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Association of life's essential 8 score with risk of all-cause and cardiovascular disease-related mortality in individuals with hypertension

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Abstract

Background The American Heart Association (AHA) recently defined a new concept of cardiovascular health-Life's Essential 8 (LE8). We sought to examine whether LE8 score is associated with a risk of all-cause and cardiovascular disease (CVD)-related mortality in individuals with hypertension.

Methods This longitudinal study analyzed data from the National Health and Nutrition Examination Survey from 2007 to 2018 in people 20 years or older with hypertension. LE8 score (range 0-100) was measured according to the AHA definition and divided into unweighted tertiles into groups T1 (< 50.00), T2 (50.00-61.25), and T3 (≥ 61.25). Primary outcomes included all-cause mortality and CVD-specific mortality.

Results A total of 15,318 individuals with hypertension were included in this study, with a mean ± standard error age of 55.06 ± 0.25 years. During the median follow-up period of 76 months, 2525 all-cause mortality occurred, of which 806 were due to CVD. Compared with participants with hypertension in the T1 group, those in T2 and T3 respectively had 28% (adjusted HR = 0.72, 95% CI 0.63–0.83, $P < 0.001$) and 39% (adjusted HR = 0.61, 95% CI 0.52–0.72, $P < 0.001$) lower risk of all-cause mortality, the T2 and T3 groups were associated with 32% (adjusted HR = 0.68, 95% CI 0.53–0.88, $P = 0.003$) and 36% (adjusted HR = 0.64, 95% CI 0.49–0.84, $P = 0.001$) reduced risk of CVD mortality separately.

Conclusions A higher LE8 score is associated with a lower risk of all-cause mortality and CVD mortality, and the higher LE8 score can be maintained in the clinic to improve prognosis by modifying the diet and lifestyle habits of individuals with hypertension.

Keywords Life's essential 8, Cardiovascular disease-related mortality, All-cause mortality, Hypertension

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Background

Hypertension is a highly prevalent chronic disease worldwide and major modifiable risk factor for cardiovascular disease (CVD), approximately 33% of the global population currently suffer from hypertension [1, 2]. Compared to the general population, individuals with hypertension have a higher risk of all-cause and CVD-related mortality [3]. Hypertension has brought heavy burden to society and family, prevention and treatment of hypertension remains a major long-term public health challenge.

In 2010, the American Heart Association (AHA) constructed Life's Simple 7 (LS7) to characterize cardiovascular health (CVH) based on 7 health behaviors and health factors, aiming to facilitate a shift from focusing solely on disease treatment to the active promotion and maintenance of health throughout the life course of populations and individuals [4]. In 2022, the AHA updated the definition of CVH based on experience and evidence, which added sleep to construct Life's Essential 8 (LE8) and quantified each metric from 0 to 100, including health behaviors (diet, physical activity, nicotine exposure, sleep health), and health factors (body mass index (BMI), blood lipids, blood glucose, and blood pressure) [5]. The LE8 is a scoring system that is more sensitive to inter-individual differences and emphasizes the social determinants of health and mental health that maintain or improve cardiovascular health (CVH). Population-based evidence suggests that high LE8-based CVH is associated with a lower risk of all-cause and CVD-related mortality in US adults, this association remains significant regardless of the presence of diabetes [6–8]. In addition, cohort studies have shown that LS7-based CVH is significantly inversely associated with the risk of developing hypertension [9]. However, few studies have investigated the applicability of LE8 in individuals with hypertension.

Healthy lifestyles not only are the cornerstone of prevention and treatment of hypertension, but also may improve CVH and general health [10]. LE8 highlights social determinants of health and psychological health for maintaining or improving CVH [5]. To date, the association between LE8 score and the risk of all-cause and CVD-related mortality in **individuals with hypertension** has not been reported. To fill this research gap, The primary objectives of this study were to explore this issue based on the National Health and Nutrition Examination Survey (NHANES), a representative database.

Methods

Individuals and study design

NHANES is a program of studies designed to assess the health and nutritional status of adults and children in the United States [11]. The National Center for Health Statistics (NCHS) administered the survey, and the NCHS Institutional Ethical Review Board approved the research protocol. NHANES obtained written informed consent from all participants. NHANES data conducted between 2007 and 2018 were used for this study. Hypertension was defined as self-reported hypertension or systolic blood pressure ≥ 130 mmHg, diastolic blood pressure ≥ 80 mmHg (AHA2017 [12]) or taking antihypertensive medication. All experimental protocols were approved by Institutional Review Board (IRB) of Henan Provincial People's Hospital (2024-59).

The study involved individuals diagnosed with hypertension (*n* = 19867) in the NHANES 2007–2018. Exclusion criteria included: (1) age < 20 years; (2) missing complete information on LE8 score assessment; (3) missing complete survival information; (4) missing important co-variates (educational level, marital status, cancer, creatinine). The final study population included 15,318 adult participants (Fig. 1).

Mortality ascertainment

The outcome variables of this study were all-cause mortality and CVD-cause mortality. Mortality information in the National Death Index (NDI) was from the date of survey participation through 31 December 2019. All data in this study are publicly available at https://www.cdc.gov/nchs/data-linkage/mortality.htm. Deaths from any cause were classified as all-cause deaths; deaths due to "disease of the heart (I00-I09, I11, I13, I20-I51)" or "cerebrovascular diseases (I60-I69)" were recorded as CVD-related deaths [13]. The cut-off time for follow-up was December 31, 2019, and the median follow-up duration (T1, T3) was 76 (42, 114) months.

Measurement of life's essential 8

The LE8 scoring algorithm consists of diet (dietary approach to stop hypertension-style diet), physical activity, nicotine exposure, sleep duration, BMI, non-high-density lipoprotein cholesterol levels, blood glucose status, and blood pressure levels. The eight CVH indicators were scored on a scale of 0 to 100. Detailed scoring criteria for each metric [5, 14] are demonstrated in Supplementary Table 1. The overall LE8 score was calculated as the unweighted average of the eight metrics. In this study, the scores were grouped according to unweighted tertiles: LE8 score < 50.00 is T1; 50.00-61.25 is T2; ≥ 61.25 is T3.

Study covariates

Covariates in the all-cause mortality as outcome model: age, race (non-Hispanic white, non-Hispanic black, Mexican American, and others), educational level (less than high school, high school, and above high school), marital status (married & living with partner, never married & divorced & separated & widowed), alcohol drinking (yes,
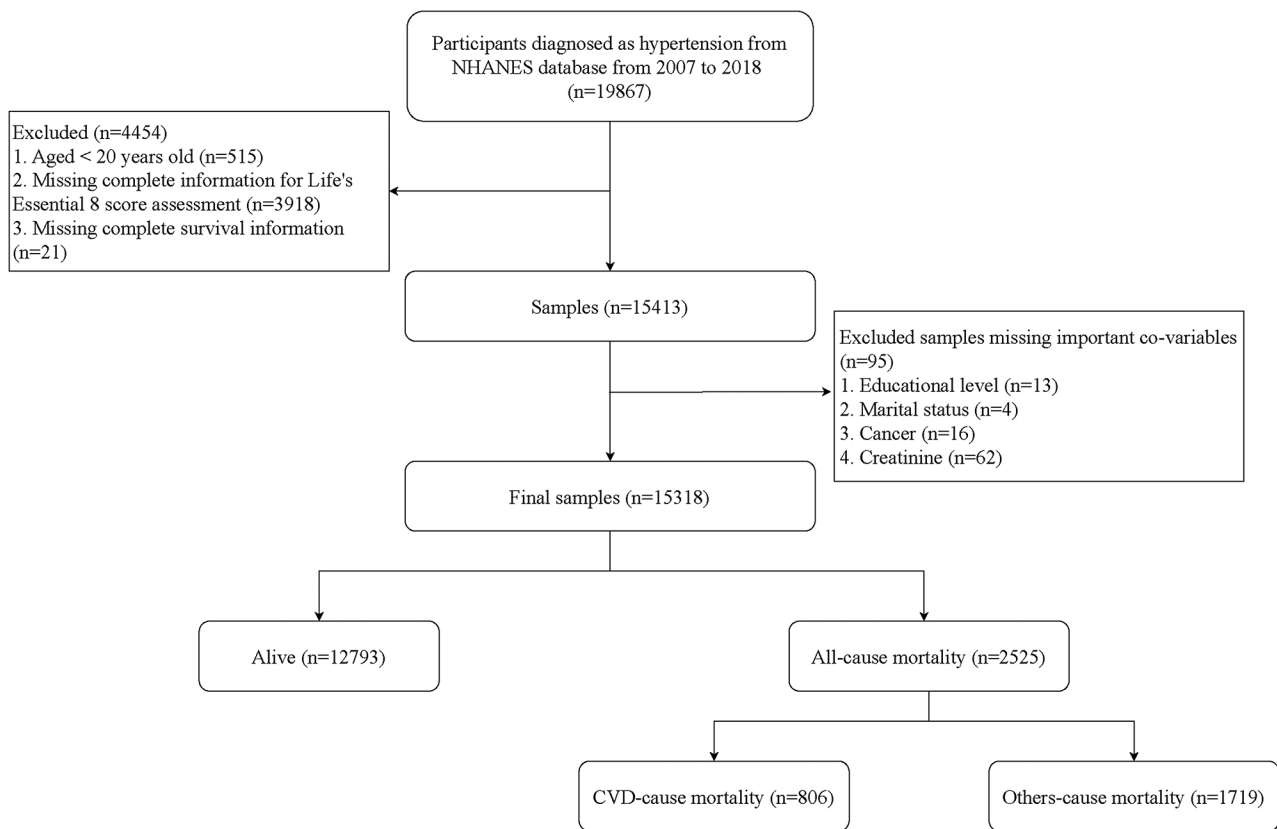
Fig. 1 Flowchart of data filtering
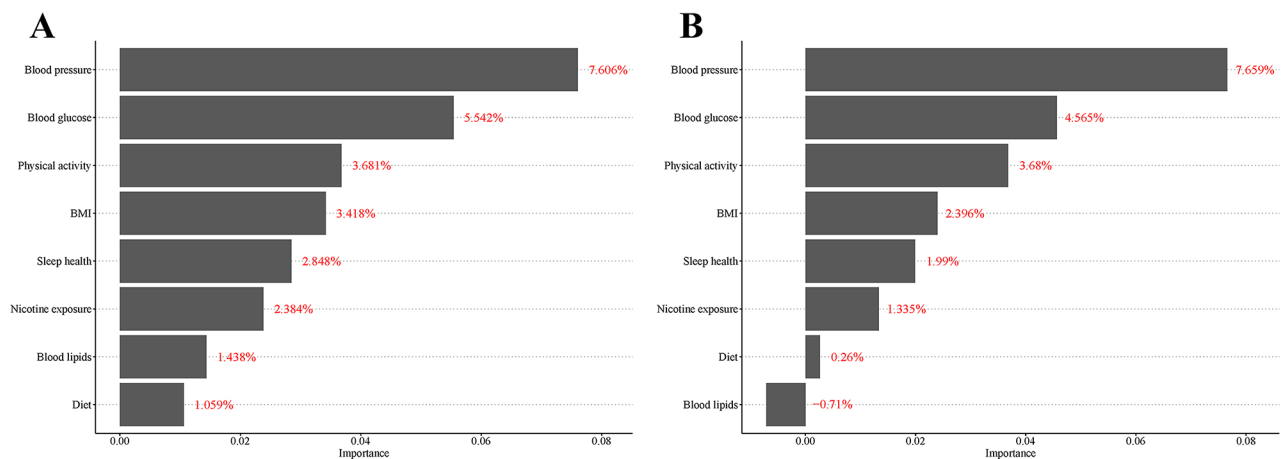
Fig. 2 Contribution of different components of Life's Essential 8 score to the risk of all-cause mortality (**A**) and CVD-related mortality (**B**)

no), CVD (yes, no), cancer (yes, no), and waist circumference (low, high, and unknown), and $eGFR_{CKD-EPI}$. As for covariates in the CVD mortality as outcome model: age, educational level, marital status, CVD, $eGFR_{CKD-EPI}$.

Statistical analysis

Given the complex sampling design of NHANES, all analyzes in this study account for sample weights, clustering, and stratification to generate nationally representative estimates. Measurement data were described as mean±standard error (S.E), and t-tests were used to compare differences between groups. Enumeration data were described using the number of cases and proportions, and comparisons of differences between groups were made using the chi-square test or Fisher's exact test. Variables with $P<0.05$ were screened using a weighted univariate Cox model with all-cause and CVD mortality as outcomes. A weighted multivariate Cox

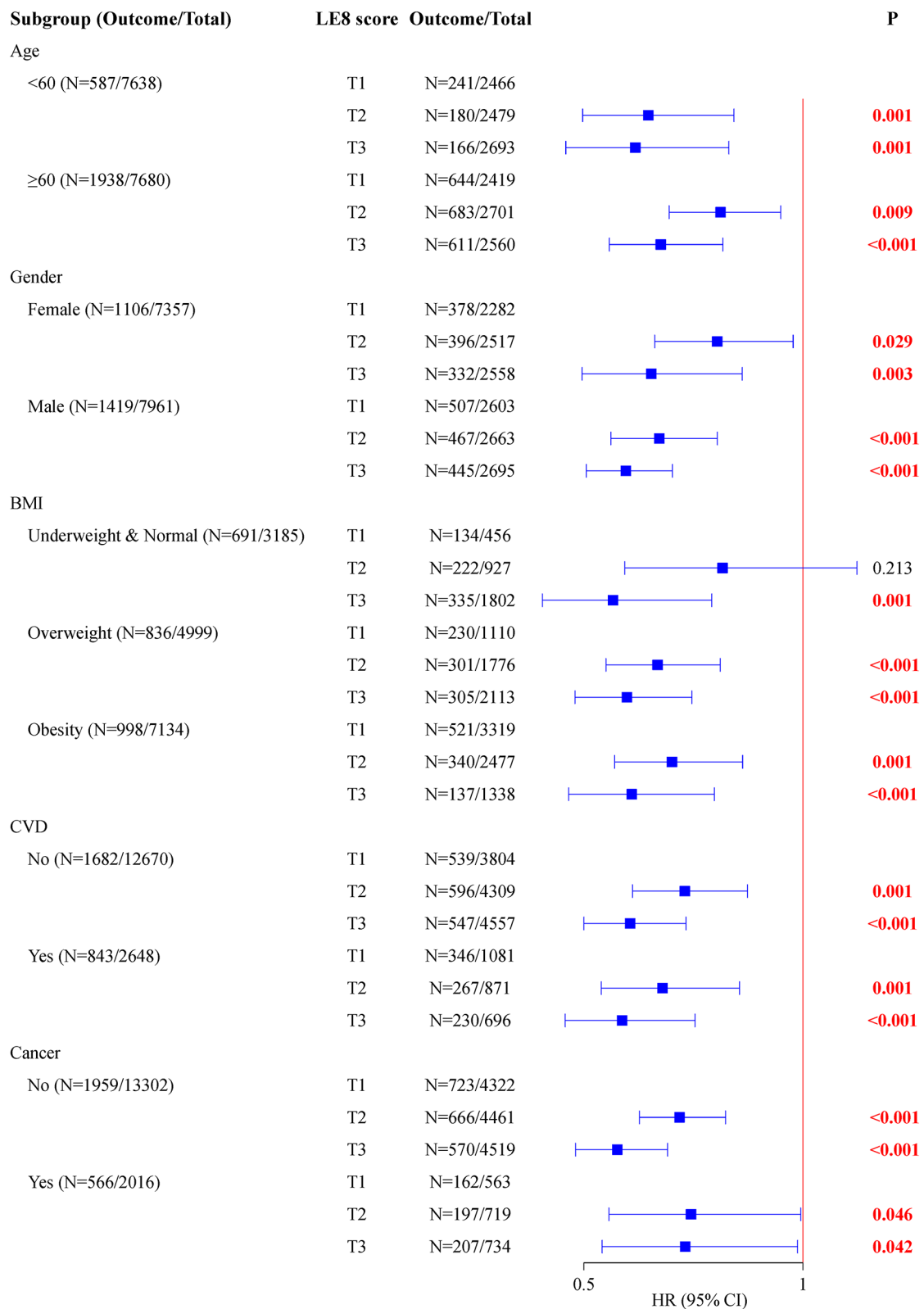| Subgroup (Outcome/Total)	LE8 score	Outcome/Total		P
Age				
<60 (N=587/7638)	T1	N=241/2466		
	T2	N=180/2479		**0.001**
	T3	N=166/2693		**0.001**
≥60 (N=1938/7680)	T1	N=644/2419		
	T2	N=683/2701		**0.009**
	T3	N=611/2560		**<0.001**
Gender				
Female (N=1106/7357)	T1	N=378/2282		
	T2	N=396/2517		**0.029**
	T3	N=332/2558		**0.003**
Male (N=1419/7961)	T1	N=507/2603		
	T2	N=467/2663		**<0.001**
	T3	N=445/2695		**<0.001**
BMI				
Underweight & Normal (N=691/3185)	T1	N=134/456		
	T2	N=222/927		0.213
	T3	N=335/1802		**0.001**
Overweight (N=836/4999)	T1	N=230/1110		
	T2	N=301/1776		**<0.001**
	T3	N=305/2113		**<0.001**
Obesity (N=998/7134)	T1	N=521/3319		
	T2	N=340/2477		**0.001**
	T3	N=137/1338		**<0.001**
CVD				
No (N=1682/12670)	T1	N=539/3804		
	T2	N=596/4309		**0.001**
	T3	N=547/4557		**<0.001**
Yes (N=843/2648)	T1	N=346/1081		
	T2	N=267/871		**0.001**
	T3	N=230/696		**<0.001**
Cancer				
No (N=1959/13302)	T1	N=723/4322		
	T2	N=666/4461		**<0.001**
	T3	N=570/4519		**<0.001**
Yes (N=566/2016)	T1	N=162/563		
	T2	N=197/719		**0.046**
	T3	N=207/734		**0.042**

HR (95% CI) 0.5 — 1

Fig. 3 Subgroup analysis of the association between Life's Essential 8 score and risk of all-cause mortality in individuals with hypertension

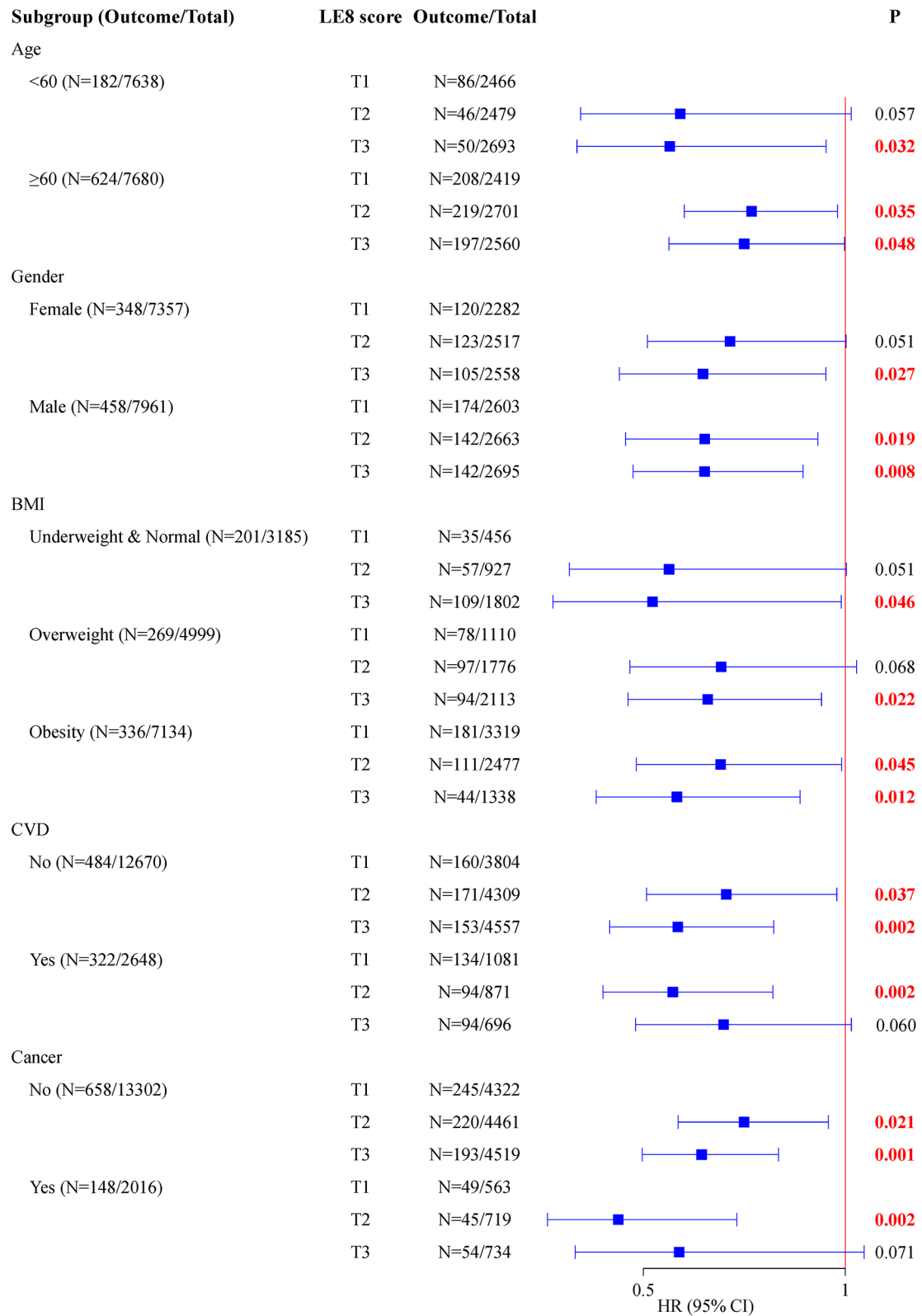| Subgroup (Outcome/Total)	LE8 score	Outcome/Total		P
Age				
<60 (N=182/7638)	T1	N=86/2466		
	T2	N=46/2479		0.057
	T3	N=50/2693		**0.032**
≥60 (N=624/7680)	T1	N=208/2419		
	T2	N=219/2701		**0.035**
	T3	N=197/2560		**0.048**
Gender				
Female (N=348/7357)	T1	N=120/2282		
	T2	N=123/2517		0.051
	T3	N=105/2558		**0.027**
Male (N=458/7961)	T1	N=174/2603		
	T2	N=142/2663		**0.019**
	T3	N=142/2695		**0.008**
BMI				
Underweight & Normal (N=201/3185)	T1	N=35/456		
	T2	N=57/927		0.051
	T3	N=109/1802		**0.046**
Overweight (N=269/4999)	T1	N=78/1110		
	T2	N=97/1776		0.068
	T3	N=94/2113		**0.022**
Obesity (N=336/7134)	T1	N=181/3319		
	T2	N=111/2477		**0.045**
	T3	N=44/1338		**0.012**
CVD				
No (N=484/12670)	T1	N=160/3804		
	T2	N=171/4309		**0.037**
	T3	N=153/4557		**0.002**
Yes (N=322/2648)	T1	N=134/1081		
	T2	N=94/871		**0.002**
	T3	N=94/696		0.060
Cancer				
No (N=658/13302)	T1	N=245/4322		
	T2	N=220/4461		**0.021**
	T3	N=193/4519		**0.001**
Yes (N=148/2016)	T1	N=49/563		
	T2	N=45/719		**0.002**
	T3	N=54/734		0.071

HR (95% CI): 0.5 – 1

Fig. 4 Subgroup analysis of the association between Life's Essential 8 score and risk of CVD-related mortality in individuals with hypertension

model was constructed using all potentially relevant variables, and variables were screened by backward stepwise regression. After adjusting for covariates, a weighted multivariate Cox proportional hazards regression model was used to examine the hazard ratio (HR) and 95% confidence interval (CI) for the associations between LE8 scores and the risk of all-cause death and CVD mortality, respectively. All-cause mortality and CVD-related mortality were used as endpoints, respectively, and a random survival forest model was constructed through the R package randomForestSRC to rank the importance of the variables in the LE8 score using the Variable Importance (VIMP) method. SAS 9.4 was used for data extraction, and R version 4.2.3 was used for data cleaning, interpolation of missing values, comparison of differences, screening of covariates, weighted Cox regression, and subgroup analysis. Differences were considered statistically significant when the P-value was 0.05 or less. All statistical tests were two-sided.

Results
Baseline characteristics
A total of 15,318 individuals aged 20 years or older were included in the study. Table 1 summarizes the baseline characteristics of the study population by all-cause mortality or not. The mean (S.E) individuals age was 55.06 ± 0.25 years, and 7961 (weighted percentage [WP], 51.85%) individuals were male. Only a small number of individuals ($n = 2648$; WP, 14.42%) suffer from CVD, whereas 81.35% (WP) of individuals ($n = 12438$) suffer from dyslipidemia. The mean (S.E) LE8 score of the study population was 57.81 ± 0.21, with T1 (< 50.00), T2 (50.00-61.25), and T3 (≥ 61.25) LE8 scores accounting for (WP) 27.89%, 33.27%, and 38.84% respectively. The mean (S.E) LE8 score was lower (55.59 ± 0.53) in individuals who experienced all-cause mortality and the difference was statistically significant ($P = 0.001$). Among this study population, 2525 individuals experienced all-cause mortality, including 806 individuals who experienced CVD-related mortality; the mean (S.E) survival time for all individuals was 85.07 ± 1.53 months.

Association of life's essential 8 score with risk of all-cause and cardiovascular disease-related mortality in individuals with hypertension
In a weighted univariate Cox proportional hazards regression model, lower levels of LE8 score were associated with the risk of all-cause mortality ($P < 0.001$). At the same time, age, race, educational level, marital status, alcohol consumption, CVD, cancer or not, waist circumference, and $eGFR_{CKD-EPI}$ were all associated with the risk of all-cause mortality (Table 2). For individuals with hypertension, the results of the adjusted multiple Cox proportional hazard regression are shown in Model 2 of

Table 3, after adjusting for age, race, educational level, marital status, alcohol drinking, CVD, cancer, waist circumference and $eGFR_{CKD-EPI}$. Compared with individuals with hypertension with low LE8 score (T1: < 50.00), individuals in group T2 (adjusted HR = 0.72, 95% CI 0.63–0.83, $P < 0.001$) and group T3 (adjusted HR = 0.61, 95% CI 0.52–0.72, $P < 0.001$) were associated with a lower risk of all-cause mortality.

The risk of CVD-cause mortality among different LE8 score groups differed significantly on the basis of the weighted univariate Cox regression analysis. After adjusting for potential confounders(age, educational level, marital status, CVD, $eGFR_{CKD-EPI}$), the T2 and T3 groups were associated with 32% (adjusted HR = 0.68, 95% CI 0.53–0.88, $P = 0.003$) and 36% (adjusted HR = 0.64, 95% CI 0.49–0.84, $P = 0.001$) reduced risk of CVD mortality separately (Table 3).

Importance of life's essential 8 score components in predicting all-cause and cardiovascular disease-related mortality
A random survival forest model was constructed using the different components of the LE8 score for the outcomes of all-cause mortality (Fig. 2A) and CVD-related mortality (Fig. 2B), respectively. The importance (VIMP value) of each component was ranked, higher VIMP indicating that the variable contributed more to the prediction of the outcome events. As shown in Fig. 2, the rank order of the components of the LE8 were similar for all-cause mortality and CVD-mortality. In both models, blood pressure was the most important predictor variable, followed by blood glucose and physical activity.

Subgroup analysis
To further observe the association between LE8 score and the risk of mortality in different subgroups of individuals with hypertension, subgroup analyses were conducted according to age (whether or not ≥ 60 years old), gender, BMI, and comorbidities (CVD and cancer), and the results are presented in forest plots (Figs. 3 and 4). Across all subgroups, higher levels of LE8 score were associated with a lower risk of all-cause mortality compared with lower levels of LE8 scores (Fig. 3). The analyses of CVD-mortality showed that the associations of LE8 score with the outcome was generally consistent across the various subgroups (Fig. 4).

Discussion
In this nationally representative longitudinal study, we found that **individuals with hypertension** with higher LE8 scores had lower all-cause and CVD-specific mortality. Various stratification and sensitivity analyses demonstrated the robustness of our results. These findings suggest that obtaining a higher LE8 score may lead to a

Table 1 Baseline characteristics

Variables	Total (N = 15318)	All-cause mortality No (N = 12793)	Yes (N = 2525)	Statistics	P
Age, years, Mean ± S. E	55.06 ± 0.25	53.50 ± 0.27	65.28 ± 0.43	t = 25.034	**< 0.001**
Gender, n (%)				$\chi^2 = 0.113$	0.738
Female	7357(48.15)	6251(48.21)	1106(47.72)		
Male	7961(51.85)	6542(51.79)	1419(52.28)		
Race, n (%)				$\chi^2 = 21.355$	**< 0.001**
Non-Hispanic white	6779(69.18)	5281(67.83)	1498(78.01)		
Non-Hispanic black	3592(11.94)	3065(12.09)	527(10.96)		
Mexican American	2000(6.78)	1778(7.18)	222(4.15)		
Others	2947(12.10)	2669(12.90)	278(6.88)		
Educational level, n (%)				$\chi^2 = 48.436$	**< 0.001**
Less than high school	3968(16.50)	3109(15.11)	859(25.67)		
High School	3694(24.33)	3024(23.76)	670(28.11)		
Above high school	7656(59.17)	6660(61.13)	996(46.22)		
Marital status, n (%)				$\chi^2 = 59.928$	**< 0.001**
Married & Living with partner	9148(63.61)	7826(64.98)	1322(54.58)		
Never married & Divorced & Separated & Widowed	6170(36.39)	4967(35.02)	1203(45.42)		
PIR, n (%)				$\chi^2 = 1.783$	0.173
<1	2807(12.58)	2321(12.32)	486(14.28)		
≥1	11,154(80.38)	9309(80.66)	1845(78.58)		
Unknown	1357(7.04)	1163(7.02)	194(7.14)		
Alcohol drinking, n (%)				$\chi^2 = 39.226$	**< 0.001**
No	4468(23.21)	3606(22.03)	862(30.99)		
Yes	10,850(76.79)	9187(77.97)	1663(69.01)		
Dyslipidemia, n (%)				$\chi^2 = 10.269$	**0.002**
No	2880(18.65)	2490(19.25)	390(14.69)		
Yes	12,438(81.35)	10,303(80.75)	2135(85.31)		
CVD, n (%)				$\chi^2 = 203.708$	**< 0.001**
No	12,670(85.58)	10,988(87.93)	1682(70.14)		
Ye	2648(14.42)	1805(12.07)	843(29.86)		
Survival status, n(%)	12,793(86.80)	12,793(100.00)	0(0.00)		
Alive	806(4.20)	0(0.00)	806(31.84)		
CVD-cause mortality	1719(9.00)	0(0.00)	1719(68.16)		
Other-cause mortality					
Diabetes, n (%)				$\chi^2 = 127.082$	**< 0.001**
No	11,243(78.81)	9652(80.54)	1591(67.43)		
Yes	4075(21.19)	3141(19.46)	934(32.57)		
Cancer, n (%)				$\chi^2 = 71.218$	**< 0.001**
No	13,302(85.69)	11,343(87.08)	1959(76.53)		
Yes	2016(14.31)	1450(12.92)	566(23.47)		
Sleep duration, hours, Mean ± S. E	7.15 ± 0.02	7.15 ± 0.02	7.09 ± 0.05	t = -1.197	0.235
BMI, kg/m^2, Mean ± S. E	30.60 ± 0.09	30.74 ± 0.10	29.71 ± 0.20	t = -4.654	**< 0.001**
BMI, n (%)				$\chi^2 = 26.848$	**< 0.001**
Underweight & Normal	3185(20.11)	2494(19.06)	691(27.05)		
Overweight	4999(32.78)	4163(32.88)	836(32.09)		
Obesity	7134(47.11)	6136(48.06)	998(40.86)		
Waist circumference, n (%)				$\chi^2 = 54.741$	**< 0.001**
Low	4781(30.17)	3985(30.17)	796(30.18)		
High	10,074(67.15)	8517(67.82)	1557(62.75)		
Unknown	463(2.68)	291(2.01)	172(7.07)		
Creatinine, mgdL, Mean ± S. E	0.93 ± 0.00	0.91 ± 0.00	1.07 ± 0.02	t = 10.171	**< 0.001**
eGFR$_{CKD-EPI}$, mL/min/1.73m^2, Mean ± S. E	92.30 ± 0.35	94.19 ± 0.37	79.89 ± 0.60	t = -21.842	**< 0.001**
Life's Essential 8 score, score, Mean ± S. E	57.18 ± 0.21	57.42 ± 0.21	55.59 ± 0.53	t = -3.462	**0.001**
Life's Essential 8 score, n (%)				$\chi^2 = 6.971$	**0.002**

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Table 1 (continued)

Variables	Total (*N* = 15318)	All-cause mortality		Statistics	*P*
		No (*N* = 12793)	Yes (*N* = 2525)		
T1: <50.00	4885(27.89)	4000(27.23)	885(32.23)		
T2: 50.00-61.25	5180(33.27)	4317(33.30)	863(33.09)		
T3: ≥61.25	5253(38.84)	4476(39.47)	777(34.68)		
Survival time, months, Mean ± S. E	85.07 ± 1.53	85.51 ± 1.62	82.18 ± 2.33	t = -1.403	0.164

Abbreviation CVD: cardiovascular disease, S.E: Standard Error, PIR: Poverty–income ratio, BMI: Body Mass Index. T stands for t-test, χ^2 stands for chi-square test

substantial reduction in mortality in individuals with hypertension.

A large number of studies have demonstrated a strong stepwise inverse relationship between the number of ideal CVH metrics or overall CVH score and total CVD and CVD mortality, all-cause mortality, and various non-CVD outcomes [6–8, 15–17]. In a meta-analysis of 9 prospective cohort studies, the highest LS7 score was associated with a relative risk of 25% for CVD mortality (95% CI, 0.10–0.63) and 45% lower risk of all-cause mortality (95% CI, 0.37–0.80) in all individuals [18]. All LS7-defined CVH metrics affect the risk of health outcomes [19]. However, as the precursor to LE8, the LS7 characteristic definitions may not ideally represent the full range of health behaviors and practices in the current context [5, 20]. The AHA updated the definitions of diet, nicotine exposure, blood lipids, and glucose metrics and added sleep health as a new metric for CVH in LE8. Multiple studies have evaluated the association between LE8 score and all-cause and CVD mortality among U.S. adults [6–8]. Higher LE8 scores were independently associated with a lower risk of all-cause disease and CVD mortality. There was an approximately linear dose-response association between increases in total CVH index scores and reductions in all-cause and CVD-specific mortality [7]. Analysis on these researches showed close relation among LE8 score and all-cause and CVD-specific mortality.

CVD is the leading cause of death worldwide, and the development of hypertension is a major risk factor for CVD [21]. The REGARDS Study has been shown that optimization of CVH components, as defined by the Life's Simple 7 metric, might reduce risk of incident hypertension among at-risk adults [9]. It is unknown whether the Life's Simple 7 metric or LE8 metric is associated with all-cause and CVD mortality in hypertensive individuals. To our knowledge, this is the first attempt to examine the relationship between the AHA's new LE8 metric and scoring algorithm and long-term prognosis in hypertension. This study suggests that the higher the LE8 index, the lower the risk of all-cause mortality and CVD-related mortality in hypertensive individuals. A higher level of LE8 can be maintained by modifying the diet and lifestyle habits of individuals with hypertension, thereby improving prognosis. As is similar with our result,

international society of hypertension position paper also suggests that lifestyle changes be continued even when blood pressure-lowering medications are prescribed [10]. In addition, our results also showed that blood pressure, blood glucose and physical activity in the LE8 score contribute the most to the risk of all-cause and CVD-specific mortality in hypertensive individuals. Because of it, Severe blood pressure, blood sugar control and lifestyle change were recommended to management of hypertension by the hypertension guidelines [10]. There was insufficient evidence for a significant association between T3 and CVD-related mortality compared with T1 of LE8 among hypertensive individuals with CVD and cancer. The possible reason for this is the small number of CVD-related deaths in these two subgroups, which needs to be further explored by increasing the sample size in subsequent studies.

Investigations of mechanisms through which higher CVH is associated with lower CVD risk (or lower CVH with higher risk) have identified several potential pathways involving inflammation, endothelial function, atherosclerosis, cardiac stress and remodeling, hemostatic factors, and epigenetics [22, 23]. Taken together, the substantial body of knowledge gained about CVH indicates that it is uniquely positioned as a health outcome itself related to upstream genetic, social, behavioral, and environmental factors, and as a determinant of major downstream health outcomes. Across the life course, assessment of CVH status has been shown to be an effective means to monitor public and individual health and a strong indicator of the extraordinary potential of primordial prevention strategies to improve and extend countless lives [5].

A major strength of this study is the use of a nationally representative sample of U.S. adults, which allows the findings to be generalized to the broader population, however, potential limitations of our study include the following. First, assessment of health behavior indicators was based on self-report questionnaires subject to measurement error. Second, we were unable to dynamically assess longitudinal changes in participants' CVH status because NHANES does not provide follow-up examinations. Finally, although we adjusted for several potential confounders, the nature of the longitudinal study design precluded us from drawing causal and temporal

Table 2 Associations of influence factor with all-cause and CVD-cause mortality in patients with hypertension

Variables	All-cause mortality HR (95% CI)	P	CVD-cause mortality HR (95% CI)	P
Age	1.06 (1.06–1.07)	< 0.001	1.06 (1.05–1.07)	< 0.001
Gender				
Female	Ref		Ref	
Male	1.04 (0.93–1.15)	0.524	1.12 (0.92–1.37)	0.259
Race				
Non-Hispanic white	Ref		Ref	
Non-Hispanic black	0.84 (0.73–0.97)	0.017	0.91 (0.68–1.21)	0.503
Mexican American	0.55 (0.45–0.68)	< 0.001	0.53 (0.38–0.75)	< 0.001
Others	0.60 (0.50–0.71)	< 0.001	0.60 (0.41–0.88)	0.009
Educational level				
Less than high school	Ref		Ref	
High School	0.82 (0.69–0.96)	0.016	0.91 (0.66–1.24)	0.543
Above high school	0.56 (0.49–0.64)	< 0.001	0.58 (0.47–0.72)	< 0.001
Marital status				
Married & Living with partner	Ref		Ref	
Never married & Divorced & Separated & Widowed	1.58 (1.43–1.75)	< 0.001	1.61 (1.32–1.95)	< 0.001
PIR				
<1	Ref		Ref	
≥1	0.85 (0.71–1.02)	0.081	0.96 (0.72–1.26)	0.748
Unknown	0.93 (0.74–1.18)	0.553	0.69 (0.45–1.07)	0.099
Alcohol drinking				
No	Ref		Ref	
Yes	0.80 (0.71–0.90)	< 0.001	0.81 (0.66-1.00)	0.047
CVD				
No	Ref		Ref	
Yes	3.09 (2.72–3.51)	< 0.001	3.90 (3.22–4.73)	< 0.001
Cancer				
No	Ref		Ref	
Yes	2.11 (1.83–2.44)	< 0.001	1.92 (1.48–2.50)	< 0.001
Waist circumference				
Low	Ref		Ref	
High	1.00 (0.88–1.13)	0.986	1.08 (0.89–1.31)	0.434

Table 2 (continued)

Variables	All-cause mortality HR (95% CI)	P	CVD-cause mortality HR (95% CI)	P
Unknown	3.46 (2.63–4.57)	< 0.001	4.03 (2.49–6.54)	< 0.001
eGFR$_{CKD-EPI}$	0.97 (0.97–0.97)	< 0.001	0.97 (0.96–0.97)	< 0.001

Abbreviation CVD: cardiovascular disease, Ref: Reference, HR: Hazard Ratio, CI: Confidence Interval. PIR: Poverty–income ratio

conclusions about the relationship between LE8 score and risk of mortality in individuals with hypertension. In future research, Life's Essential 8 metrics will be used to instruct the comprehension management and control of hypertension, and improve the long-term prognosis of individuals with hypertension.

Conclusions

Our study demonstrated that a higher LE8 score could be especially important for individuals with hypertension not only in reducing the risk of all-cause mortality but also in CVD-specific mortality. Furthermore, it is worth noting that blood pressure, blood glucose and physical activity in the LE8 score contribute the most to reducing the risk. These findings suggest that maintain a higher LE8 score in hypertensive individuals, especially severe blood pressure and blood sugar control and lifestyle change, may reduce the risk of early mortality in the later stages of life.

Table 3 Association of Life's essential 8 score with all-cause and CVD-cause mortality in patients with hypertension

Variables	Model 1[a] HR (95%CI)	P	Model 2[b] HR (95%CI)	P
All-cause mortality				
Life's Essential 8 score				
T1: <50.00	Ref		Ref	
T2: 50.00-61.25	0.75 (0.66–0.86)	**< 0.001**	0.72 (0.63–0.83)	**< 0.001**
T3: ≥61.25	0.61 (0.53–0.71)	**< 0.001**	0.61 (0.52–0.72)	**< 0.001**
CVD-cause mortality				
Life's Essential 8 score				
T1: <50.00	Ref		Ref	
T2: 50.00-61.25	0.69 (0.53–0.89)	**0.004**	0.68 (0.53–0.88)	**0.003**
T3: ≥61.25	0.59 (0.45–0.76)	**< 0.001**	0.64 (0.49–0.84)	**0.001**

Abbreviation CVD: Cardiovascular disease, Ref: Reference, HR: Hazard Ratio, CI: Confidence Interval

[a] Model 1 was analyzed using a weighted univariate Cox proportional hazards regression model

Model 1 (Univariable Model): A univariable Cox regression model was established with mortality as the outcomes, and LE8 score as an independent variable

[b] When all-cause mortality was the outcome, Model 2 adjusted for age, race, educational level, marital status, alcohol drinking, CVD, cancer, waist circumference and $eGFR_{CKD-EPI}$. When CVD-cause mortality is the outcome, Model 2 adjusts for age, educational level, marital status, CVD, $eGFR_{CKD-EPI}$

Abbreviations

AHA	American Heart Association
BMI	Body Mass Index
CI	Confidence Interval
CVD	Cardiovascular Disease
CVH	Cardiovascular Health
HR	Hazard Ratio
LE8	Life's Essential 8
LS7	Life's Simple 7
NCHS	National Center for Health Statistics
NHANES	National Health and Nutrition Examination Survey
S.E	Standard Error
VIMP	Variable Importance
WP	Weighted Percentage

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12872-024-04115-3.

Supplementary Material 1

Supplementary Material 2

Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the institutional review board of the NCHS. Written informed consent to participate in NHANES III was obtained from all participants.

Consent for publication

Consent to publish has been obtained from all authors.

Competing interests

The authors declare no competing interests.

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