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Life's Simple 7 at midlife and Risk of Recurrent Cardiovascular Disease and Mortality after Stroke: The ARIC Study

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Abstract

Background: Stroke is a leading cause of morbidity and mortality among adults in the U.S. Ideal levels of the Life's Simple 7 (LS7) are associated with lower cardiovascular disease (CVD) and all-cause mortality. However, the association of LS7 with CVD, recurrent stroke, and all-cause mortality after incident stroke is unknown.

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DISCLOSURES
None

Methods: We used data from the ARIC study, a cohort of 13,508 adults from four US communities, 45–64 years old at baseline (1987–1989). Cardiovascular hospitalizations and mortality were ascertained in follow-up through December 31st, 2017. We defined cardiovascular health (CVH) based on AHA definitions for LS7 (range 0–14) and categorized CVH into four levels: LS7 0–3, 4–6, 7–9, and ≥10 (ideal LS7), according to prior studies. Outcomes included incident stroke, CVD, recurrent stroke, all-cause mortality, and a composite outcome including all the above. Adjusted hazard ratios (95% CI) were estimated with Cox proportional hazards regression models.

Results: Median (25%−75%) follow-up for incident stroke was 28 (18.6–29.2) years. Participants with incident stroke were 55.7 (SD 5.6) years-old at baseline, 53% were women and 35% Black. Individuals with LS7 score ≥10 had 65% lower risk (HR: 0.35; 95% CI: 0.29–0.41) of incident stroke than those with LS7 4–6 (reference group). Of 1,218 participants with incident stroke, 41.2% (n=502) had composite CVD and 68.3% (n=832) died during a median (25%−75%) follow-up of 4.0 (0.76–9.95) years. Adjusted HR (95% CI) for stroke survivors with LS7≥10 at baseline were 0.74 (0.58–0.94) for the composite outcome, 0.38(0.17–0.85) for myocardial infarction, 0.60 (0.40–0.90) for heart failure, 0.63 (0.48–0.84) for all-cause mortality, and 0.65 (0.39–1.08) for recurrent stroke.

Conclusions: Good and excellent midlife cardiovascular health are associated with lower risks of incident stroke and CVD after stroke. Clinicians should stress the importance of a healthy lifestyle for primary and secondary CVD prevention.

Keywords

stroke; cardiovascular disease; recurrent event; lifestyle; risk factor

INTRODUCTION

Cardiovascular disease (CVD), including stroke, is a major cause of morbidity and mortality in the United States (US) with direct and indirect costs exceeding $350 billion annually.[1] The prevalence of stroke, a leading cause of disability, cognitive impairment and mortality among U.S. adults was 2.5% in 2016.[1] By 2030, almost 4% of U.S. adults will have experienced a stroke, which will represent a 20.5% increase from 2012.[2] Stroke causes impaired mobility in more than half of stroke survivors age 65 and over.[1] Given the aging population and a higher risk of stroke with advancing age, the burden of disability among stroke survivors and economic burden will continue to rise if primary prevention strategies are not implemented.

Data from the Global Burden of Disease Study suggest that approximately 90% of CVD and stroke can be prevented through optimizing modifiable risk factors such as hypertension, obesity, hyperglycemia, hyperlipidemia, and that over 70% of strokes are attributable to health behaviors, such as smoking, sedentary lifestyle and unhealthy diet.[3] Improving health behaviors can avert the occurrence and recurrence of stroke. Despite robust evidence on the contribution of a healthy lifestyle, most US adults eat unhealthy diets and have sedentary lifestyles.[4, 5]

The American Heart Association (AHA) developed the “Life’s Simple 7(LS7)” metric which includes seven modifiable components, including 3 health factors (glucose, cholesterol, and blood pressure) and 4 health behaviors (body mass index, physical activity, diet, and cigarette smoking), with each of the 7 indices categorized into ideal, intermediate, and poor levels.[6] Only 2% of adults in the U.S. meet all 7 CVH metrics.[7, 8] Prior studies, including adults free from CVD, have suggested that having ideal levels of the LS7 metric is associated with lower cardiovascular and all-cause mortality.[9, 10]

In a study based on data from the Atherosclerosis Risk in Communities (ARIC) study[11], LS7 scores at middle age were inversely associated with adverse outcomes after myocardial infarction (MI), independently of access to care and MI severity. However, pathophysiology and treatment of stroke are distinct from MI, and it is unknown whether a similar pattern holds for stroke.

Thus, we sought to characterize the associations of the LS7 metric at middle-age with the risk of incident stroke, as well as CVD, recurrent stroke, and all-cause mortality after an incident stroke. We hypothesized that stroke risk would be lower in individuals with better CVH in midlife, and stroke survivors with better CVH (higher LS7 scores) at midlife (pre-stroke) would have lower risk of post-stroke CVD, recurrent stroke, and all-cause mortality than those with poorer baseline CVH.

METHODS

Study Population and Design

We used data from the ARIC study, an ongoing community-based cohort of 15,792 middle-aged men and women aged 45–64 years at baseline (1987–1989) selected from four U.S. communities (Forsyth County, North Carolina; the city of Jackson, Mississippi; eight northern suburbs of Minneapolis, Minnesota; and Washington County, Maryland).[12] Follow-up of ARIC cohort participants is conducted through active surveillance of hospitalizations and vital status and repeat clinic visits. Of the 15,792 participants who attended Visit 1 (1987–1989), participants who had prevalent stroke (n=258) prevalent coronary heart disease(n=676), prevalent heart failure(n=655), and were not Black or White (n=48) were excluded. We further excluded participants who had any missing components for calculating the LS7 score (n=773) or covariates(n=126), which yielded an analytic sample of 13,508. Study participants provided informed consent, and institutional review boards approved the study at each study site.

Life’s Simple 7 at ARIC Study Baseline Visit 1

Trained ARIC study staff administered a standardized questionnaire to elicit sociodemographic characteristics, medical history, medication, and health behaviors including diet, physical activity, and smoking status. Body Mass Index (BMI) was calculated as weight (in kilograms) divided by height squared (in meters). Three seated blood pressure (BP) measurements were taken after 5 minutes by a certified technician using a random-zero sphygmomanometer. The mean of the second and third blood pressure measurements was used for analysis. Fasting plasma total cholesterol concentration was

assessed by enzymatic procedures. Fasting blood glucose levels were measured by the modified hexokinase/glucose-6-phosphate dehydrogenase method.

We used the AHA definitions for ideal, intermediate, and poor health for BP, cholesterol, body mass index (BMI), and physical activity, glycemic status, smoking, and diet score (Supplementary Table 1).[13, 14] By assigning 2 points for ideal, 1 point for intermediate, and 0 points for poor health, we created a sum of the scores from each metric, with a cumulative range of 0 to 14. The following cutoffs were used 0–3 (poor CVH, 4–6, 7–9, and ≥10 (ideal CVH). The cutoffs were selected based on prior studies which have used the LS7 metric.[11, 15, 16]

Outcomes

The primary outcomes for this study were incident stroke after Visit 1 and through December 31, 2016; CVD, recurrent stroke and all-cause mortality after incident stroke through December 31, 2017 as previously described.[17, 18] In ARIC, stroke is identified among participants at ARIC visits or through annual (semiannual since 2012) telephone calls and surveillance of hospitals in the community. Stroke hospitalizations records with stroke-related ICD codes (ICD-9 codes 430–438 [from 1990–1997] and ICD-9 codes 430–436 or ICD-10 codes G45.X, I60.X, I61.X, I62.X, I63.X, I65.X, I66.X, I67.X [from 1998 until end of follow-up]) were reviewed, and stroke events were adjudicated by study physicians as definite/probable ischemic stroke, or definite/probable intracerebral hemorrhage. Data on all cause-mortality were collected through linkage with the National Death Index.[18, 19]

The composite outcome included incident fatal or non-fatal coronary heart disease (CHD) (including MI, fatal coronary disease, or revascularization), recurrent stroke, heart failure, and all-cause mortality after stroke. CHD was defined as a hospitalized definite or probable MI or CHD death. CHD was ascertained from annual telephone phone calls with participants and proxies, study visits, hospital discharge information on fatal and non-fatal MI, physician questionnaires, and death certification, and a professional committee adjudicated these events.[17] Incident HF after stroke was defined as the first HF hospitalization after stroke or death with an HF diagnosis per the International Classification of Diseases-9th Revision (ICD-9) code 428(428.0 to 428.9) or ICD-10 code of I50 in any position ascertained by the ARIC study retrospective surveillance of hospital discharges, or a death certificate with death from HF among any of the listed diagnoses or underlying causes of death.[20]

Covariates

We included baseline covariates such as age, sex, race, health insurance status, and family income which were self-reported by participants using a standard study questionnaire at visit 1.

Statistical Analysis

We used descriptive statistics (means and standard deviations for continuous variables and proportions for categorical variables) to summarize baseline (Visit 1) characteristics across

categories of LS7 summary scores of 0 to 3, 4 to 6, 7 to 9, and ≥10.[14] For incident stroke, we calculated time at risk (time to event or time to censoring) from the date of the baseline examination (Visit 1) to the earliest of the following: date of hospital admission for incident stroke, date of death, date of last follow-up contact, or December 31, 2016 to allow at least one year of follow-up time. For CVD, recurrent stroke, and all-cause mortality, we calculated time at risk from the date of incident stroke to the earliest of the following: date of hospital admission for CVD or recurrent stroke, date of death, date of last follow-up contact, or December 31, 2017. We used Cox proportional hazards regression models to estimate hazard ratios and their 95% confidence intervals for the association between LS7 scores with the risk of incident stroke, adjusting for covariates. Among those who had an incident stroke during follow-up, we evaluated the association of LS7 score using the cutpoints of 0–3, 4–6, 7–9, and ≥10 and cardiovascular outcomes after stroke using the Kaplan-Meier method, as well as Cox proportional hazards regression models accounting for covariates. We used 4–6 as the reference group because of the relatively smaller number of participants with LS7 scores of 0–3. We also examined the associations between the individual components of the LS7 metric and the composite outcome after incident stroke. We performed a competing risk analysis with death as a competing outcome and sensitivity analysis by stroke type(ischemic versus hemorrhagic). The level of statistical significance was set at $p<0.05$. All analyses were conducted using Stata/SE version 16.1(StataCorp, College Station, TX, USA).

RESULTS

Association between Life's Simple 7 Scores at Midlife and Incident Stroke

The baseline characteristics of 13,508 participants free of prevalent stroke stratified by LS7 scores at midlife are summarized in Table 1. The baseline characteristics of participants who had incident stroke up to December 31, 2016, stratified by LS7 scores at Visit 1 are described in Table 2. The mean age at baseline among the 1,218 participants who had incident stroke was 56 years and 36% were black. Also, 57.4% of stroke survivors had LS7 scores ≥7 and 14.6 % had LS7 scores ≥10 at baseline (Table 2 and Figure 1). Participants with incident stroke who had the most favorable CVH (LS7 scores ≥10), were more likely to be older, college-educated, White, report higher family income, and have health insurance coverage than those with the worst CVH (LS7 score 0–3).

Over a median follow-up of 28 years, we observed 1218 incident stroke events. Most (73.2%) participants who had incident stroke had intermediate CVH at baseline (LS7 score of 4–9). There was a graded inverse association between higher LS7 scores and risk of incident stroke (Table 3). Compared with participants with LS7 scores of 4–6, those with a score of ≥10 and 7–9 had 65% and 41% lower risk of incident stroke, respectively (HR 0.35 [95% CI, 0.29–0.41] and 0.59 [0.52–0.67]). Likewise, those who had the worst CVH (LS7 score 0–3) were almost twice as likely to have incident stroke as those with LS7 scores 4–6 (HR 1.85 [95% CI, 1.45–2.36]) (Table 3). When LS7 was modeled as a continuous variable, a 1-point increase in LS7 score was associated with decreased risk of incident stroke (HR 0.81 [95% CI, 0.80–0.84]

Association between Life's Simple 7 Scores at Midlife, CVD, Recurrent Stroke and Death after Incident Stroke

Of the 1218 participants with incident stroke, 218 (17.9%) had recurrent stroke, 127 (10.4%) had MI, 351 (28.8%) had HF, and 832 (68.3%) died during a median follow-up of 2.4 years (maximum follow-up, 28.8 years). Overall, we observed an inverse association between LS7 scores and risk of each type of CVD after incident stroke except for recurrent stroke (**Table 4** and Figure 2). For instance, stroke survivors with best CVH (LS7 scores ≥10) at baseline (pre-stroke) were 62% less likely to have MI, 40% less likely to have HF, 26% less likely to have a composite outcome, and 37% less likely to die from all causes, than stroke survivors with lower cardiovascular health (LS7 scores 4–6) (**Table 4**). Likewise, participants with incident stroke who had the worst CVH (LS7 score 0–3) were more likely to have recurrent CVD than those with LS7 scores 4–6. These associations were consistent after adjusting for demographic characteristics including age, sex, and race-center, social determinants (education, income, and health insurance status), clinical characteristics (aspirin use, history of atrial fibrillation), and calendar year to account for temporal changes in stroke management during follow-up. However, the association between LS7 scores and recurrent stroke after initial stroke was non-significant.

We also examined the associations between the individual LS7 metrics and adverse outcomes after incident stroke (Supplementary Table 2) and found that ideal levels of BP, fasting blood glucose, and smoking status in midlife were each associated with lower risk of CVD or death after incident stroke. Notably, ideal levels of BP (HR 0.59, 95% CI: 0.40–0.85) and fasting blood glucose (HR 0.62, 95% CI: 0.44–0.86) were associated with a lower risk of recurrent stroke, specifically.

Sensitivity Analyses

Several sensitivity analyses were performed to test the robustness of the specified models. First, when stroke cases who died within 14 days after incident stroke were excluded from the analyses, the results were not materially changed (Data not shown). Second, to account for some participants who had incident stroke earlier and had chance of developing adverse outcomes with longer follow-up, we restricted the follow-up times to 1, 3, and 5 years after incident stroke and observed consistent results with the unrestricted analyses. In this context, we also included elapsed time as a covariate in the model and observed similar results. Lastly, competing risk analyses were performed accounting for death as a competing event, and demonstrated similar results although the association of LS7 of 7–9 with heart failure was attenuated. (Supplementary Table 3). Excluding hemorrhagic stroke cases provided results similar our overall analyses for recurrent stroke events.

DISCUSSION

We undertook this investigation to determine whether cardiovascular health at midlife was associated with incident stroke and CVD after stroke and recurrent stroke in a community-based sample of Black and White adults. We observed an inverse association between LS7 scores at midlife and risk of incident stroke and adverse CVD outcomes among stroke survivors. Specifically, higher LS7 scores were associated with lower risk of MI and HF,

but not recurrent stroke after adjusting for sociodemographic and clinical conditions. The individual components of the LS7 score which were significantly associated with lower risk of adverse outcomes (CVD and death) among stroke survivors were normal BP, normal fasting blood glucose, non-smoking and normal weight at midlife.

Consistent with prior studies[11, 21, 22] our results suggest that the LS7 score is a useful metric in characterizing CVH. More importantly, the prevalence of ideal CVH at midlife was low in this sample, as only 24% had LS7 scores ≥ 10 and less than 1% had LS7 scores of 14. Other national studies have also reported low prevalence of ideal CVH using the LS7 metric.[8, 23, 24] The most favorable LS7 metric was smoking with 52% reporting never having smoked or being a former smoker who quit for > 12 months. The least favorable metric was healthy diet with only 6.2% having a healthy diet score. We observed that adults with better CVH (LS7 scores 7–9 and LS7 scores ≥ 10) at midlife had a 41% and 65% lower risk of incident stroke, respectively. Our results corroborate findings from the Reasons for Geographic And Racial Differences in Stroke (REGARDS) study, where LS7 scores were inversely associated with incident stroke such that better health category was associated with a 25% lower risk of incident stroke (HR, 0.75; 95% CI, 0.63–0.90).[22]

Although there is ample evidence on risk factors for incident stroke, less is known about adverse outcomes after stroke. As the U.S. population continues to age and survive previously fatal stroke events, aggressive treatment and lifestyle changes are required to prevent subsequent cardiovascular events. Our study highlights the importance of early primary prevention of CVD among midlife adults to prevent incident stroke and recurrent adverse outcomes. Among stroke survivors, we have shown for the first time that worse CVH at midlife (LS7 score 0–3) was associated with 1.54 higher risk of adverse outcomes (CVD or death). Our findings were robust for MI after incident stroke but non-significant for recurrent stroke in the fully adjusted model. Furthermore, MI and HF were more common than recurrent stroke after incident stroke, which is consistent with prior studies which have shown that the population burden of cardiac disease outweighs stroke in the U.S.[25]

Approximately 795,000 people experience a stroke in the U.S. every year and 23% of those events are recurrent strokes.[25] Among the 1218 stroke survivors in this study, 17.5% experienced a recurrent stroke during 28.8 years of follow-up and 41% developed MI or HF. In the Northern Manhattan Stroke Study, which included white, black, or Hispanic patients who had experienced ischemic stroke, the risk of recurrent stroke at 5 years was 20%.[26] We observed that hypertension and high fasting blood glucose were associated with adverse outcomes and recurrent stroke specifically. This finding is consistent with other studies[26–28] which have shown that blood pressure control prevents recurrent strokes. MI occurred among 10% of stroke survivors over a median follow-up of 2.4 years. A prior meta-analysis and systematic review found that although stroke survivors were more likely to die from recurrent stroke than a fatal MI, those with CVD risk factors such as hypertension were at higher risk for subsequent MI.[29]

Our findings have important clinical and research considerations. Stroke is a severe event for patients and poses a significant burden to families and society, yet it is preventable at high percentages. Although prevention of incident stroke in the first place is ideal, our

findings emphasize that good CVH at midlife may reap benefits beyond the initial stroke events and prevent other adverse outcomes later in life. Poor CVH has detrimental health consequences in the short and long term and therefore warrants aggressive lifestyle changes and pharmacologic treatment to stave off adverse events. There is a large body of evidence that demonstrates the effectiveness of secondary prevention measures that reduce the burden of modifiable CVD risk factors.[30, 31]

Our study has important strengths. We showed that the LS7 score is meaningful predictor of incident stroke and subsequent CVD in the large, community-based prospective ARIC cohort of Black and White adults, with active surveillance and adjudicated incident and recurrent cardiovascular outcomes, over 25 years of follow-up, and standardized measurement of exposures and covariates. Also, we examined a composite outcome of cardiovascular events and death as well as separate outcomes of MI, HF, stroke, and all-cause mortality. However, this study has limitations. First, several risk factors were self-reported including smoking status, physical activity, and diet; therefore, the possibility of misclassification in exposures cannot be completely ruled out. Furthermore, we did not examine changes in LS7 scores over time because diet and physical activity were not assessed at every visit. Second, the aim of our study was to study associations between mid-life LS7 metrics and risk of stroke and CVD after stroke, but it is possible that changes in risk factors over time have some effect on the risk, which was not evaluated in the present study.

CONCLUSION

In a large community-based prospective study of White and Black adults, better CVH in mid-life was associated with lower risk of incident stroke and recurrent CVD after stroke. Ideal levels of BP, fasting blood glucose and smoking status were associated with lower risk of CVD or death after incident stroke. Clinicians should emphasize the importance of good CVH at midlife for the primary prevention of stroke and recurrent adverse CVD outcomes including mortality.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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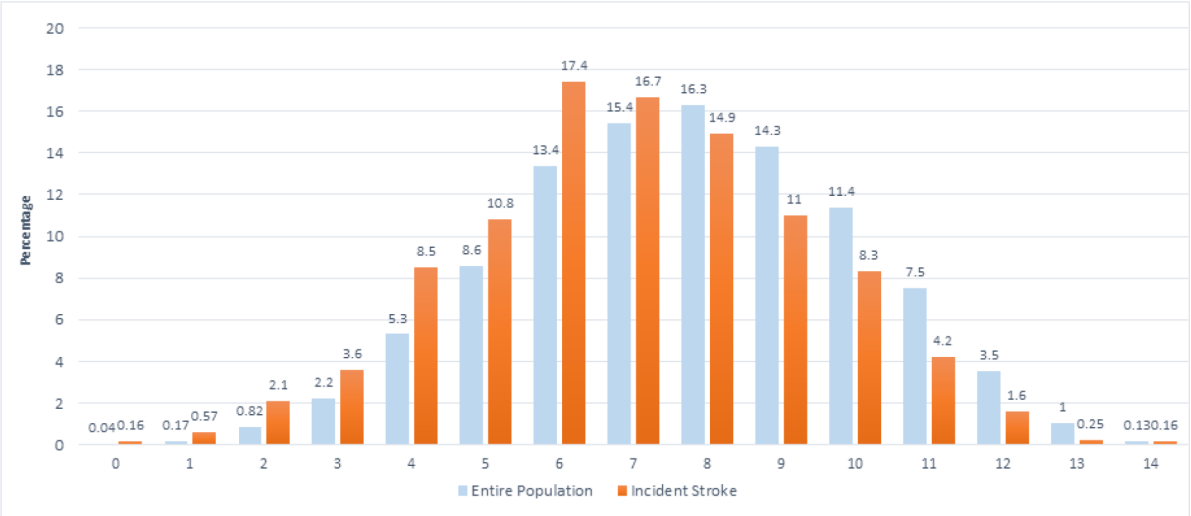

Figure 1:

Life's Simple 7 scores in the entire study population and participants with incident stroke during follow-up.

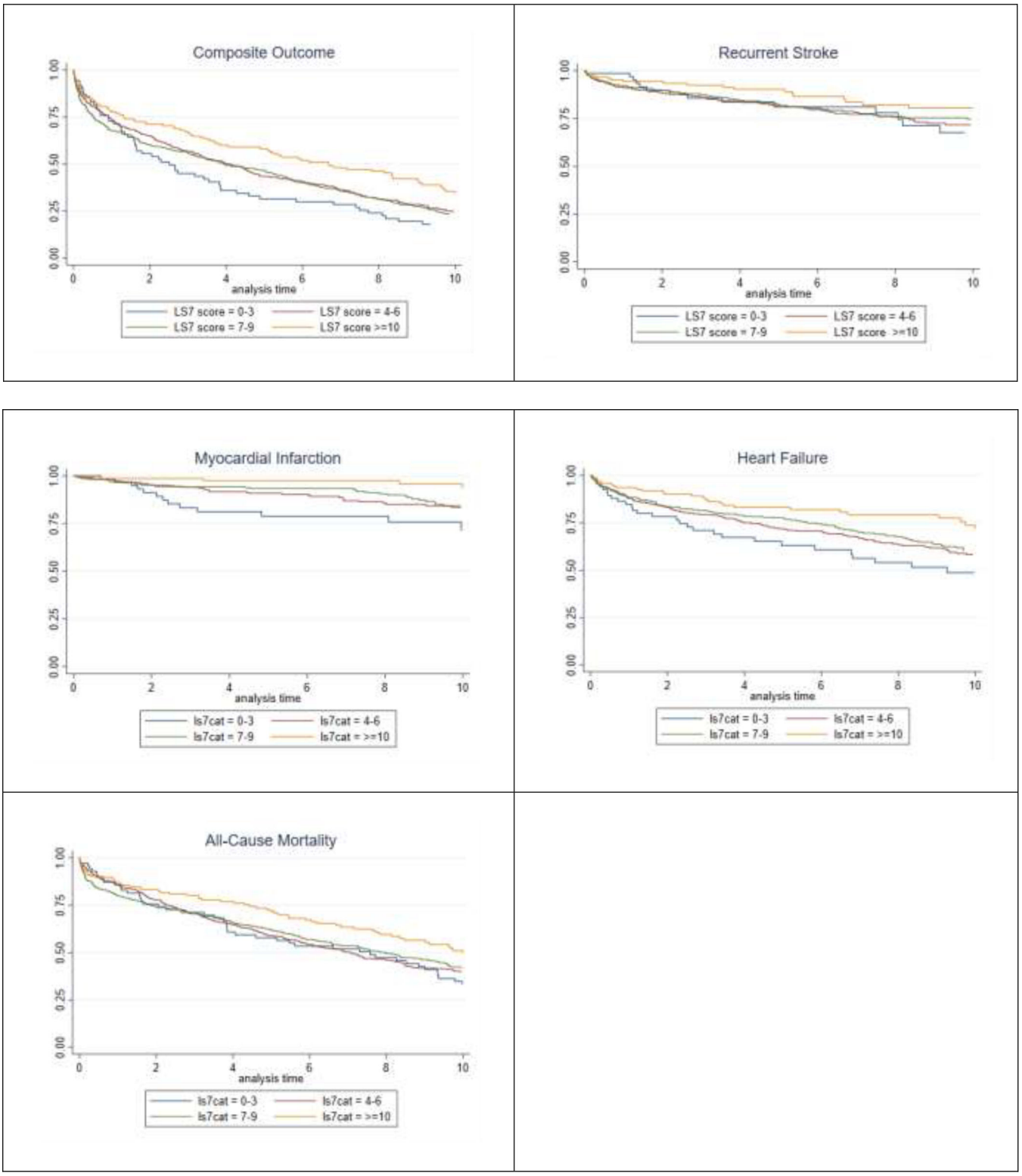

Figure 2:

Kaplan-Meier Curves for Composite Outcome, Recurrent Stroke, Myocardial Infarction, Heart Failure, and All-Cause Mortality by Life's simple 7 score among stroke patients, N=1218

Table 1:

Baseline Characteristics of Atherosclerosis Risk in Communities Study Population without Stroke at Visit 1 (1987–1989), stratified by Life's Simple 7 scores, N= 13,508

Mean (±SD)/n (%)	**Total, 13,508**	**0–3(n=441)**	**4–6(n=3680)**	**7–9(n=6213)**	**≥10(n=3174)**
Age, years	54.0 ± 5.7	543 ± 5.6	54.6 ± 5.6	54.1 ± 5.8	52.9 ± 5.7
Female	55.9	61.5	53.7	53.2	63.2
African American	25.2	56.5	38.7	22.4	10.7
≥ College education	36.8	20.2	26.8	36.6	51.1
Health insurance (yes)	90.8	76.4	86.1	91.8	96.2
Family income for the past 12 months					
≥$25 000	64.3	35.2	51.2	66.4	78.9
Current smoker	25.7	62.1	38.6	23.8	7.5
Systolic blood pressure, mm Hg	120.8 ± 18.5	139.7 ± 20.9	129.5 ± 19.6	119.6 ± 16.5	110.4 ± 12.6
Diastolic blood pressure, mm Hg	73.5 ± 11.1	82.0 ± 13.2	77.7 ± 11.8	73.1 ± 10.3	68.4 ± 8.6
Body mass index, kg/m^2	27.4 ± 5.2	33.0 ± 5.1	30.1 ± 5.6	27.1 ± 4.7	24.4 ± 3.3
Total cholesterol, mg/dL	214.4 ± 41.6	251.1 ± 39.7	229.9 ± 43.7	212.4 ± 39.1	195.4 ± 33.2
HDL-C, mg/dL	52.2 ± 17.1	46.3 ± 14.6	49.0 ± 16.3	51.7 ± 16.7	57.8 ± 17.5
LDL-C, mg/dL	137.0 ± 39.1	170.6 ± 37.6	151.6 ± 40.4	135.9 ± 36.9	118.3 ± 31.7
Life's Simple 7 categories					
Smoking status					
Poor	25.5	62.1	38.9	24.2	7.5
Intermediate	22.8	20.0	25.0	23.9	18.4
Ideal	52.7	17.9	36.1	51.9	74.1
Body Mass Index					
Poor	26.1	78.5	46.8	21.4	3.9
Intermediate	39.6	18.6	38.9	45.5	31.8
Ideal	34.3	2.9	14.3	33.1	64.3
Physical Activity					
Poor	37.4	87.5	64.5	33.1	7.6
Intermediate	24.7	11.1	21.5	28.2	23.6
Ideal	37.9	1.4	14.0	38.8	68.8
Healthy diet					
Poor	49.6	81.6	64.5	48.9	29.2
Intermediate	44.1	17.7	33.4	46.1	56.4
Ideal	6.3	0.7	2.1	5.0	14.3
Total cholesterol					
Poor	24.5	68.3	39.9	21.1	7.3
Intermediate	38.1	26.3	38.3	41.5	32.8
Ideal	37.4	5.4	21.8	37.4	59.9
Blood pressure					

Mean (±SD)/n (%)	**Total, 13,508**	**0–3(n=441)**	**4–6(n=3680)**	**7–9(n=6213)**	**≥10(n=3174)**
Poor	16.7	60.3	31.3	12.7	2.4
Intermediate	42.1	34.9	51.6	46.2	24.2
Ideal	41.2	4.8	17.1	41.6	73.4
Glucose					
Poor	8.8	43.5	18.7	4.5	0.8
Intermediate	38.6	46.7	52.3	40.3	18.5
Ideal	5152.6	9.8	29.1	55.2	80.8

Data are given as mean±SD for continuous variables or percentage for categorical variables,; HDL-C-high density lipoprotein cholesterol; LDL-C-low density lipoprotein cholesterol

Table 2:

Baseline Characteristics of Participants with Incident Stroke, stratified by Life's Simple 7 scores, N=1218

Mean ± SD/ %	Total(N=1218)	0–3(n=78)	4–6(n=446)	7–9(n=518)	≥10 (n=176)
Age at baseline, years	55.7 ± 5.6	54.2 ± 5.7	55.7 ± 5.3	55.6 ± 5.7	55.5 ± 5.6
Age at stroke, years	72.3 ± 8.9	66.1± 9.3	71.4 ± 8.7	73.2 ± 8.7	74.6 ± 8.8
Female	53	63.8	52.4	51.2	57.4
African American	34.9	66.7	48.0	26.8	11.4
≥ College education	29.2	18.0	25.8	29.9	40.9
Health insurance (yes)	87.8	68.0	85.2	91.3	93.1
Family income ≥$25 000 for the past 12 months	52.5	31.5	41.4	58.7	70.8
Current smoker, %	29.1	64.1	35.0	25.3	9.7
Fasting blood glucose, mg/dl	118.8 ± 55.5	161.3 ± 75.9	132.9 ± 66.3	107.5 ± 41.8	97.6 ± 19.6
Systolic blood pressure, mm Hg	128.0 ± 20.6	145.2 ± 23.4	134.4 ± 20.8	124.8 ± 17.9	113.6 ± 13.7
Diastolic blood pressure, mm Hg	76.6 ± 12.7	84.9 ± 15.2	79.4 ± 12.6	75.3 ± 11.9	69.4 ± 9.5
Body mass index, kg/m^2	28.4 ± 5.4	33.3 ± 5.3	30.0 ± 5.2	27.4 ± 5.3	24.6 ± 2.9
Total cholesterol, mg/dL	220.6 ± 44.7	253.8 ± 32.7	232.2 ± 47.2	212.0 ± 41.4	202.0 ± 36.0
HDL-C, mg/dL	50.5 ± 16.7	46.5 ± 15.3	49.3 ± 16.8	50.1 ± 15.9	56.6 ± 18.1
LDL-C, mg/dL	142.7 ± 40.4	169.2 ± 32.7	152.9 ± 42.1	136.1 ± 37.9	125.0 ± 33.6
Life's Simple 7 categories					
Smoking status					
Poor	29.1	64.1	35.0	25.3	9.7
Intermediate	23.2	21.8	26.2	23.4	15.9
Ideal	47.7	14.1	38.8	51.4	74.4
Body Mass Index					
Poor	30.9	78.2	44.0	21.2	5.1
Intermediate	40.0	19.2	42.8	43.6	31.3
Ideal	29.2	2.6	13.2	35.1	63.6
Physical Activity					
Poor	41.5	80.7	60.5	30.9	7.4
Intermediate	24.6	14.1	24.2	26.8	23.9
Ideal	33.8	5.1	15.3	42.3	68.8
Healthy diet					
Poor	50.5	83.3	60.8	46.1	22.7
Intermediate	43.1	15.4	36.5	46.7	61.4
Ideal	6.4	1.3	2.7	7.1	15.9
Total cholesterol					
Poor	29.6	69.2	41.7	20.7	8.0
Intermediate	38.4	30.7	34.3	42.1	41.5
Ideal	31.9	0	24.0	37.3	50.6
Blood pressure					

Mean ± SD/ %	**Total(N=1218)**	**0–3(n=78)**	**4–6(n=446)**	**7–9(n=518)**	**≥10 (n=176)**
Poor	27.3	64.1	38.8	19.7	4.0
Intermediate	45.3	32.1	49.1	49.6	29.0
Ideal	27.4	3.9	12.1	30.7	67.1
Glucose					
Poor	16.8	56.4	27.1	7.1	1.1
Intermediate	38.8	32.1	46.6	39.0	21.0
Ideal	44.5	11.5	26.2	53.9	77.8

Data are given as mean±SD for continuous variables or percentage for categorical variables; HDL-C-high density lipoprotein cholesterol; LDL-C-low density lipoprotein cholesterol

Table 3:

Crude Incidence Rate (per 1000 Person-Years) and Hazard Ratio (95% CI) of Incident Stroke According to Life's Simple 7 Score at Baseline in the Entire Study Population (N=13,508), ARIC Study, 1987 to 2017

	Life Simple 7 (LS7) Scores				
	0–3(n=441)	**4–6(n=3680)**	**7–9(n=6213)**	**≥10(n=3174)**	**P-value for Trend**
Stroke cases	78	446	518	176	
Incidence rate	9.9	5.7	3.5	2.1	
Hazard Ratio (95% CI)	1.85 (1.45–2.36)*	1(Reference)	0.59 (0.52–0.67)*	0.35 (0.29–0.41)*	<0.001