after adjusting for systematic differences between the 2 groups across an array of risk factors.

Conclusions—Spousal caregivers of stroke survivors may be at risk for poor cognitive functioning. More work is needed to identify the processes that may contribute to the diminished cognitive capacity among these adults so that interventions may be developed to reduce caregiver burden and promote cognitive health.

Keywords

cognitive function; family caregiving; Health and Retirement Study; memory

Stroke is one of the most prevalent health problems in the United States, and stroke-related complications among family members, as well as survivors, are a major public health concern among the aging American population. Approximately 75% of stroke survivors are discharged home after acute and subacute rehabilitation care,¹ returning to lives shared with their spouses and partners. With the increasing awareness of the growing problem of caregiver burden,² the American Stroke Association has devoted an entire Web site (Life after Stroke) to caregiver support, and its magazine (*Stroke Connection*) often publishes personal stories and professional advice for families.^{3,4} This outreach is informed by decades of research demonstrating that spousal caregivers of stroke survivors are more

likely to experience poor physical⁵ and mental health,⁶ financial strain,⁷ social isolation,⁸ biographical disruption,⁹ and poor quality of life.¹⁰ Comparatively little research has focused on cognitive functioning as an aspect of caregiver health and well-being that is negatively affected by the strain of caring for a stroke survivor.

Research conducted among caregivers for persons with other chronic conditions suggests that cognitive functioning suffers after a protracted illness. In a longitudinal study of spousal caregivers of people with Alzheimer's disease, Vitaliano and colleagues reported that the depressed mood of caregivers mediated decline in caregivers' cognitive processing speed¹¹ and that chronic stress was associated with decline in caregivers' verbal intelligence.¹² Based on these findings, Vitaliano et al¹³ concluded that caregivers are at risk for cognitive decline independent of the aging process. Cross-sectional studies have consistently shown that in comparison with healthy non-caregivers, spousal caregivers of people with chronic diseases or disabilities had poorer processing speed, verbal learning, and memory, which may be mediated by caregivers' chronic stress,¹⁴ distress,¹⁵ or self-perceived incompetence.¹⁶ However, very few studies have focused on cognitive functioning in spousal caregivers of stroke survivors. A notable exception is the work of Lee and colleagues¹⁷ based on the Nurses' Health Study. After controlling for psychological stress and mental health, which may confound the effect of caregiving on cognitive performance, the authors found that members of this relatively homogeneous sample of nursing professionals were at risk for poorer cognitive functioning if they provided care to their spouses who had survived a stroke in comparison with their non-caregiving peers.¹⁷

Other evidence suggests that impaired caregiver functioning may impede the recovery of stroke survivors¹⁸ as well as compromise caregivers' cognition and health. In the general population, most spousal caregivers have limited health care training or inadequate knowledge of long-term consequences after a stroke¹⁹ and thus are often ill prepared to manage and adapt to the new life shared with their spouses who have had a stroke.²⁰ This study was designed to explore the relationship between caregiving and cognitive functioning using data from the Health and Retirement Study (HRS) to advance the understanding of the health risks posed by caring for a stroke survivor in the United States. We compared stroke caregivers with non-caregivers across 5 areas of cognitive functioning (ie, time orientation, working memory, semantic memory, learning, and episodic memory) and adjusted for a range of demographic, socioeconomic, and health-related covariates. A particular strength of this analysis was the use of a large, nationally representative dataset of older adults to assess these associations.

Methods

Database

This study used publicly available data from the HRS, a nationally representative, longitudinal study of noninstitutionalized adults born between 1931 and 1941. The HRS used a multistage area probability design to select a sample of US households with supplemental oversamples of African Americans, Hispanics, and residents of the state of Florida.²¹ Household respondents included the age-eligible individuals (a member of the 1931-1941 birth year cohort) and their spouses. This sample design resulted in a large number of healthy, community-dwelling couples, which was well suited to the analytic objectives of this study. HRS was initiated in 1992, and participants were re-interviewed at subsequent 2-year intervals. This study is based primarily on data from the 1996 interview when several areas of cognitive functioning were fully assessed for the first time. Use of the 1996 data, rather than more current data, eliminated the practice effect, which may result from multiple administrations of the same cognitive tests.²² A total of 10,964 individuals

completed the 1996 interview, yielding a response rate of 86.9%. Approval to conduct this analysis was obtained from the authors' local institutional review board.

Analytic sample derivation

The panel design of the HRS enabled us to derive caregiving status among persons whose spouse experienced a stroke. We began by selecting couples in the database. A respondent was dropped from the sample if he or she was not a member of a couple household ($n = 2,658$) and if he or she had more than 1 spouse who was an HRS participant ($n = 410$). A respondent was categorized as a stroke caregiver if he or she met 2 criteria: (1) his or her spouse was healthy (ie, reported no major health conditions or activity limitations) in 1992 and subsequently reported experiencing a stroke in either 1994 or 1996, and (2) the stroke survivor reported limitations in performing everyday activities. Respondents were dropped from among the dyads if both spouses reported a stroke between 1992 and 1996 ($n = 12$). A comparison group of non-caregivers was selected from HRS couples who reported no history of stroke between 1992 and 1996. Among the nonstroke dyads, a respondent was dropped if his or her spouse reported limitations in performing everyday activities ($n = 788$), implying that spousal assistance might be required for another, nonstroke-related condition. One respondent per non-caregiving couple was randomly dropped to eliminate nesting in the dyads ($n = 3,076$). Of the remaining 3,710 non-caregivers and 155 stroke caregivers, 327 cases were dropped as a result of either proxy reports or missing data on the dependent variable. This resulted in a final analytic sample of 146 stroke caregivers and 3,416 noncaregivers ($N = 3,562$).

Measures of cognitive functioning

Objective measures of 5 areas of cognitive functioning used by the HRS study were selected for analysis. *Time orientation* was evaluated by asking the interviewees the year, month, date, and day of week. *Working memory* was assessed with the serial 7s test, in which the examinees were asked to subtract 7 from 100 for 5 times. *Semantic memory* was assessed with 4 questions (What do people usually use to cut paper? What do you call the kind of prickly plant that grows in the desert? Who is the President of the United States right now? Who is the Vice President?). *Learning* was defined by the number of accurately recalled words immediately after the examiner read a list of 10 words (ie, immediate recall). *Episodic memory* was measured by the number of accurately recalled words approximately 30 minutes later (ie, delayed recall). All these tests are commonly used in neuropsychologic assessment batteries.²³ Each test is scored in the counts of correct answers, and the higher counts in a given test reflect the better functioning in its corresponding cognitive area.

Covariates

Several predictors of the effects of stroke caregiving on cognitive functioning were assessed for the analysis. *Demographic background* included categorical measures of gender, race/ethnicity, and age group. *Socioeconomic status* (SES) was assessed by a categorical measure of years of education completed (did not complete high school, high school graduate, and completed some college or more) and household income in 1996. Because of the skewed distribution of the income variable, a logarithmic transformation was used in all analyses to satisfy normality assumptions and improve the accuracy and interpretability of this predictor.²⁴

Health and behavioral risk factors included depressive symptoms, self-rated health, and stroke-related risk factors assessed in 1996. Depressive symptoms were based on a count of 8 items from the Center for Epidemiologic Studies Depression Scale.²⁵ Using a timeframe of the past week, the respondent provided yes or no answers to statements that they felt depressed, felt that everything was an effort, had restless sleep, could not get going, felt

lonely, enjoyed life, felt sad, and felt happy. Positive items were reverse scored, and all items were then summed to recreate a symptom total where higher scores indicated more depressive symptoms. The self-rated general health status, which was measured on a 5-point scale, was dichotomized into poor health (ie, rated poor or fair health) versus good health (ie, rated good, very good, or excellent health). The binary measures of stroke-related risk factors included physically inactive (vs physically active 3 or more times a week), obese (versus nonobese based on body mass index BMI < 30), current smoking (vs nonsmoker or former smoker), current heavy drinking (vs no or moderate drinking [ie consumption of fewer than 3 drinks daily]) as well as self-reported history of diagnosed hypertension, diabetes, and heart problems.

Analysis

The goal of this analysis was to assess whether there may be an association between caregiver status and cognitive functioning after stroke among spousal caregivers. Multivariate models were estimated by using Poisson regression, which is appropriate for analysis of count data. Tests of overdispersion and comparisons of the deviance statistic across models were used to assess the appropriateness of the Poisson model and model fit, respectively. Following a sequential strategy for each area of cognitive functioning, a model first estimated the overall difference in the score between stroke caregivers and non-caregivers. Subsequent models adjusted for the demographic, socioeconomic, and health and behavioral risk factors. A final “full” model adjusted for all of these factors simultaneously. All multivariate analyses, conducted in Stata/SE version 12 (StataCorp LP, College Station, TX),²⁶ applied normalized grand sample weights as recommended for use of the HRS data and generalizations to the general population.

Results

Table 1 provides the descriptive statistics of the analytic sample. Males were slightly underrepresented relative to females, and the majority of the sample was non-Hispanic White. With nearly 70% of the individuals between age 55 and 64, the sample was relatively homogeneous in terms of age, which is largely attributable to the HRS sampling design. Overall, the majority of the sample was well educated, and the average household income of \$66,000 was only slightly higher than the national average in 1996.²⁷ The sample was characterized by low levels of depressive symptomatology in 1996, with approximately 1 in 5 individuals evaluating their health as “poor.” However, obesity and hypertension characterized a large portion of the sample. Smoking, heavy drinking, and a history of diabetes or heart problems were comparatively less prevalent.

Caregiver and non-caregiver differences

Although the analytic sample was fairly representative of older adults in the United States, we found substantial differences between the stroke caregiver and non-caregiver groups (reported in **Table 1**). The caregivers were significantly more likely to be female, to be from a minority group, and to have low SES; this reflects, in part, the risk profile of a spouse who had a stroke in this sample. As expected, the stroke caregivers were more likely to report poor health and a higher average number of depressive symptoms than non-caregivers. However, the pattern of group differences for the stroke-related risk factors was mixed. Noncaregivers were significantly more likely to be physically inactive and obese, and smoking and hypertension were common among the stroke caregivers. There were no differences observed between the 2 groups for drinking and history of diabetes and heart problems.

Caregiver differences in cognitive functioning

The results from the multivariate models are presented in **Table 2**. As shown in Model I for each sequence, stroke caregivers had a significantly lower rate of correct scores compared with non-caregivers across 4 of the 5 areas (working memory, semantic memory, episodic memory, and learning). However, these differences were largely accounted for by group differences in demographic background, SES, and health characteristics (Models II-IV).

The gap between stroke caregivers and non-caregivers in episodic memory (assessed with a 10-word delayed recall task) remained after adjusting for systematic differences between the 2 groups across an array of risk factors. **Table 3** presents the details of the modeling analyses on episodic memory. The experience of caregiving for a spouse who has had a stroke decreases the expected number of correct items measuring episodic memory by 14% (Model I), a gap that is not diminished after adjusting for differences in age, gender, and race between caregivers and non-caregivers (Model II). The caregiver gap is mitigated slightly by income and education level (relative risk [RR] = 0.91; 95% CI, 0.84-0.99), suggesting that the difference in episodic memory can be explained in part by differences in SES (Model III). In other words, higher income and education may be somewhat protective of cognitive functioning in the face of caregiving-related stress and burden. A similar pattern emerged after adjusting for the health and behavioral risk factors, depicted in Model IV (RR = 0.89; 95% CI, 0.82-0.97), suggesting that poorer episodic memory among caregivers is partially related to their overall poorer health status relative to non-caregivers. Despite systematic differences across all of these factors, a small effect for caregiving on episodic memory persists (Model V) after controlling for a full array of the covariates (**Table 3**).

Discussion

To our knowledge, this is 1 of 2 population-based studies¹⁷ focused on cognitive functioning in spousal caregivers of stroke survivors. These caregivers, as suggested by the current findings, may be at risk for poor cognitive functioning. In particular, being a stroke caregiver was associated with a small but persistent increase in the risk for poor episodic memory. Episodic memory is a fundamental neurocognitive function in daily life as one constantly encounters and needs to remember new events, names, faces, objects, and locations. Although we initially also observed significant differences in working memory, semantic memory, and learning between stroke caregivers and non-caregivers, the results of the multivariate analysis indicated that poorer functioning in these areas is largely attributable to the greater vulnerability observed among the stroke caregivers in terms of demographic, SES, and several major dimensions of health and well-being.

Stroke changes the lives not only of the patients but also of their spousal caregivers. Mental health^{18,28-31} and quality of life^{8,10,32} in these caregivers have been extensively studied, and various interventions focused on depression, stroke care knowledge, or social support have been developed to improve their well-being (see review by Visser-Meily et al³³). However, cognitive functioning also plays a crucial role in well-being but is underrecognized in the literature. For example, depression may lead to poor cognitive functioning, especially memory.³⁴ Many studies have suggested that depression in caregivers mediates poor cognitive functioning.^{11,16} However, similar to the findings of Lee et al,¹⁷ we found that stroke caregivers recalled fewer words than non-caregivers in a delayed recall task, despite differences between these groups in depressive symptoms.

The focus of the present investigation was to establish the association between stroke caregiving and cognitive functioning. The finding demonstrates that stroke caregivers' poor performance in episodic memory cannot be fully accounted for by demographic, SES, and

several major dimensions of health and well-being, suggesting that being a stroke caregiver is a significant predictor of cognitive functioning.

The next direction for the current research in the field of stroke rehabilitation is to identify mediators of the specific poor cognitive functioning in stroke caregivers so that interventions may be tailored to alleviate these negative effects of caregiving. In particular, caregiver strain has been identified elsewhere in the literature as a mediator of cognitive functioning. In studies on caregivers of spouses with dementia, it was shown that caregivers were more likely to exhibit cognitive decline during the study period if they had higher suspicion that others intend harm to them¹² or if they had low self-competence.¹⁶ Furthermore, prior work suggests that gender may moderate the complex interplay among caregiving, strain, and cognition.³⁵ Also, episodic memory is vulnerable to stress¹⁴ and aging,³⁶ because the related brain deficits commonly occur in the prefrontal and medial temporal cortices or the connecting white-matter tracts that are critical for episodic memory.³⁷⁻³⁹ The age-related decline in episodic memory may be accelerated in people who became stroke caregivers of their spouses at an older age.

The limitations of this study include the lack of objective measures of caregiver status (ie, they were not explicitly identified as caregivers but as spouses living with stroke survivors), caregivers' cognitive functioning before their spouses' stroke, stroke severity (ie, the degree of dependence), poststroke disorders (physical, mental, or cognitive), caregiver burden (eg, hours of caregiving per day), and nonverbal-mediated neurocognitive functioning (eg, visuospatial cognition). The analysis was cross-sectional with the use of an existing database, thus limiting our ability to draw causal inferences about the relationship between caregiver status and cognition. The main drawback of secondary data is that the data were not collected to examine the question of the current interest. For example, the spousal caregivers were not explicitly identified in this study. However, we based our procedure on the strength of other analyses that had identified caregivers retrospectively for exploratory analytic purposes.³⁵ Also, measures of the caregivers' cognitive function before their spouses' stroke onset were not controlled; these measures were unavailable, because we used the survey wave when the HRS first incorporated cognitive measures. We selected this specific survey wave, rather than a more current survey wave, to eliminate the practice effect that may result from multiple administration of the same cognitive tests.²² In addition, the cognitive measures selected were all verbally mediated for the convenience of telephone surveys. A complete face-to-face examination of the global and detailed cognitive functions, including visuospatial cognitive skills, would be ideal for obtaining more specific information on cognitive consequences related to providing care for a stroke survivor.

Although the use of secondary data limits this analysis to existing measures, the HRS dataset is an unparalleled source of information on many issues related to aging in the general population. One of the advantages of using this exceptionally rich dataset was the large sample and wide array of measures that allowed us to build a fully elaborated model. In particular, the HRS data provide the opportunity to analyze the multiple dimensions of SES – an important social determinant of health that changes significantly at the end of the life course. Based on our inclusion of education and income as important predictors in the model, we have demonstrated that stroke caregivers are considerably disadvantaged relative to noncaregivers, which has further implications for the relationship between caregiving and cognition. Further analysis is needed to assess how the effects of a disadvantaged SES compound over time. Moreover, as the risk for stroke increases with age, we expect that a greater number of individuals from other social strata will become caregivers. Therefore, it will be important to assess how the effect of caregiving and cognition may be buffered by SES resources and other support.

Another potential limitation is the use of the data collected in 1996 to extrapolate to the problems faced by stroke caregivers today. Professional stroke care has changed significantly compared with care provided more than 15 years ago, thanks to the advances of medical and rehabilitative research. Such change has improved the stroke survival rates and consequently increased the number of stroke survivors returning home and receiving care from their families, especially spouses.⁴⁰ Thus, over the years, more people have become caregivers for their relatives. However, there is little evidence that informal stroke care has changed. Spousal caregivers nowadays may or may not be experiencing less stress or less burden, or in turn be having fewer cognitive consequences, than those in 1996. Because there is not sufficient evidence of an effective intervention program or systematic training widely accessible for family caregivers then or now,³³ our finding may well be applied to the present day. The nationally representative HRS sample was a considerable strength of this study, albeit the generalizations of these findings are limited to community-dwelling older adults. Our finding of the gap between stroke caregivers and non-caregivers may in fact be underestimated, because individuals who were institutionalized or were very impaired were either not included or dropped out over time from the HRS study.

Demonstration of an association between caregiver status and episodic memory in this study provides a basis for future analyses to investigate the implications of caregiving over time and to identify the processes related to accelerated cognitive decline. The results of this study add support to the body of evidence documenting the risk that caregiving may pose to health and well-being in the older population. Spousal caregivers of stroke survivors may be at risk for poor cognitive functioning. More work is needed to identify the processes that negatively contribute to the diminished cognitive capacity among these adults, so that interventions may be developed to alleviate the negative effects of caregiving on cognitive health.

Acknowledgments

Financial support/disclosures: This work was supported by the Kessler Foundation.

Additional contributions: The authors thank Giuseppe Amore for assistance with the literature search.

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Table 1

Summary of sample characteristics

Characteristics	Total (N=3,562)	Non-caregivers (n=3,416)	Stroke caregivers (n=146)
Demographic background			
Female	53.2	52.5	68.5***
Race/ethnicity			
Non-Hispanic White	78.5	79.2	62.3
African American	11.2	10.7	24.7
Hispanic	8.5	8.3	12.3
Asian/Pacific Islander/Other	1.8	1.8	0.7***
Age group, years			
Less than 45	1.66	1.6	2.1
45-54	17.7	17.9	12.3
55-64	66.3	66.1	69.2
65 or older	14.4	14.3	16.4
Socioeconomic characteristics			
Education level			
Less than 12 years	25.0	24.1	44.5
High school graduate/GED	35.9	35.9	34.9
Some college or more	39.1	40.0	20.6***
Income (in 1,000 dollars)	65.5 (74.5)	67.0(75.4)	33.1 (34.2)***
Health & behavioral risk factors			
Depressive symptoms (0-8)	1.12 (1.74)	1.07 (1.70)	2.05 (2.25)***
Poor vs good health	20.2	19.6	33.6***
Physically inactive vs active	52.0	52.5	40.4**
Obese	41.5	41.8	33.6*
Current smoker vs nonsmoker	18.2	17.7	28.1**
Drinks 3+ drinks/day	9.3	9.4	7.5
History of hypertension	36.0	35.6	45.2*
History of diabetes	10.9	10.8	14.4
History of heart problems	12.7	12.6	15.1
Cognitive function			
Working memory (0-5)	3.70 (1.57)	3.72 (1.55)	3.12 (1.85)***
Semantic memory (0-4)	3.65 (0.63)	3.66 (0.62)	3.42 (0.78)***
Time orientation (0-4)	3.81 (0.50)	3.81 (0.50)	3.78 (0.48)
Learning (0-10)	6.05 (1.67)	6.07 (1.67)	5.60 (1.72)***
Episodic memory (0-10)	5.03 (2.04)	5.06 (2.03)	4.23 (2.13)***

Note: Data are presented as a percentage or mean (SD). Between-group comparisons are bivariate chi-square tests of significance or *t* tests.

*
 $P < .05$.

**
 $P < .01$.

 $P < .001$.

Table 2

Multivariate results predicting cognition differences between stroke caregivers and non-caregivers

		Relative risk	95% CI	P value
Working memory				
I	Caregiver only	0.89	0.81-0.96	.005
II	Adjusted for demographic background	0.94	0.87-1.02	.134
III	Adjusted for SES	0.97	0.90-1.04	.363
IV	Adjusted for health & behavioral risk factors	0.94	0.88-1.02	.178
V	Fully adjusted model	1.02	0.95-1.10	.554
Semantic memory				
I	Caregiver only	0.95	0.92-0.98	.003
II	Adjusted for demographic background	0.97	0.95-1.00	.064
III	Adjusted for SES	0.98	0.94-1.00	.189
IV	Adjusted for health & behavioral risk factors	0.97	0.94-1.00	.067
V	Fully adjusted model	0.99	0.97-1.02	.692
Time orientation				
I	Caregiver only	0.99	0.97-1.01	.422
II	Adjusted for demographic background	0.99	0.97-1.01	.399
III	Adjusted for SES	1.00	0.98-1.02	.827
IV	Adjusted for health & behavioral risk factors	1.00	0.98-1.02	.987
V	Fully adjusted model	1.00	0.98-1.02	.789
Learning (immediate recall)				
I	Caregiver only	0.94	0.90-0.99	.030
II	Adjusted for demographic background	0.95	0.91-0.99	.029
III	Adjusted for SES	0.99	0.94-1.04	.791
IV	Adjusted for health & behavioral risk factors	0.97	0.93-1.02	.295
V	Fully adjusted model	0.99	0.95-1.04	.718
Episodic memory (delayed recall)				
I	Caregiver only	0.86	0.78-0.93	.000
II	Adjusted for demographic background	0.86	0.78-0.93	.000
III	Adjusted for SES	0.91	0.84-0.99	.028
IV	Adjusted for health & behavioral risk factors	0.89	0.82-0.97	.006
V	Fully adjusted model	0.91	0.84-0.98	.018

Note: SES = socioeconomic status.

Table 3

Poisson regression models predicting episodic memory (delayed recall)

	Model I	Model II	Model III	Model IV	Model V
Stroke caregiver^a	0.86 (0.04) [0.78-0.93]	0.86 (0.04) [0.79-0.93]	0.91 (0.04) [0.84-0.99]	0.89 (0.04) [0.82-0.97]	0.91 (0.04) [0.84-0.98]
Demographic characteristics					
Female ^b		1.17 (0.02) [1.13-1.20]			1.18 (0.02) [1.15-1.22]
Age, years ^c		1.14 (0.06) [1.03-1.27]			1.08 (0.06) [0.97-1.19]
					1.12 (0.03) [1.07-1.18]
		1.18 (0.03) [1.12-1.24]			1.09 (0.02) [1.07-1.17]
		1.12 (0.03) [1.07-1.17]			0.82 (0.02) [0.78-0.86]
Race/ethnic group ^d		0.82 (0.02) [0.78-0.86]			0.83 (0.02) [0.78-0.87]
		0.83 (0.02) [0.78-0.87]			0.93 (0.05) [0.83-1.04]
		0.93 (0.05) [0.83-1.04]			
Socioeconomic characteristics					
Income (logged)			1.04 (0.00) [1.03-1.06]		1.04 (0.00) [1.03-1.06]
Education ^e			1.17 (0.02) [1.12-1.22]		1.17 (0.02) [1.12-1.22]
			1.25 (0.03) [1.20-1.31]		1.25 (0.03) [1.20-1.31]
Health and behavioral risk factors					
Depressive symptoms				0.98 (0.01) [0.97-0.99]	0.98 (0.01) [0.96-1.00]
Perceived poor health ^f				0.89 (0.02) [0.85-0.93]	0.95 (0.02) [0.91-1.00]
Hypertension ^g				0.96 (0.01) [0.93-0.99]	0.98 (0.01) [0.96-1.01]
Diabetes ^h				0.93 (0.02) [0.89-0.98]	0.97 (0.02) [0.92-1.02]
Heart problems ⁱ				0.96 (0.02) [0.91-1.00]	0.98 (0.02) [0.94-1.02]
Sedentary ^j				1.00 (0.01) [0.98-1.03]	0.99(0.01) [0.97-1.02]
Obese ^k				0.99 (0.01) [0.97-1.01]	1.03 (0.01) [1.00-1.05]
Smoker ^l				0.99 (0.02) [0.95-1.02]	1.01 (0.02) [0.97-1.04]
Heavy drinker ^m				0.96 (0.02) [0.92-1.00]	1.00 (0.02) [0.96-1.05]
Intercept	5.14 (0.04) [5.07-5.21]	4.32 (0.09) [4.14-4.52]	2.76 (0.23) [2.34-3.24]	5.49 (0.07) [5.36-5.63]	3.01 (0.02) [2.57-3.53]

	Model I	Model II	Model III	Model IV	Model V
Stroke caregiver^a	0.86 (0.04) [0.78-0.93]	0.86 (0.04) [0.79-0.93]	0.91 (0.04) [0.84-0.99]	0.89 (0.04) [0.82-0.97]	0.91 (0.04) [0.84-0.98]
Deviance statistic	2720.05	2518.42	2555.72	2632.23	2376.71
Degrees of freedom	3499	3492	3496	3486	3476

Note: Data are expressed as incident rate ratios [95% confidence interval] unless noted otherwise. Entries are bolded if $P < .05$. Omitted reference categories:

^a non-caregiver

^b male

^c age > 65 years

^d non-Hispanic white

^e less than high school

^f good health

^g no hypertension

^h no diabetes

ⁱ no heart problems

^j physically active

^k non-obese (body mass index < 30)

^l non-smoker or former smoker

^m non-heavy drinker or nondrinker.