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Pre-Stroke Weight Loss is Associated with Post-Stroke Mortality among Men in the Honolulu-Asia Aging Study

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Abstract

Objective—To examine baseline pre-stroke weight loss and post-stroke mortality among men.

Design—Longitudinal study of late-life pre-stroke body mass index (BMI), weight loss and BMI change (midlife to late-life), with up to 8-year incident stroke and mortality follow-up.

Setting—Honolulu Heart Program/Honolulu-Asia Aging Study.

Participants—3,581 Japanese-American men aged 71–93 years and stroke-free at baseline.

Main Outcome Measure—Post-stroke Mortality: 30-day post-stroke, analyzed with stepwise multivariable logistic regression and long-term post-stroke (up to 8-year), analyzed with stepwise multivariable Cox regression.

Results—Weight loss (10-pound decrements) was associated with increased 30-day post-stroke mortality (aOR=1.48, 95%CI 1.14–1.92), long-term mortality after incident stroke (all types n=225, aHR=1.25, 95%CI=1.09–1.44) and long-term mortality after incident thromboembolic stroke (n=153, aHR 1.19, 95%CI-1.01–1.40). Men with overweight/obese late-life BMI (≥25kg/m^2, compared to normal/underweight BMI) had increased long-term mortality after incident hemorrhagic stroke (n=54, aHR=2.27, 95%CI=1.07–4.82). Neither desirable nor excessive BMI reductions (vs. no change/increased BMI) were associated with post-stroke mortality. In the overall sample (n=3,581), nutrition factors associated with increased long-term mortality included 1) weight loss (10-pound decrements, aHR=1.15, 1.09–1.21); 2) underweight BMI (vs. normal BMI, aHR=1.76, 1.40–2.20); and 3) both desirable and excessive BMI reductions (vs. no change or gain, separate model from weight loss and BMI, aHRs=1.36–1.97, p<0.001).

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Conclusions—Although obesity is a risk factor for stroke incidence, pre-stroke weight loss was associated with increased post-stroke (all types and thromboembolic) mortality. Overweight/obese late-life BMI was associated with increased post-hemorrhagic stroke mortality. Desirable and excessive BMI reductions were not associated with post-stroke mortality. Weight loss, underweight late-life BMI and any BMI reduction were all associated with increased long-term mortality in the overall sample.

Keywords

older men; stroke; weight loss; BMI; mortality; aged; longitudinal

Obesity, which affects 33.7% of adults in the U.S.,[1] is a known risk factor for cardiovascular disease.[2] Weight reduction programs have emphasized cardiovascular benefits of weight loss for obese adults, especially with diabetes.[3] A recent meta-analysis reported that increasing body mass index (BMI) measures were associated with increasing cardiovascular mortality.[4]

However, data are conflicting on the relationship between pre-stroke nutritional status and post-stroke mortality, especially in the elderly. The recent meta-analysis reported stronger relationships between increasing BMI and stroke mortality in midlife compared to late-life.[4] Previous studies have suggested that higher BMI at the time of stroke may be associated with reduced risk of post-stroke mortality.[5,6] Undernourished stroke patients were reported to have higher rates of post-stroke complications including pneumonia.[7]

Underweight BMI and weight loss are known risk factors for mortality among elderly nursing home patients.[8–10] Stroke is an important cause of mortality for older adults.[1] However, data examining pre-stroke weight loss and post-stroke mortality are limited because most studies of post-stroke mortality use data from large hospital stroke samples without information on nutritional status prior to the stroke hospitalization.

The Honolulu Heart Program has over 47 years of prospective, longitudinally collected data on both cardiovascular disease and nutritional status, with nearly complete follow-up for mortality.[11–14] We sought to examine the relationship between prospectively measured nutritional measures collected prior to incident stroke, and post-stroke mortality. We hypothesized that both underweight BMI and weight loss between midlife and late-life were associated with post-stroke mortality among elderly men.

Methods

Population, Data Collection, and Design

This study used Honolulu Heart Program/Honolulu-Asia Aging Study (HHP/HAAS) data. This prospective longitudinal study of cardiovascular disease began in 1965 with 8,006 Japanese-American men born between 1900 and 1919.[12] The 1991–93 examination included 80% of the 4676 survivors of the original HHP cohort, 3,741 men aged 71–93 years. Longitudinal follow-up has included serial examinations and review of hospital and death records since 1965.

These analyses included men who were stroke-free by both self-report and continuous stroke event hospital surveillance from 1965 to the 1991–93 examination (n=3,581). The 1991–93 examination served as the late-life baseline for the current analyses, which focus on mortality after incident stroke among elderly men. Participants were followed for incident stroke and mortality from 1991 to December 1999, and were divided into groups by stroke and mortality status. The stroke group included participants with first-ever incident stroke between 1991 and December 1999. The stroke-free group remained without stroke from 1991 through 1999. Each group was further divided into participants who died prior to 1/1/2000, and those who survived through 12/31/1999. All data collection and analyses were approved by the institutional review boards of the University of Hawaii and Kuakini Medical Center. All subjects gave written informed consent at each examination.

Stroke Surveillance

Continuous surveillance of all Oahu hospital and death records detected incident ischemic and hemorrhagic strokes. Strokes were diagnosed if there were neurological deficits that persisted for two weeks or until death, accompanied by blood in CSF or neuroimaging evidence of infarct or hemorrhage. Possible strokes were not included as stroke events, but were included in the stroke-free group. Repeat analyses excluding the possible strokes resulted in minimal difference in hazard ratios for variables in the models. Diagnosis of stroke was reviewed and confirmed by a study neurologist and the morbidity and mortality review committee.[13,15]

Nutritional Measures

Nutritional indicators included weight loss (10-pound decrements, average of weights measured in 1965 to 1974 at the midlife examinations minus weight measured in 1991 to 1993 at the late-life baseline examination); midlife body mass index (BMI in kg/m^2, average of midlife examinations, categorized according to U.S. Centers for Disease Control (CDC) criteria: underweight (<18.5 kg/m^2), normal (18.5 to <25 kg/m^2), overweight (25 to <30 kg/m^2), and obese (≥30 kg/m^2));[16] and late-life BMI (late-life baseline examination by CDC categories). In addition, weight loss from midlife to late-life with a corresponding change in BMI category was categorized as desirable reduction (if BMI category decreased from overweight/obese), excessive reduction (if BMI category decreased to underweight), gain (BMI category increased) or no change in BMI category.

Outcome

These analyses examined all-cause mortality through up to 8 years of follow-up (1991 through December 1999). Death was ascertained from continuous surveillance of all Oahu hospital and death records for all subjects.[17] The out-migration rate for this cohort is less than 1 per thousand per year, and surveillance for mortality is essentially complete.[18]

Covariates

Late-life baseline (pre-stroke) patient characteristics included conditions associated with mortality based on previous literature:[19–21] age, marital status (married versus not married), lived at home (versus lived in nursing home or other facility), physical function, physical activity index,[22,23] smoking, hypertension, diabetes mellitus, cognitive impairment, coronary heart disease, and cancer. Late-life pre-stroke physical function was measured with a questionnaire and in-person performance-based tests. Questionnaire items included difficulties in activities of daily living (ADLs: walking, transferring from bed to chair, dressing, toileting, bathing and eating),[24] instrumental activities of daily living (IADLs: light housework, shopping, meal preparation, paying bills and using the telephone),[25] and walking ½ mile (a Roslow/Breslau/Nagi task).[25] The ADLs and IADLs were categorized as three hierarchical functional groups:[19] completely independent, difficulty with IADLs but not ADLs; and difficulty with ADLs. Walking ½ mile was a dichotomous measure (independent versus any reported difficulty).[26] Performance-based items included handgrip strength (in kg),[26] the best performance of three attempts with the dominant hand using a dynamometer;[27,28] and gait speed (in m/s), calculated from the time (in seconds) required to walk 10 feet (3m) at a usual pace.[29] Cognitive impairment was defined by scores less than

74 on the Cognitive Abilities Screening Instrument (CASI).[30] Baseline prevalent cancer and coronary heart disease were identified through the examination and systematic surveillance of cancer tumor registry records[31] and coronary heart disease hospitalization records.[18] Prevalent hypertension was defined as a blood pressure of greater than 140/90 or treatment with antihypertensive medications. Prevalent Diabetes Mellitus was defined as active treatment with insulin or oral hypoglycemic agents.[15]

Statistical analyses

Chi-square, fisher's exact, and t-tests compared baseline characteristics, functional ability and comorbid conditions of the stroke-free and incident stroke groups. Baseline characteristics were also compared by incident stroke type: thromboembolic versus hemorrhagic stroke. Univariate and multivariable stepwise regression models examined the outcome of 30-day post-stroke (logistic regression) and up-to eight year post-stroke mortality (Cox regression). Stepwise multivariable regression models retained age and all covariates with p values ≤0.1. Separate Cox regression models examined the following groups: 1) incident stroke (all types); 2) incident thromboembolic stroke; 3) incident hemorrhagic stroke; and 4) the overall sample. Correlation between variables were all <0.6, except for BMI category change with weight loss (r=−0.612) and with underweight late-life BMI (r=0.86). The BMI category change variable was examined with a separate regression model from weight loss and BMI to avoid including collinear variables in the same model. The Honolulu Heart Program data quality evaluation included data cleaning and verification of extreme values against the actual measures, minimizing outliers due to data errors. All reported p-values are two-sided. All statistical analyses were performed using SAS 9.1 (SAS Institute, Inc., Cary, NC).

Results

Table 1 displays the late-life baseline pre-stroke characteristics of the study sample, stratified by incident stroke. Of the 3,581 men who were stroke-free at late-life baseline, 225 (6.3%) men suffered incident first-ever strokes between 1991 and December 1999. At late-life baseline pre-stroke, 83% of men were married and only 33 men of the entire sample (<1%) lived in a nursing home, the remainder lived at home (data not shown). There were no statistically significant differences in BMI, weight loss or baseline difficulties with ADLs or IADLs between the stroke and stroke-free groups. More men in the stroke group had baseline pre-stroke difficulty walking ½ mile than men in the stroke-free group. Mean handgrip strength was higher and mean gait speed was faster in the stroke-free group than in the stroke groups. More men in the stroke group had diabetes and hypertension compared to the stroke-free group.

Among men with incident stroke, 68.0% had thromboembolic strokes, 24.0% had hemorrhagic strokes, and 8% had strokes of undetermined type (definite strokes but died prior to stroke workup completion, data not shown). More men with thromboembolic strokes were overweight or obese at midlife (38.6% in thromboembolic group vs. 27.8% in hemorrhagic group, p=0.06, data not shown), and had Diabetes Mellitus (25.5% in thromboembolic group vs. 9.3% in hemorrhagic group p=0.01, data not shown). Men with undetermined strokes were older (mean age 82.2 years), more lived in nursing homes (11.1%), and more had baseline ADL difficulties (44.4%), weak handgrip (83.3%) and inability to walk ½ mile (61.1%, data not shown). Fewer men with undetermined strokes had normal midlife BMI (50% in undetermined group vs. 61% in thromboembolic group and 67% in the hemorrhagic group, p=0.06, data not shown). All other baseline characteristics did not differ significantly by stroke type.

Table 2 displays late-life baseline characteristics of the men with incident stroke, stratified by survival status. Men with incident stroke who died were older and lost significantly more weight from midlife to late life than men who survived. Late-life baseline physical function was also lower for men with stroke who died than those who survived. More of the men with stroke who died had difficulty with IADLs and ADLs, inability to walk ½ mile, weaker handgrip and slower gait speed at the late-life baseline prior to stroke than the men who survived. More of the men with incident stroke who died had cognitive impairment at the late-life baseline prior to stroke than the men who survived. More men died in the hemorrhagic group (70%) compared to the thromboembolic group (56.9%, $p=0.0008$, data not shown).

Table 3 displays the stepwise multivariable logistic regression model of late-life baseline factors associated with 30-day post-stroke mortality. Every 10 pounds of weight loss from midlife to late-life (pre-stroke) was associated with a 48% increased likelihood of 30-day post-stroke mortality. Age, pre-stroke hypertension and ADL disability were borderline significantly associated with increased likelihood of 30-day post-stroke mortality. Late-life BMI categories and type of BMI reduction (desired vs. excessive) were not significantly associated with 30-day post-stroke mortality.

Table 4 displays multivariable stepwise Cox proportional hazards models of factors associated with the outcome of long-term (up to 8-year) all-cause mortality for the incident stroke (all types) group, the incident thromboembolic stroke subgroup and the incident hemorrhagic stroke subgroup. Weight loss from midlife to late-life (pre-stroke) was associated with increased likelihood of long-term mortality in men with incident stroke (all types) and in men with incident thromboembolic stroke, but was not significant for hemorrhagic stroke. Overweight or obese late-life BMI was associated with increased likelihood of long-term mortality in men with hemorrhagic stroke (vs. normal or underweight BMI) but was not significant for mortality after incident stroke (all types) or thromboembolic stroke. Type of BMI change (desirable or excessive vs. no change/gain) was not significantly associated with mortality in any of the groups. Age and difficulty walking ½ mile were associated with increased likelihood of long-term mortality in men with incident stroke (all types) and incident thromboembolic stroke. Smoking was associated with increased likelihood of long-term mortality in men with incident stroke (all types) and among men with incident hemorrhagic stroke. Baseline handgrip strength was associated with reduced likelihood of long-term mortality (9% decreased risk for every 1kg increase in strength) among men with incident hemorrhagic stroke.

Table 5 displays the multivariable stepwise Cox proportional hazards models of factors associated with the outcome of up to 8-year all-cause mortality for the overall sample (elderly men with and without incident stroke). Two separate models were created due to the correlation between weight loss and type of BMI change: the first model included weight loss and late-life BMI categories, while the second model included type of BMI change. In the first model, weight loss from midlife to late-life and underweight late-life BMI (compared to normal BMI) were independently associated with increased likelihood of long-term mortality. There was no significant difference between normal and overweight/obese BMI. In the second model, desirable and excessive BMI reductions (vs. no change or gain) were each significantly associated with increased likelihood of long-term mortality. Other factors associated with mortality did not change between the two models, and included incident stroke, age (7% increase for every additional year), difficulty walking ½ mile, smoking, cognitive impairment, cancer and heart disease. Baseline married status, stronger handgrip, faster gait speed and higher physical activity (mets/week) were all associated with decreased mortality in the overall sample. Residence at home, IADL disability, hypertension and diabetes were not selected ($p>0.1$) in either final multivariable model.

Discussion

This study examined the relationship between pre-stroke nutritional status and mortality among older Japanese-American men with and without incident stroke. We included multiple measures of nutritional status in our analyses. This study had several key findings. First, every 10 pounds of prospectively measured weight loss from midlife to late-life was associated with a 48% increased risk of 30-day post-stroke mortality and a 19–25% increased risk of long-term (up to 8-year) mortality in the incident stroke group and the incident thromboembolic stroke subgroup. Second, after adjusting for weight loss, late-life BMI category was not significantly associated with post-stroke mortality in the incident stroke (all types) group and the thromboembolic stroke subgroup. Among men with hemorrhagic stroke, pre-stroke overweight or obese BMI was associated with an increased likelihood of mortality compared to men with normal or underweight BMI. In the overall sample, including men who remained stroke-free and those with incident stroke, weight loss and underweight BMI were significantly and independently associated with increased likelihood of up to 8-year mortality. In the overall sample, including men who remained stroke-free and those with incident stroke, both desirable (reducing BMI from overweight or obese range) and excessive (reducing BMI to underweight range) were each significantly associated with long-term mortality compared to no change or gain in BMI.

To our knowledge, no other study has examined the relationship between pre-stroke weight loss and post-stroke mortality. Previous studies have examined the relationship of BMI, measured either before or at the time of stroke, and post-stroke mortality. In the FOOD trial, undernourished stroke patients were at increased risk for complications after stroke.[7] Obese BMI was associated with increased likelihood of post-stroke survival compared to those with normal BMI among post-menopausal American women[32] and in two European studies.[5,33] A meta-analysis[4] and several Asian studies reported that increasing BMI was associated with increased likelihood of survival post-stroke.[6,34] One study in Japan reported a u-shaped relationship between post-stroke mortality and BMI.[35]

Obesity is a significant modifiable risk factor for stroke incidence.[2] Weight reduction may be an important public health intervention to reduce the burden of cardiovascular disease.[2] However, data are limited on the benefits of weight loss for post-stroke mortality.[3,36] Weight loss in midlife has been associated with reduced diabetes but not a reduction in cardiovascular disease events.[37] In fact, a BMI in the overweight range is associated with reduced mortality for adults, especially older adults.[38,39]

We found that pre-stroke weight loss from midlife to late-life was associated with increased likelihood of 30-day and up to 8-year post-stroke mortality among older men with incident stroke and those with incident thromboembolic stroke. Weight loss may be associated with loss of lean muscle mass, and decreased nutritional reserve during the acute post-stroke period. Post-stroke dysphagia and aspiration risks may precipitously reduce oral intake, increasing mortality risk in patients with poor baseline nutritional status. Since an unintentional 10-lb weight loss in the past year is a part of the definition of frailty,[40] our findings might reflect development of frailty in these elderly men. Gait speed, another marker of frailty,[41–43] was not associated with post-stroke mortality, but was strongly associated with overall (stroke + stroke-free) mortality, consistent with previous studies.[19]

Consistent with previous elderly population studies,[19,29] we found that poor functional ability is strongly associated with mortality. Pre-stroke inability to walk ½ mile was associated with mortality after incident stroke (all types) and incident thromboembolic stroke. Pre-stroke handgrip strength was associated with mortality after incident hemorrhagic stroke. Patients with more disability pre-stroke may have had more severe strokes, since pre-stroke physical activity correlates with stroke severity.[44] Interestingly, pre-stroke physical activity index was not associated with post-stroke mortality, although it was strongly associated with mortality in the overall group.

Study Limitations and Strengths

This cohort consists entirely of Japanese-American men and few of the participants were obese at midlife. Generalizability might be limited by cohort effects or genetic, cultural, or other factors. Measures of stroke severity, type or location were not available for these analyses. Lower numbers of strokes than national stroke database studies may limit power, yet surprisingly robust associations were demonstrated even for the small hemorrhagic stroke subgroup (n=54). Other measures of frailty, such as exhaustion or energy level, were not available for this study. Weight, height and calculated BMI were measured at midlife and late-life, and the exact timing of the weight loss was not available for this study.

Study strengths include data from one of the largest, longest and most complete follow-up studies on aging men. Measures were prospective, standardized, and included pre-stroke nutritional measures not usually available in stroke studies. Stroke and mortality case-finding methods were thorough and complete, and mortality included in-hospital and out-of-hospital deaths.

Clinically, although weight loss is recommended to reduce the risk of stroke incidence, pre-stroke weight loss appears to be a poor prognostic indicator for post-stroke survival. Further examination of the role of pre-stroke nutritional status, and weight loss in particular, with risk of stroke and post-stroke outcomes is an important area of future to improve cardiovascular disease outcomes among older adults.

Conclusions

Although obesity is a risk factor for stroke incidence, pre-stroke weight loss was associated with increased likelihood of post-stroke mortality. Overweight or obese BMI was associated with increased likelihood of post-hemorrhagic stroke mortality. Weight loss, underweight BMI and decrease in BMI category were associated with increased likelihood of up to 8-year mortality in the overall sample. Type of weight loss (desirable vs. excessive) was not significantly associated with post-stroke mortality. Further research on the relationship between weight loss and stroke outcomes is needed.

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List of abbreviations

BMI	Body mass index
HHP/HAAS	Honolulu Heart Program/Honolulu-Asia Aging Study

CDC	Centers for Disease Control
ADL	Activities of Daily Living
IADL	Instrumental Activities of Daily Living

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Table 1

Late-Life Baseline Characteristics Stratified by Occurrence of Incident Stroke.

Late-Life Baseline Characteristics*	Stroke-Free n=3,356 (93.7%)†	Incident Stroke n=225 (6.3%)	P value
Mean age (years)‡ (± SD)	78.2 ± 4.6	78.8 ± 4.8	0.08
BMI category at midlife			
Underweight (<18.5kg/m^2) n(%)	76 (2.3)	5 (2.2)	0.5
Normal weight (18.5 to <25 kg/m^2) n(%)	2187 (65.2)	138 (61.3)	
Overweight/Obese (≥25 kg/m^2) n(%)§	1092 (32.6)	82 (36.4)	
BMI category at late life			
Underweight (<18.5kg/m^2) n(%)	169 (5.2)	12 (5.5)	0.1
Normal weight (18.5 to <25 kg/m^2) n(%)	2129 (65.4)	128 (58.5)	
Overweight/Obese (≥25 kg/m^2) n(%)	958 (29.4)	79 (36.1)	
Weight loss (lbs midlife - late-life)	5.1 ± 14.0	4.8 ± 13.5	0.8
Type of Weight change midlife to late-life**			
Desirable weight loss n(%)	418 (12.8)	27 (12.3)	0.9
Excessive weight loss n(%)	128 (3.9)	8 (3.7)	
No change in BMI category n(%)	2347 (72.1)	157 (71.7)	
Weight gain n(%)	363 (11.2)	27 (12.3)	
No Difficulty in ADL/IADLs n(%)	2585 (77.2)	162 (72.0)	0.2
IADL difficulty only n(%)	470 (14.0)	37 (16.4)	
ADL difficulty n(%)	292 (8.7)	26 (11.6)	
Unable to walk ½ mile n(%)	604 (18.5)	57 (25.9)	0.01
Mean handgrip (kg)	30.2 ± 6.9	29.2 ± 6.6	0.03
Mean gait speed (timed 10 foot walk, m/s)	0.82 ± 0.24	0.78 ± 0.22	0.004
Physical Activity Index (mets/week)	30.9 ± 4.6	30.3 ± 4.4	0.05
Ever Smoker n(%)	1955 (62.5)	127 (61.4)	0.8
Hypertension n(%)	2454 (73.1)	186 (82.7)	0.002
Diabetes Mellitus n(%)	447 (13.3)	45 (20.0)	0.007
Cognitive Impairment n(%)	481 (14.3)	36 (16.0)	0.5
Coronary Heart Disease n(%)	812 (24.2)	60 (26.7)	0.4
Cancer n(%)	674 (20.1)	36 (16.0)	0.1

*All men stroke-free at baseline. mean ± standard deviation for continuous, n(%) for categorical variables.

†Column %, may not add up to 100% due to rounding and/or missing data

‡Age range for study population 71.3 to 93.6 years at baseline.

§Obese at midlife: stroke-free n=55 (1.6%), stroke group n=2 (0.9%); obese at late life: stroke-free n=69 (2.1%), stroke group n=4 (1.8%).

**BMI category change: desirable (BMI decreased from overweight/obese), excessive (BMI decreased to underweight), gain (BMI increased) or no change.

Table 2

Late-Life Baseline Characteristics of Stroke Group by Survival Status (n=225).

Late-Life (Pre-Stroke) Characteristics	Died N=143 (63.6%)	Alive N=82(36.4%)	P value
Mean age* (± SD)	79.9 ± 5.1	76.8 ± 3.6	<.0001
BMI category at midlife			
Underweight (<18.5kg/m^2) n(%)	5 (3.5)	0	0.3
Normal weight (18.5 to <25 kg/m^2) n(%)	86 (60.1)	52 (63.4)	
Overweight/Obese (≥25 kg/m^2) n(%)†	52 (36.4)	30 (36.6)	
BMI category at late life			
Underweight (<18.5kg/m^2) n(%)	10 (7.3)	2 (2.4)	0.4
Normal weight (18.5 to <25 kg/m^2) n(%)	79 (57.7)	49 (59.8)	
Overweight/Obese (≥25 kg/m^2) n(%)	48 (35.0)	31 (37.8)	
Weight loss (lbs midlife - late-life)‡	6.7 ± 13.5	1.6 ± 12.9	0.006
BMI change type midlife to late-life§			
Desirable weight loss n(%)	19 (13.9)	8 (9.8)	0.7
Excessive weight loss n(%)	6 (4.4)	2 (2.4)	
No change in BMI category n(%)	95 (69.3)	62 (75.6)	
Weight gain n(%)	17 (12.4)	10 (12.2)	
Level of difficulty with ADLs and IADLs			
No Difficulty in ADLs and IADLs n(%)	95 (66.4)	67 (81.7)	0.02
IADL difficulty only n(%)	26 (18.2)	11 (13.4)	
ADL difficulty n(%)	22 (15.4)	4 (4.9)	
Unable to walk ½ mile n(%)	47 (33.3)	10 (12.7)	0.0007
Mean handgrip (kg)	27.9 ± 6.6	31.5 ± 6.1	<.0001
Mean gait speed (m/s)	0.7 ± 0.2	0.8 ± 0.2	0.002
Physical Activity Index (mets/week)	30.0 ± 4.5	30.7 ± 4.3	0.3
Ever Smoker n(%)	85 (66.4)	42 (53.2)	0.06
Hypertension n(%)	123 (86.0)	63 (76.8)	0.08
Diabetes Mellitus n(%)	27 (18.9)	18 (22.0)	0.6
Cognitive Impairment n(%)	29 (20.3)	7 (8.5)	0.02
Coronary Heart Disease n(%)	39 (27.3)	21 (25.6)	0.8
Cancer n(%)	27 (18.9)	9 (11.0)	0.1

*Age range for study population 71.3 to 93.6 years at baseline.

†Obese at midlife: died n=2 (1.4%), alive group n=0; obese at late life: died n=3 (2.2%), alive n=1 (1.2%).

‡Weight change (midlife - late life) range in men with stroke: 27 lbs gained to 45.9 lbs lost, mean 4.8lbs lost ± 13.5.

§BMI category change: desirable (BMI decreased from overweight/obese), excessive (BMI decreased to underweight), gain (BMI increased) or no change.

Table 3

Factors associated with 30-day post-stroke mortality (n=225 with incident stroke).*

Factor	aOR* (95% CI)	p value
Age	1.06 (0.99–1.14)	0.078
Weight Loss from mid to late-life (10-lb decrements)	1.48 (1.14–1.92)	0.003
ADL Disability	2.30 (0.86–6.13)	0.097
Hypertension	3.08 (0.98–9.63)	0.053
Diabetes	0.48 (0.18–1.25)	0.132

*Stepwise multivariable logistic regression: variables included baseline age, married, living at home, IADL disability, ADL disability, reported difficulty walking ½ mile independently, handgrip strength, gait speed on timed 10 foot walk, physical activity index, weight loss between midlife and late life (in 10 pound decrements), late-life pre-stroke baseline BMI categories (underweight, normal and overweight/obese), type of BMI change (desirable vs. excessive vs. none/gain), smoking, hypertension, diabetes, cognitive impairment, cancer and coronary heart disease. Shown variables were selected for inclusion using stepwise procedure (p values≤0.1).

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Table 4

Factors associated with up to 8-year mortality after incident stroke. Stepwise cox proportional hazards: incident stroke, incident thromboembolic stroke and incident hemorrhagic stroke subgroups.

	Stroke subgroup (all types) n=225		Thromboembolic stroke n=153		Hemorrhagic stroke n=54	
Factor	**aHR* (95% CI)**	**p value**	**aHR (95% CI)**	**p value**	**aHR (95% CI)**	**p value**
Age (years)	1.08 (1.05–1.12)	<.0001	1.10 (1.05–1.15)	<.0001	1.07 (0.97–1.18)	0.18
Weight loss mid- to late-life (10-pound decrements)	1.25 (1.09–1.44)	0.001	1.19 (1.01–1.40)	0.035	not selected	
Overweight/obese BMI late life (vs. normal/underweight)	not selected		not selected		2.27 (1.07–4.82)	0.032
Difficulty walking ½ mile	1.95 (1.32–2.89)	0.0009	2.49 (1.55–4.01)	0.0002	not selected	
Handgrip (kg)	not selected		not selected		0.91 (0.85–0.98)	0.013
Ever vs. never smoked	1.64 (1.12–2.41)	0.01	not selected		4.09 (1.87–8.94)	0.0004

* Stepwise multivariable regression with separate models for stroke subgroup, thromboembolic stroke subgroup, and hemorrhagic stroke subgroup. Variables included baseline age, married, living at home, IADL disability, ADL disability, reported difficulty walking ½ mile independently, handgrip strength, gait speed on timed 10 foot walk, physical activity index, weight loss between midlife and late life (in 10 pound decrements), late-life baseline BMI (underweight, normal and overweight/obese), type of BMI change (desirable vs. excessive vs. none/gain), smoking, hypertension, diabetes, cognitive impairment, cancer and coronary heart disease. Shown variables were selected for inclusion using stepwise procedure (p values≤0.1).

Table 5

Factors associated with up to 8-year mortality in overall sample (n=3581).

	Model 1 Weight loss/BMI*		Model 2 BMI change	
Factor	**aHR (95% CI)**	**p value**	**aHR (95% CI)**	**p value**
Stroke	2.16 (1.78–2.62)	<.0001	2.10 (1.73–2.54)	<.0001
Age (years)	1.07 (1.05–1.08)	<.0001	1.07 (1.05–1.09)	<.0001
Married	0.82 (0.71–0.96)	0.013	0.82 (0.70–0.96)	0.011
Weight loss (10-lb decrement)	1.15 (1.09–1.21)	<.0001	not included	
Late-Life BMI categories				
Underweight BMI late-life	1.76 (1.40–2.20)	<.0001	not included	
Normal BMI late-life	1.00 (ref)		not included	
Overweight/Obese BMI	0.96 (0.82–1.12)	0.59	not included	
Type of BMI change				
Desirable BMI decrease	not included		1.36 (1.15–1.61)	0.0005
Excessive BMI decrease	not included		1.97 (1.53–2.53)	<.0001
No change/BMI gain	not included		1.00 (ref)	
ADL disability vs. None	1.26 (0.99–1.61)	0.065	1.26 (0.98–1.61)	0.068
Difficulty walking ½ mile	1.68 (1.42–2.00)	<.0001	1.70 (1.43–2.01)	<.0001
Handgrip (kg)	0.97 (0.96–0.98)	<.0001	0.96 (0.95–0.98)	<.0001
Gait speed (m/s)	0.75 (0.55–1.02)	0.069	0.75 (0.55–1.03)	0.073
Physical activity index	0.98 (0.96–0.99)	0.002	0.98 (0.96–0.99)	0.002
Ever vs. never smoked	1.36 (1.19–1.55)	<.0001	1.35 (1.18–1.54)	<.0001
Cognitive Impairment	1.50 (1.26–1.79)	<.0001	1.49 (1.25–1.78)	<.0001
Cancer	2.46 (2.16–2.81)	<.0001	2.50 (2.19–2.85)	<.0001
Coronary heart disease	1.87 (1.64–2.13)	<.0001	1.91 (1.68–2.18)	<.0001

*Separate stepwise models for: 1) weight loss (midlife to late life in 10 pound decrements) and late-life baseline BMI categories (underweight, normal and overweight/obese); and 2) type of BMI change (desirable vs. excessive vs. none/gain) due to correlation between type of BMI change and weight loss. Shown variables were selected for inclusion using stepwise procedure (p values≤0.1). Variables included baseline age, married, living at home, IADL disability, ADL disability, reported difficulty walking ½ mile independently, handgrip strength, gait speed on timed 10 foot walk, physical activity index, weight loss between midlife and late life (in 10 pound decrements), late-life baseline BMI (underweight, normal and overweight/obese), type of BMI change (desirable vs. excessive vs. none/gain), smoking, hypertension, diabetes, cognitive impairment, cancer and coronary heart disease. Variables significant on univariate analyses but not selected in the stepwise multivariable models included living at home, IADL disability and diabetes.