Impact of the American Heart Association's Life's Essential 8 goals on incident cardiovascular diseases (CVD) in the Strong Heart Family Study

Pyone Yadanar Paing, MPH, Department of Epidemiology, University of Washington, Seattle, WA

Alyson J. Littman, PhD, Department of Epidemiology, University of Washington, Seattle, WA Jessica A. Reese, PhD, University of Oklahoma Health Sciences Center, Oklahoma City, OK

Colleen M. Sitlani, PhD, Department of Medicine, University of Washington, Seattle, WA

Jason G. Umans, PhD, MedStar Health Research Institute, Washington, DC.

Shelley A. Cole, PhD, Texas Biomedical Research Institute, San Antonio, Texas, TX

Ying Zhang, PhD, University of Oklahoma Health Sciences Center, Oklahoma City, OK

Tauqeer Ali, PhD, University of Oklahoma Health Sciences Center, Oklahoma City, OK

Amanda M. Fretts, PhD, Department of Epidemiology, University of Washington, Seattle, WA

Corresponding author

Pyone Yadanar Paing, pyoneyadanarpaing.uch@gmail.com, 4142 12th Avenue NE, Seattle, WA 98105

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Abstract

Background: Cardiovascular diseases (CVD) are a leading cause of morbidity and mortality among American Indians. In 2022, the American Heart Association (AHA) developed the Life's Essential 8 goals to promote optimal cardiovascular health (CVH) for Americans. The goals comprise 4 health behaviors (i.e., diet, physical activity, nicotine exposure, and sleep) and 4 health factors (i.e., body mass index, blood lipids, blood pressure, and blood glucose). We examined whether achievement of the AHA's Life's Essential 8 goals was associated with incidence of CVD in American Indians who participated in the Strong Heart Family Study (SHFS), a longitudinal study of risk factors for CVD in 12 American Indian communities.

Methods: A total of 2,139 SHFS participants without CVD at baseline were included in analyses. We created a composite CVH score based on achievement of the AHA Life's Essential 8 goals. The composite score used data on diet quality, physical activity, nicotine exposure, body mass index, blood lipids, blood pressure and blood glucose; sleep data were not collected in the SHFS, and sleep was not included in the composite score. Scores of 0-49 represented low CVH, 50-69 moderate CVH, and 70-100 high CVH. Incident CVD was defined as new onset myocardial infarction, coronary heart disease, congestive heart failure, or stroke. Cox proportional hazard models were used to examine the relationship of CVH and incident CVD.

Results: The incidence rate of CVD at the 20-year follow-up (through 2021) was 7.43 per 1000 person-years. Compared to participants with low CVH, participants who had moderate and high CVH had a lower risk of incident CVD; the hazard ratios and 95% confidence intervals (CI) for incident CVD for moderate and high CVH were 0.52 (95%

CI: 0.40-0.68) and 0.25 (95% CI: 0.14-0.44), respectively, after adjustment for age, sex, education, and study site.

Conclusion: Better CVH was associated with lower risks of CVD in American Indians. Our findings support the need for comprehensive public health interventions targeting CVH promotion to reduce the risk of CVD among American Indians.

Abbreviations

AHA : American Heart Association

AHEI : Alternative Healthy Eating Index

ARIC : Atherosclerosis Risk in Communities Study

BMI : Body Mass Index

CI : Confidence Interval

CVD : Cardiovascular Diseases

CVH : Cardiovascular Health

ECG : Electrocardiogram

FBG : Fasting Blood Glucose

FFQ : Food Frequency Questionnaire

HbA1c : Hemoglobin A1C

HCHS/SOL : Hispanic Community Health Study/Study of Latinos

HDL : High-density Lipoprotein

HEI : Healthy Eating Index

HR : Hazard Ratio

MESA : Multi-Ethnic Study of Atherosclerosis Study

NDS : Nicotine-delivery System

NHANES : National Health and Nutrition Examination Survey

SD : Standard deviation

SHFS : Strong Heart Family Study

Introduction

Cardiovascular diseases (CVD) are a leading cause of morbidity and mortality among American Indians. In 2020, CVD was the second leading cause of death, after COVID-19, among American Indians (1). Compared to other racial and ethnic groups in the United States, American Indians carry a disproportionately high burden of CVD (2). Significant health disparities persist in terms of CVD and its risk factors among American Indians because of structural racism that has resulted in low socioeconomic status and limited access to quality healthcare (2). The American Heart Association (AHA) recommends Americans strive to achieve the Life's Essential 8 goals to maximize cardiovascular health (CVH). The Life's Essential 8 goals comprise eight major predictors of CVH, including four modifiable health behaviors (i.e., diet, physical activity, exposure to nicotine, sleep) and four health factors (i.e., adiposity, based on body mass index [BMI], non-high density lipoprotein blood cholesterol, systolic and diastolic blood pressures, and fasting blood glucose) (3).

Prior to 2022, CVH was defined by the AHA using a metric called "Life's Simple 7". The updated Life's Essential 8 goals reflect all seven goals of the Life's Simple 7, with the addition of sleep health. Additionally, the scoring metric for the "Life Essential 8" accounts for finer stratification of CVH than the Life's Simple 7. A number of studies have examined associations of achievement of the Life's Simple 7 goals with various cardio-metabolic outcomes. However, prior studies included primarily white or Black populations who reside in urban or suburban communities (4–12); no studies have assessed the association between achievement of the Life's Simple 7 goals (or the newer Life's Essential 8 goals) and risk of CVD in American Indians. Findings from other racial/ethnic

groups may not be generalizable to American Indians who reside in rural communities because of stark differences in underlying risk factors and health behaviors across populations.

In this analysis, we examined the association of achievement of the Life's Essential 8 goals and the incidence CVD during a 20-year follow-up (through 2021) among American Indians who participated in the SHFS. We hypothesized that participants who achieved a greater number of AHA goals had a lower risk of CVD when compared to participants who achieved fewer goals.

Methods

Study design:

The SHFS is a longitudinal cohort study of CVH in American Indians.

Study setting:

The SHFS is the largest epidemiological study of American Indian health in the United States, and includes American Indians from 12 communities in Arizona, North Dakota, South Dakota, and Oklahoma. The study comprised two in-person examinations, a baseline examination in 2001-2003 and a follow-up examination in 2006-2009. Follow-up for major cardiovascular events (e.g., incidence of CVD) is on-going and our analysis covered CVD identified through December 31, 2021.

Study subjects:

Of the 2,269 participants in the SFHS, we excluded participants with CVD at baseline (n=130), leaving 2,139 for the analytic sample.

Data collection:

Each SHFS examination included a standardized personal interview, physical examination, and laboratory work-up (13). Personal interviews ascertained information about previous/current medical conditions, education, and nicotine use, including exposure to secondhand smoke. Diet information was collected using Block Food Frequency Questionnaires (FFQ) and the Alternative Health Eating Index (AHEI). Daily ambulatory activity (i.e., steps per day) was collected using Accusplit AE120 pedometers (Yamax, Japan). Participants were asked to wear pedometers for seven consecutive days, except while bathing or swimming, and to record the steps accumulated each day in a log. Weight and height were measured at each in-person study exam while the participant was wearing lightweight clothing and no shoes. Body mass index (BMI) was calculated as body weight divided by height-squared (kg/m^2). Blood pressure was measured three times on the right arm using standard mercury sphygmomanometers after five minutes rest, and the average of the second and third systolic and diastolic measurements were used in this analysis. Blood samples were collected after a 12-hour overnight fast and stored at -70 degrees Celsius. Plasma glucose was measured using enzymatic methods. Low density lipoprotein cholesterol and high density lipoprotein cholesterol were measured using standard procedures, as described previously (13–15).

Exposure:

The primary exposure of interest was achievement of a modified version of the Life's Essential 8 goals at baseline. We utilized the AHA's new and updated "Metrics for Measurement and Quantitative Assessment of CVH" scoring algorithm to calculate CVH (possible score range 0 to 100 points, Table 1) (3). For our analyses, nicotine exposure, body mass index, blood lipids and blood pressure were scored according to the standard

AHA scoring guidelines. We utilized the AHEI to assess diet quality since calculation of the Healthy Eating Index (HEI) was not possible with the Block FFQ utilized in the SHFS. Similar to previous analyses in the SHFS and other populations, we considered 10,000 steps per day as ideal level of physical activity (16–21). In the SHFS, 60% of participants had missing values for HbA1c. For these participants, we estimated HbA1C based on fasting glucose measures using the American Diabetes Association conversion calculator: 28.7 X HbA1C – 46.7 = Fasting glucose (22). Lastly, we excluded sleep from analyses since sleep duration was not available in the SHFS. As recommended by the AHA writing group, a composite measure of overall CVH was created by summing the scores for the 7 components of CVH and dividing by 7 to obtain an unweighted average score (range: 0 to 100 points). We then categorized CVH into 3 groups: 1) low: 0 to 49 points; 2) moderate CVH: 50 to 69; and 3) high CVH: 70 to 100. For analyses of individual CVH goals, we used the same categorization scheme.

Table I. New and Updated Metric on the Measurement and Quantitative Assessment of CVH

CVH metric	Quantification of CVH metric by AHA advisory	Modifications
Diet	Quantiles of HEI-2015 (population) Scoring (population): Points Quantile 100 ≥95th percentile (top/ideal diet)	Alternative Healthy Eating Index Points Quantile 100 80-100 80 60-<80 50 40-<60

	80 75th–94th percentile 50 50th–74th percentile 25 25th–49th percentile 0 1st–24th percentile (bottom/ least ideal quartile)	25 20-<40 0 <20
Physical Activity	Metric: Minutes of moderate- to vigorous-intensity activity per week Scoring: Points Minutes 100 ≥150 90 120–149 80 90–119 60 60–89 40 30–59 20 1–29 0 0	Pedometer-measured ambulatory activity Points Steps/day 100 ≥ 10,000 90 ≥ 9000 & < 10000 80 ≥ 8000 & < 9000 60 ≥ 6000 & < 8000 40 ≥ 4000 & < 6000 20 ≥ 2000 & < 4000 0 < 2000
Nicotine exposure	Metric: Combustible tobacco use or inhaled Nicotine-Delivery System (NDS) use; or secondhand smoke exposure Scoring: Points Status	Tobacco use calculated as defined in the AHA metric. SHFS collected secondhand smoke information as average number of hours per day a

	100 Never smoker 75 Former smoker, quit ≥5 y 50 Former smoker, quit 1–<5 y 25 Former smoker, quit <1 y, or currently using inhaled NDS. 0 Current smoker Subtract 20 points (unless score is 0) for living with active indoor smoker in home	participant is exposed to the smoke of others. We categorized 0 hours as unexposed, and more than 0 hours as exposed.
Body mass index	Metric: BMI (kg/m^2) Scoring: <u>Points</u> <u>Level</u> 100 <25 70 25.0–29.9 30 30.0–34.9 15 35.0–39.9 0 ≥40.0	BMI calculated as defined in the AHA metric.
Blood lipids	Metric: Non–HDL cholesterol (mg/dL) Scoring: <u>Points.</u> <u>Level</u> 100 <130 60 130–159 40 160–189	Non-HDL cholesterol calculated as defined in the AHA metric.

	20 190–219 0 ≥220 If drug-treated level, subtract 20 points	
Blood glucose	Metric: Fasting Blood Glucose (mg/dL) or HbA1c (%) Scoring: Points Level 100 No history of diabetes and FBG <100 (or HbA1c <5.7) 60 No diabetes and FBG 100–125 (or HbA1c 5.7–6.4) (prediabetes) 40 Diabetes with HbA1c <7.0 30 Diabetes with HbA1c 7.0–7.9 20 Diabetes with HbA1c 8.0–8.9 10 Diabetes with Hb A1c 9.0–9.9 0 Diabetes with HbA1c ≥10.0	We estimated HbA1C values for participants missing HbA1C values as: 28.7 X A1c – 46.7 = eAG equation from American Diabetes Association. Then we used the same scoring as AHA metric.
Blood pressure	Metric: Systolic and diastolic blood pressures (mm Hg) Scoring: Points Level 100 <120/<80 (optimal)	Blood pressure calculated as defined in the AHA metric.

	75 120–129/<80 (elevated) 50 130–139 or 80–89 (stage 1 hypertension) 25 140–159 or 90–99 0 ≥160 or ≥100 Subtract 20 points if treated level	

Outcome:

Incident CVD was defined as new onset myocardial infarction (possible, probable, definite, or fatal), coronary heart disease (possible, definite, or fatal), congestive heart failure (including fatal), or ischemic stroke (possible, definite, or fatal). Incident CVD was identified at the follow-up study exam (via ECG and positive Rose Angina Questionnaire), and through on-going surveillance of medical records and death certificates through 2021. Between 2009 and 2021, cases were also identified through phone interviews with participants, and confirmed by medical record review.

Data analysis:

Descriptive statistics were used to examine the distribution of baseline characteristics of study participants (i.e., age, biological sex, education, study site, nicotine exposure, BMI, diet quality, physical activity, blood pressure, cholesterol, fasting glucose) across the three groups of CVH (low, medium, and high CVH). Incidence rates per 1000 person-years were calculated for the total population and across CVH category. Cox proportional hazard models with robust standard errors that accounted for family clusters were used to examine the association of Life's Essential 8 composite scores with CVD risk. In exploratory analyses, we additionally assessed: (1) associations of each of

the individual components of the Life's Essential 8 (i.e., diet quality, physical activity, nicotine exposure, BMI, blood lipids, blood pressure, plasma glucose) with incident CVD; and (2) association of achievement of the Life's Essential 8 with each sub-types of CVD (i.e., myocardial infarction, coronary heart disease, congestive heart failure and stroke). We fit two models for each analysis-- a crude model and a model adjusted for potential confounders, including age, sex, study site, and education (primary model). All confounders were chosen *a priori* based on potential associations of the Life's Essential 8 goals and CVD. All analyses were conducted in Stata version 17.0.

Results

The mean (SD) age at baseline was 34.6 (16.3) years, 39.9% (n=854) of study participants were male, and 60.1% (n=1285) of study participants were female. In total, 28.4% (n=608) participants had low CVH, 49.8% (n=1065) had moderate CVH, and 21.8% (n=466) had high CVH. Participants who achieved high CVH were younger than participants with low or moderate CVH. There were no differences in education or biological sex according to CVH achievement. There was a wide distribution of scores for each of the individual components of the Life's Essential 8 goals, except diet; diet quality was low for all SHFS participants (mean diet scores were 35.8, 38.2, and 39.2 for low, moderate, and high categories) (Table 1A).

Achievement of each of the ideal CVH metrics was generally lower for the health behaviors (i.e., diet quality, physical activity) than the health factors (i.e., BMI, blood pressure, plasma glucose, cholesterol). No participants achieved high diet quality, 13% (n=273) of participants achieved ideal physical activity, and 22% (n=474) of participants achieved ideal (i.e., low) nicotine exposure. For the health factors, 20% (n=430)

participants achieved ideal BMI, 50% (n=1078) achieved ideal blood lipids, 37% (n=795) achieved ideal blood pressure, and 61% (n=1309) achieved ideal blood glucose (Table 1B).

There were 274 individuals who developed CVD over a total of 36,892 person-years of follow-up (incidence rate of 7.43 per 1000 person years). After adjustment for age, sex, education and site, the risk of developing CVD was lower among participants in the moderate CVH group (HR: 0.52, 95% CI: 0.40-0.68) and the high CVH group (HR: 0.25, 95% CI: 0.14-0.44) compared to low CVH group (Table 2).

Exploratory analyses that assessed associations of individual components of the Life's Essential 8 with risk of CVD are shown in Table 3. Diet quality was not associated with risk of CVD. For physical activity and nicotine, the adjusted hazard ratios of CVD risk comparing extreme categories (high versus low) were: 0.64 (95% CI: 0.44-0.92) and 0.73 (95% CI: 0.55-0.98), respectively. Similarly, participants who achieved high CVH for BMI had lower risk of CVD compared to participants with low CVH for BMI (adjusted HR: 0.77, 95% CI: 0.59-0.99). Participants who achieved high CVH for non-HDL cholesterol and blood pressure had 32% (HR: 0.68, 95% CI: 0.52-0.89) and 48% (HR: 0.52: 95% CI: 0.35-0.77) lower risks of CVD when compared to participants with low CVH in blood pressure and non-HDL cholesterol, respectively. Finally, participants with high CVH for blood glucose had a 68% lower risk of CVD compared to participants with low CVH for blood glucose (adjusted HR: 0.32, 95% CI: 0.24-0.43).

In analyses that assessed the relationship of Life's Essential 8 with each sub-type of CVD, we observed inverse associations of CVH with myocardial infarction, coronary

heart disease, and congestive heart failure (Table 4). There was no statistically significant association of Life's Essential 8 with stroke.

Discussion

This study was designed to better understand the association between achievement of the AHA Life's Essential 8 goals and risk of CVD in a population of American Indians with a high burden of CVD. In the SHFS, nearly a third of the participants had low CVH based on AHA criteria. The overall incidence rate of CVD among SHFS participants was 7.3 per 1000 person years. Risk of incident CVD was lower among participants with moderate or high CVH compared to those with low CVH.

Few published papers to date have assessed achievement of the Life's Essential 8 goals with risk of CVD in the general population since the guidelines are fairly new (established in 2022). In the National Health and Nutrition Examination Survey, mean CVH score was 64.7 (23) and about 24% of NHANES participants had low CVH (24). Although it is challenging to directly compare CVH in SHFS versus NHANES since we were unable to include sleep in the CVH score, achievement of CVH in NHANES was higher than the SHFS (mean CVH score in the SHFS was 58.4 and 28.4% of SHFS had low CVH). Taken together, these findings highlight the need for improvements in CVH for all Americans.

To our knowledge, this is the first study that has examined the relationship of achievement of the Life's Essential 8 goals and incidence of CVD in American Indians. Our findings are consistent with findings from NHANES—which indicate that participants who achieved a greater number of Life's Essential 8 goals had a lower risk of death from CVD when compared to participants who achieved fewer goals (25). In NHANES,

participants who achieved moderate and high CVH had 38-64% lower risk of death from CVD compared to those with low CVH (24). The findings reported herein expand that work and suggest that achievement of CVH is also associated with reduced risk of CVD-specific morbidity.

The findings reported herein are also consistent with reports from previous studies that assessed associations of achievement of the Life's Simple 7 goals (i.e., precursor to Life's Essential 8) with risk of CVD and related outcomes in white, Black, Hispanic, and Asian populations in the CVD United States (4–8,10–12,26–28). For instance, in the Multiethnic Study of Atherosclerosis (MESA), achievement of the Life's Simple 7 goals was associated with lower hepatocyte growth factor levels, an important potential biomarker of CVD risk (5), and also risk of developing congestive heart failure (28). Findings from the Atherosclerosis Risk in Communities Study, the Hispanic Community Health Study/Study of Latinos (HCHS/SOL), and the Jackson Heart Study show that achievement of the Life's Simple 7 goals was inversely associated with risk of myocardial infarction (7), coronary heart disease (26), and congestive heart failure, respectively. However, in the HCHS/SOL (26) and ARIC cohorts (12), achievement of Life's Simple 7 was also associated with a lower risk of stroke; we did not observe an association of achievement of Life's Essential 8 with stroke in the SHFS. This may be due to a lower average age in the SHFS than the other cohorts (i.e., mean age in the SHFS was 34.6 years compared to 55.3 years in HCHS/SOL (29) and 55.0 years in ARIC (7)), and limited number of stroke events in the SHFS.

For each health behavior (i.e., physical activity, smoking) and health factor (i.e., blood pressure, blood lipids, BMI, blood glucose) that comprise the Life's Essential 8,

achievement of moderate or high CVH for each individual behavior or factor was associated with a lower risk of CVD, except for diet quality. We did not observe an association between diet and incident CVD. This was not surprising given the limited variability of diet quality within the SHFS. Due to limited availability or access to healthy foods in many of the SHFS communities, many participants reported poor diet quality. In a previous study that examined the association of achievement of the AHA Life's Simple 7 goals with risk of diabetes, we also reported no association between diet and diabetes (30).

Our findings indicate that that the magnitude of the association of achievement of the Life's Essential 8 goals on risk of CVD is greater when the health behaviors and risk factors are combined into a single CVH score. This may suggest that multi-faceted interventions that target multiple health behaviors and risk factors simultaneously may be more effective at lowering risk of CVD than strategies that target individual behaviors or risk factors.

Our study has several strengths. The SHFS is the largest study of CVH of American Indians in the United States. Detailed information on CVD-related health behaviors and health factors were collected using tools shown to be reliable and valid in free-living populations, including the Block Frequency Food Questionnaire, Yamax pedometer, sphygmomanometer, and blood tests. Incidence of CVD over a follow-up of over 20 years was also ascertained through rigorous process including via ECG and positive Rose Angina Questionnaire at the follow-up exam, and through on-going surveillance of medical records and death certificates. The study also has potential limitations. Although ambulatory activity was assessed using pedometers, study

participants may have altered their physical activity patterns during the days that the pedometer was worn. Additionally, pedometers only capture ambulatory movement, and activities such as swimming or cycling are not captured with these devices. However, previous work in the SHFS has shown that walking is the primary form of activity in the cohort (30). Additionally, it is possible that some participants did not accurately recall usual diet quality and/or exposure to nicotine (i.e., recall bias and social desirability bias). For participants without measures of HbA1c, we utilized a single measure of fasting plasma glucose to assess blood sugar control—which may not be an accurate marker of long-term circulating blood glucose for some participants. However, for each of these limitations in exposure measurement, any poorly measured factors would result in non-differential misclassification; our risk estimates may therefore be attenuated estimates. Finally, sleep data were not available in the SHFS, so our composite score is based on seven of the eight AHA Life's Essential 8 metrics.

Conclusion

In conclusion, achievement of the AHA Life's Essential 8 goals was inversely associated with risk of developing CVD in American Indians. These findings add to the growing body of evidence regarding the value of the AHA's Life's Essential 8 goals in CVH promotion efforts in diverse populations.

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Disclosures

No conflict of interests was reported.

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Tables

Table 1A. Baseline Characteristics of Strong Heart Family Study participants according to cardiovascular health (CVH) based on achievement of the Life's Essential 8 goals (n=2,139).

Variables	Low CVH* n (%) OR Mean [SD]	Moderate CVH* n (%) OR Mean [SD]	High CVH* n (%) OR Mean [SD]
Total population	608 (28.4%)	1065 (49.8%)	466 (21.8%)
Demographics			
Age (Years)			
Mean [SD]	45.1 [14.0]	40.3 [16.4]	30.9 [15.2]
Education (Years)			
Mean [SD]	12.4 [2.2]	12.3 [2.2]	12.0 [2.5]
Less than 12 years	139 (22.9%)	289 (27.1%)	180 (38.6%)
12 years	239 (39.3%)	423 (39.7%)	132 (28.3%)
13-15 years	168 (27.6%)	241 (22.6%)	103 (22.1%)
16 years or more	62 (10.2%)	51 (10.9%)	51 (10.9%)
Gender			

Male	265 (43.6%)	397 (37.3%)	192 (41.2%)
Female	343 (56.4%)	668 (62.7%)	274 (58.8%)
Site			
Arizona	91 (15.0%)	113 (10.6%)	38 (8.2%)
Oklahoma	284 (46.7%)	508 (47.7%)	220 (47.2%)
South Dakota	233 (38.3%)	444 (41.7%)	208 (44.6%)
Life's Essential 8 Health behaviors (points)			
Diet			
Mean [SD]	35.8 [12.6]	38.2 [14.0]	39.2 [15.1]
0-49	347 (57.1%)	527 (49.5%)	222 (47.6%)
50-69	259 (42.6%)	514 (48.3%)	225 (48.3%)
70-100	2 (0.3%)	24 (2.3%)	19 (4.1%)
Physical activity			
Mean [SD]	29.3 [24.3]	46.5 [29.1]	70.5 [27.3]
0-49	495 (81.4%)	634 (59.5%)	129 (27.7%)
50-69	81 (13.3%)	214 (20.1%)	92 (19.7%)
70-100	32 (5.3%)	217 (20.4%)	245 (52.6%)
Nicotine exposure			
Mean [SD]	28.0 [36.3]	47.2 [41.8]	74 [33.5]
0-49	394 (64.8%)	475 (44.6%)	82 (17.6%)
50-69	78 (12.8%)	102 (9.6%)	23 (4.9%)
70-100	136 (22.4%)	488 (45.8%)	361 (77.5%)
Life's Essential 8 Health factors			

Body mass index			
Mean [SD]	27.5 [25.7]	48 [32.2]	81.9 [23.2]
0-49	497 (81.7%)	569 (53.4%)	44 (9.4%)
50-69	-	-	-
70-100	111 (18.3%)	496 (46.6%)	422 (90.6%)
Blood lipids			
Mean [SD]	56.8 [28.6]	76.7 [26.6]	92.8 [17.0]
0-49	240 (39.5%)	189 (17.7%)	15 (3.2%)
50-69	224 (36.8%)	298 (28.0%)	57 (12.2%)
70-100	144 (23.7%)	578 (54.3%)	394 (84.5%)
Blood pressure			
Mean [SD]	59.1 [24.2]	76.7 [22.3]	89.5 [16.8]
0-49	114 (18.8%)	52 (4.9%)	3 (0.6%)
50-69	229 (37.7%)	248 (23.3%)	41 (8.8%)
70-100	265 (43.6%)	765 (71.8%)	422 (90.6%)
Blood glucose			
Mean [SD]	54.8 [32.8]	83.6 [25.1]	97.5 [10.4]
0-49	250 (41.1%)	113 (10.6%)	1 (0.2%)
50-69	201 (33.1%)	238 (22.3%)	27 (5.8%)
70-100	157 (25.8%)	714 (67.0%)	438 (94.0%)

*****A composite measure of overall CVH, which was created by summing the scores for the 7 components of CVH and dividing by 7 to obtain an unweighted average score

(range: 0 to 100 points), was categorized CVH into 3 groups: 1) low: 0 to 49 points; 2) moderate CVH: 50 to 69; and 3) high CVH: 70 to 100.

CVH = cardiovascular health

CVD = cardiovascular diseases

HR = hazard ratio

Table 1B: Distribution of ideal cardiovascular health metrics in the Strong Heart Family Study (n=2,139).

Cardiovascular Health Metrics	n (%)
Health behaviors	
Diet (achieved 80-100 score of AHEI diet index)	0 (0%)
Physical Activity (achieved >= 10,000 steps)	273 (12.8%)
Nicotine Exposure (never smoker)	474 (22.2%)
Health factors	
Body Mass Index (<25 kg/m^2)	430 (20.1%)
Blood Lipids (<130 mg/dl of non–HDL Cholesterol)	1078 (50.4%)
Blood Pressure (<120/80 mmHg of systolic and diastolic blood pressure)	795 (37.2%)
Blood Glucose (no history of diabetes and FBG <100 mg/dl or HbA1c <5.7%)	1309 (61.2%)

Table 2: Hazard Ratios (HR) for Association of Life's Essential 8 goals with incident CVD among Strong Heart Family Study participants (n= 2,139)

	No. of cases	Time at risk (days)	Incidence rate (per 1000 person-years)	Unadjusted HR (95% CI)	Adjusted HR for age, sex, education and site. (95% CI)
Overall	274	36892	7.43		
Low CVH	138	9527	14.48	1 (Reference)	1 (Reference)
Moderate CVH	120	18660	6.43	0.45 (0.35-0.57)	0.52 (0.40-0.68)
High CVH	16	8705	1.83	0.13 (0.07-0.22)	0.25 (0.14-0.44)

CVH = cardiovascular health

CVD = cardiovascular diseases

HR = hazard ratio

Table 3: Hazard Ratios (HR) for Association of individual Life's Essential 8 goals with incident CVD among Strong Heart Family Study participants (n = 2,139)

	No. of cases	Time at risk (days)	Incidence rate (per 1000 person-years)	Unadjusted HR (95% CI)	Adjusted HR for age, sex, education and site. (95% CI)
Diet					
Low CVH*	116	19362	5.99	1 (Reference)	1 (Reference)
Moderate CVH*	148	16818	8.79	1.46 (1.14-1.88)	0.94 (0.71-1.25)
High CVH*	10	712	14.05	2.31 (1.21-4.43)	0.89 (0.52-1.49)
Physical exercise					
Low CVH*	197	20947	9.40	1 (Reference)	1 (Reference)
Moderate CVH*	39	6831	5.71	0.61 (0.45-0.82)	0.86 (0.62-1.19)
High CVH*	38	9114	4.17	0.44 (0.30-0.64)	0.64 (0.44-0.92)
Nicotine exposure					
Low CVH*	120	16405	7.31	1 (Reference)	1 (Reference)
Moderate CVH*	39	3257	11.97	1.64 (1.11-2.43)	0.99 (0.64-1.54)
High CVH	115	17230	6.67	0.91 (0.69-1.19)	0.73 (0.55-0.98)
Body mass index					
Low CVH*	155	18849	8.22	1 (Reference)	1 (Reference)
Moderate CVH**	0	0	--		

High CVH*	119	18043	6.59	0.80 (0.62-1.04)	0.77 (0.59-0.99)
Blood lipids					
Low CVH*	86	7243	11.87	1 (Reference)	1 (Reference)
Moderate CVH*	89	9988	8.91	0.75 (0.60-0.93)	0.87 (0.69-1.08)
High CVH*	99	19662	5.03	0.42 (0.33-0.55)	0.68 (0.52-0.89)
Blood pressure					
Low CVH*	42	2609	16.09	1 (Reference)	1 (Reference)
Moderate CVH*	92	8544	10.77	0.67 (0.47-0.97)	0.66 (0.45-0.98)
High CVH*	140	25738	5.43	0.34 (0.24-0.49)	0.52 (0.35-0.77)
Blood glucose					
Low CVH*	125	5186	24.10	1 (Reference)	1 (Reference)
Moderate CVH*	56	8017	6.98	0.29 (0.21-0.41)	0.31 (0.21-0.45)
High CVH*	93	23688	3.92	0.16 (0.13-0.21)	0.32 (0.24-0.43)

*A score ranging from 0-100 points for individual components of Life's Essential 8 goals was categorized into 3 groups: 1) low: 0 to 49 points; 2) moderate CVH: 50 to 69; and 3) high CVH: 70 to 100.

**Based on the scoring no one qualifies as having moderate CVH for BMI.

CVH = cardiovascular health

CVD = cardiovascular diseases

HR = hazard ratio

Table 4: Hazard Ratios (HR) for Association of Life's Essential 8 goals with incident CVD (sub-types) among Strong Heart Family Study participants (n = 2,139)

	No. of cases	Time at risk (days)	Incidence rate (per 1000 person-years)	Unadjusted HR (95% CI)	Adjusted HR for age, sex, education and site. (95% CI)
Myocardial infarction					
Overall	73	36565	1.99		
Low CVH	41	9448	4.34	1 (Reference)	1 (Reference)
Moderate CVH	30	18470	1.62	0.37 (0.24-0.59)	0.45 (0.28-0.73)
High CVH	2	8647	0.23	0.05 (0.01-0.22)	0.09 (0.03-0.37)
Coronary heart disease					
Overall	164	36516	4.49		
Low CVH	87	9432	9.22	1 (Reference)	1 (Reference)
Moderate CVH	68	18426	3.69	0.40 (0.29-0.56)	0.48 (0.35-0.66)
High CVH	9	8657	1.04	0.11 (0.06-0.23)	0.21 (0.11-0.42)
Congestive heart failure					
Overall	62	36388	1.70		
Low CVH	26	9274	2.80	1 (Reference)	1 (Reference)
Moderate CVH	33	18451	1.79	0.63 (0.38-1.05)	0.74 (0.24-1.23)
High CVH	3	8662	0.35	0.12 (0.04-0.39)	0.26 (0.08-0.87)

Stroke					
Overall	53	36389	1.45		
Low CVH	23	9322	2.47	1 (Reference)	1 (Reference)
Moderate CVH	24	18424	1.30	0.53 (0.31-0.92)	0.59 (0.33-1.04)
High CVH	6	8642	0.69	0.28 (0.12-0.67)	0.57 (0.23-1.40)

CVH = cardiovascular health

CVD = cardiovascular diseases

HR = hazard ratio