

The Joint Effect of Life's Essential 8 and Mood Disorders on Mortality: A Prospective Cohort Study from NHANES 2007–2012

Shupeng Jiang

Huazhong University of Science and Technology

Jiji Zhu

Huazhong University of Science and Technology

Mengmeng Ji

Huazhong University of Science and Technology

Luying Jiang

Huazhong University of Science and Technology

Shilang Fan

Wuhan University of Science and Technology

Houjuan Zuo

Huazhong University of Science and Technology

Zixuan Zhang

zhangzixuan0218@outlook.com

Huazhong University of Science and Technology

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Abstract

Background Life's Essential 8 (LE8) comprehensively measures cardiovascular health (CVH), yet its joint impact with mood disorders on mortality remains unclear. This study examines their independent and joint effects on all-cause and cause-specific mortality in the U.S. population.

Methods: Data from 11,088 adults in the National Health and Nutrition Examination Survey (2007–2012), linked to mortality records through 2019, were analyzed. LE8 scores were categorized into low (0–49), moderate (50–79), and high (80–100). Depression (PHQ-9 $\geq$ 10) and anxiety ($\geq$ 7 anxious days/month) were assessed. Mortality outcomes included all-cause, cardiovascular disease (CVD)-related and cancer-related mortality. Adjusted Cox proportional hazards models estimated hazard ratios (HRs). Subgroup analyses stratified results by age and sex, and sensitivity analyses excluded participants with early deaths or pre-existing CVD or cancer.

Results: Higher LE8 scores were associated with lower all-cause (HR: 0.98, 95% CI: 0.97–0.99) and CVD mortality (HR: 0.97, 95% CI: 0.95–0.99). Depression increased all-cause (HR: 1.54, 95% CI: 1.28–1.86) and CVD mortality (HR: 1.99, 95% CI: 1.22–3.24). Low LE8 scores with depression compounded CVD mortality risk (HR: 12.5, 95% CI: 3.75–41.30). Anxiety alone was not a significant predictor but showed increased risk trends when combined with low LE8. Joint effects for cancer mortality were less pronounced.

Conclusion: LE8 and mood disorders independently and jointly influence mortality, particularly from CVD. Integrating mental health into CVH strategies may optimize preventive interventions.

Introduction

In recent years, the paradigm of cardiovascular health (CVH) management has expanded and become increasingly comprehensive, emphasizing the significance of multidimensional health factors in cardiovascular disease (CVD) prevention. The American Heart Association (AHA) introduced the Life's Essential 8 (LE8), encompassing eight core CVH metrics: diet, physical activity, nicotine exposure, sleep health, body mass index (BMI), blood lipids, blood glucose, and blood pressure [1]. Studies have shown a strong association between higher LE8 scores and a reduced risk of mortality [2, 3]. Specifically, an increase of one standard deviation (SD) in the LE8 scores is associated with an approximately 41% reduction in CVD mortality risk [4].

While the LE8 scores have been validated as an effective composite tool for assessing CVH, the role of psychological health in CVD risk is equally critical. Mood disorders, such as depression and anxiety, not only significantly impact an individual's quality of life but may also adversely influence CVH through various physiological and behavioral pathways. A study encompassing 21 countries found a strong link between depressive symptoms and both cardiovascular events and mortality risk, with an especially pronounced risk observed in urban populations [5]. A meta-analysis of 46 cohort studies demonstrated associations between anxiety and an elevated risk of cardiovascular events, including coronary artery disease, stroke, heart failure, and CVD mortality [6].

Furthermore, previous research has underscored the importance of psychological health in cardiovascular management, revealing strong associations between mood disorders and the onset, recurrence, and prognosis of CVD. Integrating mental health assessments into cardiovascular risk evaluations has been recommended to enhance intervention strategies [7–9]. However, there remains a gap in systematically quantifying how LE8 scores and mood disorder together impact mortality risk, an area this study aims to address.

Given the pivotal roles of LE8 metrics and mental health in CVH, this study aims to systematically analyze both the independent and joint effects of LE8 scores and mood disorders on all-cause and cause-specific mortality. By elucidating the synergy between psychological health and CVH, this study seeks to provide evidence-based insights that could guide prevention and health promotion strategies in cardiovascular care.

Method

1. Study population

This analysis was based on data from the National Health and Nutrition Examination Survey (NHANES), a nationwide cross-sectional survey conducted by the National Center for Health Statistics (NCHS) to assess the health and nutritional status of the entire U.S. population (https://www.cdc.gov/nchs/nhanes/about_nhanes.htm). NHANES is conducted biennially using a stratified, multistage sampling design to ensure national representativeness. The survey combines information from household interviews and physical examinations, with interviews covering demographic, socioeconomic, dietary, and health-related questions. All participants provide informed consent prior to enrollment in the study. To ensure the completeness of key data, including the eight components of the LE8

scores, as well as depression and anxiety status, this study included three survey cycles from 2007 to 2012, focusing on adults aged 20 years and older. Mortality data were obtained from the NCHS by linking with the National Death Index (NDI), with data records updated through December 31, 2019 (<https://www.cdc.gov/nchs/data-linkage/mortality-methods.htm>). After excluding individuals with missing data or those who did not meet the study criteria, a total of 11,088 eligible participants were included in the final analysis (Fig. 1).

2. Outcome

The primary outcome of this study was all-cause mortality, while the secondary outcome was cause-specific mortality. Causes of death were identified based on the International Classification of Diseases, Tenth Revision (ICD-10) coding. The outcome variables analyzed included all-cause mortality, CVD-related mortality, and cancer-related mortality.

3. Definition of LE8, Depression, and Anxiety

a) LE8 Score

The LE8 score is calculated according to the AHA's standards and includes eight CVH metrics: dietary quality, physical activity (minutes per week), nicotine exposure (smoking and secondhand smoke), sleep duration, BMI, blood pressure, lipoprotein (non-HDL) cholesterol, and blood glucose levels (**Table S1**). Dietary quality is measured using the Healthy Eating Index 2015 (HEI-2015) (**Table S2**) [10], and BMI is calculated as weight (kg) divided by height (m²). Blood pressure is the average of two measurements, and non-HDL cholesterol is obtained by subtracting HDL cholesterol from total cholesterol. Scores for each metric range from 0 to 100, with higher scores indicating better CVH. The total score is classified into three levels: low (0–49), moderate (50–79), and high (80–100) [1].

b) Depression

Depression was assessed using the Patient Health Questionnaire-9 (PHQ-9), which includes nine items based on the Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV) criteria [11]. Scores range from 0 to 27, with higher scores indicating greater severity of depression. A PHQ-9 score of ≥ 10 indicates depression.

c) Anxiety

Anxiety was assessed using the Computer-Assisted Personal Interviewing (CAPI) system, where participants reported how many days in the past 30 they felt anxious. Participants reporting anxiety for 7 or more days were classified as having anxiety, based on the CDC's Health-Related Quality of Life (HRQoL) indicators. This assessment tool has shown moderate to excellent reliability [12].

4. Covariates

Covariates included demographic characteristics, economic status, education level, and self-reported histories of CVD. Demographic characteristics encompassed baseline age, sex, race, and marital status. Race categories included non-Hispanic White, non-Hispanic Black, Hispanic, and other race. Marital status was recorded as coupled and single or separated. Economic status was assessed using the ratio of household monthly income to the poverty line (Poverty Income Ratio, PIR). Education level was classified into three groups: less than high school, high school graduate, and more than high school.

5. Statistical Analysis

Statistical analyses were conducted in alignment with the CDC guidelines for complex NHANES data analysis. Continuous variables following a normal distribution are presented as mean $\pm$ SD, while non-normally distributed variables are reported as median (interquartile range, IQR). Categorical variables are summarized as frequency (percentage). To compare baseline characteristics across groups, one-way ANOVA and Kruskal-Wallis rank-sum tests were used for continuous variables, while Pearson's Chi-squared test was applied to weighted percentages for categorical data.

To evaluate both the independent and joint associations of LE8 scores, depression, and anxiety with mortality outcomes, weighted Cox proportional hazards regression models were employed to estimate hazard ratios (HR) with 95% confidence intervals (CI). The models adjusted for potential confounders, including age, sex, race, PIR, education level, marital status, and histories of CVD. Forest plots were used to visualize the joint effects of LE8 scores and mood disorders on mortality. Additionally, restricted cubic spline (RCS) models were created to examine the linear relationships between LE8 scores, PHQ-9 scores, and days with anxiety in relation to mortality. The

nonlinearity of these associations was tested using likelihood ratio tests. Kaplan-Meier survival curves were generated to display mortality differences across groups stratified by LE8 and mood disorder status.

Subgroup analyses were performed to further explore the independent and joint associations of LE8 scores and mood disorders with mortality, stratified by age (< 60 vs. ≥60 years) and sex (male vs. female). Sensitivity analyses were conducted by excluding participants who died within the first two years of follow-up and those with prior histories of CVD or cancer to ensure the robustness and consistency of the observed effects of LE8 scores and mood disorders on mortality. All analyses were performed using R version 4.4.1, with statistical significance set at $P < 0.05$.

Results

1. Baseline Characteristics

Table 1 provides an overview of the baseline characteristics of the study population, segmented by LE8 categories. Significant differences were observed across several characteristics. Participants in the high LE8 group were generally younger (mean age: 40 ± 16 years) compared to those in the moderate and low LE8 groups. Gender distribution revealed a higher proportion of females in the high LE8 group (59.2%), while a more balanced gender distribution was observed in the moderate and low LE8 groups. In terms of race, the low LE8 group had a higher proportion of non-Hispanic Black participants (29.1%), whereas the high LE8 group was predominantly non-Hispanic White (53.2%).

Table 1
Baseline characteristics of participants in NHANES 2007–2012.

Characteristic	Overall Weighted N = 89,758,539 Unweighted N = 11,088 (100%)	LE8			P Value
		Low LE8 (0–49) Weighted N = 13,931,982 Unweighted N = 2,141 (16%)	Moderate LE8 (50–79) Weighted N = 63,927,407 Unweighted N = 7,750 (71%)	High LE8 (80–100) Weighted N = 11,899,151 Unweighted N = 1,197 (13%)	
Age	50 ± 18	55 ± 15	50 ± 18	40 ± 16	< 0.001
Gender					< 0.001
Female	5,655 (51.0%)	1,096 (51.2%)	3,850 (49.7%)	709 (59.2%)	
Male	5,433 (49.0%)	1,045 (48.8%)	3,900 (50.3%)	488 (40.8%)	
Race					< 0.001
Non-Hispanic White	5,430 (49.0%)	943 (44.0%)	3,850 (49.7%)	637 (53.2%)	
Non-Hispanic Black	2,197 (19.8%)	624 (29.1%)	1,448 (18.7%)	125 (10.4%)	
Hispanic	2,675 (24.1%)	488 (22.8%)	1,900 (24.5%)	287 (24.0%)	
Other	786 (7.1%)	86 (4.0%)	552 (7.1%)	148 (12.4%)	
PIR	2.16 (1.12, 4.20)	1.54 (0.92, 3.09)	2.26 (1.17, 4.34)	2.91 (1.37, 5.00)	< 0.001
Education level					< 0.001
< High school	1,056 (9.5%)	298 (13.9%)	692 (8.9%)	66 (5.5%)	
High school	4,202 (37.9%)	1,032 (48.2%)	2,921 (37.7%)	249 (20.8%)	
> High school	5,830 (52.6%)	811 (37.9%)	4,137 (53.4%)	882 (73.7%)	
Marital					< 0.001
Coupled	6,701 (60.4%)	1,166 (54.5%)	4,797 (61.9%)	738 (61.7%)	
Single or separated	4,387 (39.6%)	975 (45.5%)	2,953 (38.1%)	459 (38.3%)	
CVD					< 0.001
No	10,171 (91.7%)	1,803 (84.2%)	7,200 (92.9%)	1,168 (97.6%)	
Yes	917 (8.3%)	338 (15.8%)	550 (7.1%)	29 (2.4%)	
Cancer					0.217
No	9,999 (90.2%)	1,932 (90.2%)	6,971 (89.9%)	1,096 (91.6%)	
Yes	1,089 (9.8%)	209 (9.8%)	779 (10.1%)	101 (8.4%)	
Anxiety status					< 0.001
Non-anxiety	8,268 (74.6%)	1,403 (65.5%)	5,915 (76.3%)	950 (79.4%)	
Anxiety	2,820 (25.4%)	738 (34.5%)	1,835 (23.7%)	247 (20.6%)	

Characteristic	Overall	LE8			P Value
	Weighted N = 89,758,539 Unweighted N = 11,088 (100%)	Low LE8 (0–49) Weighted N = 13,931,982 Unweighted N = 2,141 (16%)	Moderate LE8 (50–79) Weighted N = 63,927,407 Unweighted N = 7,750 (71%)	High LE8 (80–100) Weighted N = 11,899,151 Unweighted N = 1,197 (13%)	
Depression status					< 0.001
Non-depression	10,089 (91.0%)	1,765 (82.4%)	7,172 (92.5%)	1,152 (96.2%)	
Depression	999 (9.0%)	376 (17.6%)	578 (7.5%)	45 (3.8%)	
Mental health care					< 0.001
No	10,284 (92.7%)	1,924 (89.9%)	7,243 (93.5%)	1,117 (93.3%)	
Yes	804 (7.3%)	217 (10.1%)	507 (6.5%)	80 (6.7%)	
LE8 score	62 ± 14	42 ± 7	64 ± 8	85 ± 4	< 0.001
Health behaviors	57 ± 19	38 ± 15	59 ± 16	80 ± 11	< 0.001
Health factors	67 ± 20	46 ± 15	69 ± 16	90 ± 10	< 0.001
All-cause Mortality					< 0.001
No	9,623 (86.8%)	1,676 (78.3%)	6,809 (87.9%)	1,138 (95.1%)	
Yes	1,465 (13.2%)	465 (21.7%)	941 (12.1%)	59 (4.9%)	
CVD mortality					< 0.001
No	10,731 (96.8%)	2,024 (94.5%)	7,517 (97.0%)	1,190 (99.4%)	
Yes	357 (3.2%)	117 (5.5%)	233 (3.0%)	7 (0.6%)	
Cancer mortality					< 0.001
No	10,709 (96.6%)	2,042 (95.4%)	7,490 (96.6%)	1,177 (98.3%)	
Yes	379 (3.4%)	99 (4.6%)	260 (3.4%)	20 (1.7%)	
One-way ANOVA, Pearson's Chi-squared test, and Kruskal-Wallis rank sum test were used in the analysis.					
LE8 = Life's Essential 8; PIR = Poverty Income Ratio; CVD = cardiovascular disease.					

Socioeconomic indicators showed that the high LE8 group had a greater median family PIR (2.91) and a higher percentage of participants with education beyond high school (73.7%). Health-related characteristics revealed that the low LE8 group had the highest prevalence of CVD (15.8%). Anxiety (34.5%) and depression (17.6%) were also more prevalent in the low LE8 group, with a notable frequency of mental health consultations (10.1%) in this group. All-cause and CVD mortality rates were lowest in the high LE8 group, underscoring health disparities across LE8 categories.

2. Separate Association of LE8 and Mood Disorders with Mortality

As summarized in Table 2, LE8 scores and mental health status were individually associated with mortality outcomes. A continuous increase in LE8 score was linked to a reduced risk of all-cause mortality, with each unit increase in LE8 score associated with an HR of 0.98

(95% CI: 0.97, 0.99). This inverse association was consistent for CVD mortality (HR: 0.97; 95% CI: 0.96, 0.98) and marginally significant for cancer mortality (HR: 0.99; 95% CI: 0.98, 1.00). RCS curves in Fig. 2A-C illustrate a linear negative association between LE8 scores and mortality risk, suggesting that higher LE8 scores correlate with lower mortality risk.

Table 2
The separate effect of LE8 and mood disorders on mortality.

Characteristic	Total ¹	All-cause mortality			CVD mortality			Cancer mortality		
		Event ¹	HR (95% CI)	p-value	Event ¹	HR (95% CI)	p-value	Event ¹	HR (95% CI)	p-value
LE8 (continuous)	11,088	1,033	0.98 (0.97, 0.99)	< 0.001	253	0.97 (0.96, 0.98)	< 0.001	298	0.99 (0.98, 1.00)	0.044
LE8 (categorical)										
High LE8	1,469	57	1.00 (Reference)	—	3	1.00 (Reference)	—	23	1.00 (Reference)	—
Moderate LE8	7,897	657	1.06 (0.67, 1.69)	0.789	161	4.42 (1.62, 12.06)	0.004	202	0.84 (0.46, 1.52)	0.562
Low LE8	1,721	318	1.77 (1.11, 2.80)	0.016	88	6.72 (2.91, 22.78)	< 0.001	69	1.07 (0.58, 1.99)	0.829
Depression status										
Non-depression	10,224	933	1.00 (Reference)	—	224	1.00 (Reference)	—	276	1.00 (Reference)	—
Depression	863	99	1.54 (1.25, 1.89)	< 0.001	28	1.99 (1.24, 3.20)	0.005	20	1.19 (0.64, 2.19)	0.585
Anxiety status										
Non-anxiety	8,198	803	1.00 (Reference)	—	190	1.00 (Reference)	—	235	1.00 (Reference)	—
Anxiety	2,889	229	1.15 (0.94, 1.41)	0.168	62	1.46 (0.96, 2.20)	0.074	61	1.09 (0.70, 1.70)	0.689

¹ The Total and Event columns show the weighted Total sample size, not the sample size in the original database.

Weighted Cox regressions were used in the analysis. All models adjusted for Age, Gender, Race, Poverty, Education level, Marital, and CVD.

HR = Hazard Ratio; CI = Confidence Interval; LE8 = Life's Essential 8; CVD = cardiovascular disease.

In categorical analyses, using the high LE8 group as a reference, the moderate LE8 group did not show a significant increase in all-cause mortality risk (HR: 1.06; 95% CI: 0.67, 1.69) but demonstrated a significantly elevated risk for CVD mortality (HR: 4.42; 95% CI: 1.62, 12.06). The low LE8 group exhibited higher risks of all-cause mortality (HR: 1.77; 95% CI: 1.11, 2.80) and CVD mortality (HR: 6.72; 95% CI: 2.91, 22.78), though associations with cancer mortality were not statistically significant.

Depression was significantly associated with increased risks of all-cause mortality (HR: 1.54; 95% CI: 1.25, 1.89) and CVD mortality (HR: 1.99; 95% CI: 1.24, 3.20), though the association with cancer mortality was not statistically significant (HR: 1.19; 95% CI: 0.64, 2.19). Figure 2D-F supports these findings, illustrating a progressive increase in all-cause and CVD mortality risks with higher PHQ-9 scores, without a clear association for cancer mortality.

Anxiety did not show a statistically significant association with all-cause mortality (HR: 1.15; 95% CI: 0.94, 1.41) or CVD mortality (HR: 1.46; 95% CI: 0.96, 2.20), with no significant link to cancer mortality (HR: 1.09; 95% CI: 0.70, 1.70). However, when anxiety days were analyzed as

a continuous variable (0–30 days), spline curves showed a trend of increasing all-cause and CVD mortality risk with more days experiencing anxiety (Fig. 2G-I).

3. Joint Association of LE8 and Mood Disorders with Mortality

Figure S1 shows Kaplan-Meier survival curves for all-cause, CVD, and cancer mortality, illustrating the significant survival differences across groups stratified by LE8 scores and the presence of mood disorders (log-rank $p < 0.001$ for all-cause and CVD mortality). The joint effects of LE8 scores and mood disorders on mortality are presented in Fig. 3. For all-cause mortality, participants with low LE8 scores and no depression had an HR of 1.75 (95% CI: 1.09, 2.82) relative to the high LE8, non-depression reference group. Those with both low LE8 scores and depression had the highest all-cause mortality risk (HR: 2.23; 95% CI: 1.26, 3.95), suggesting a compounded risk associated with poor CVH and depressive symptoms. Among those with anxiety, low LE8 scores combined with anxiety were associated with increased mortality, though not statistically significant compared to the reference group.

For CVD mortality, the interaction between LE8 scores and mood disorders was pronounced. Participants with moderate LE8 scores and depression had an HR of 8.28 (95% CI: 2.54, 27.00), higher than moderate LE8 scores without depression (HR: 4.20; 95% CI: 1.54, 11.50). Those with low LE8 scores and depression showed the highest CVD mortality risk (HR: 12.5; 95% CI: 3.75, 41.30), exceeding that of individuals with low LE8 scores without depression (HR: 7.71; 95% CI: 2.74, 21.70). Anxiety showed a similar, albeit weaker, pattern, with those in the low LE8 and anxiety group at an HR of 10.1 (95% CI: 2.79, 36.50) for CVD mortality, higher than those with low LE8 but no anxiety (HR: 7.29; 95% CI: 2.57, 20.70).

No significant joint effects were observed for cancer mortality, though there was a nonsignificant trend towards higher cancer mortality with lower LE8 scores and mood disorders.

4. Subgroup and Sensitivity Analysis

Subgroup analyses (Tables S3–6) further supported the consistency of these findings across sex and age groups. Lower LE8 scores were consistently associated with increased risks of all-cause and CVD mortality as independent factors among both males and females, as well as in younger (< 60 years) and older (≥ 60 years) age groups. Similarly, the joint effects of low LE8 scores and mood disorders on mortality were evident across these subgroups, with the compounded risk particularly pronounced for CVD mortality. Sensitivity analyses confirmed the robustness of the findings. Excluding participants who died within the first two years of follow-up and those with prior histories of CVD or cancer did not alter the significant interactive effects of low LE8 scores and mood disorders on CVD mortality (Fig. S2).

Discussion

This study systematically examined the independent and joint effects of LE8 scores and mood disorders (depression and anxiety) on all-cause and CVD mortality. Our findings demonstrate that lower LE8 scores are significantly associated with increased risks of all-cause and CVD mortality, with these risks being particularly pronounced when depression and anxiety co-occur. This highlights the critical, synergistic impact of physical, behavioral, and mental health on long-term health outcomes, underscoring the need for integrated management of these dimensions.

First, our findings validate the LE8 score as an effective composite measure for CVH. The strong inverse, linear association observed between LE8 scores and mortality risk—both all-cause and CVD—is consistent with existing literature, reinforcing the importance of lifestyle factors, weight management, and control of blood glucose and lipids in reducing cardiovascular events [13–15]. Improvements in these behaviors and physiological metrics promote metabolic balance and reduce inflammation levels [16], lowering the risk of chronic conditions such as atherosclerosis, hypertension, and diabetes, which in turn decreases the incidence of fatal events like heart attacks and strokes [17, 18]. Beyond physical and behavioral factors, LE8 may also indirectly lower mortality risk by improving mental health and reducing chronic stress. Furthermore, we observed higher rates of depression and anxiety among individuals with lower LE8 scores, suggesting that future health interventions should prioritize both physical and mental health.

At the psychological level, our study reinforces the independent impact of depression on mortality, especially CVD mortality, whereas anxiety did not emerge as an independent predictor. Depression is closely linked to cardiovascular risk through mechanisms such as neuroendocrine dysregulation, chronic inflammation, and adverse lifestyle behaviors [19–21]. In contrast, the effect of anxiety on mortality was less pronounced and may be overshadowed by other health factors in certain contexts [22, 23]. However, anxiety remains relevant, as it may indirectly elevate cardiovascular risk by affecting stress responses and lifestyle behaviors, particularly when anxiety is frequent or persistent [24].

When both depression or anxiety and low LE8 scores co-occur, CVD mortality risk is significantly heightened, with the combined effect exceeding the impact of each factor alone. LE8 emphasizes not only traditional physiological metrics but also lifestyle factors crucial to CVH. Psychological health, on the other hand, is often considered an "invisible risk", neglecting its management can lead to more severe health deterioration [25]. Physiologically, mood disorders like depression can trigger systemic inflammation, and individuals with poor CVH may already have a baseline inflammatory burden. When these factors overlap, inflammation may increase substantially, accelerating atherosclerosis and endothelial dysfunction, thus raising CVD mortality risk [26, 27]. Mood disorders can also disrupt the hypothalamic-pituitary-adrenal (HPA) axis, resulting in chronic stress. In individuals with low LE8 scores, this stress response may exacerbate cardiovascular strain, increasing the likelihood of cardiovascular events [28, 29]. Behaviorally, the influence of mental health on CVH and longevity can be understood as a "broken window effect," where a decline in psychological well-being leaves individuals more susceptible to other health issues [30]. Mood disorders often lead to increases in harmful health behaviors, such as irregular eating habits, lack of exercise, smoking, or alcohol abuse, which further amplify cardiovascular risk [31, 32]. Thus, even with high LE8 scores, neglecting psychological health may lead to a "state of entropy," creating a vicious cycle that deteriorates both mental and physical health, ultimately impacting quality of life and lifespan [33–35]. Given the close interconnection between psychological and physical health, neglecting either can compromise overall health stability [36].

Therefore, implementing multi-tiered, comprehensive health interventions, particularly those targeting psychological well-being, is crucial for high-risk populations. Studies have shown that psychological interventions, such as cognitive behavioral therapy (CBT), can effectively manage mood disorders by improving cognitive strategies and coping mechanisms, thereby reducing the recurrence of negative emotions [37, 38]. Future CVD prevention strategies should integrate psychological, physical, and behavioral components, incorporating mood disorder interventions into holistic health management systems. This integrated approach may not only prevent the progression of mood disturbances into severe mood disorders but also mitigate the long-term adverse effects of psychological health issues on CVH, offering a more cost-effective model for health management [39].

Despite revealing the independent and joint effects of LE8 scores and mood disorders on mortality risk, this study has certain limitations. First, data were collected at two time points only—baseline health data and survival status in 2019—limiting our ability to capture changes in individuals' lifestyle over time. Future research should incorporate more time points to assess the dynamic influence of cardiovascular and psychological health changes on mortality risk. Second, mental health status was self-reported, potentially subjecting it to subjective bias and recall limitations. Future studies could use more objective assessments of psychological health (e.g., biomarkers or clinical evaluations) to enhance accuracy. Additionally, this study did not fully differentiate between types of depression or anxiety in relation to mortality risk, a focus for future research to further elucidate how different types of mood disorders may differentially impact health outcomes.

Conclusion

In summary, this study demonstrates that the joint effect of low LE8 scores and mood disorders significantly increases CVD mortality risk. These findings highlight the necessity of incorporating mental health into CVH management to achieve more comprehensive and effective health interventions.

Declarations

Author contributions statement

H.Z. developed the methodology and supervised the work. Z.Z. performed analysis and wrote the original draft. S.J. and L.J. curated the data, M.J. and S.F. reviewed and edited the manuscript. All authors reviewed and approved the final manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author Contribution

H.Z. developed the methodology and supervised the work. Z.Z. performed analysis and wrote the original draft. S.J. and L.J. curated the data, M.J. and S.F. reviewed and edited the manuscript. All authors reviewed and approved the final manuscript.

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None.

Data Availability

The datasets analyzed during the current study are available from publicly accessible databases. The accession numbers and sources are provided in the manuscript.

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Figures

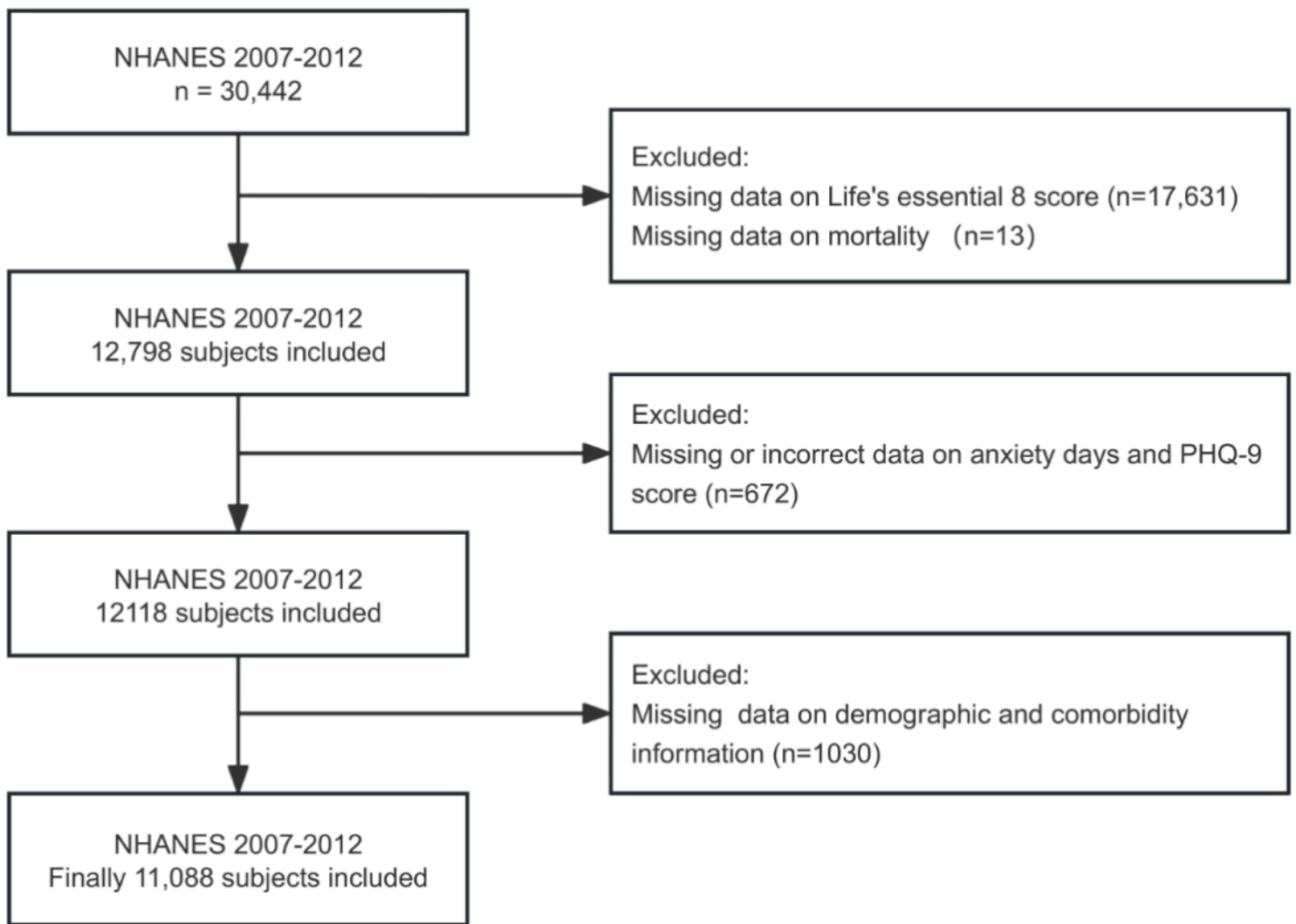


Figure 1

Flow chart of the inclusion of the study population.

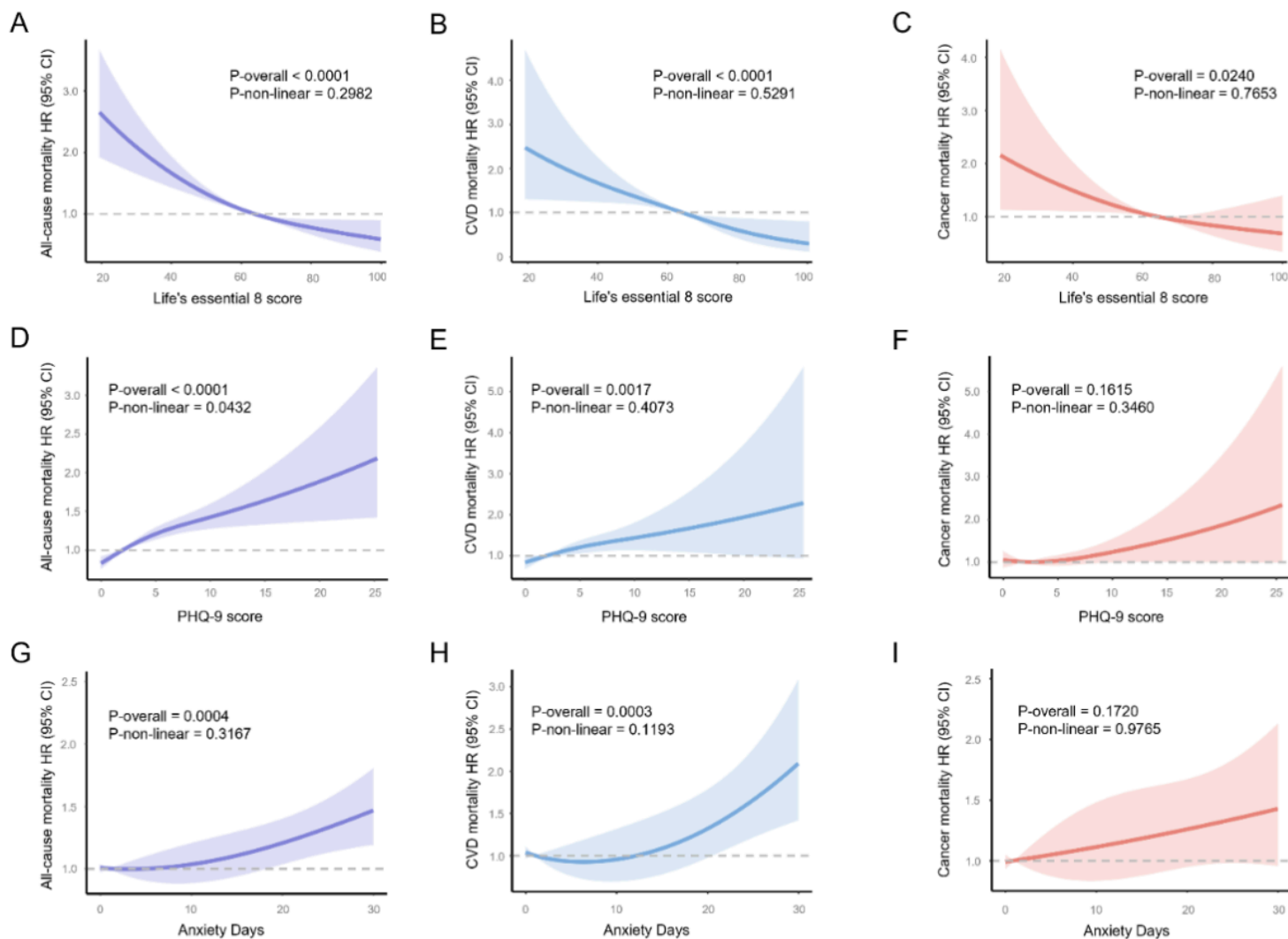


Figure 2

Restricted cubic spline curves of LE8 score and mood disorders for all-cause, CVD and cancer mortality. Panels A, B, and C depict the association between LE8 scores and all-cause, CVD, and cancer mortality, respectively. Panels D, E, and F show the relationship between PHQ-9 scores and all-cause, CVD, and cancer mortality, respectively. Panels G, H, and I illustrate the relationship between the number of anxiety days and all-cause, CVD, and cancer mortality, respectively. All analyses were adjusted for age, sex, race, PIR, marital status, education levels, and prior CVD diagnosis. CVD = cardiovascular disease; LE8 = Life's Essential 8; PIR = poverty income ratio; HR = hazard ratio; CI = confidence interval.

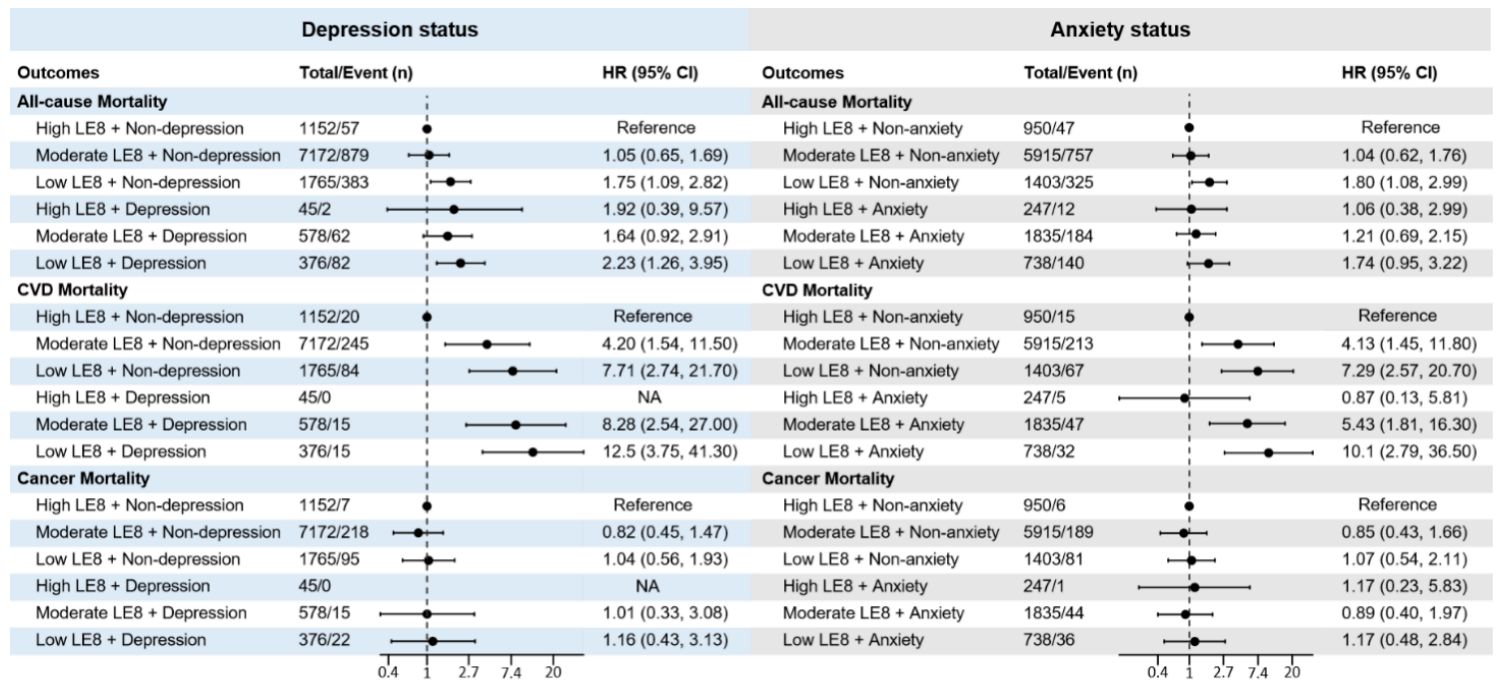


Figure 3

The joint effects of LE8 scores and mood disorders on mortality outcomes. The analysis was conducted using weighted Cox proportional hazards models, with adjustments for age, sex, race, PIR, marital status, education levels, and prior CVD diagnosis. LE8 = Life's Essential 8; CVD = cardiovascular disease; PIR = Poverty income ratio; HR = hazard ratio; CI = confidence interval.

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