The Association Between Emotional Well-Being and the Incidence of Stroke in Older Adults

GLENN V. OSTIR, PHD, KYRIAKOS S. MARKIDES, PHD, M. KRISTEN PEEK, PHD, AND JAMES S. GOODWIN, MD

Objective: Individuals with high levels of depressive symptoms have an increased risk of many illnesses, including stroke. Measures of depressive symptoms include questions about the presence of negative affect, such as sadness, as well as the absence of positive affect, such as happiness and optimism. We assessed whether positive or negative affect, or both, predicted risk of stroke. **Methods:** Data were from a 6-year prospective cohort study of a population-based sample of 2478 older whites and blacks from five counties in North Carolina who reported no history of stroke at the baseline interview. Baseline, in-person interviews were conducted to gather information on sociodemographic, psychosocial, and health-related characteristics of subjects. Thereafter interviews were conducted annually for 6 years. **Results:** Increasing scores on the modified version of the Center for Epidemiological Studies Depression Scale (CES-D) were significantly associated with stroke incidence for the overall sample (relative risk [RR] = 1.04 for each one-point increase, 95% confidence interval [CI] = 1.01–1.09) over the 6-year follow-up period after adjusting for sociodemographic characteristics, blood pressure, body mass index, smoking status, and selected chronic diseases. Positive affect score demonstrated a strong inverse association with stroke incidence (RR = 0.74, 95% CI = 0.62–0.88). **Conclusions:** Increasing scores on the modified CES-D are related to an increased risk of stroke, whereas high levels of positive affect seem to protect against stroke in older adults. **Key words:** stroke, positive affect, depression, emotional well-being, aging.

BMI = body mass index; CES-D = Center for Epidemiological Studies Depression Scale; CI = confidence interval; EPESE = Established Population for the Epidemiologic Study of the Elderly; RR = relative risk.

INTRODUCTION

Stroke is the third most common cause of death and a leading cause of long-term disability among the elderly (1). Approximately 400,000 new stroke cases occur each year in the United States (2). Previous epidemiologic and clinical studies have identified modifiable and nonmodifiable risk factors of stroke. Nonmodifiable risk factors include age, male sex, race, and other hereditary factors (3–5). Modifiable risk factors include smoking, obesity, excess alcohol use, low level of exercise (3–8), hypertension, and diabetes (3–8).

An additional and potentially modifiable risk factor for stroke is emotional well-being. Several studies have shown that individuals with high levels of depressive symptoms are at higher risk for stroke (6–8). However, scales that assess depressive symptomatology include questions about the presence of negative affect and the absence of positive affect. Measurements of positive and negative affect have been shown to be relatively independent of each other, and the two measures correlate with different personal characteristics (9, 10). Moreover, positive affect is not simply the lack of depressive symptoms (9). Persons in a positive mood are more likely to engage in social relationships (8), to be optimistic about their future (7), to cope successfully with stressful situations (11), and to feel in control of their lives (11). Conversely, negative affect is related to depression or depressive mood, increased anxiety, and feelings of hopelessness (9–12). Separate neural networks seem to regulate positive and negative emotions, with dopamine metabolism associated with positive affect and serotonin associated with negative affect (13, 14).

The purpose of this study was to investigate the relationship between emotional well-being and incidence of stroke in older adults. We asked which components of emotional well-being, negative affect, positive affect, or both, are associated with risk of stroke.

METHODS

Sample

Data are from the North Carolina EPESE study, a population-based study of 4162 noninstitutionalized, community-dwelling adults. Sampling and data collection procedures are described elsewhere (15). Briefly, in 1986, subjects 65 years of age or older were identified using a four-stage stratified probability sample drawn from five counties in North Carolina. Baseline data were collected by in-person interviews, during which information on sociodemographic, psychosocial, and health-related characteristics of subjects was gathered. Annual follow-up interviews were conducted for the next 6 years. In 1989 and 1992, in-person interviews were conducted; telephone interviews were conducted in the intervening years. This study included data on 2478 subjects (772 men and 1706

From the Department of Preventive Medicine and Community Health (G.V.O., K.S.M., J.S.G.), Sealy Center on Aging (G.V.O., K.S.M., M.K.P., J.S.G.), Department of Internal Medicine (J.S.G.), and Department of Health Promotion and Gerontology (M.K.P.), University of Texas Medical Branch, Galveston, Texas.

Address reprint requests to: Glenn V. Ostir, PhD, Preventive Medicine and Community Health, University of Texas Medical Branch, 700 Harborside Dr., 1.128 Ewing Hall, Galveston, TX 77555-1143. Email: gostir@utmb.edu

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women) who had no history of stroke at baseline and for whom complete stroke information was available at all follow-up interviews; this sample represents 65.4% of those who were stroke-free at baseline.

Measures

Emotional well-being. The CES-D scale is widely used in community settings as a measure of depressive symptomatology (16). The scale consists of 20 items in which subjects are asked whether they have experienced certain feelings or symptoms in the past week. A modified version of the CES-D scale was presented to subjects in a "yes" (reported the symptom at least some of the time during the previous 2 weeks) or "no" (rarely or none of the time during the previous 2 weeks) format. Scores on the modified CES-D range from 0 to 20, with increasing scores indicating poorer emotional well-being.

Factor analysis has demonstrated that the CES-D has a two-factor structure with a negative and positive valence (17–19). The 16-item negative affect structure includes the following items: "I felt that I could not shake off the blues even with help from my family and friends," "I felt depressed," "I thought my life had been a failure," "I felt fearful," "I felt lonely," "I had crying spells," "I felt sad," "I was bothered by things that usually don't bother me," "I did not feel like eating; my appetite was poor," "I had trouble keeping my mind on what I was doing," "I felt everything I did was an effort," "My sleep was restless," "It seemed that I talked less than usual," "People were unfriendly," "I felt that people disliked me," and "I could not get going." Higher scores on the negative affect scale indicate higher depressive symptomatology. The remaining four items make up the positive affect structure: "I felt that I was just as good as other people," "I felt hopeful about the future," "I was happy," and "I enjoyed life." The score on this scale ranges from 0 to 4, with higher scores indicating higher positive affect. Baseline scores for the modified CES-D were obtained by reversing the score on the four positive affect items and summing it with the 16 negative affect items. In addition to using the modified CES-D score as a continuous variable, we also dichotomized the scale. Blazer et al. (20) determined that a cutoff point of 9 on the modified CES-D was equivalent to a cutoff point of 16 on the original scale. Individuals who score 9 or more on the modified CES-D are classified as having high levels of depressive symptomatology.

Stroke. The data collected for the North Carolina EPESE study included information on a number of chronic health conditions, including stroke. The incidence of stroke was calculated by summing the number of physician-diagnosed strokes reported at any follow-up interview and the number of deaths in which stroke (ICD-9 codes 430–438) was listed as the immediate or underlying cause of death. During the 6-year follow-up period, 340 strokes occurred in the study population; 265 were nonfatal and 75 were fatal.

Covariates. Baseline variables used in the analyses included gender, age (65–74, 75–84, and ≥85 years), marital status, household income (<$10,000 and ≥$10,000), number of years of education (0–8, 8–11, 12, and >12), BMI (<22, 22–29.9, and ≥30), any smoking in the last month, and physician-diagnosed heart disease or diabetes. Blood pressure was measured twice using a standard mercury sphygmomanometer with an appropriately sized cuff after the subject had remained seated for at least 5 minutes, according to the standard protocol used in the Hypertension Detection and Follow-Up Program (21). Blood pressure was categorized as a mean systolic pressure of <140 mm Hg, ≥140 to <160 mm Hg, or ≥160 mm Hg at baseline.

Statistical Analyses

Cox proportional hazard models were used to estimate the RR of stroke over 6 years from the modified CES-D score at baseline as well as from scores on the negative and positive affect subscales, adjusting for baseline sociodemographic variables, heart attack, diabetes, hypertension, BMI, and smoking status. Analyses were stratified by gender or ethnicity. SAS software was used for these analyses.

RESULTS

Table 1 presents baseline characteristics of the total sample by gender. Most subjects were nonsmokers and had a BMI between 22 and 29.9. Fourteen percent of the total sample reported heart disease, 17% reported diabetes, and 53% had a systolic blood pressure ≥140 mm Hg.

Table 2 shows the correlations for scores on the modified CES-D and the positive and negative subscales by covariates at baseline. The score on the modified CES-D was strongly correlated with female gen-

TABLE 1. Baseline Sociodemographic Characteristics of Subjects by Gender

	Total		Men		Women	
	N	%	*N*	%	*N*	%
Age						
65–74 y	1632	66	597	77	1035	57
75–84 y	730	29	152	20	578	34
85+ y	116	5	23	3	93	5
Race						
White	1129	46	359	47	770	45
Black	1349	54	413	53	936	55
Marital status						
Married	982	42	550	75	432	27
Unmarried	1371	58	186	25	1185	73
Education						
0–8 y	1021	42	341	45	680	40
9–11 y	841	34	232	30	609	36
12 y	213	9	61	8	152	9
>12 y	381	15	129	17	252	15
Current smoking status						
Yes	390	17	197	26	193	11
No	2085	83	574	74	1511	89
BMI						
<22	419	19	118	16	301	20
22–29.9	1417	63	535	71	882	59
≥30	418	17	97	13	321	21
Heart attack						
No	2172	86	652	85	1520	89
Yes	301	14	119	15	182	11
Diabetes						
No	2046	82	638	83	1408	83
Yes	429	17	134	17	295	17
Systolic blood pressure						
<140 mm Hg	1118	47	349	50	769	46
140–<160 mm Hg	787	33	256	35	531	33
≥160 mm Hg	459	20	134	18	325	20

TABLE 2. Pearson correlation coefficients for Covariates by Total CES-D Score and scores on Positive Affect and Negative Affect Subscales

Covariate	CES-D	Positive Affect	Negative Affect
Gender (male)	−0.12	0.001	−0.13
Age	0.08	−0.07	0.07
Race (black)	0.05	−0.04	0.05
Marital status (unmarried)	0.15	−0.03	0.16
Household income (≥$10,000)	−0.21	0.14	−0.19
Education	−0.17	0.09	−0.16
BMI	−0.003	0.01	−0.03
Current smoker	0.02	−0.02	0.02
Heart attack	0.11	−0.04	0.11
Diabetes	0.05	−0.03	−0.03
Systolic blood pressure	0.003	−0.01	0.01

der, unmarried marital status, low household income (<$10,000), less education, and heart attack. Similar findings were observed for the 16-item negative affect scale. Positive affect was most strongly correlated with higher income (≥$10,000) and higher education.

Table 3 shows the RR of stroke during follow-up by the continuous modified CES-D score after adjusting for baseline sociodemographic characteristics, behavioral factors, and chronic disease. For the total sample, the RR for stroke increased by 4% for each one-point increase in score on the modified CES-D. Each unit increase in score for men was associated with a 9% increase in stroke incidence. Women also showed an association between increasing CES-D score and stroke incidence, although the relationship did not reach significance. Other significant independent predictors of stroke (eg, controlling for the other explanatory factors in the model) included older age, less education, underweight, current smoking, heart disease, diabetes, and hypertension at baseline. Interaction effects with gender were also investigated for the variables in Table 3. With the exception of a gender-by-age interaction ($p < .006$), there were no significant interactions. Women were observed to have a greater increase in the risk of stroke with increasing age as compared with men.

In addition, scores on the modified CES-D were dichotomized, with a score ≥9 representing depressive symptomatology. The results indicate a nonsignificant relationship between a score of 9 or more and incident stroke (RR = 1.30, 95% CI = 0.85–1.99, $p < .23$).

Table 4 shows the independent effects of the 4-item

TABLE 3. Multivariate Analysis of Risk of Stroke[a] by Continuous CES-D Score During the 6-Year Follow-Up Period

	Total (*N* = 2478)			Men (*N* = 772)			Women (*N* = 1706)		
	RR	95% CI	*p*	RR	95% CI	*p*	RR	95% CI	*p*
CES-D (one-point increase in score)[b]	1.04	1.01–1.09	.03	1.09	1.02–1.16	.006	1.03	0.98–1.08	.28
Age									
65–74 y	1.00			1.00			1.00		
75–84 y	1.58	1.17–2.14	.003	2.00	1.19–3.37	.009	1.53	1.05–2.23	.03
≥85 y	1.83	0.98–3.41	.06	1.21	0.28–5.24	.80	2.17	1.08–4.38	.03
Income (≥$10,000)	0.84	0.57–1.24	.38	1.04	0.61–1.77	.88	0.60	0.33–1.10	.10
Education									
0–8 y	2.07	1.16–3.69	.01	3.64	1.35–9.77	.01	1.32	0.63–2.73	.46
9–11 y	1.64	0.93–2.91	.09	2.39	0.89–6.14	.08	1.19	0.58–2.45	.64
12 y	1.66	0.81–3.37	.17	1.78	0.47–6.68	.39	1.61	0.68–3.81	.28
>12 y	1.00		1.00		1.00				
Marital status (unmarried vs. married)	1.05	0.77–1.43	.77	0.83	0.50–1.39	.48	1.78	1.06–3.01	.03
BMI									
<22	1.41	1.00–1.99	.05	1.48	0.86–2.57	.16	1.41	0.90–2.20	.14
≥30	1.32	0.95–1.84	.10	1.86	1.03–3.35	.04	1.33	0.88–2.01	.18
22–29.9 (reference)	1.00			1.00			1.00		
Current smoker	1.50	1.06–2.13	.02	1.30	0.80–2.10	.29	1.40	0.82–2.41	.22
Heart attack	1.64	1.17–2.30	.004	1.24	0.70–2.19	.11	1.70	1.02–2.62	.02
Diabetes	1.79	1.32–2.43	.0002	0.88	0.49–1.59	.67	2.51	1.73–3.65	.0001
Systolic blood pressure									
<140 mm Hg	1.00			1.00			1.00		
140–<160 mm Hg	1.38	1.01–1.88	.04	1.22	0.73–2.06	.45	1.46	0.98–2.16	.06
≥160 mm Hg	1.81	1.29–2.55	.0006	2.17	1.27–3.71	.005	1.71	1.10–2.68	.02

[a] A total of 340 strokes (117 in men and 223 in women) occurred during the 6-year follow-up period. All subjects were stroke-free at baseline.
[b] CES-D scores were obtained by summing the four reversed positive affect items with the 16 negative affect items.

TABLE 4. Multivariate Analysis of Risk of Stroke[a] by Continuous Positive and Negative Affect During the 6-Year Follow-Up Period

	Total (*N* = 2478)			Men (*N* = 772)			Women (*N* = 1706)		
	RR[b]	95% CI	*p*	RR[b]	95% CI	*p*	RR[b]	95% CI	*p*
Positive affect	0.74	0.62–0.88	.0006	0.59	0.45–0.78	.0002	0.82	0.66–1.00	.05
Negative affect	1.01	0.97–1.05	.64	1.01	0.94–1.10	.75	1.01	0.95–1.07	.77
Age									
65–74 y	1.00			1.00			1.00		
75–84 y	1.56	1.16–2.13	.004	1.98	1.18–3.33	.01	1.52	1.15–2.21	.006
≥85 y	1.76	0.94–3.27	.08	1.07	0.25–4.67	.93	2.10	1.04–4.24	.007
Income (≥$10,000)	0.87	0.59–1.28	.47	1.13	0.66–1.92	.66	0.61	0.33–1.12	.11
Education									
0–8 y	2.14	1.20–3.83	.01	3.84	1.42–10.41	.007	1.36	0.65–2.84	.40
9–11 y	1.66	0.94–2.95	.08	2.30	0.85–6.21	.07	1.21	0.59–2.51	.60
12 y	1.72	0.84–3.52	.13	1.80	0.48–6.78	.13	1.68	0.71–4.00	.24
>12 y	1.00			1.00			1.00		
Marital status (unmarried vs. married)	1.09	0.80–1.48	.60	0.87	0.52–1.45	.59	1.82	1.08–3.09	.02
BMI									
<22	1.44	1.02–2.03	.04	1.62	0.93–2.82	.09	1.43	0.91–2.24	.02
≥30	1.35	0.97–1.89	.08	2.08	1.16–3.76	.01	1.34	0.89–2.03	.45
22–29.9 (reference)	1.00			1.00			1.00		
Current smoker	1.52	1.12–2.08	.008	1.35	0.88–2.08	.17	1.39	0.81–2.40	.23
Heart attack	1.68	1.20–2.36	.002	1.32	0.76–2.31	.32	1.74	1.13–2.68	.01
Diabetes	1.82	1.34–2.47	.0001	0.92	0.51–1.66	.78	2.52	1.74–3.66	.0001
Systolic blood pressure									
<140 mm Hg	1.00			1.00			1.00		
140–<160 mm Hg	1.36	1.00–1.86	.05	1.20	0.72–1.85	.50	1.45	0.97–2.15	.02
≥160 mm Hg	1.79	1.27–2.51	.0008	2.32	1.35–3.99	.002	1.68	1.07–2.63	.004

[a] A total of 340 strokes (117 in men and 223 in women) occurred during the 6-year follow-up period. All subjects were stroke-free at baseline.
[b] Each point increase in positive and negative affect is associated with the respective RR for stroke.

positive affect and 16-item negative affect subscales on the incidence of stroke stratified by gender and adjusting for all variables included in Table 3. There was a significant and inverse association between positive affect and incidence of stroke for both men and women. Results were stronger for men, in whom each unit increase in positive affect was associated with a 41% decrease in the incidence of stroke, than for women, in whom each unit increase in positive affect was associated with a 18% decrease in stroke incidence.

There were nonsignificant trends between negative affect scores and stroke incidence for the entire sample and for men and women separately. Results for the other predictors of stroke were similar to those listed in Table 3.

Table 5 shows the relationship between stroke and the 4-item positive affect and 16-item negative affect subscales stratified by race and adjusting for sociodemographic and health characteristics. A significant inverse relationship between positive affect and stroke was observed for both older whites and blacks. Each unit increase in positive affect was associated with a 32% decrease in the risk of stroke for whites and a 27% decrease in risk for blacks.

DISCUSSION

The role of depressive symptomatology has received increased attention because of its impact on chronic disease and disability in older populations (2, 6–8, 22–24). The present study supplements the observations of earlier studies with two important findings. First, the influence of depressive symptomatology on stroke is independent of other known risk factors for stroke. Second, measures of positive affect are more strongly linked to stroke incidence than are measures of negative affect. For the overall sample, the risk of stroke increased by 4% for each unit (one-point) increase in score on the modified CES-D after adjusting for sociodemographic characteristics and other known risk factors for stroke. We then divided the CES-D into its two main components, the 16-item negative affect subscale and the 4-item positive affect subscale. Our results suggest that increasing levels of positive affect are strongly associated with a reduced risk of stroke. This inverse association between positive affect and stroke held for the entire sample, by gender and by race, after controlling for known risk factors of stroke and for negative affect score.

Education had a significant relationship with stroke

TABLE 5. Multivariate Analysis of Risk of Stroke[a] by Continuous Positive and Negative Affect During the 6-Year Follow-Up Period

	Whites (*N* = 1129)			Blacks (*N* = 1349)		
	RR[b]	95% CI	*p*	RR[b]	95% CI	*p*
Positive affect	0.78	0.62–0.98	.04	0.73	0.56–0.95	.02
Negative affect	1.06	0.99–1.13	.10	0.98	0.92–1.05	.60
Gender (male)	2.36	1.47–3.80	.0004	1.34	0.72–2.47	.22
Age						
65–74 y	1.00			1.00		
75–84 y	1.96	1.25–3.07	.003	1.36	0.89–2.06	.15
≥85 y	2.16	0.92–5.06	.08	1.38	0.53–3.59	.51
Income (≥$10,000)	0.47	0.28–0.78	.003	0.61	0.33–1.12	.11
Education						
0–8 y	2.07	0.96–4.46	.06	1.92	0.77–4.80	.16
9–11 y	1.78	0.86–3.67	.11	1.32	0.52–3.36	.56
12 y	2.22	0.94–5.26	.07	1.14	0.28–4.64	.86
>12 y	1.00			1.00		
Marital status (unmarried vs. married)	1.05	0.63–1.73	.86	1.66	1.03–2.67	.04
BMI						
<22	1.63	1.04–2.54	.03	1.19	0.66–2.14	.57
≥30	1.59	0.90–2.82	.11	1.50	0.97–2.31	.07
22–29.9 (reference)	1.00			1.00		
Current smoker	1.35	0.82–2.23	.23	1.33	0.78–2.25	.29
Heart attack	1.53	0.97–2.44	.07	1.51	0.90–2.53	.12
Diabetes	1.47	0.89–2.44	.14	2.19	1.47–3.26	.0001
Systolic blood pressure						
<140 mm Hg	1.00			1.00		
140–<160 mm Hg	1.47	0.95–2.28	.08	1.21	0.77–1.90	.41
≥160 mm Hg	1.64	0.97–2.76	.06	1.96	1.24–3.12	.004

[a] A total of 340 strokes (152 in whites and 188 in blacks) occurred during the 6-year follow-up period. All subjects were stroke-free at baseline.
[b] Each point increase in positive and negative affect is associated with the respective RR for stroke.

for the overall sample and for men in particular. Being unmarried also had a significant relationship with incident stroke for women and blacks. This finding may be due to the increased number of stressors facing older women. In addition to living alone, older women typically report more health problems than men. Thus, the additive effect of being unmarried and the greater health burdens of old age may make older women more vulnerable to stroke. In general, higher systolic blood pressure was related to incident stroke for men and women as well as for whites and blacks.

Various mechanisms can be proposed to account for the association between positive affect and stroke incidence. Positive affect is related to a number of characteristics known to improve health or to protect against chronic disease. Individuals who report high levels of positive affect may be more likely to exercise, to maintain a healthy lifestyle, and to adhere to medical therapy. In addition, the recently described associations between moderate alcohol consumption and lower risk of stroke (25) might be linked to our findings of a protective effect of positive affect on stroke. Although we do not have reliable information on alcohol intake in our population, Poikolainen and Vartiainen (26) reported that the consumption of one to four drinks of wine per week was significantly associated with good subjective health for men and women aged 25 to 64, and moderate consumption of alcohol relative to heavy consumption seems to reduce the risk of total stroke and ischemic stroke by reducing platelet aggregation and fibrinogen levels as well as by increasing levels of tissue plasminogen activator (24).

There are a number of limitations to this study. First, because we used self-reported data, we were unable to determine the severity of the stroke, its location, or type. In addition, it is possible that some individuals may have experienced a stroke without their knowledge or their physician's knowledge before the baseline interview. Second, the inverse relationship observed between positive affect and stroke incidence is not necessarily causal and may be mediated by some unmeasured variable. However, a strong relationship between positive affect remained for men and women and for whites and blacks after controlling for known risk factors of stroke. Thus, the results of our analyses suggest an independent and protective effect of positive affect on incidence of stroke. A third limitation may be the use of the modified CES-D. Because

each item on the modified version was collapsed from a four-level response to a dichotomous response, some of the variability in the original scale may have been lost. Blazer et al. (20) report, however, that the modified CES-D produced results similar to those obtained with the original CES-D when tested on individuals from the New Haven EPESE study. Finally, our measure of positive affect is relatively crude. Because positive affect encompasses such overlapping concepts as happiness, self-efficacy, personal growth, optimism, autonomy, and morale, one could argue that it would not be well represented by a four-item scale (27). On the other hand, this scale was a relatively robust, independent predictor of stroke, which validates its ability to discriminate within a population.

In conclusion, degree of positive affect is strongly associated with risk of stroke. Together with known risk factors of stroke, an individual's emotional state may play a role in stroke risk. Perhaps the next step is to investigate whether interventions aimed at improving an older individual's level of positive affect can reduce his or her risk of stroke or improve recovery from stroke.

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