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Pre-Stroke Factors Associated with Post-Stroke Mortality and Recovery in Older Women in the Women's Health Initiative

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Abstract

Objectives—We sought to examine pre-stroke lifestyle factors associated with post-stroke mortality and recovery in older women.

Design—Longitudinal prospective cohort study.

Setting—The Women's Health Initiative (clinical trials and observational study), 40 clinical centers in the U.S.

Participants—WHI participants, women aged 50–79, who were stroke-free at baseline 1993–1998, with incident stroke prior to 2005.

Measurements—Participants were followed for mortality through 2010. Pre-stroke characteristics were from the most proximal examination before the stroke event. Annual follow-up for clinical events ascertained hospitalization for stroke which was subsequently physician-adjudicated with medical records. Multivariable regression models analyzed factors associated with post-stroke mortality and post-stroke recovery at hospital discharge (post-stroke Glasgow score), adjusting for stroke type.

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Study concept and design: CB, AL, KM, JDC, SWS

Acquisition of data: AL, SWS (representing the WHI)

Analysis and interpretation of data: CB, KM, EH, TM, JDC, SWS

Preparation of manuscript: CB, KM

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Results—Of 3,173 women with incident stroke, 1,111 (35%) died. Overweight and obese BMI pre-stroke was associated with reduced post-stroke mortality (vs. normal BMI, obese BMI hazards ratio, HR=0.69, 95% confidence interval (CI)=0.53–0.88; overweight BMI: HR=0.72, 95% CI=0.58–0.90); underweight pre-stroke BMI had borderline increased post-stroke mortality (HR=2.02, 95% CI=0.98–4.16). Other pre-stroke factors associated with post-stroke mortality included diabetes (HR=1.28, 95% CI=1.01–1.64), current smoking (vs. nonsmoker, hazard ratio (HR)=2.13, 95% CI=1.53–3.00), physical inactivity (vs. >150 minutes exercise/week, HR=1.39, 95% CI=1.09–1.78) and lowest physical function quartile (vs. highest, HR=1.54, 95% CI=1.18–2.02). Pre-stroke diabetes was associated with reduced odds of good recovery post-stroke (odds ratio (OR)= 0.60, 95% CI= 0.44–0.82). Current hormone use pre-stroke was associated with increased odds of moderate vs. severe disability post-stroke (OR=1.29, 95% CI=1.00–1.66).

Conclusion—Potentially modifiable factors pre-stroke, including smoking, diabetes and underweight BMI, were associated with increased post-stroke mortality in older women. Pre-stroke overweight or obese BMI and physical activity were associated with reduced post-stroke mortality in older women.

Keywords

stroke; mortality; women; BMI; recovery; diabetes

INTRODUCTION

Older age is a significant risk factor for stroke.¹ Stroke is a leading cause of disability^{2,3} and the third leading cause of death in women.⁴ Older women may have lower functional recovery,⁵ higher risk of disability² and higher mortality⁶ from stroke than older men. For clinicians caring for older women, a clear understanding of the risks and benefits are important when making recommendations for lifestyle modifications to reduce stroke morbidity and mortality.

Lifestyle modifications including weight reduction, physical exercise, and smoking cessation may be beneficial due to effects on diabetes and vascular disease⁷ and are recommended to reduce stroke incidence.¹ Recent studies in non-stroke populations suggest that in older adults body mass index (BMI) may have an inverse relationship with overall mortality.⁸ Low BMI has been associated with increased overall mortality, while overweight BMI is associated with reduced overall mortality compared to normal BMI.⁹

Although obesity is a risk factor for stroke incidence,¹⁰ data on the relationships of BMI with post-stroke outcomes have been conflicting.^{11,12} For example, weight loss is recommended to reduce stroke morbidity and mortality,¹ but poor nutritional status was associated with worse outcomes for hospitalized stroke patients in the FOOD trial.¹³ Data is elusive on the relationship between BMI and stroke mortality or recovery in older women, limiting clinicians' ability to determine whether weight loss should be recommended for older overweight or obese women with stroke risk factors. Since most previous studies of post-stroke mortality were hospital-based, there are virtually no prospective data from large cohorts on the impact of pre-stroke lifestyle on post-stroke mortality or recovery. However, modifying lifestyle factors may help efforts to reduce post-stroke mortality and improve post-stroke recovery among older women.

The Women's Health Initiative (WHI) provides a unique opportunity to examine lifestyle factors associated with post-stroke mortality and recovery in older women. This large, multi-center study collected data on older women who suffered first-time incident stroke. We sought to identify pre-stroke lifestyle factors related to mortality and recovery after incident stroke among WHI participants.

METHODS

Sample population

The WHI study has been described in detail elsewhere.^{14–17} Data from the WHI were collected prospectively from 40 clinical centers to complete the randomized clinical trials (CTs) and observational study (OS). The 161,808 postmenopausal women participants aged 50–79 were recruited from 1993 through 1998. Women likely to die or relocate within three years were excluded. Each study center obtained informed consent and IRB approval. These analyses included women, stroke-free at baseline examination, with a first-time incident stroke before 2005. We excluded 2221 women with prevalent strokes at baseline, leaving 3,173 WHI participants who suffered first-time stroke between enrollment and 2005. Figure 1 displays the selection process of participants for the analytic sample.

Stroke Surveillance

Study neurologists reviewed and adjudicated all potential strokes using standardized criteria. We excluded events not requiring hospitalization and transient ischemic events. Stroke type was classified as ischemic, hemorrhagic or undefined, using brain imaging. Ischemic strokes were rapid onset of a persistent (>24 hours) neurological deficit from an occlusion of cerebral or precerebral arteries with infarction without evidence for other causes.¹⁸ Hemorrhagic strokes had blood in the subarachnoid space or intraparenchymal hemorrhage by computed tomography or magnetic resonance imaging. Undefined strokes satisfied criteria for stroke but had inadequate information for categorization as hemorrhagic or ischemic.¹⁹ Post-stroke Glasgow Outcomes Scale scores were determined at hospital discharge from hospital records with post-stroke recovery categorized as good recovery, moderate disability, severe disability and vegetative survival.²⁰

Data collection

Pre-stroke baseline data were collected from questionnaires and physical examinations. The most proximal measure before the stroke was used. Covariates included cardiovascular risk factors and mortality risk factors.

Pre-stroke lifestyle factors considered potentially modifiable included BMI (underweight <18.5 kg/m², normal 18.5–24.9 kg/m², overweight 25.0–29.9 kg/m², and obese ≥30 kg/m²);²¹ functional status (determined by Rand-36 physical function subscale); physical activity (minutes of moderate/vigorous activity per week: none, 1–74 minutes/week, 75–149 minutes/week and >150 minutes/week); smoking (current, past and never smoker); depressive symptoms (assessed using the Center for Epidemiologic Studies Depression Scale);^{22,23} hormone status (clinical trial vs. observational study enrollment or randomization were not controlled for) and prevalent diabetes and hypertension.

Other pre-stroke factors included prevalent diseases, income, marital status and social support. Pre-stroke prevalent diseases examined included CHD and cancer. Income levels pre-stroke were dichotomized by median \$35,000/year. Marital status pre-stroke was dichotomized as married/like relationship vs. not married, divorced, widowed. Social support pre-stroke was assessed using the Medical Outcomes Study Social support questionnaire score. Date and cause of death were adjudicated through 2010.

Statistical methods

The primary endpoint was survival after incident stroke, time from incident stroke to death from any cause or end of follow up in the absence of death. Participants without a verified death date were censored at the date last known alive. Cox proportional hazards models assessed univariate associations between potential risk factors for the outcome of post-stroke

good mortality. A secondary analysis explored factors related to post-stroke recovery through multinomial logistic regression models. We modeled post-stroke recovery as measured by the Glasgow outcomes scale comparing the outcomes of good recovery vs. severe disability or vegetative survival and moderate disability vs. severe disability or vegetative survival.²⁰ In both sets of analyses, multivariable models included all covariates strongly related upon univariate analysis. The proportional hazards assumption was assessed, with appropriate adjustments made when non-proportionality was detected. All reported p-values are two-sided. Analyses used SAS (version 9.2, SAS Institute Inc., Cary, NC) and Stata (version 10.1, Stata Corp) software.

RESULTS

Of the 3,173 WHI participants who suffered first-time stroke between enrollment and 2005, 35% (n=1,111) died by 2010. The mean age at stroke was 72.6 years. The majority of women (71%) suffered ischemic strokes, 17% suffered hemorrhagic stroke and 12% suffered undefined strokes. Glasgow Outcome Scale at post-stroke hospital discharge showed good recovery in 32%, moderate disability in 36%, severe disability in 31% and vegetative survival in less than 1% in patients where it was available. The cause of death was cerebrovascular for 44% of women, cancer for 16% of women, and other heart disease for 17% of women. Table 1 displays the participants' baseline characteristics.

Table 2 displays the unadjusted associations between demographic or stroke characteristics and survival. Increased post-stroke mortality was associated with the following lifestyle factors: underweight BMI, smoking, lack of physical activity, lower pre-stroke physical function, diabetes and hypertension. Other factors associated with post-stroke mortality included increased age at stroke, unmarried status, lower income, previous TIA, heart disease and cancer. Hemorrhagic and other stroke types were associated with higher mortality risk compared to ischemic strokes. Severe post-stroke disability (hospital discharge Glasgow Outcome Scale) was associated with higher mortality risk than good function post-stroke.

Table 3 displays the final adjusted multivariable Cox regression model for the outcome of post-stroke mortality. Overweight and obese BMI pre-stroke was associated with reduced post-stroke mortality compared to normal BMI. Underweight pre-stroke BMI was borderline significantly associated with increased post-stroke mortality compared to normal BMI. Pre-stroke diabetes was associated with increased odds of post-stroke mortality. Other modifiable factors associated with post-stroke mortality included smoking, physical inactivity and low physical function. Prevalent hypertension demonstrated a borderline significantly association with increased post-stroke mortality. Worsened post-stroke recovery on Glasgow Outcome Scale at the time of discharge from stroke hospitalization was associated with post-stroke mortality, with highest association at 1-year post-stroke and decreasing associations out to 10-years post-stroke.

Table 4 displays the final adjusted multivariable multinomial logistic regression models for the outcomes of post-stroke recovery. These models examined the outcomes of good recovery vs. severe disability or vegetative survival and moderate disability vs. severe disability or vegetative survival. Pre-stroke diabetes was associated with reduced odds of good recovery post-stroke. Current hormone use pre-stroke was associated with increased odds of moderate vs. severe disability post-stroke. Older age, unmarried status, and hemorrhagic (vs. ischemic) stroke type were also associated with reduced odds of good post-stroke recovery at hospital discharge. Pre-stroke BMI categories were not associated with likelihood of post-stroke recovery at hospital discharge (data not shown).

DISCUSSION

This study examined 3,173 post-menopausal women aged 51 to 88 years at the time of stroke and is the first prospective study to examine the relationship between BMI and post-stroke mortality and recovery specifically in older women. Overweight and obese older women had decreased likelihood of post-stroke mortality compared to women with normal BMI, and underweight women had a borderline increased likelihood of post-stroke mortality compared to normal BMI. Additional potentially modifiable pre-stroke factors associated with post-stroke mortality included diabetes, smoking, physical activity and physical function. Important and potentially modifiable pre-stroke lifestyle factors associated with post-stroke function at the time of acute hospital discharge included diabetes and pre-stroke current hormone use.

Overweight and obese pre-stroke was associated with a 30% decreased likelihood of post-stroke mortality compared to women with normal BMI. Women with underweight pre-stroke BMI had double the mortality risk of women with normal BMI, even after controlling for smoking, cancer, diabetes, cardiovascular risk factors and physical activity. To our knowledge, there are no previous population-based studies of the relationship between prospectively measured pre-stroke BMI and post-stroke mortality among older women in the U.S. In previous studies, BMI has been associated with decreased likelihood of post-stroke mortality among men and women of all ages hospitalized for stroke in Greece¹¹ and Japan.²⁴ The FOOD Trial Collaboration found that male and female hospitalized stroke patients (mean age 73 years) who appeared to be undernourished suffered more complications post-stroke, including pneumonia, infections and gastrointestinal hemorrhage.¹³ Underweight BMI may indicate frailty,²¹ a mortality risk factor in the WHI Observational Study.²⁵

Our study identified several additional other modifiable pre-stroke factors associated with post-stroke mortality and recovery. Pre-stroke diabetes was associated with decreased odds of post-stroke mortality. Pre-stroke diabetes was also associated with decreased odds of good recovery post-stroke at the time of hospital discharge. Pre-stroke smoking more than doubled the post-stroke mortality risk in older women, after controlling for cancer, other cardiovascular risk factors, stroke type and Glasgow Outcome Scale. Past smoking increased the risk by 49%. Carter examined male and female stroke patients in four hospitals in England combined and reported that smoking was not a significant predictor of post-stroke mortality in multivariate analyses.²⁶ Lack of physical activity pre-stroke was associated with a 39% increased risk of post-stroke mortality compared to women who exercised more than 150 minutes per week. This risk factor may be modifiable through exercise and activity programs for older women. Although low physical activity is a known stroke risk factor,²⁷ no previous study has examined the relationship between physical activity prior to stroke and post-stroke mortality. The only prior study to examine physical activity and post-stroke mortality was a Norwegian study by Engstad which collected data on the Frenchay Activity Index as a measure of activity level after stroke and examined long-term post-stroke mortality comparing to a group of stroke-free subjects. In that study, the post-stroke activity level may have been a function of the stroke severity, rather than a modifiable lifestyle factor, as our pre-stroke physical activity measure represents.²⁸ Lower pre-stroke function was associated with higher risk of mortality post-stroke. No prior study of post-stroke mortality examined prospectively measured pre-stroke function. Few studies have examined retrospectively assessed pre-stroke function (as prior difficulty walking obtained during stroke admission evaluation) and post-stroke mortality.^{29,30} Post-stroke mortality risk progressively increased with decreasing levels of pre-stroke function.

This study is one of the largest studies of post-stroke mortality of women and included pre-stroke comorbid diseases, lifestyle and physical function not available in many stroke database studies. The WHI study cohort includes a very large, ethnically and geographically diverse U.S. population and long follow-up period. The stroke data were carefully measured and prospectively collected using standardized criteria. Loss to follow up was minimal.²⁹

This study had several limitations. Not all strokes were typed due to death before imaging. Only strokes with hospitalization were included. Hospital stroke management, medication use, hyperlipidemia, peripheral artery disease, alcohol use, cognitive function and atrial fibrillation were not included in this study.

Further research is needed to identify potential interventions to reduce post-stroke mortality. Smoking cessation and increasing physical activity may be important areas for future study in older women. Low protein diets have been associated with frailty risk.³⁰ Clinical experience suggests that higher BMI could be protective against post-stroke mortality in older women due to increased BMI reserve in the post-stroke period, when dysphagia and nutritional intake issues may be especially problematic for women with lower BMI. Increased dietary protein in underweight older women may be an important potential intervention to reduce post-stroke mortality. Our research suggests that physical activity may be a beneficial recommendation for older women to reduce stroke morbidity and mortality. More research is needed to understand the implications of lifestyle modification among older women at risk for stroke morbidity and mortality.

Conclusion

This study of 3,173 post-menopausal women in the WHI aged 51 to 88 years at the time of stroke is the first to examine prospectively collected lifestyle factors before stroke and found that overweight and obese BMI is associated with reduced post-stroke mortality compared to normal BMI, while underweight BMI was associated with increased post-stroke mortality. Pre-stroke smoking and low physical function were also associated with increased post-stroke mortality; physical activity pre-stroke was associated with decreased post-stroke mortality. Pre-stroke diabetes was associated with reduced post-stroke recovery at hospital discharge.

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Conflict of Interest:

Drs. Bell, Masaki, Manini and Wassertheil-Smoller received WHI grant funding from NHLBI.

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Figure 1.
Flow of participants through study process.

Table 1

Baseline Characteristics of Postmenopausal Women with Incident Stroke.

Participant characteristic	Overall sample n= 3,173 (% ^a)	Survivors n= 2,062 (65.0%)	Decedents n=1,111 (35.0%)
Age at stroke ^b	72.6 ± 6.8	71.8 ± 6.8	74.0 ± 6.4
Race/ Ethnicity			
White	2616 (82.8)	1679 (64.2)	937 (35.8)
Black	350 (11.1)	244 (69.7)	106 (30.3)
Hispanic	76 (2.4)	51 (67.1)	25 (32.9)
Asian	67 (2.1)	48 (71.6)	19 (28.4)
Other	51 (1.6)	32 (62.8)	19 (37.3)
Marital status			
Never/ not married	1500 (47.5)	924 (61.6)	576 (38.4)
Currently married	1656 (52.5)	1129 (68.2)	527 (31.8)
Social support score ^c	34.9 ± 8.1	35.1 ± 8.1	34.6 ± 8.2
Education			
Less than high school	245 (7.8)	151 (61.6)	94 (38.4)
High school graduate	589 (18.7)	402 (68.3)	187 (31.8)
> High school	1263 (40.2)	826 (65.4)	437 (34.6)
College degree	1048 (33.3)	663 (63.3)	385 (36.7)
Income			
Income <\$35,000	1648 (55.8)	1028 (62.4)	620 (37.6)
Income ≥\$35,000	1308 (44.3)	890 (68.0)	418 (32.0)
Body mass index (BMI)			
Underweight BMI ^a	32 (1.0)	15 (46.9)	17 (53.1)
Normal BMI	936 (29.8)	557 (59.5)	379 (40.5)
Overweight BMI	1126 (35.9)	750 (66.6)	376 (33.4)
Obese BMI	1044 (33.3)	720 (69.0)	324 (31.0)
Baseline diabetes	499 (15.7)	298 (59.7)	201 (40.3)
Baseline hypertension	2031 (64.0)	1287 (63.4)	744 (36.6)
Depressive symptoms ^b	761 (24.3)	497 (65.3)	264 (34.7)
Smoking status			
Never smoker	1589 (50.8)	1089 (68.5)	500 (31.5)
Past smoker	1270 (40.6)	792 (62.4)	478 (37.6)
Current smoker	268 (8.6)	153 (57.1)	115 (42.9)
Pre-stroke physical activity ^c			
No physical activity	1386 (46.4)	862 (62.2)	524 (37.8)
1–74 minutes/week	574 (19.2)	380 (66.2)	194 (33.8)
75–149 minutes/week	354 (11.8)	244 (68.9)	110 (31.1)
>150 minutes /week	675 (22.6)	462 (68.4)	213 (31.6)
Pre-stroke functional ability			

Participant characteristic	Overall sample n= 3,173 (% ^a)	Survivors n= 2,062 (65.0%)	Decedents n=1,111 (35.0%)
Lowest function Q1	769 (24.5)	437 (56.8)	332 (43.2)
Function Q2	625 (19.9)	396 (63.4)	229 (36.6)
Function Q3	790 (25.1)	524 (66.3)	266 (33.7)
Highest function Q4	959 (30.5)	688 (71.7)	271 (28.3)
Hormone status			
Never used hormones	1106 (36.2)	718 (64.9)	388 (35.1)
Past hormone user	838 (27.4)	535 (63.8)	303 (36.2)
Current hormone user	1114 (36.4)	746 (67.0)	368 (33.0)
Prevalent diseases			
TIA	238 (7.5)	137 (57.6)	101 (42.4)
Coronary Heart Disease	125 (3.9)	63 (50.4)	62 (49.6)
Cancer	492 (15.5)	258 (52.4)	234 (47.6)
Stroke type			
Ischemic Stroke type	2255 (71.1)	1565 (69.4)	690 (30.6)
Hemorrhagic Stroke type	540 (17.0)	262 (48.5)	278 (51.5)
Other Stroke type	378 (11.9)	235 (62.2)	143 (37.8)
Post-Stroke Glasgow			
Good recovery	705 (32.1)	559 (79.3)	146 (20.7)
Moderately disabled	782 (35.6)	618 (79.0)	164 (21.0)
Severely disabled	692 (31.5)	428 (61.9)	264 (38.2)
Vegetative survival	15 (0.7)	6 (40.0)	9 (60.0)

^aCounts may not add up to overall totals due to missing data.

^bAge at stroke, range 51.08–87.95 years.

^cSocial Support Score (Medical Outcomes Study): median 36.00, range 9–45, higher=greater support.

^aMean BMI 28.50 ±6.13 (range 14.63–67.33), median 27.44.

^bDepressive symptoms(CESD-11 instrument).

^cMinutes of moderate to vigorous physical activity per week.

Table 2

Factors Associated with Mortality among Women after Incident Stroke (Crude Unadjusted Cox Proportional Hazards Models).

Participant characteristic	Hazards Ratio (95% Confidence Intervals)	p value
Age at Stroke	1.06 (1.05–1.07)	<.001
Race/Ethnicity	White = reference	
Black	0.86 (0.71–1.05)	0.15
Hispanic	1.00 (0.67–1.49)	0.99
Asian	0.82 (0.52–1.29)	0.39
Other	1.09 (0.69–1.71)	0.73
Marital status	Currently married = reference	
Never/ not married	1.28 (1.14–1.44)	<.001
Social Support score	0.99 (0.99–1.00)	0.07
Education	College graduate = reference	
More than high school	0.97 (0.84–1.11)	0.65
High school graduate	0.89 (0.75–1.06)	0.18
Less than high school	1.14 (0.91–1.43)	0.27
Income \$35,000	0.79 (0.70–0.89)	<.001
Body Mass Index (BMI)	Normal BMI =reference	
Underweight	1.62 (1.00–2.64)	0.05
Overweight	0.78 (0.67–0.89)	<.001
Obese	0.72 (0.62–0.83)	<.001
Baseline diabetes	1.27 (1.09–1.48)	0.002
Baseline hypertension	1.27 (1.12–1.44)	<.001
Baseline depressive symptoms	0.98 (0.85–1.12)	0.74
Baseline smoking status	Never smoker = Reference	
Past smoker	1.26 (1.11–1.43)	<.001
Current smoker	1.52 (1.24–1.86)	<.001
Pre-stroke physical activity	>150 minutes /week = Reference	
No physical activity	1.31 (1.11–1.53)	0.001
1–74 minutes/week	1.15 (0.95–1.40)	0.16
75–149 minutes/week	1.02 (0.81–1.28)	0.90
Pre-stroke functional ability	Highest function quartile 4 = Reference	
Lowest function quartile 1	1.84 (1.57–2.16)	<.001
Function quartile 2	1.42 (1.19–1.69)	<.001
Function quartile 3	1.27 (1.07–1.50)	0.006
Hormone status	Never used hormones = Reference	
Past hormone user	1.03 (0.89–1.20)	0.70
Current hormone user	0.92 (0.80–1.06)	0.25
History of previous TIA	1.31 (1.07–1.61)	0.009
Baseline coronary heart disease	1.78 (1.38–2.30)	<.001
Baseline cancer	1.75 (1.51–2.02)	<.001

Participant characteristic	Hazards Ratio (95% Confidence Intervals)	p value
Incident stroke type	Ischemic stroke = Reference	
Hemorrhagic stroke	2.29 (1.99–2.64)	<.001
Other stroke type	1.34 (1.12–1.61)	0.001
Glasgow Score Post-stroke	Good recovery = Reference	
Moderately disabled	1.07 (0.85–1.33)	0.58
Severely disabled	2.57 (2.10–3.15)	<.001
Vegetative survival	6.07 (3.09–11.90)	<.001

Table 3

Factors Associated with Mortality among Women after Incident Stroke (Multivariable Cox Proportional Hazards Model, N=2,749)

Participant characteristic	Adjusted Hazards Ratio (95% CI)	p value
Age at stroke	1.07 (1.05–1.08)	<.001
Not married ^a vs. married	0.95 (0.77–1.16)	0.59
Social support score	1.00 (0.98–1.01)	0.39
Income <\$35,000 vs. \$35,000	1.11 (0.91–1.37)	0.31
Normal BMI	Reference	
Underweight BMI	2.02 (0.98–4.16)	0.06
Overweight BMI	0.72 (0.58–0.90)	0.004
Obese BMI	0.69 (0.53–0.88)	0.003
Baseline diabetes	1.28 (1.01–1.64)	0.045
Baseline hypertension	1.19 (0.98–1.45)	0.09
Never smoker	Reference	
Current smoker	2.13 (1.53–3.00)	<.001
Past smoker	1.48 (1.22–1.79)	<.001
Pre-stroke physical activity		
No physical activity	1.39 (1.09–1.78)	0.009
1–74 minutes/week	1.32 (0.99–1.76)	0.06
75–149 minutes/week	1.14 (0.82–1.58)	0.44
>150 minutes /week	Reference	
Pre-stroke functional ability		
Lowest function quartile 1	1.54 (1.18–2.02)	0.002
Function quartile 2	1.30 (0.99–1.72)	0.06
Function quartile 3	1.23 (0.95–1.57)	0.1
Highest function quartile 4	Reference	
Incident stroke type		
Ischemic stroke	Reference	
Hemorrhagic stroke	1.02 (0.77–1.36)	0.87
Other stroke type	1.33 (0.80–2.20)	0.28
Prevalent conditions pre-stroke		
TIA prior to stroke	0.89 (0.60–1.33)	0.57
Coronary heart disease	1.39 (0.92–2.11)	0.12
Cancer	1.73 (1.39–2.15)	<0.0001
Post-stroke Glasgow outcome scale		
Good recovery	Reference	
Moderately disabled	1.05 (0.78–1.40)	0.75
Severely disabled /vegetative survival ^a 1 year	2.58 (1.99–3.33)	<.001
Severely disabled / vegetative survival 5 years	1.69 (1.26–2.26)	<.001
Severely disabled / vegetative survival 10 years	1.40 (0.97–2.03)	0.07

^aNever married, divorced or widowed vs. currently married

^aGlasgow outcome scale score at stroke hospitalization discharge as a time varying covariate for the outcome of post-stroke mortality, (the hazard of death at year 1 for those “Severe or worse” on the Glasgow scale is approximately 2.58 times that of a woman with “Good” Glasgow score, and this risk decreases to 1.4 times by year 10).

Table 4

Factors Associated with Short-Term Recovery among Women at Hospital Discharge Post-stroke
(Multivariable Cox Proportional Hazards Model, N=2,118)

Participant characteristic	Odds of good recovery vs. severe disability/vegetative state	Odds of moderate disability vs. severe disability/vegetative state	p value
Age at stroke (1 year increase)	0.95 (0.93 – 0.96)	0.96 (0.95 – 0.98)	<0.001
Not married vs. married	0.79 (0.64 – 0.99)	0.72 (0.58 – 0.89)	0.010
Stroke type			
Ischemic	Reference	Reference	<0.001
Hemorrhagic	0.29 (0.20 – 0.40)	0.33 (0.24 – 0.46)	
Other stroke type	3.01 (1.55 – 6.13)	2.21 (1.09 – 4.44)	
Baseline diabetes	0.60 (0.44 – 0.82)	0.98 (0.74 – 1.31)	0.001
Hormone status			
Never used	Reference	Reference	0.075
Past user	0.85 (0.65 – 1.13)	1.20 (0.92 – 1.56)	
Current user	0.99 (0.76 – 1.28)	1.29 (1.00 – 1.66)	