Status of Cardiovascular Health in US Adults and Children Using the American Heart Association's New "Life's Essential 8" Metrics: Prevalence Estimates From the National Health and Nutrition Examination Survey (NHANES), 2013 Through 2018

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BACKGROUND: The American Heart Association recently published an updated algorithm for quantifying cardiovascular health (CVH)—the Life's Essential 8 score. We quantified US levels of CVH using the new score.

METHODS: We included individuals ages 2 through 79 years (not pregnant or institutionalized) who were free of cardiovascular disease from the National Health and Nutrition Examination Surveys in 2013 through 2018. For all participants, we calculated the overall CVH score (range, 0 [lowest] to 100 [highest]), as well as the score for each component of diet, physical activity, nicotine exposure, sleep duration, body mass index, blood lipids, blood glucose, and blood pressure, using published American Heart Association definitions. Sample weights and design were incorporated in calculating prevalence estimates and standard errors using standard survey procedures. CVH scores were assessed across strata of age, sex, race and ethnicity, family income, and depression.

RESULTS: There were 23 409 participants, representing 201 728 000 adults and 74 435 000 children. The overall mean CVH score was 64.7 (95% CI, 63.9–65.6) among adults using all 8 metrics and 65.5 (95% CI, 64.4–66.6) for the 3 metrics available (diet, physical activity, and body mass index) among children and adolescents ages 2 through 19 years. For adults, there were significant differences in mean overall CVH scores by sex (women, 67.0; men, 62.5), age (range of mean values, 62.2–68.7), and racial and ethnic group (range, 59.7–68.5). Mean scores were lowest for diet, physical activity, and body mass index metrics. There were large differences in mean scores across demographic groups for diet (range, 23.8–47.7), nicotine exposure (range, 63.1–85.0), blood glucose (range, 65.7–88.1), and blood pressure (range, 49.5–84.0). In children, diet scores were low (mean 40.6) and were progressively lower in higher age groups (from 61.1 at ages 2 through 5 to 28.5 at ages 12 through 19); large differences were also noted in mean physical activity (range, 63.1–88.3) and body mass index (range, 74.4–89.4) scores by sociodemographic group.

CONCLUSIONS: The new Life's Essential 8 score helps identify large group and individual differences in CVH. Overall CVH in the US population remains well below optimal levels and there are both broad and targeted opportunities to monitor, preserve, and improve CVH across the life course in individuals and the population.

Key Words: American Heart Association ■ diet ■ exercise ■ health ■ nutrition surveys ■ prevention and control ■ sleep

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Clinical Perspective

What Is New?

- These data provide the first assessment of the cardiovascular health of the US population using the American Heart Association's Life's Essential 8 score.
- Cardiovascular health is well below optimal in adults and children and it declines with age beginning from ages 2 to 5 years; suboptimal diet, physical activity, and body mass index contribute most to lower Life's Essential 8 scores.
- Compared with the original Life's Simple 7 score, the new Life's Essential 8 updated scoring algorithm and sleep information contribute to understanding disparities in cardiovascular health across sociodemographic groups.

What Are the Clinical Implications?

- Clinicians and patients can measure the Life's Essential 8 score and monitor it over time to assess an individual's current cardiovascular health and opportunities to maintain or improve it to enhance long-term health outcomes.
- Measurement in clinical settings may require routine assessment of diet patterns, physical activity, and sleep habits using rapid questionnaires recommended by the American Heart Association.
- Cardiovascular health assessment appears useful at all ages and may particularly enhance communication and health promotion strategies in children and young adults, for whom the benefits of optimizing cardiovascular health may be especially large over the remaining life course.

Nonstandard Abbreviations and Acronyms

AHA	American Heart Association
BMI	body mass index
BP	blood pressure
CVD	cardiovascular disease
CVH	cardiovascular health
HDL	high-density lipoprotein
LE8	Life's Essential 8
LS7	Life's Simple 7
NH	non-Hispanic
NHANES	National Health and Nutrition Examination Survey
PA	physical activity

In 2010, the American Heart Association (AHA) published its novel definition of cardiovascular health (CVH)[1] to promote improvements in individual and population health and to provide metrics for measuring and monitoring it. Assessment of CVH was on the basis of levels of 7 health behaviors and factors—diet, physical activity (PA), cigarette smoking, body mass index (BMI), total cholesterol, blood pressure (BP), and blood glucose—called Life's Simple 7 (LS7). For each of these 7 metrics, 3 strata were defined as poor, intermediate, or ideal using clinical cut points. Overall CVH could be quantified by a summary score ranging from 0 (all 7 metrics at poor levels) to 14 (all 7 metrics at ideal levels).[1,2]

The prevalence and distributions of CVH have been described in populations around the world.[2] Higher CVH scores are associated prospectively with a multitude of favorable health outcomes across the life course.[2–19] Numerous investigators have also described upstream determinants, cross-sectional correlates, and molecular mechanisms of higher CVH and its associations with health outcomes.[19–24] This body of scientific evidence has substantially advanced our understanding of the life course of CVH, healthy aging, and the potential power of primordial prevention.[25–28] At the same time, limitations of the original LS7 CVH score were identified. Therefore, the AHA recently enhanced and expanded the definition and methods for quantification of CVH[29] to increase the sensitivity of scoring to interindividual differences and to change over time in both individuals and populations. In addition, sleep health was added as an eighth CVH metric. The critical contexts of social determinants of health and psychological health for maintaining CVH or improving it were also highlighted. The new CVH construct is now called Life's Essential 8 (LE8).[29]

We leveraged data from the National Health and Nutrition Examination Survey (NHANES) from 2013 through 2018[30] to demonstrate methods of assessing the LE8 score in the population and to describe current prevalence and distributions of CVH using the new score overall and by age, self-identified sex and race and ethnicity, socioeconomic position, and depressive symptom status. We also compared CVH scores overall and for each component metric using both the original LS7 score (0 to 14-point scale) and the new LE8 approach (0 to 100-point scale).

METHODS

Study Sample

All data and guidance on analytical approaches are publicly and freely available from the US Centers for Disease Control and Prevention's National Center for Health Statistics and can be accessed at https://www.cdc.gov/nchs/nhanes/index.htm. This cross-sectional analysis used 6 years of data from the 2013 to 2018 NHANES cycles. NHANES collected data in 2-year cycles and used a complex, multistage probability sampling design to select a sample representative of the civilian, noninstitutionalized US population.[30] Participants were interviewed at home and were invited to attend a mobile examination center, where they underwent various anthropometric and physiologic examinations and blood tests. Written informed consent was obtained from all participants or their parents or guardians. This research was deemed exempt by the Northwestern University Institute Review Board given the use of fully de-identified data.

The total combined sample of NHANES 2013 through 2018 (the most recent complete data given the disruptions caused by the COVID-19 pandemic) comprised 29 400 participants. We excluded individuals with an incomplete interview or examination (n=1339), those age >79 years or <2 years (n=2903 [given limited data or CVH metrics not collected]), those who were pregnant or breastfeeding at the time of examination (n=313 [given the nonrepresentativeness of some metrics (e.g., cholesterol values, pregnancy)]), and those having self-reported history of coronary heart disease, angina, heart attack, or stroke (n=1436 [given the focus on CVH before onset of cardiovascular disease (CVD)]). The analysis sample for the current report consisted of 13 521 adults (ages 20 to 79 years) and 9888 children (ages 2 to 19 years). Individuals self-identifying as multiracial (n=1374) were included in all analyses except for those stratified by race and ethnicity given the heterogeneous makeup of this group. We analyzed all available data, excluding individuals from analyses only if relevant variables were missing; participants with complete information for all 8 CVH components were included for calculation of the full CVH score.

Demographic and Social Characteristics

Demographic characteristics (age, self-reported sex and race and ethnicity, and annual household income) were queried during the home interview. Participants were stratified by age into 6 groups: preschoolers (2–5 years), childhood (6–11 years), adolescence (12–19 years), young adulthood (20–39 years), middle age (40–64 years), or older age (65–79 years). Self-reported race and ethnicity was categorized as non-Hispanic (NH) Asian, NH Black, NH White, Mexican American, or other Hispanic, according to NHANES protocol. Annual household income was categorized as <$45 000 or ≥$45 000.[31] Household poverty was calculated as the ratio of monthly family income to poverty levels defined by Department of Health and Human Services guidelines and categorized as low income (≤1.30), low middle income (1.31–1.85), middle income (1.86–3.50), and high income (>3.50).[32]

Depression Status

Whereas depression (or its absence) is only one aspect of psychological health, it is one of the more reliable psychological phenotypes measured in NHANES, which has not yet routinely measured aspects of positive psychological health. Depression was measured among participants ages 18 years and older using the Patient Health Questionnaire–2 (PHQ-2), a reliable short screening tool for assessing depression levels in the general population.[33] Participants were asked “Over the last 2 weeks, how often have you been bothered by the following problems?” and responded to 2 items (“Feeling down, depressed, or hopeless” and “Little interest or pleasure in doing things”) on a scale with the response options “not at all,” “several days,” “more than half the days,” and “nearly every day”; responses are scored as 0, 1, 2, or 3, respectively. Scores of ≥3 out of 6 are the validated threshold for detecting probable cases of depression.[34]

Quantification of CVH

Detailed methods for applying the LE8 scoring algorithm for each of the metrics to NHANES data for adults and children are provided in the Supplemental Material and in the AHA Presidential Advisory.[29] Definitions and scoring for the component metrics of CVH, including the 4 health behaviors (diet, PA, smoking, and sleep) and 4 health factors (BMI, non–high-density lipoprotein [HDL] cholesterol, blood glucose, and BP) for adults and children are outlined in Table S1. For each individual, each of the 8 CVH metrics was scored on a scale of 0 to 100 points according to the AHA algorithm. In adults, overall CVH was calculated for each individual by summing the scores for each of the 8 metrics together and dividing the total by 8, to provide an LE8 score ranging from 0 to 100. In children, overall CVH was calculated by summing the scores for all metrics available in NHANES for the given age range and dividing by the denominator of the number of metrics. For example, diet, PA, and BMI are available for ages 2 through 19, so a CVH score for all ages 2 through 19 could be calculated by summing the scores for metrics together and dividing the total by 3, to provide an LE8 score ranging from 0 to 100. There are 4 metrics available from ages 6 to 19 (including lipids), 5 metrics from 8 to 19 (including BP), 7 metrics from 12 to 19 (including nicotine and glucose), and all 8 metrics (including sleep) available for ages 16 to 19. The overall CVH score was calculated for each of these age ranges to assess the consistency of the LE8 score across different numbers of metrics and diverse ages.

Statistical Analysis

All analyses were performed using SAS version 9.4 (SAS Institute). To incorporate the complex multistage sampling design of NHANES in the statistical analysis, SAS procedures SURVEYFREQ and SURVEYMEANS were used. To create a larger sample, data from three 2-year cycles of the continuous NHANES were combined for 2013 through 2018. Per NHANES analytical guidelines for combining data across cycles, sample weights were constructed with rescaling of the weights such that the sum of weights matched the survey population at the midpoint of each survey period. Sample weights for laboratory and physical examination data were used to estimate the number of individuals in the US population overall and in each age, sex, and racial and ethnic group as appropriate. Final sampling weights were divided by the number of combined surveys to estimate population averages. Sample weights and design were incorporated in calculating prevalence estimates and standard errors. For prevalence estimates, nonoverlapping 95% CIs indicate statistical significance; in these analyses, these are all equivalent to $P<0.001$.

RESULTS

Sample Characteristics

In the NHANES samples, there were 13 521 adult and 9888 child participants, representing 201 728 000 and 74 435 000 US adults and children, respectively. Characteristics of the sample with weighted population numbers are presented in Table 1 for adults and Table 2 for

Table 1. Characteristics of US Adults (Ages 20 to 79 Years; Not Pregnant, Not Institutionalized) Without Cardiovascular Disease by Self-Reported Sex

Characteristics	Men, prevalence, % (n [in millions], weighted)	Women, prevalence, % (n [in millions], weighted)
Total sample (n=13 521), weighted to 201 728 000 adults	48.9 (98.7)	51.1 (103)
Age, y, mean (SE)	44.3 (0.28)	46.5 (0.35)
Age strata, y		
20–39	42.0 (41.5)	36.9 (38.0)
40–64	46.2 (45.6)	47.7 (49.1)
65–79	11.8 (11.6)	15.4 (15.9)
Self-reported race and ethnicity		
Non-Hispanic Asian	5.7 (5.7)	6.3 (6.4)
Non-Hispanic Black	10.8 (10.7)	12.0 (12.4)
Non-Hispanic White	62.8 (62.0)	62.9 (64.8)
Mexican	10.2 (10.1)	8.8 (9.1)
Other Hispanic	6.6 (6.5)	6.7 (6.9)
Other race, including multiracial	3.9 (3.8)	3.3 (3.4)
Poverty index		
≤1.30	19.7 (17.9)	22.6 (21.4)
1.31–1.85	9.8 (8.9)	10.6 (10.0)
1.86–3.50	24.5 (22.2)	24.1 (22.8)
>3.50	46.0 (41.7)	42.7 (40.3)
Family income		
≥$45 000	62.4 (57.0)	59.1 (56.3)
<$45 000	37.6 (34.3)	40.9 (39.0)
Depression		
PHQ-2 score <3	93.2 (86.3)	90.9 (86.0)
PHQ-2 score ≥3	6.8 (6.3)	9.1 (8.6)
AHA Life's Essential 8 scores (100 possible points), mean (SE)		
Total CVH score	63.6 (0.44)	68.1 (0.48)
DASH diet score	38.1 (0.84)	51.9 (0.90)
Physical activity score	54.0 (1.03)	49.2 (1.18)
Tobacco or nicotine exposure score	63.1 (0.90)	75.1 (0.82)
Sleep health score	84.0 (0.51)	85.3 (0.38)
BMI score	57.8 (0.73)	57.1 (0.88)
Blood lipids (non-HDL cholesterol) score	64.8 (0.68)	69.9 (0.65)
Blood glucose score	76.8 (0.63)	80.0 (0.43)
BP score	67.6 (0.68)	73.8 (0.53)

Data from National Health and Nutrition Examinations, 2013 through 2018. AHA indicates American Heart Association; BMI, body mass index; BP, blood pressure; CVH, cardiovascular health; DASH, Dietary Approaches to Stop Hypertension; HDL, high-density lipoprotein; and PHQ, Patient Health Questionnaire.

children, stratified by sex. The data represent the sex, age, and race and ethnicity of the US population, with approximately half being female, a mean age of 45 years in adults and 10 years in children, and individuals identifying as NH Asian (6%), NH Black (11%), NH White (63%), Mexican (9%), other Hispanic (7%), and other race including multiracial (4%) in adults and NH Asian (5%), NH Black (14%), NH White (51%), Mexican (16%), other Hispanic (8%), and other race including multiracial (6%) in children. Characteristics are presented stratified by age groups in Tables S2 and S3 for adults and children, respectively.

Comparison of New LE8 With Original LS7 CVH Scores in Adults

Figure 1 displays the median and range of LE8 CVH 100-point scores at each level of the original LS7 14-point score in adults. There was a stepwise increase in LE8 CVH score with each higher point of the LS7 score but with a broad range of the new LE8 scores within each point level of the original score. When the LE8 score was stratified into discrete ranges, there was modest variation in LS7 scores (Figure S1). The overall correlation between the LE8 score and the LS7 score was 0.88 (P<0.0001); Figure S2 demonstrates that the correlation between the 2 scores remained strong across all sex, age, and race and ethnicity strata. Of note, as designed by the AHA writing group, within the original categorical levels (poor, intermediate, ideal) of the 7 metrics common to both CVH scores, there was a broader range of LE8 scores assigned (Figure S3). Most notably, there was wide variation in scores assigned to individuals within each of the original poor, intermediate, and ideal categories of the diet and lipid scores. Greater individual variation in scores was also particularly evident across the strata of the BP metric and within the original intermediate stratum of PA.

Both the revision of scoring for the original 7 components (noted previously) and the addition of the new sleep metric appeared to provide new information. The correlation of the original LS7 score with the new LE8 score not including sleep was 0.90 (P<0.0001). The sleep metric was significantly, although modestly, correlated with all of the other 7 CVH metrics except for lipids (Table S4); sleep score was more closely correlated with other health behaviors (diet, PA, and nicotine exposure) than with health factors. When participants were stratified into quartiles of LE8 score without considering sleep versus including sleep, 16.4% of participants were reclassified by inclusion of sleep; 7.9% of participants were reclassified into a higher quartile of LE8 score and 8.4% were reclassified downward to a lower quartile.

Status of CVH in Adults

Figure 2 displays the mean (95% CI) and median (5th–95th percentile) LE8 CVH scores (possible range, 0 to 100) for adults overall and by sex, age, and race and ethnicity groups. The overall mean CVH score was 64.7 (95% CI, 63.9–65.6). Scores were significantly higher among women than men (mean, 67.0 versus 62.5) and

Table 2. Characteristics of US Children (Ages 2 to 19 Years; Not Pregnant, Not Institutionalized) Without Cardiovascular Disease by Reported Sex

Characteristics	Boys, % (n [in millions], weighted)	Girls, % (n [in millions], weighted)
Total sample (n=9888), weighted to 74 435 000 children	50.9 (37.9)	49.1 (36.5)
Age, y, mean (SE)	10.5 (0.11)	10.6 (0.13)
Age strata, y		
2–5	21.4 (8.1)	21.8 (8.0)
6–11	33.3 (12.6)	33.2 (12.1)
12–19	45.2 (17.1)	44.9 (16.4)
Reported race and ethnicity		
Non-Hispanic Asian	4.9 (1.9)	4.8 (1.8)
Non-Hispanic Black	13.4 (5.1)	13.9 (5.1)
Non-Hispanic White	51.8 (19.6)	50.8 (18.5)
Mexican	15.6 (5.9)	16.6 (6.1)
Other Hispanic	8.6 (3.2)	7.6 (2.8)
Other race, including multiracial	5.7 (2.2)	6.4 (2.3)
Poverty index		
≤1.30	33.1 (11.6)	34.1 (11.6)
1.31–1.85	11.6 (4.1)	12.3 (4.2)
1.86–3.50	26.5 (9.3)	24.1 (8.2)
>3.50	28.7 (10.0)	29.6 (10.0)
Family income		
≥$45 000	58.0 (20.5)	57.5 (19.7)
<$45 000	42.0 (14.8)	42.5 (14.6)
Depression (ages 18 or 19)		
PHQ-2 score <3	93.6 (34.8)	91.5 (34.7)
PHQ-2 score ≥3	6.4 (0.2)	8.5 (0.3)
AHA Life's Essential 8 scores (of 100 possible points), mean (SE)		
Total score, ages 16 to 19 years	73.4 (0.71)	73.6 (0.51)
Total score, ages 12 to 19 years (includes diet, PA, nicotine, BMI, non-HDL cholesterol, glucose, BP)	74.0 (0.54)	74.1 (0.51)
Total score, ages 8 to 19 years (includes diet, PA, BMI, non-HDL cholesterol, BP)	70.3 (0.41)	69.6 (0.43)
Total score, ages 6 to 19 years (includes diet, PA, BMI, non-HDL cholesterol)	65.3 (0.50)	63.8 (0.52)
Total score, ages 2 to 19 years (includes diet, PA, BMI)	65.4 (0.61)	65.5 (0.61)
DASH diet score (ages 2 to 19 years)	37.6 (0.97)	43.6 (0.89)
Physical activity score (ages 2 to 19 years)	78.2 (0.79)	71.8 (0.82)
Tobacco or nicotine exposure score (ages 12 to 19 years)	83.2 (1.1)	88.0 (0.89)
Sleep health score (ages 16 to 19 years)	79.3 (1.2)	77.0 (1.1)
BMI score (ages 2 to 19 years)	80.8 (0.64)	81.4 (0.71)
Blood lipids score (non-HDL cholesterol; ages 6 to 19 years)	74.5 (0.64)	72.5 (0.74)
Blood glucose score (ages 12 to 19 years)	90.5 (0.56)	94.1 (0.48)
BP score (ages 8 to 19 years)	94.8 (0.38)	97.3 (0.23)

Data from National Health and Nutrition Examinations, 2013 through 2018. AHA indicates American Heart Association; BMI, body mass index; BP, blood pressure; DASH, Dietary Approaches to Stop Hypertension; HDL, high-density lipoprotein; PA, physical activity; and PHQ, Patient Health Questionnaire.

among those age 20 to 39 years compared with older groups (68.7 versus ≈62.2). Mean scores were highest among those who identified as NH Asian (69.4) followed by NH White (65.0), other Hispanic (64.7), Mexican (61.6), and NH Black (60.0). Figure S4 displays the full distribution density plots of CVH scores by sex, age, and

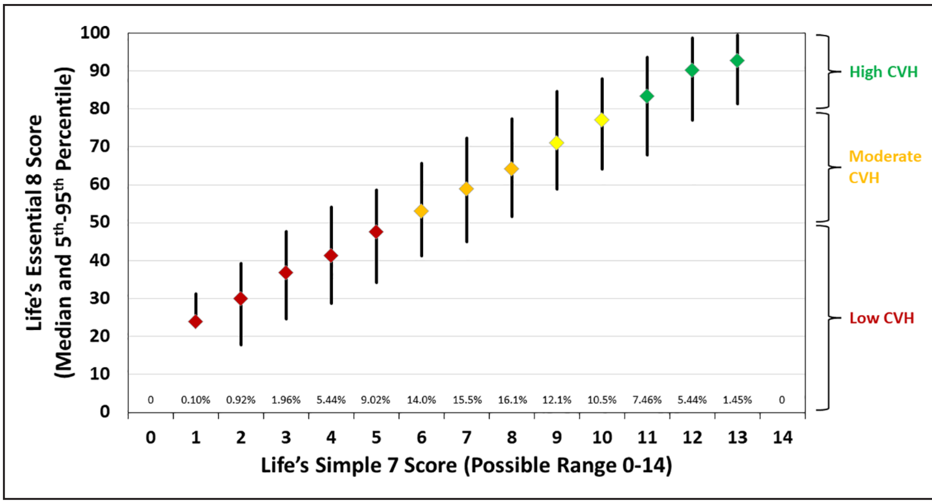

Figure 1. Life's Essential 8 CVH scores at each level of Life's Simple 7 CVH score among US adults.
Scores derived from National Health and Nutrition Examination Survey data, 2013 through 2018. Values are median (5th to 95th percentile). CVH indicates cardiovascular health.

race and ethnicity groups. In total, only 32 adults from the sample, representing ≈762 000 US adults (0.45%), had an optimal CVH score of 100. Using the cut points suggested by AHA, 19.6% of adults (≈33 million) had high CVH (scores ≥80), 62.5% (≈106 million) had moderate CVH (scores of 50 to 79), and 17.9% (≈30 million) had low CVH (scores of <50). Those with high CVH were more likely to be younger and female.

The mean score (out of 100) for a nonclinical CVH score comprising 5 metrics (diet, PA, nicotine exposure, sleep, and BMI) among adults was 61.9 (95% CI, 60.7–63.0) and it was higher in women than men (63.9 versus 59.7), was higher in the older compared with the younger groups (65.1 versus ≈61), and ranged from 54.9 in NH Black to 68.4 in NH Asian individuals.

As shown in Figure 3, mean scores were lowest for the diet, PA, and BMI metrics and highest for sleep and glucose. Women had significantly higher (although still low) diet scores than men and better scores on nicotine exposure, blood lipids, blood glucose, and BP; scores for women were similar to those for men for sleep and BMI and lower for PA. At older compared with younger ages, diet and nicotine exposure scores were significantly higher, sleep scores were similar, and PA, BMI, blood lipids, and especially blood glucose and BP scores were lower. Compared with NH Asian participants, NH Black participants had significantly lower scores for diet, nicotine exposure, sleep, BMI, and BP and higher lipid scores. NH White participants had lower diet and nicotine exposure scores and higher glucose scores compared with NH Asian individuals. Within all individuals identifying as Hispanic, many component metric scores were similar, although PA, BMI, and blood glucose scores were better among other Hispanic compared with Mexican American individuals. Comparing all Hispanic with NH Asian individuals, component metric scores for diet, nicotine exposure, and PA were lower and others were similar.

The specific distributions of point scores for each component metric are shown in Figure S5. Fewer than 10% of individuals had the highest level of diet scores and there were large proportions at high and low extremes for PA and nicotine exposure. More than 50% of individuals had maximal scores (100) for sleep health and glucose. BMI, non-HDL cholesterol, and glucose point distributions tended to show rising proportions at higher point scores. The effect of these point score distributions was that for some metrics there are wide disparities between mean and median values (Table S5).

Status of CVH in Children

The mean CVH scores for US children are shown in Figure 4A through 4E for the metrics available at each age range. For ages 2 through 19 years (Figure 4A), 3 metrics were available (diet, PA, BMI) and mean overall CVH score was 65.5 (95% CI, 64.4–66.6). With the addition of lipids starting at age 6 years (Figure 4B), the mean overall CVH score for ages 6 through 19 years was similar (64.6). The addition of BP starting at age 8 (Figure 4C), nicotine and glucose at age 12 (Figure 4D), and sleep at age 16 (Figure 4E) yielded somewhat higher overall CVH scores given that more children tended to score higher on these added metrics in the older age ranges. The approach recommended by the AHA for tracking CVH through childhood using available metrics and dividing by the denominator of the number of metrics appeared to provide a reasonable means for representing CVH across early life. There were differences noted between sociodemographic groups in overall CVH score (Figure 4). Figure S6 displays the full distribution density plots of CVH scores by sex, age, and race and ethnicity groups. However, for every age stratum of children, regardless of which metrics were available, scores were greater than those for adults. Among children ages 2 to

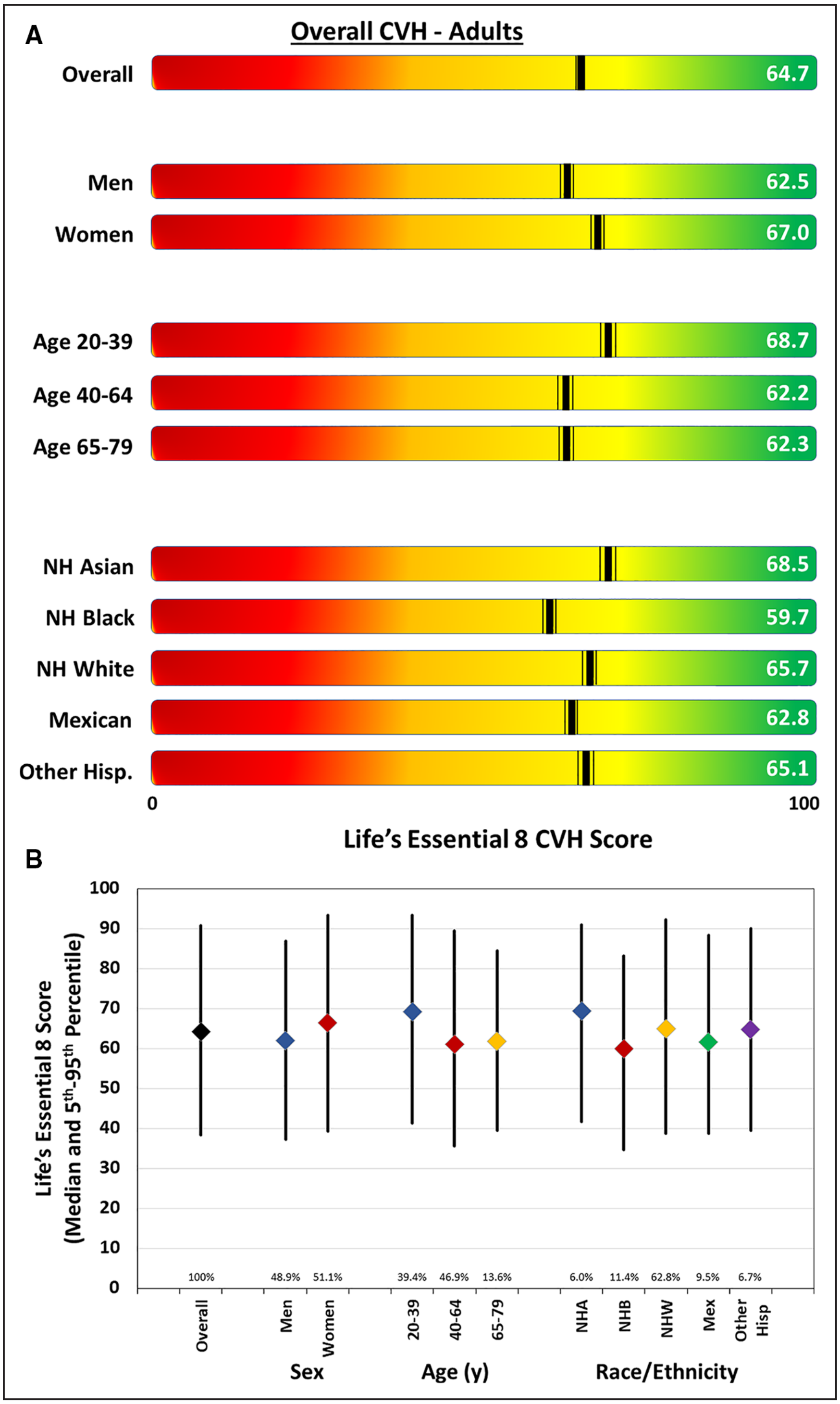

Figure 2. Life's Essential 8 CVH scores.
Scores derived from National Health and Nutrition Examination Survey data, 2013 through 2018. **A**, Mean (thick black bar) and 95% CI (thin bars). Proportions for race and ethnicity do not add up to 100% because of absence of the group identifying as multiracial or other race and ethnicity. **B**, Median (diamond) and 5th to 95th percentile (black lines) for US adults, overall and by sex, age, and race and ethnicity strata. CVH indicates cardiovascular health; and NH, non-Hispanic.

19 years, ≈133 000 (2.2%) had optimal CVH scores of 100 and ≈17 million (29.1%) had high CVH. The proportion with high CVH declined markedly with older age: 56.5% of 2- to 5-year-old children had high CVH, compared with 33.5% of 6- to 11-year-old children and 14.0% of 12- to 19-year-old adolescents.

As shown in Figure 5, among US children, scores were lowest for diet and highest for BP, glucose, and nicotine exposure at the relevant age ranges. (Scores are partially age-dependent because ages at which specific metrics are available differ.) On average, girls had higher (although still low) diet scores and higher scores for nicotine exposure, glucose, and BP, whereas boys had higher scores for PA. With older ages in childhood, diet and PA scores were substantially lower and BMI scores somewhat lower compared with younger ages. There were differences in individual metric scores across racial and ethnic groups for diet, PA, nicotine exposure, sleep, and BMI. Larger disparities were observed for diet, with NH Asian youths having the highest scores (mean 50.4)

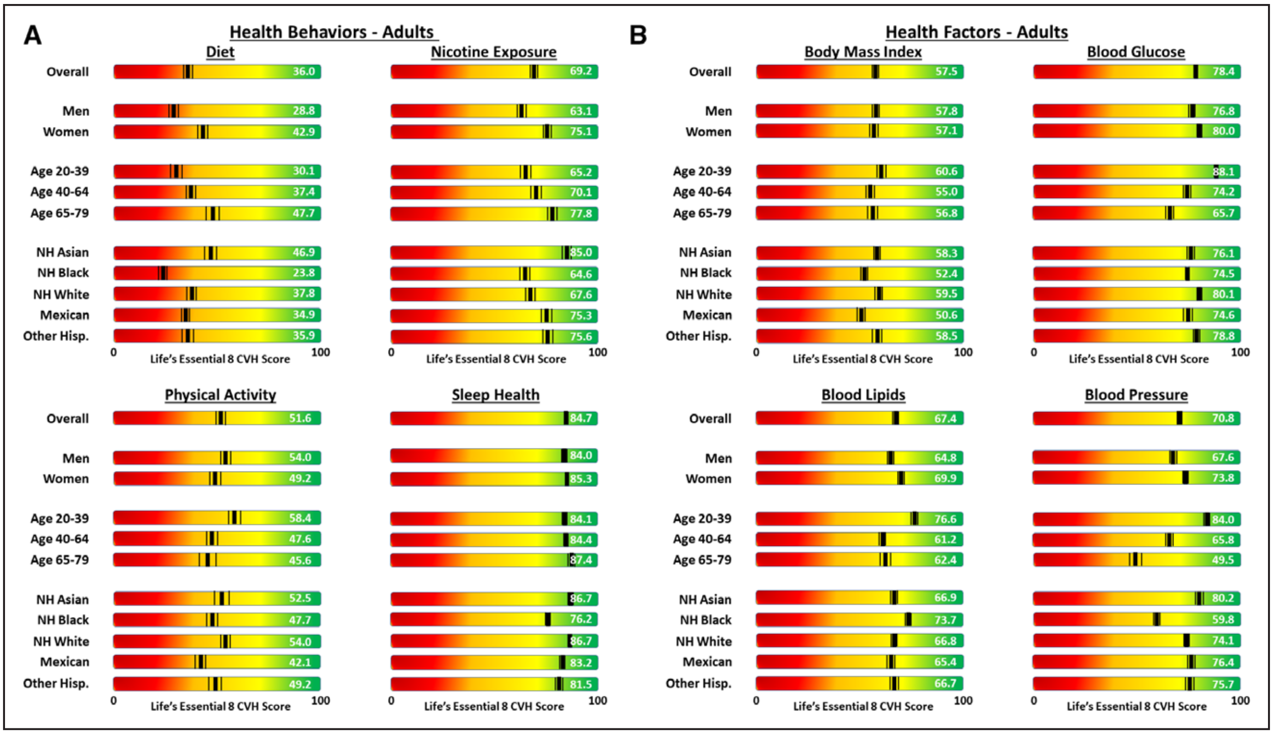

Figure 3. Scores for individual cardiovascular health behaviors and health factors.
Scores for individual CVH behaviors (**A**) and health factors (**B**), overall and by sex, age, and race and ethnicity strata among US adults. Mean scores derived from National Health and Nutrition Examination Survey data, 2013 through 2018. CVH indicates cardiovascular health; and NH, non-Hispanic.

and NH Black youths the lowest (30.7); for BMI, with NH Asian youths having the highest (89.4) and Mexican youths the lowest (74.4) scores; for nicotine exposure, with NH Asian youths having the highest (93.0) and NH White youths the lowest (83.6) scores; and for PA, with NH White youths having the highest (77.2) and other Hispanic youths the lowest (69.2) scores.

The specific distributions across point scores for each component metric are shown in Figure S7 for the US child population. Compared with adults (Figure S5), higher scores were observed for children for each metric.

Differences in CVH by Family Income and Depression Status

As shown in Table S6, overall CVH scores differed significantly by family income, poverty index, and the presence of depression in both adults and children. For adults, the major drivers of CVH score differences across income and poverty index levels were the 4 health behaviors with lower CVH metric scores present in those with lower family income (diet, PA, nicotine exposure, and sleep). Depression in adults was also associated with lower scores for the 4 health behaviors and more modest differences in health factors. In children, income and poverty index were associated with differences in BMI, nicotine exposure, and diet, whereas depression (measured among 16- to 19-year-old adolescents) was associated with lower scores for diet, PA, nicotine exposure, BMI, and lipids.

DISCUSSION

Principal Findings

This is the first examination of the CVH of the US population using the AHA's new LE8 metrics and scoring algorithm.[29] The overall CVH of US adults and children is suboptimal and prevalence of the most favorable levels is low, with statistically significant and important differences by age, sex, race and ethnicity, family income, and depression status. CVH status was generally lower at successively older ages starting from childhood through adulthood. CVH was also higher among women compared with men and among NH Asian Americans compared with other racial and ethnic groups. There was even greater variation across sociodemographic groups within some of the individual component metrics of CVH, particularly for diet, PA, nicotine exposure, blood lipids, and BP.

When applied to the US population, the new 100-point CVH score is highly correlated with the older 14-point score, indicating that there is overall alignment with the underlying construct of CVH that has been validated in numerous populations and settings since 2010. That said, using the new CVH score, we observed that there was greater interindividual variation within many of the CVH metrics (Figure S3). The new score should also enhance sensitivity to changes in individual or population CVH in response to behavior change, policy changes, or other

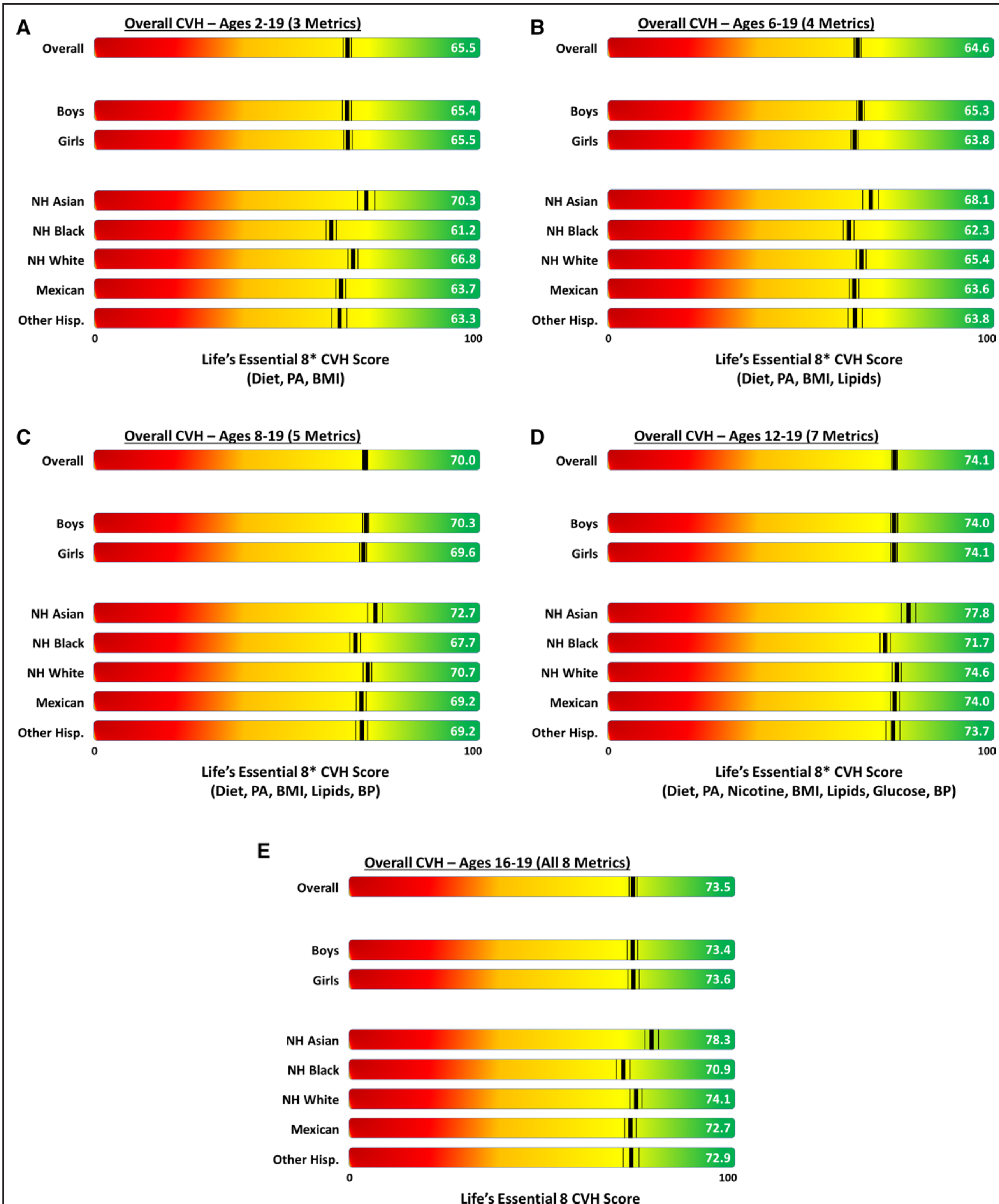

Figure 4. Life's Essential 8 CVH scores for US children in different age ranges.
A through **E**, Values are means on the basis of availability of component metric data, overall and by sex, age, and race and ethnicity strata; derived from National Health and Nutrition Examination Survey data, 2013 through 2018. BMI indicates body mass index; CVH, cardiovascular health; NH, non-Hispanic; and PA, physical activity.

influences. As an example, an individual who participates in 1 minute of moderate-intensity PA per week would be classified as intermediate (1 point) for the original LS7 PA score; if that same individual increased weekly activity to 149 minutes of moderate intensity, that participant would still be considered intermediate and receive the same 1

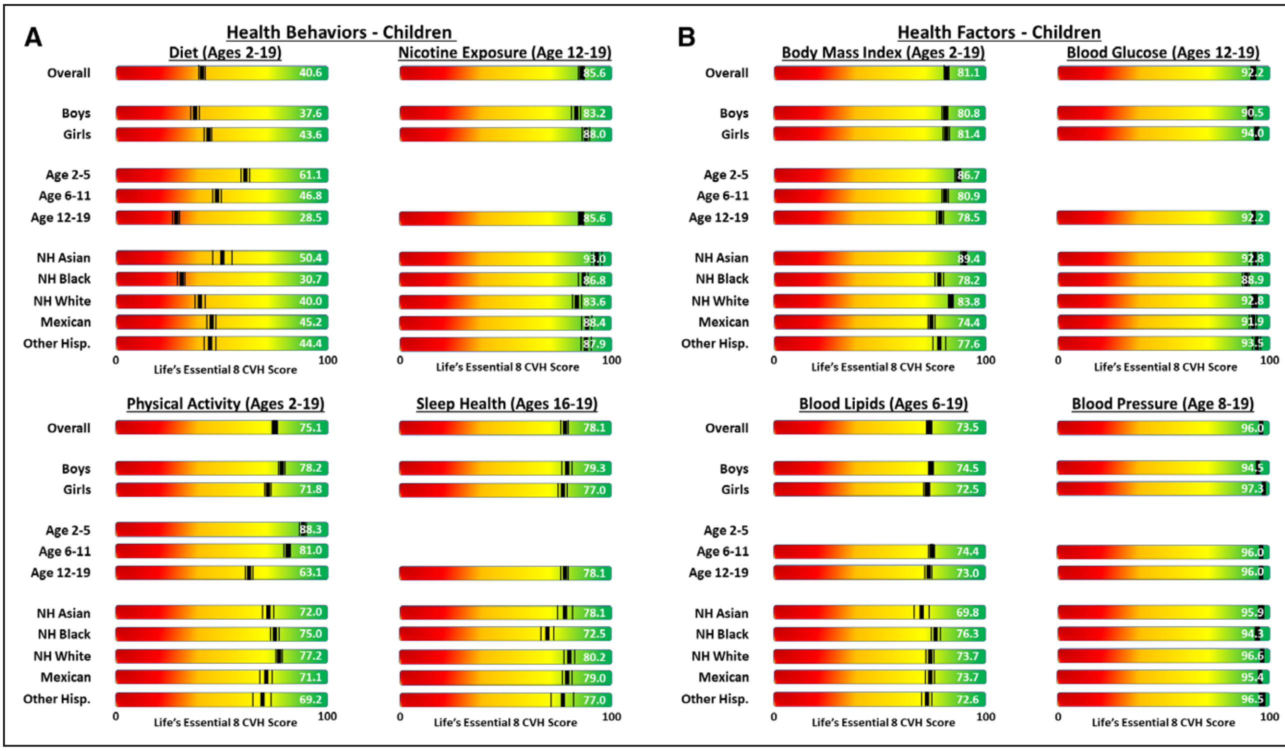

Figure 5. Scores for individual CVH behaviors and health factors.

Values are mean scores for individual cardiovascular health behaviors (**A**) and health factors (**B**), overall and by sex, age, and race and ethnicity strata among US children in different age ranges, depending on availability of component metric data; derived from National Health and Nutrition Examination Survey data, 2013 through 2018. CVH indicates cardiovascular health; and NH, non-Hispanic.

point, with no change in overall 14-point LS7 CVH score (assuming all other metrics remained the same). Using the new LE8 score, the same individual would go from 20 points to 90 points for the PA metric score; the difference of 70 points in the PA metric would be reflected as a 9-point increase in the overall LE8 CVH score (assuming all other metrics remained the same). The implications of such a difference or change in CVH score for future health outcomes should be examined in future studies of diverse health outcomes from longitudinal cohorts.

Although the LE8 and LS7 scores are highly correlated, we observed that differences between the scores arise both from the rescoring of the original 7 metrics and also from the addition of the new sleep metric. In this cross-sectional study, sleep score was significantly but only modestly correlated with 6 of the 7 other CVH metric scores and was more correlated with other health behaviors than with health factors. The rationale, strengths, and limitations of adding sleep are discussed extensively in the AHA Presidential Advisory.[29] In this study, there was less variation noted in the new sleep metric than anticipated across sociodemographic groups, which may indicate limitations of the means for ascertaining true sleep duration (as opposed to time spent in bed) or less reliability of the tool used in NHANES. Further research is needed to understand these issues as well as whether interventions on sleep duration (or quality) can improve overall CVH and health outcomes.

Implications for Public and Individual Health

There are substantial opportunities for preserving and improving CVH in the entire population, especially through improvements in diet quality. Individual changes in eating patterns can have markedly beneficial effects on health factors, even independent of weight change.[35] Rather than relying solely on individual change, however, improvements in diet can be amplified at the policy level, through subsidies (e.g., for fruit and vegetable production) or incentives for healthier food options, by making healthy food and drink choices the default options (e.g., removing sugar-sweetened beverage options in schools), and in working with the food industry to change the food supply (e.g., through voluntary sodium reduction). Additional strategies for improving population CVH through federal, state, local, and institutional policies are discussed in detail in the Presidential Advisory on Life's Essential 8.[29]

On the basis of the data shown here, targeted opportunities also exist to improve aspects of CVH to address disparities and improve health equity. Such opportunities may include attempts to improve eating patterns and nicotine exposure in men; raise leisure-time PA and improve control of glucose, lipids, and BP in middle-aged and older adults; improve diet, nicotine exposure, sleep health, and BP control in NH Black communities; and increase participation in leisure-time PA in Hispanic communities. Once again, interventions at the social and public health policy levels are likely to have far greater effect than a focus solely on individual behavior change, given the substantial barriers and impediments to change imposed by structural and social determinants of health.[29] Equally urgent emphasis should be placed on optimizing CVH in children from early life and then preserving these higher levels of CVH as they age. Such a strategy of primordial prevention (maintaining high CVH and avoiding the development of adverse risk factor levels) holds great promise for a healthier population and dramatic reductions in the future burden of CVD and other chronic diseases of aging.[8,27,28]

The values in overall mean LE8 scores across sociodemographic groups we observed ranged from 59.7 to 68.7 points, a difference of 9 points, or 9% of the total range. This may appear modest, but previous studies of LS7 showed that a 1-point, or 7%, difference in LS7 scores was associated with important differences in CVD outcomes. For example, Perak et al.[36] observed 20% to 31% lower CVD and mortality hazards per 1-point higher LS7 score measured at age 18 to 30 years. Higher CVH at all ages is associated with extremely favorable health outcomes. Children with high CVH and favorable CVH trajectories have significantly lower burden of subclinical CVD in midlife.[5,8,9] Adolescents and young adults with high CVH are at substantially lower risk for premature clinical CVD events.[36] Individuals with high CVH achieved or preserved into midlife have markedly greater longevity, longer health span, greater compression of multiple forms of morbidity, dramatically fewer cardiovascular and other health events, markedly lower rates of most chronic diseases of aging, better cognitive function, and higher quality of life.[2–15,19] In addition, those with high midlife CVH require substantially less medical care and incur significantly lower costs across their life span, despite living longer.[13,16,17] A recent study observed that those with high predicted genetic risk for coronary heart disease but with high CVH had 11 years' greater total longevity, 18 years' longer health span, and an average of 7 years fewer spent with coronary heart disease compared with those with favorable genetics but with low CVH status.[37]

Thus, assessing CVH regularly from early life in individuals and populations, and helping them to maintain or achieve high CVH from early life to midlife, is of paramount importance for improving public health, for individual opportunity for a full, healthy life span, and for national economic viability. Furthermore, attainment or maintenance of high CVH appears to be a critical strategy for reducing health disparities in longevity and chronic diseases and for promoting health equity.[14,27,36]

Studies have also demonstrated that improvement in CVH among those with lower CVH at baseline is associated with significantly lower rates of subclinical and clinical CVD.[7,38,39] Likewise, other studies have also indicated that the package of high CVH can be maintained or achieved at midlife through pursuit of known lifestyle strategies related to healthy eating patterns, participation in PA, maintenance of lean body weight, and avoidance of tobacco.[20,21] Whereas declining CVH with aging is the current pattern at both individual and population levels, it is not inevitable: high proportions of individuals who pursue healthy lifestyles preserve high CVH into later life.[21] It is clear that the earlier CVH is improved, the larger the effect on outcomes.[7] This knowledge may empower individuals and communities to undertake efforts at CVH improvement through clinical approaches and policy initiatives starting at any age.

Social determinants of health and psychological health are foundational constructs that influence one's ability to optimize CVH.[29] We observed that simple indicators of social determinants, such as family income and relative poverty index, were associated with disparities in CVH score, driven largely by the health behavior metrics. Associations with overall CVH and health behavior metrics were also evident for depression status, such that those not screening positive for symptoms of depression had higher CVH scores than those with depression symptoms. The absence of depression is an insufficient metric for determining overall or positive psychological health attributes, but these findings open avenues for future research.

Further work is needed to understand the strongest correlates with CVH and to address barriers to achieving high CVH among the domains of social determinants and their upstream causes of structural racism and societal biases.[40–42] Likewise, more research is needed to understand the complex and bidirectional interplay of positive psychological health attributes and higher CVH.[43] In the meantime, application of proven public health and health care interventions to maintain and improve CVH at all ages is long overdue.[40]

Strategies for assessing, monitoring, and improving CVH are emerging[44–46]; their accelerated dissemination and implementation are urgently needed. The current study indicates the feasibility of measuring and monitoring CVH in the US population and subgroups using NHANES, although more robust data are needed for children younger than 16 years. Regular, systematic assessment of the LE8 metrics in primary care and community health practice are necessary to promote and preserve the most favorable levels of CVH and to realize the potential of electronic health records to provide large-scale data on CVH. For individuals, the new CVH scoring algorithm will be most easily performed through online or app-based platforms. It can be incorporated into electronic health record systems, but full deployment will require targeted data collection for diet, PA, and sleep metrics, as well as enhanced assessment of nicotine exposure, to be able to leverage the full spectrum of CVH. Periodic assessment and tracking of CVH from early life will facilitate regular reinforcement of optimal health behaviors as well as detection of declining CVH and early triggering of interventions when they are likely to be most effective.

Limitations

Data from NHANES represent successive samples of the nonpregnant, noninstitutionalized population of the US. Further work is needed to assess CVH status using the new LE8 algorithm in non-US populations and special populations, including those excluded by NHANES. Data on CVH in pregnancy are of particular importance, given recent studies indicating that CVH may be a better predictor of adverse pregnancy outcomes than individual risk factors[47] and further data indicating that maternal gestational CVH is strongly associated with offspring CVH in adolescence.[48] Additional means for defining CVH from birth are needed to understand, track, and promote CVH even in infancy. NHANES participants are asked to self-identify their race and ethnicity. These identities represent social constructs and are not meant to imply genetic ancestry or other biological mechanisms to explain the disparities observed across sociodemographic groups. We were unable to provide data on disaggregated subgroups of individuals (e.g., people identifying as East Asian or South Asian American) or for American Indians or Alaska Natives, as they were not collected by NHANES.

Conclusions

The AHA's new LE8 construct for describing and quantifying CVH represents an important evolution in this novel construct. As originally conceived, CVH was designed to represent a positive health attribute empowering individuals and populations to take specific, positive actions to improve their CVH and overall health outcomes. On the basis of the data presented here, the new CVH algorithm provides an approach to describing CVH that is both broader and more granular than the original score. Whereas the LE8 score is highly correlated with the LS7 score, greater interindividual variation can be represented in the new approach. Overall CVH in the US population is well below optimal levels. There are both broad and targeted opportunities to preserve and improve CVH across the life course in individuals and the population. Improving the CVH of the US population could have major effects on healthy longevity, quality of life, and health care use and expenditures, with the promise of greater health equity and societal well-being.

ARTICLE INFORMATION

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Supplemental Material

Supplemental Methods
Figures S1–S7
Tables S1–S6
References 49–51

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