Cardiovascular health by Life's Essential 8 and chronic kidney disease: Korea National Health and Nutrition Examination Survey 2019-2021

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GLOSSARY OF TERMS

ACC/AHA: American College of Cardiology and American Heart Association

BMI: Body mass index

BP: Blood pressure

CI: Confidence interval

CKD: Chronic Kidney Disease

CVD: Cardiovascular disease

CVH: Cardiovascular Health

DBP: Diastolic blood pressure

DM: Diabetes Mellitus

eGFR: estimated Glomerular Filtration Rate

ESKD: End-Stage Kidney Disease

FBG: Fasting Blood Glucose

KDIGO: Kidney Disease Improving Global Outcomes

KNHANES: Korea National Health and Nutrition Examination Survey

LS7: Life's simple 7

LE8: Life's Essential 8

HDL: High-Density Lipoprotein

HbA1c: Hemoglobin A1c

OR: Odds ratio

SBP: Systolic blood pressure

UACR: Urine Albumin-Creatinine-Ratio

WHO: World Health Organization

ABSTRACT

Cardiovascular health by Life's Essential 8 and chronic kidney disease: Korea National Health and Nutrition Examination Survey 2019-2021

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(Directed by Professor Hokyou Lee, M.D, Ph.D.)

Background:

The American Heart Association's (AHA) "Life's Essential 8" is an updated definition and quantification method for cardiovascular health (CVH), with aims to better monitor and promote improvements in individual and population health. Studies on the association of the new LE8 CVH score with health outcomes are emerging, with a primary focus on cardiovascular diseases (CVD). Chronic

kidney disease (CKD) is an increasing global health problem, closely linked to CVD and of growing importance in early prevention. Yet, data are scarce regarding the association between ideal cardiovascular health and CKD, particularly within the new LE8 framework. Using nationally-representative data, this study aimed to examine the association between the LE8 CVH score and CKD among Korean adults.

Methods:

This was a cross-sectional study based on the 8th cycle of the Korea National Health and Nutrition Examination Survey (KNHANES VIII) from 2019 to 2021. The CVH metrics in the LE8 construct include diet, physical activity, nicotine exposure, sleep quality, body mass index (BMI), blood lipid levels, blood glucose, and blood pressure, each scaled from 0 to 100 points. The LE8 CVH score is calculated as the average of 8 component metric scores. The CVH scores of 80 to 100 were categorized as high CVH, 50 to <80 as moderate CVH, and 0 to <50 as low CVH. CKD was defined as an estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m^2 or the presence of albuminuria with an urine albumin-to-creatinine ratio ≥30 mg/g. Multivariable logistic regression models were derived to calculate odds ratios (OR) and 95% confidence intervals (CI) for CKD associated with the LE8 CVH score. All statistical analyses accounted for the complex survey design of the KNHANES data.

Results:

The study sample included 12,264 participants. The weighted mean age of the population was 48.1 years, and 50.7% were men. After multivariable adjustment, a higher LE8 CVH score was associated with lower odds of CKD, decreased eGFR, and albuminuria. When the low CVH group was the reference, the odds ratio (OR) for CKD was 0.41 (95% CI: 0.34-0.49) in the moderate CVH group and 0.25 (95% CI: 0.17-0.36) in the high CVH group. Each 10-point higher LE8 CVH score was associated with 31% lower odds of having CKD (OR, 0.69; 95% CI, 0.64-0.73). In graphical inspection of the restricted cubic spline plot, there was a linear and dose-dependent association between the LE8 CVH score and CKD. A higher cardiovascular health behavior score and a health factor score were both associated with lower odds of CKD; the OR (95% CI) for CKD was 0.93 (0.89-0.97) per 10-point higher health behavior score and 0.72 (0.68-0.75) per 10-point higher health factor score. The association of the LE8 CVH score and CKD was consistently observed in both men and women and across other subgroups of social determinants of health.

Conclusion:

Ideal CVH, as demonstrated by a higher LE8 CVH score, was associated with a lower risk of having CKD in a nationally-representative population. This

highlights the importance of maintaining ideal individual CVH for decreasing the burden of CKD.

Keywords: cardiovascular health; Life's Essential 8; chronic kidney disease; primordial prevention

I. INTRODUCTION

In 2010, the American Heart Association (AHA) introduced “Life’s Simple 7”, (LS7) to prevent an increasing risk of cardiovascular disease (CVD) and aimed to improve cardiovascular health (CVH) in the general population. LS7 framework comprised 7 components: 4 health behaviors (diet, physical activity, smoking, and body mass index) and 3 health factors (fasting glucose level, total cholesterol, and blood pressure).[1] According to a previous study in LS7, ideal CVH indicated an inverse association with the risk of CVD and mortality. Additionally, optimal CVH improves survival rates and life expectancy, positively affecting the quality of life in CVD.[2,3] In 2022, the AHA updated the CVH to encourage the population to further improve CVH. A new framework proposed for defining and quantifying CVH metrics is known as “Life’s Essential 8”.[4] Specially, LE8 introduced a new component of sleep health.[5] Significantly, there are consistent findings linking sleep health and quality with CVD and CKD risk.[6,7] LE8 is a more comprehensive scoring system that emphasizes socioeconomic determinants of health and psychological health for managing CVH.[8]

In 2017, CKD caused the deaths of 1.2 million people globally. The all-age mortality from CKD increased 41.5% between 1990 and 2017.[9] CKD has also been reported as a risk factor for CVD that is independent of other known risk

factors.[10] CKD increases the risk of CVD mortality and contributes to the risk for people with chronic diseases including diabetes and hypertension.[10-13] Furthermore, when the eGFR is less than 60 ml/min/1.73m^2, CVD becomes a leading cause of death. As GFR decreases, it increases CVD mortality, including heart failure and valvular heart disease.[14] Approximately half of the patients with CKD die from CVD before progressing to End-Stage Kidney Disease (ESKD).[12] A recent study by Ruilope introduced the concept of the "blind spot" of CKD, which is associated with the absence of early detection and effective treatment for the risks of CVD. This emphasizes the need for a comprehensive approach to prevent CKD and reduce the associated risk of death.[15]

LE8 and CKD is yet to be explored. Given the known association between CKD and CVD, improving CVH is crucial for CKD prevention and management. Using nationally-representative data, this study aimed to examine the association between the LE8 CVH score and CKD among Korean adults.

II. METHODS

1. Data source and study population

In this study, we used data from the Korea National Health and Nutrition Examination Survey (KNHANES) from 2019–2021. The KNHANES is a continuous cross-sectional survey targeting all age groups in Korea. This survey involves approximately 10,000 individuals annually and includes health interviews, health examinations, and nutrition surveys. The KNHANES generates a sample weighted to represent complex sampling and utilizes a multi-stage clustered probability sampling design.[16,17] Figure 1 shows detailed information on the study populations. In this study, the initial number of populations was 22,559. After excluding individuals under the age of 20 (N=4,048), pregnant women (N=50), those with missing data for covariates (N=2,097), missing LE8 values (N=3,558), and missing urine albumin to creatinine rate measurements (N=542), Consequently, the final population consisted of 12,264 participants: 5,353 men and 6,911 women.

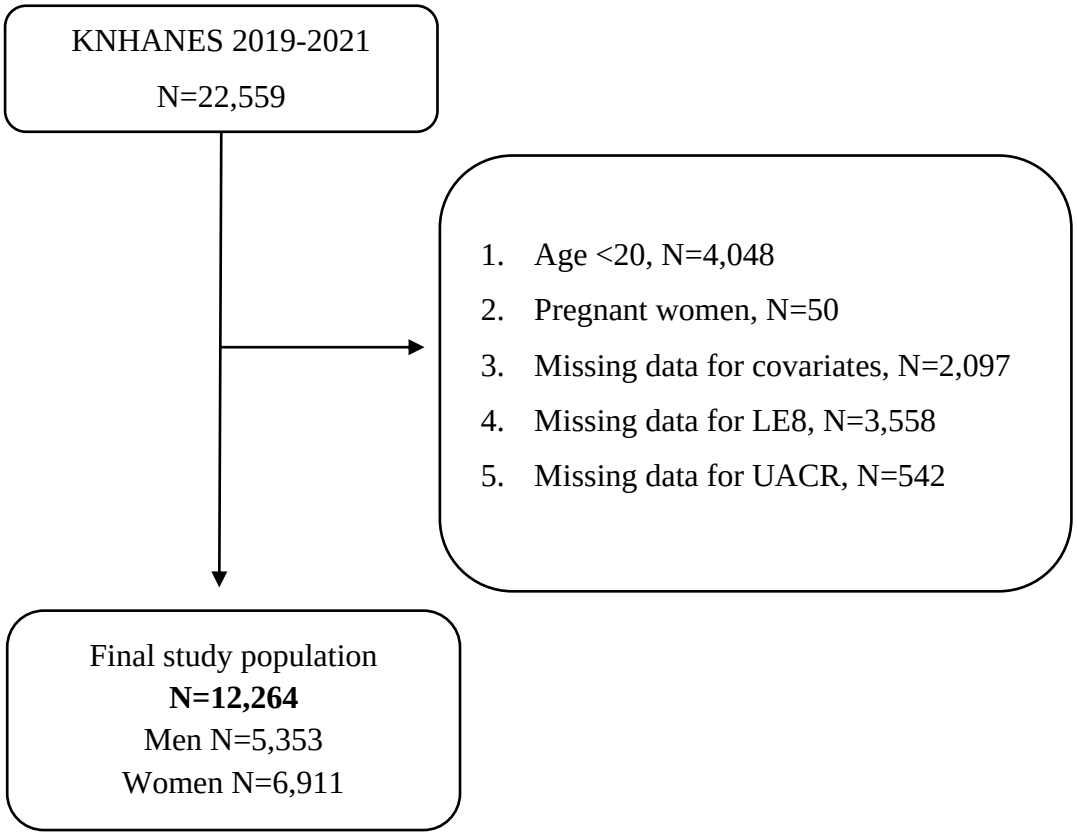

Figure 1. Flow diagram of the study.

2. Measurement

(1) Cardiovascular metrics in Life's Essential 8

LE8 is organized into two primary domains: health behaviors and health factors. The health behavior domain includes four components: diet, physical activity, nicotine exposure, and sleep health. Additionally, the health factors domain incorporates crucial variables such as body mass index, blood lipids, blood glucose, and blood pressure.[5] Detailed criteria for each component are described in Appendix Table 1.

Diet

In this research, dietary information of participants was acquired through a 24-hour recall method, capturing detailed consumption of foods and beverages in a day. Additionally, the Dietary Approaches to Stop Hypertension (DASH) method was used to assess dietary patterns, considering nine nutrient parameters: protein, fiber, calcium, potassium, total fat, sodium, cholesterol, saturated fat, and magnesium.[18] Quintile ranges for each nutrient were computed using the 8th KNHANES population as a reference, categorizing nutrient intake into quintiles. Nutrients considered beneficial, such as protein, fiber, calcium, potassium, and magnesium were assigned a scoring system where increased intake correlated with higher scores, ranging from 1 point in the lowest quintile (Q1) and 5 points

in the highest quintile (Q5). In contrast, for nutrients like total fat, sodium, cholesterol, and saturated fat, this scoring was inversed, with 5 points allocated to Q1 and 1 point to Q5 as detailed in Appendix Table 2. Thus, the overall score ranged from 9 to 45 points, and the 25^{th}, 50^{th}, 75^{th}, and 95^{th} percentiles of the DASH diet score in the reference population can be found in Appendix Table 3.

Physical activity

Physical activity was assessed through health interview surveys, utilizing the Global Physical Activity Questionnaire (GPAQ). High and moderate-intensity activities during work and leisure were converted to minutes. According to AHA guidelines, for adults, each minute of moderate-intensity activity was calculated as 1 minute, and each minute of high-intensity activity was counted as 2 minutes toward the weekly total.[19,20]

Nicotine exposure

Nicotine exposure was determined through health interview surveys. Nicotine exposure was segmented as follows: current smokers; former smokers, and non-smokers. Additionally, among former smokers, the duration of smoking cessation and the use of inhalable nicotine products were investigated. Furthermore,

individuals exposed to secondhand smoke at home incurred a deduction of 20 points.

Sleep health

For 2019–2020, the average daily sleep duration during weekdays and weekends was calculated in hours. In contrast, for 2021, the times individuals went to bed and woke up on both weekdays and weekends were used to determine the average daily sleep duration in hours.

BMI

BMI was calculated utilizing standardized methods and equipment to measure height and weight, derived by dividing weight in kilograms by the square of height in meters. Following the recommendations of the AHA for Asian populations, BMI was categorized as follows: ≥35.0 kg/m², 30.0–34.9 kg/m², 25.0–29.9 kg/m², 23.0–24.9 kg/m², and <23.0 kg/m².[21,22]

Blood lipids

Participants provided blood samples in the morning after a minimum of 8 hours of fasting. Total cholesterol and HDL-C levels were measured using the enzymatic

method with Labospect 008AS equipment (Hitachi, Japan). Non-HDL-C was calculated by subtracting HDL-C from total cholesterol.

Blood glucose

Blood samples were collected from participants after a minimum of 8 hours of fasting to analyze fasting blood glucose (FBG) and hemoglobinA1c (HbA1c) levels. Blood glucose, HbA1c, and insulin were measured using hexokinase, high performance liquid, and electrochemiluminescence immunoassay methods respectively, with the equipment used being Labospect 008AS (Hitachi/Japan), Tosoh G8 (Tosoh/Japan), and Modular E801 (Roche/Germany). In addition, diabetes was defined by investigating the use of diabetes medications, insulin administration, or medical diagnosis information.[23]

Blood pressure

BP measurements were conducted by trained nurses, with participants undergoing measurement on the right arm after at least 5 minutes of rest. Following the Minamata Convention on Mercury, the prohibition of mercury usage led to the transition to mercury-free sphygmomanometers from 2020 onwards. Various sphygmomanometers were utilized over the years: the Baumanometer® Wall Unit 33 W.A.Baum mercury sphygmomanometer from the USA in 2019, the

Greenlight 300TM auscultatory sphygmomanometer from Accoson, UK in 2020, and finally the Greenlight 300TM WatchBP oscillometric sphygmomanometer in 2021. Blood pressure determined the average systolic and diastolic blood pressure levels by calculating the mean of the two measurements. If participants were on antihypertensive medication, a deduction of 20 points was applied.[24,25]

The final CVH was derived from the unweighted average of all CVH metrics, each scored on a scale from 0 to 100. Based on this composite score, participants were categorized into high, moderate, and low CVH groups. Specifically, scores from 80–100 were considered high, scores from 50–<80 were considered moderate, and scores from 0–<50 were categorized as low. All score assignments followed the criteria of the AHA.

(2) Assessment and definition of chronic kidney disease

The definition and categorization of CKD followed KDIGO guidelines, considering both the decreased eGFR and the ACR in the urine.[26-29] Urine samples were collected during the first-morning void to measure urinary albumin concentration (μg) and creatinine concentration (mg). The turbidimetric immunoassay was employed to measure albumin concentration, while the kinetic colorimetric assay was utilized for creatinine concentration, using Labospect 008AS (Hitachi/Japan) equipment. Blood samples obtained in a fasting state were used to measure serum creatinine concentration, utilizing the same methods and analyzed with the Cobas (Roche/Germany) equipment. Albuminuria was defined as having an ACR (mg/g) of 30 or higher, following KDIGO guidelines.[28] It's important to note that a decreased eGFR cut-off of less than 60 was defined, and the decreased eGFR was calculated from serum creatinine level which was standardized to isotope dilution mass spectrometry.[29]

UACR was categorized into three levels: A1 was normal to mildly increased (UACR, <30mg/g); A2 indicated moderately increased (UACR, 30–300mg/g); and A3 was severely increased (UACR, >300mg/g). Additionally, eGFR was classified into five levels: G1 was normal or high (eGFR, ≥90 mL/min/1.73 m^2); G2 indicated mildly decreased (eGFR, 60–89 mL/min/1.73 m^2); G3 represented mild to severe decreases (eGFR, 30–59 mL/min/1.73 m^2); G4

denoted severely decreased (eGFR, 15–29 mL/min/1.73 m^2); and G5 was kidney failure (eGFR, <15 mL/min/1.73 m^2). We defined CKD as cases with albuminuria of 30 or above, or a decreased eGFR below 60.

(3) Covariate

The covariates included are age, sex, residential area, household income, educational attainment, and drinking. Demographic and social factors were collected using a standardized questionnaire during health interviews. Residential areas are categorized as urban, represented by *dong*, and rural, known as *eup* or *myeon*. Household income is measured by the equivalized household income, calculated by dividing the monthly average household income by the square root of the number of household members. Household income is classified into tertiles: low (<25%), moderate (25%–74%), and high (≥75%). The variable of educational attainment is classified in divided with the Korean education system into less than elementary school, middle school, and high school or above. Individuals with middle school education or less are classified as low education. High school graduates are middle education, and those with more than college education are high education. Lastly, drinking is categorized based on the annual drinking frequency of participants: those who did not drink in a year are classified as none, those who drink 1 to 4 times a month, and those who drink 2 to greater than 4 times a week.

3. Statistical analysis

(1) Main analyses

The baseline characteristics of the study population are presented as frequencies, weighted percentages, or means (95% confidence interval), using chi-square tests and analysis of variance (ANOVA). To examine the association between CVH scores, including, health behavior score, and health factor score, all considered categorically, and CKD, we conducted multiple logistic regression analyses, considering both the categorical scores and the continuous CVH score with a per 10-point increase. Additionally, the restricted cubic spline model was utilized to evaluate the nonlinear associations of continuous CVH scores, health behavior scores, and health factor scores with the risk of CKD, decreased eGFR, and albuminuria. The association between each of the eight components of CVH and CKD, decreased eGFR, and albuminuria was investigated. Model 1 served as the unadjusted model. Model 2 was adjusted for age and sex. Model 3 was fully adjusted, considering factors such as age, sex, residential area, household income, educational attainment, and drinking. All results were analyzed while accounting for sampling weights and the study complex survey design. Statistical computations were carried out using SAS software, version 9.4, provided by SAS Institute Inc., based in Cary, North Carolina, USA.

(2) Subgroup analyses

Subgroup analyses were executed using multiple logistic regression based on subgroups. Stratification was performed based on age (20–49 years and 50 years and above), residential area (urban and rural), household income (low-middle and high), educational attainment (low: up to high school, high: college level or above), and drinking (non-drinkers: no alcohol consumption in the past year, drinkers: consumed alcohol in the past year). For all results, sampling weights and a complicated survey design, including clusters and strata, were taken into consideration.

(3) Sensitivity analysis

The sensitivity analyses were performed to the robustness of the finding. First, our analysis included an evaluation without considering sampling weights to observe the impact of sampling weights on our findings. Second, the CVH LE8 scores were divided into quintiles, to assess associations with CKD, decreased eGFR, and albuminuria. Third, to assess reverse causation, we conducted sensitivity analyses based on the sensitivity of CKD stages. Finally, we examined the association between the scores of each of the nine nutrients and CKD, decreased eGFR, and albuminuria. Statistical computations were carried out using SAS

software, version 9.4, provided by SAS Institute Inc., based in Cary, North Carolina, USA.

(4) Ethical approval

The survey data for this research originates from the KNHANES, which is a nationally representative database managed by the KCDC. Ethical clearance for the study has been granted by the KCDC Institutional Review Board, under the authorization numbers 2018-01-03-C-A, 2018-01-03-2C-A, 2018-01-03-5C-A. Prior to participation, all study subjects provided their informed consent in writing. To confidential analysis, any information that could identify individual participants has been excluded.

III. RESULTS

1. Characteristics of population

Table 1 shows the general characteristics. The total number of participants was 12,264, categorized into low CVH (N=1,478), moderate CVH (N=9,368), and high CVH (N=1,418). The average age of all participants was 48 years, which decreased to 40 years in the high CVH score group. In a high CVH score, there was an increased proportion of women and a decreased proportion of men. Additionally, there was a positive change in both decreased eGFR and UACR as the CVH score rose. Notably, the rates of CKD were lowest among participants with high CVH scores.

Table 1. Characteristics of the study population according to Life's Essential 8 cardiovascular health scores

Variables	Total (N=12,264)	Low CVH (N=1,478)	Moderate CVH (N=9,368)	High CVH (N=1,418)
Age, year	48.1 (47.6-48.7)	50.3 (49.3-51.3)	49.0 (48.4-49.6)	40.8 (39.9-41.7)
Gender, %				
Men	50.7 (49.8-51.7)	76.6 (74.1-79.0)	49.7 (48.6-50.8)	30.4 (27.6-33.2)
Women	49.3 (48.3-50.2)	23.4 (21.0-25.9)	50.3 (49.2-51.4)	69.6 (66.8-72.4)
Residential area, %				
Urban	85.6 (83.0-88.3)	84.2 (80.7-87.6)	85.0 (82.3-87.8)	90.8 (88.3-93.2)
Rural	14.4 (11.7-17.0)	15.8 (12.4-19.3)	15.0 (12.2-17.7)	9.2 (6.8-11.7)
Household income, %				
Low (<25%)	13.5 (12.4-14.6)	16.6 (14.4-18.8)	14.1 (12.9-15.3)	6.7 (5.1-8.2)
Moderate (25%–74%)	52.1 (50.4-53.9)	55.9 (52.6-59.1)	52.0 (50.2-53.9)	48.9 (45.2-52.5)
High (≥75%)	34.4 (32.3-36.4)	27.6 (24.5-30.6)	33.9 (31.8-35.9)	44.5 (40.7-48.2)
Educational attainment, %				
Low (middle school or lower)	19.4 (18.2-20.7)	23.5 (20.9-26.0)	21.0 (19.6-22.3)	5.9 (4.7-7.0)
Middle (high school)	35.6 (34.4-36.9)	38.3 (35.2-41.4)	35.6 (34.3-36.9)	33.1 (30.1-36.2)
High (college or higher)	44.9 (43.2-46.7)	38.2 (34.8-41.7)	43.4 (41.6-45.2)	61.0 (57.9-64.1)
Drinking, %				
None	24.9 (23.9-25.9)	17.0 (14.7-19.2)	26.9 (25.7-28.1)	21.0 (18.6-23.5)
1 to 4 times/month	54.0 (52.9-55.1)	45.3 (42.3-48.3)	53.4 (52.1-54.8)	66.4 (63.7-69.0)
2 to greater than 4 times/week	21.1 (20.2-22.0)	37.7 (34.9-40.6)	19.6 (18.6-20.7)	12.6 (10.5-14.7)
DASH diet score quantiles, (%)				
1^{st}–24^{th} percentile	21.6 (20.6-22.7)	35.2 (32.2-38.3)	21.0 (19.9-22.2)	11.1 (9.1-13.1)
25^{th}–49^{th} percentile	26.1 (25.2-27.1)	32.1 (29.4-34.9)	26.2 (25.1-27.2)	19.7 (17.1-22.3)
50^{th}–74^{th} percentile	27.0 (26.1-28.0)	23.8 (21.5-26.2)	27.1 (26.0-28.1)	30.1 (27.4-32.9)
75^{th}–94^{th} percentile	19.2 (18.4-20.1)	7.1 (5.6-8.5)	19.8 (18.8-20.7)	28.8 (26.2-31.4)
≥95^{th} percentile	6.0 (5.4-6.5)	1.7 (1.0-2.5)	6.0 (5.4-6.5)	10.2 (8.3-12.1)
Smoking status, (%)				
Never	56.9 (55.8-57.9)	20.6 (18.4-22.8)	58.4 (57.2-59.6)	85.3 (83.1-87.4)
Former	24.7 (23.8-25.5)	26.3 (23.7-28.8)	26.2 (25.1-27.2)	13.9 (11.7-16.0)
Current	18.5 (17.5-19.4)	53.2 (50.2-56.2)	15.4 (14.4-16.4)	0.9 (0.3-1.4)
Sleep hours, per night	7.0 (6.9-7.0)	6.4 (6.3-6.5)	7.0 (7.0-7.0)	7.4 (7.3-7.4)
Body mass index, kg/m^2	24.1 (24.0-24.2)	27.1 (26.8-27.3)	24.0 (23.9-24.1)	21.7 (21.5-21.8)
Non-HDL-Cholesterol, mg/dL	140.0 (139.2-140.7)	161.7 (159.3-164.2)	139.4 (138.5-140.3)	120.7 (119.1-122.3)
Lipid-lowering drugs, %	13.6 (12.8-14.4)	16.9 (14.8-18.9)	14.4 (13.6-15.3)	5.1 (3.9-6.3)

Table 1. Characteristics of the study population according to Life's Essential 8 cardiovascular health scores *(continued)*

Variables	Total (N=12,264)	Low CVH (N=1,478)	Moderate CVH (N=9,368)	High CVH (N=1,418)
Blood glucose, %				
Normal	63.8 (62.7-65.0)	31.6 (28.8-34.5)	64.8 (63.5-66.1)	91.5 (90.0-93.0)
Prediabetes	28.8 (27.8-29.9)	45.1 (42.0-48.2)	29.4 (28.2-30.6)	8.2 (6.7-9.7)
Diabetes	7.3 (6.8-7.9)	23.2 (20.6-25.9)	5.8 (5.3-6.3)	0.2 (0.0-0.4)
SBP, mmHg	118.3 (117.9-118.7)	128.5 (127.6-129.5)	118.3 (117.8-118.8)	107.6 (107.0-108.2)
DBP, mmHg	75.5 (75.3-75.8)	82.9 (82.2-83.5)	75.2 (74.9-75.5)	69.8 (69.4-70.2)
BP-lowering drugs, %	18.3 (17.4-19.3)	30.6 (27.7-33.4)	18.7 (17.7-19.7)	3.1 (2.2-3.9)
LE8 CVH Score[a]				
Total CVH score	64.5 (64.2-64.9)	43.0 (42.6-43.3)	64.8 (64.6-65.1)	85.1 (84.8-85.4)
Health behavior score	57.0 (56.5-57.4)	34.3 (33.5-35.1)	57.1 (56.8-57.5)	79.4 (78.8-80.0)
Health factor score	72.1 (71.7-72.6)	51.6 (50.8-52.5)	72.6 (72.1-73.0)	90.9 (90.3-91.4)
Diet	41.4 (40.6-42.2)	27.3 (25.7-29.0)	41.9 (41.0-42.7)	53.3 (51.4-55.1)
Physical activity	33.3 (32.1-34.4)	7.8 (6.4-9.3)	30.1 (28.9-31.4)	78.8 (76.5-81.0)
Nicotine exposure	72.4 (71.5-73.3)	36.1 (33.6-38.5)	75.0 (74.0-76.0)	94.5 (93.7-95.4)
Sleep health	80.7 (80.2-81.3)	66.1 (64.4-67.7)	81.5 (80.9-82.1)	91.1 (90.0-92.2)
Body mass index	74.0 (73.4-74.6)	53.6 (52.1-55.1)	74.6 (74.0-75.3)	91.5 (90.5-92.5)
Blood lipids	65.8 (65.2-66.5)	46.7 (45.2-48.3)	65.9 (65.2-66.6)	85.3 (84.0-86.7)
Blood glucose	76.7 (76.1-77.3)	58.2 (56.7-59.7)	77.2 (76.5-77.8)	93.2 (92.3-94.1)
Blood pressure	72.0 (71.2-72.8)	48.1 (46.4-49.8)	72.5 (71.7-73.4)	93.4 (92.5-94.3)
eGFR, ml/min/1.73m^2	98.1 (97.6-98.6)	95.1 (94.0-96.2)	97.5 (97.0-98.0)	105.0 (104.1-105.9)
eGFR category, %				
G1	71.3 (70.0-72.5)	67.8 (67.8-70.6)	69.7 (68.3-71.0)	84.5 (82.3-86.6)
G2	26.3 (25.2-27.5)	28.5 (28.5-31.2)	27.8 (26.5-29.0)	15.3 (13.2-17.5)
G3	2.2 (1.9-2.5)	3.2 (2.4-4.1)	2.3 (2.0-2.6)	0.2 (0.0-0.4)
G4-G5	0.2 (0.1-0.3)	0.5 (0.1-0.9)	0.2 (0.1-0.3)	-
UACR, mg/g	19.7 (17.6-21.7)	31.5 (25.9-37.0)	19.3 (16.8-21.9)	9.4 (6.9-11.9)
UACR category, %				
A1	93.1 (92.6-93.7)	85.3 (83.3-87.3)	93.8 (93.2-94.4)	97.2 (96.3-98.2)
A2	5.9 (5.4-6.4)	12.4 (10.5-14.3)	5.3 (4.8-5.9)	2.6 (1.7-3.5)
A3	1.0 (0.8-1.2)	2.3 (1.5-3.1)	0.9 (0.7-1.1)	0.1 (0.0-0.3)
Chronic kidney disease, %[b]	8.4 (7.8-8.9)	16.2 (14.2-18.3)	7.9 (7.3-8.5)	2.9 (1.9-3.9)

Values are presented as weighted % or mean (95% confidence interval).

Low CVH was defined as a LE8 score of 0–<50, moderate CVH of 50–<80, and high CVH of 80–100.
[a]LE8 CVH Score was entered as a continuous variable.
[b]Those with albumin-to-creatinine ratio above 30 mg/g or estimated glomerular filtration rate below 60 mL/min/1.73 m^2 were defined as patients with chronic kidney disease.
eGFR and UACR categories were based on the KDIGO 2012 Clinical Practice Guideline.
The categories for eGFR and UACR are defined as follows: G1, ≥90; G2, 60–89; G3, 30–59; G4, 15–29; G5, <15; A1, <30; A2, 30–300; A3, >300.

CVH, cardiovascular health; UACR, urine albumin to creatinine ratio; HDL, high-density lipoprotein; eGFR, estimated glomerular filtration rate; DASH, dietary approaches to stop hypertension; SBP, systolic blood pressure; DBP, diastolic blood pressure; LE8, life's essential 8.

2. LE8 CVH score and CKD

Table 2 shows the association of the LE8 CVH score with CKD, decreased eGFR, and albuminuria. The finding demonstrate a clear trend as the CVH score increases, the odds ratio for CKD consistently decrease. The OR for CKD was 0.41 (95% CI: 0.34-0.49) with a moderate CVH score and 0.25 (95% CI: 0.17-0.36) with a high CVH score, both in reference to a low CVH score. Similar patterns were noted for the association of the CVH score with decreased eGFR and albuminuria. The OR for decreased eGFR was 0.60 with a moderate CVH score and decreased to 0.14 with a high CVH score. With an increase in the CVH score, the OR for albuminuria decreased from 0.36 (95% CI: 0.30-0.44) to 0.24 (95% CI: 0.16-0.35). In all results, it was observed that the OR decreased with a higher CVH score. Moreover, a significant association was found for per 10-point higher CVH score.

Figure 2 displays restricted cubic spline models illustrating the association between the continuous CVH score and outcomes (CKD, decreased eGFR, and albuminuria). Solid lines represent odds ratios, with shaded regions indicating the 95% CI. A visual examination of the model reveals a linear and dose-dependent association between the LE8 CVH score and CKD. Similar findings were observed for decreased eGFR and albuminuria.

Table 2. Association of the Life's Essential 8 cardiovascular health score with chronic kidney disease, decreased eGFR, and albuminuria

Disease / CVH score	No. of people	No. (%) of people with chronic kidney disease	OR (95% CI)		
			Model 1	Model 2	Model 3
Chronic kidney disease					
Low CVH	1478	287 (19.42)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	9368	953 (10.17)	0.44 (0.38-0.52)	0.39 (0.33-0.47)	0.41 (0.34-0.49)
High CVH	1418	45 (3.17)	0.15 (0.11-0.22)	0.22 (0.15-0.32)	0.25 (0.17-0.36)
Per 10-point higher CVH score			0.66 (0.63-0.70)	0.67 (0.63-0.72)	0.69 (0.64-0.73)
Decreased eGFR					
Low CVH	1478	80 (5.41)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	9368	338 (3.61)	0.68 (0.50-0.91)	0.62 (0.45-0.84)	0.60 (0.44-0.82)
High CVH	1418	6 (0.42)	0.06 (0.02-0.16)	0.13 (0.05-0.36)	0.14 (0.05-0.38)
Per 10-point higher CVH score			0.68 (0.64-0.73)	0.72 (0.65-0.79)	0.71 (0.64-0.79)
Albuminuria					
Low CVH	1478	246 (16.64)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	9368	728 (7.77)	0.39 (0.32-0.46)	0.35 (0.29-0.42)	0.36 (0.30-0.44)
High CVH	1418	41 (2.89)	0.16 (0.11-0.24)	0.21 (0.15-0.32)	0.24 (0.16-0.35)
Per 10-point higher CVH score			0.65 (0.62-0.70)	0.66 (0.61-0.71)	0.67 (0.62-0.72)

Model 1: Unadjusted model
Model 2: Adjusted for age, sex
Model 3: Adjusted for model 2 + residential area, household income, educational attainment, and drinking

Low CVH was defined as a LE8 score of 0–<50, moderate CVH of 50–<80, and high CVH of 80–100.
CVH, cardiovascular health; eGFR, estimated glomerular filtration rate.

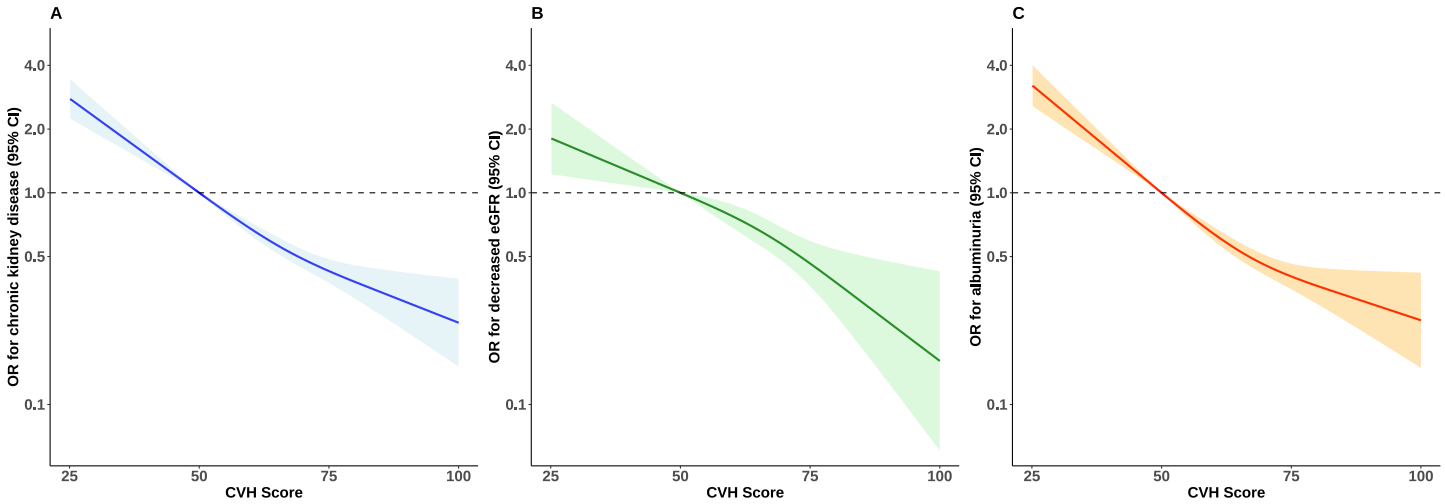

Figure 2. Association of the Life's Essential 8 cardiovascular health score with chronic kidney disease, decreased eGFR, and albuminuria by restricted cubic spline functions

Multivariable model was adjusted for age, sex, residential area, household income, educational attainment, and drinking

eGFR, estimated glomerular filtration rate.

3. LE8 CVH health behavior score and CKD

Table 3 shows Life's Essential 8 cardiovascular health behavior score with CKD, decreased eGFR, and albuminuria. A moderate CVH score has an OR of 0.82 (95% CI: 0.71-0.96) with CKD compared to the low reference. In the case of decreased eGFR, both high CVH score and moderate CVH score were observed and OR of 0.39, and 0.73, respectively, indicating an association. Looking at moderate CVH score in association with albuminuria, OR compared to the low reference was 0.82 (95% CI, 0.69-0.97). Lastly, a per 10-point higher CVH score was associated with CKD, decreased eGFR, and albuminuria, with ORs of 0.93, 0.88, and 0.93, respectively, observed in each score.

When graphical examination of the restricted cubic spline model, a linear and dose-dependent association between the LE8 CVH score and CKD (Figure 3). Additionally, similar results were observed for decreased eGFR and albuminuria.

Table 3. Association of the Life's Essential 8 cardiovascular health behavior score with chronic kidney disease, decreased eGFR, and albuminuria

Disease / CVH score	No. of people	No. (%) of people with chronic kidney disease	OR (95% CI)		
			Model 1	Model 2	Model 3
Chronic kidney disease					
Low CVH	3595	420 (11.68)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	7231	756 (10.45)	0.88 (0.76-1.02)	0.78 (0.67-0.91)	0.82 (0.71-0.96)
High CVH	1438	109 (7.58)	0.70 (0.56-0.88)	0.71 (0.56-0.90)	0.80 (0.64-1.02)
Per 10-point higher CVH score			0.94 (0.91-0.97)	0.91 (0.87-0.95)	0.93 (0.89-0.97)
Decreased eGFR					
Low CVH	3595	152 (4.23)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	7231	249 (3.44)	0.85 (0.68-1.08)	0.75 (0.59-0.95)	0.73 (0.57-0.93)
High CVH	1438	23 (1.60)	0.33 (0.20-0.55)	0.37 (0.21-0.63)	0.39 (0.23-0.67)
Per 10-point higher CVH score			0.92 (0.87-0.97)	0.88 (0.82-0.94)	0.88 (0.82-0.95)
Albuminuria					
Low CVH	3595	331 (9.21)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	7231	590 (8.16)	0.86 (0.73-1.01)	0.78 (0.65-0.92)	0.82 (0.69-0.97)
High CVH	1438	94 (6.54)	0.77 (0.60-0.99)	0.76 (0.59-0.98)	0.87 (0.67-1.11)
Per 10-point higher CVH score			0.94 (0.90-0.98)	0.91 (0.87-0.95)	0.93 (0.89-0.98)

Model 1: Unadjusted model
Model 2: Adjusted for age, sex
Model 3: Adjusted for model 2 + residential area, household income, educational attainment, and drinking

Low CVH was defined as a LE8 score of 0–<50, moderate CVH of 50–<80, and high CVH of 80–100.
CVH, cardiovascular health; eGFR, estimated glomerular filtration rate.

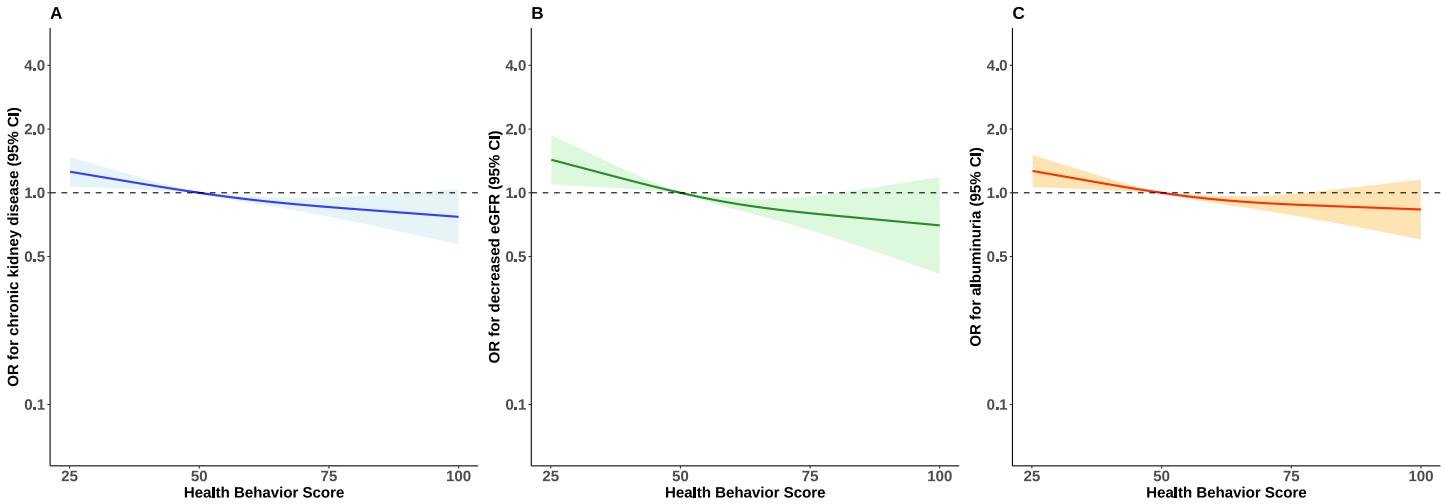

Figure 3. Association of the Life's Essential 8 cardiovascular health behavior score with chronic kidney disease, decreased eGFR, and albuminuria by restricted cubic spline functions

Multivariable model was adjusted for age, sex, residential area, household income, educational attainment, and drinking

eGFR, estimated glomerular filtration rate.

4. LE8 CVH health factor score and CKD

Table 4 presents the association of Life's Essential 8 cardiovascular health factor score and CKD, decreased eGFR, and albuminuria. For CKD, the odds ratio for a moderate health factor score compared to the low reference was 0.37 (95% CI: 0.30-0.46), and for a high score, it was 0.22 (95% CI: 0.17-0.28). In decreased eGFR, the odds ratio for a high CVH score compared to the low reference was observed as 0.35. Regarding the association between health factor score and albuminuria, both moderate (OR: 0.33, 95% CI: 0.27-0.40) and high scores (OR: 0.20, 95% CI: 0.15-0.26) showed significant associations with albuminuria compared to the low reference. Furthermore, associations were observed for CKD, decreased eGFR, and albuminuria with a per 10-point higher CVH score.

In Figure 4, restricted cubic spline models showed the association of continuous CVH health factor scores CKD, decreased eGFR, and albuminuria. Graphical observation of the restricted cubic spline model revealed a linear and dose-dependent association between LE8 CVH score and CKD, with similar trend found for decreased eGFR and albuminuria.

Table 4. Association of the Life's Essential 8 cardiovascular health factor score with chronic kidney disease, decreased eGFR, and albuminuria

Disease / CVH score	No. of people	No. (%) of people with chronic kidney disease	OR (95% CI)		
			Model 1	Model 2	Model 3
Chronic kidney disease					
Low CVH	1250	287 (22.96)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	7069	836 (11.83)	0.41 (0.34-0.50)	0.36 (0.29-0.44)	0.37 (0.30-0.46)
High CVH	3945	162 (4.11)	0.14 (0.11-0.17)	0.21 (0.16-0.27)	0.22 (0.17-0.28)
Per 10-point higher CVH score			0.67 (0.64-0.70)	0.71 (0.68-0.75)	0.72 (0.68-0.75)
Decreased eGFR					
Low CVH	1250	62 (4.96)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	7069	321 (4.54)	0.90 (0.65-1.25)	0.77 (0.55-1.09)	0.79 (0.57-1.10)
High CVH	3945	41 (1.04)	0.16 (0.10-0.26)	0.35 (0.22-0.57)	0.35 (0.22-0.57)
Per 10-point higher CVH score			0.71 (0.68-0.75)	0.80 (0.74-0.87)	0.80 (0.74-0.87)
Albuminuria					
Low CVH	1250	255 (20.40)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	7069	628 (8.88)	0.34 (0.28-0.42)	0.32 (0.26-0.39)	0.33 (0.27-0.40)
High CVH	3945	132 (3.35)	0.13 (0.10-0.17)	0.19 (0.15-0.25)	0.20 (0.15-0.26)
Per 10-point higher CVH score			0.66 (0.63-0.70)	0.69 (0.65-0.73)	0.70 (0.66-0.74)

Model 1: Unadjusted model
Model 2: Adjusted for age, sex
Model 3: Adjusted for model 2 + residential area, household income, educational attainment, and drinking

Low CVH was defined as a LE8 score of 0–<50, moderate CVH of 50–<80, and high CVH of 80–100.
CVH, cardiovascular health; eGFR, estimated glomerular filtration rate.

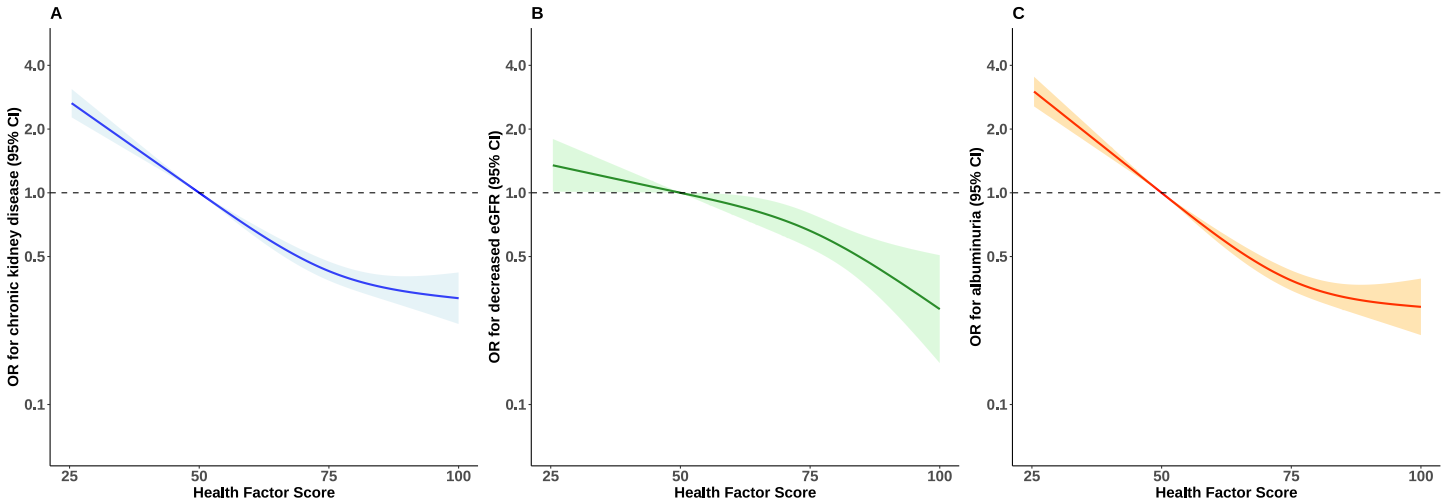

Figure 4. Association of the Life's Essential 8 cardiovascular health factor score with chronic kidney disease, decreased eGFR, and albuminuria by restricted cubic spline functions

Multivariable model was adjusted for age, sex, residential area, household income, educational attainment, and drinking

eGFR, estimated glomerular filtration rate.

5. Cardiovascular health component and CKD, decreased eGFR, albuminuria

Table 5 shows the associations of individual cardiovascular health component scores with CKD, decreased eGFR, and albuminuria. Each component was assessed with a per 10-point higher CVH score. In the association between each of the eight components and CKD, five components: physical activity, sleep health, body mass index, blood glucose, and blood pressure, showed significant associations. In decreased eGFR, associations were observed with physical activity, blood glucose, and blood pressure. Moreover, for albuminuria, associations were shown with physical activity, sleep health, body mass index, blood glucose, and blood pressure. The consistently identified components were physical activity, blood glucose, and blood pressure.

Table 5. Association of individual cardiovascular health component score with chronic kidney disease, decreased eGFR, and albuminuria

Component	OR (95% CI)		
	Chronic kidney disease	Decreased eGFR	Albuminuria
Diet	1.01 (0.98-1.04)	0.96 (0.92-1.00)	1.02 (0.99-1.05)
Physical activity	0.97 (0.95-0.99)	0.95 (0.91-0.98)	0.98 (0.96-0.99)
Nicotine exposure	0.98 (0.96-1.00)	0.97 (0.93-1.01)	0.98 (0.95-1.00)
Sleep health	0.96 (0.94-0.99)	0.98 (0.95-1.02)	0.96 (0.93-0.99)
Body mass index	0.92 (0.89-0.94)	0.97 (0.92-1.01)	0.91 (0.88-0.94)
Blood lipids	1.01 (0.99-1.04)	1.03 (0.98-1.07)	1.01 (0.98-1.04)
Blood glucose	0.81 (0.78-0.84)	0.93 (0.88-0.99)	0.79 (0.76-0.83)
Blood pressure	0.83 (0.80-0.85)	0.85 (0.81-0.89)	0.81 (0.79-0.83)

Adjusted for age, sex, residential area, household income, educational attainment, and drinking
Each component was applied with an increase of 10 points.

eGFR, estimated glomerular filtration rate.

6. Sex-stratified CVH and CKD

A sex-stratified analysis is presented in Table 6. Among men, the odds ratios (OR) for CKD were 0.38 (95% CI: 0.30-0.48) for CVH moderate score, 0.22 (95% CI: 0.12-0.40) for CVH high, and 0.64 (95% CI: 0.59-0.71) for per 10 point higher CVH score. Similarly, in women, the OR for CKD was 0.44 (95% CI: 0.32-0.60) for CVH moderate, 0.23 (95% CI: 0.13-0.40) for CVH high, and 0.69 (95% CI: 0.63-0.76) per 10 point higher CVH score. In women, all findings only showed a significant association with decreased eGFR. Lastly, the association between CVH score and albuminuria. For men, the ORs were 0.33 (95% CI: 0.26-0.42) for CVH moderate, 0.24 (95% CI: 0.13-0.45) for CVH high, and 0.63 (95% CI: 0.57-0.70) per 10-point higher CVH score. Similarly, in women, the ORs were 0.41 (95% CI: 0.30-0.57) for CVH moderate, 0.22 (95% CI: 0.13-0.39) for CVH high, and 0.69 (95% CI: 0.62-0.76) for per 10-point higher CVH score.

Table 6. Association of the Life's Essential 8 cardiovascular health score with chronic kidney disease, decreased eGFR, and albuminuria by sex

Disease /	Men (N=5,353)			Women (N=6,911)		
CVH score	N	CKD (%)	OR (95% CI)	N	CKD (%)	OR (95% CI)
Chronic kidney disease						
Low CVH	1016	184 (18.11)	1.00 (Reference)	462	103 (22.29)	1.00 (Reference)
Moderate CVH	3973	417 (10.50)	0.38 (0.30-0.48)	5395	536 (9.94)	0.44 (0.32-0.60)
High CVH	364	16 (4.40)	0.22 (0.12-0.40)	1054	29 (2.75)	0.23 (0.13-0.40)
Per 10-point higher CVH score			0.64 (0.59-0.71)			0.69 (0.63-0.76)
Decreased eGFR						
Low CVH	1016	49 (4.82)	1.00 (Reference)	462	31 (6.71)	1.00 (Reference)
Moderate CVH	3973	186 (4.68)	0.74 (0.50-1.10)	5395	152 (2.82)	0.44 (0.26-0.72)
High CVH	364	4 (1.10)	0.18 (0.05-0.63)	1054	2 (0.19)	0.09 (0.02-0.51)
Per 10-point higher CVH score			0.74 (0.66-0.84)			0.67 (0.55-0.82)
Albuminuria						
Low CVH	1016	158 (15.55)	1.00 (Reference)	462	88 (19.05)	1.00 (Reference)
Moderate CVH	3973	296 (7.45)	0.33 (0.26-0.42)	5395	432 (8.01)	0.41 (0.30-0.57)
High CVH	364	14 (3.85)	0.24 (0.13-0.45)	1054	27 (2.56)	0.22 (0.13-0.39)
Per 10-point higher CVH score			0.63 (0.57-0.70)			0.69 (0.62-0.76)

Adjusted for age, residential area, household income, educational attainment, and drinking

Low CVH was defined as a LE8 score of 0–<50, moderate CVH of 50–<80, and high CVH of 80–100.
CVH, cardiovascular health; eGFR, estimated glomerular filtration rate.

7. Subgroup analyses

Subgroup analyses explored associations with CKD by stratifying age and examining factors such as on residential area, household income, educational attainment, and drinking. In the 20-49 age group, the OR for CKD was 0.30 (95% CI: 0.20-0.45) for moderate CVH score and 0.20 (95% CI: 0.11-0.36) for high CVH score compared to the low reference. For those aged 50 and older, the OR for CKD was 0.49 (95% CI: 0.40-0.60) for moderate CVH score and 0.22 (95% CI: 0.13-0.37) for high CVH score compared to the low reference. Also, for a per 10-point higher CVH score, the OR was shown as 0.66 (95% CI: 0.58-0.76) in the 20–49 age group and 0.70 (95% CI: 0.65-0.74) in the over 50 age group compared to the low reference. Associations were identified in both urban and rural residential areas. Regarding income, associations were discovered in both groups, with a lower OR noted in the low-middle income category. Similar results were observed in educational attainment. Lastly, associations were found across all groups in drinking. A consistent pattern was observed across all subgroups, showing a decreasing trend in ORs from moderate CVH score to high CVH score, and all results were statistically significant.

Table 7. Association of the Life's Essential 8 cardiovascular health score with chronic disease across subgroups

CVH score	Subgroup			Subgroup		
	N	CKD (%)	OR (95% CI)	N	CKD (%)	OR (95% CI)
	Aged 20–49			Aged 50+		
Low CVH	576	54 (9.38)	1.00 (Reference)	902	233 (25.83)	1.00 (Reference)
Moderate CVH	3663	131 (3.58)	0.30 (0.20-0.45)	5705	822 (14.41)	0.49 (0.40-0.60)
High CVH	944	20 (2.12)	0.20 (0.11-0.36)	474	25 (5.27)	0.22 (0.13-0.37)
Per 10-point higher CVH score			0.66 (0.58-0.76)			0.70 (0.65-0.74)
	Urban			Rural		
Low CVH	1148	214 (18.64)	1.00 (Reference)	330	73 (22.12)	1.00 (Reference)
Moderate CVH	7408	683 (9.22)	0.37 (0.30-0.45)	1960	270 (13.78)	0.59 (0.39-0.89)
High CVH	1219	36 (2.95)	0.23 (0.15-0.36)	199	9 (4.52)	0.29 (0.14-0.64)
Per 10-point higher CVH score			0.68 (0.63-0.73)			0.70 (0.63-0.78)
	Low-middle income			High income		
Low CVH	1137	249 (21.90)	1.00 (Reference)	341	38 (11.14)	1.00 (Reference)
Moderate CVH	6636	788 (11.87)	0.38 (0.31-0.47)	2732	165 (6.04)	0.53 (0.34-0.82)
High CVH	807	28 (3.47)	0.22 (0.14-0.35)	611	17 (2.78)	0.32 (0.16-0.61)
Per 10-point higher CVH score			0.66 (0.61-0.71)			0.75 (0.65-0.87)
	Low Education			High education		
Low CVH	1015	230 (22.66)	1.00 (Reference)	463	57 (12.31)	1.00 (Reference)
Moderate CVH	5887	776 (13.18)	0.45 (0.37-0.55)	3481	177 (5.08)	0.30 (0.21-0.43)
High CVH	587	28 (4.77)	0.29 (0.18-0.46)	831	17 (2.05)	0.17 (0.09-0.32)
Per 10-point higher CVH score			0.70 (0.65-0.76)			0.65 (0.57-0.73)
	Non-Drinking			Drinking		
Low CVH	317	77 (24.29)	1.00 (Reference)	1161	210 (18.09)	1.00 (Reference)
Moderate CVH	3040	448 (14.74)	0.53 (0.37-0.76)	6328	505 (7.98)	0.37 (0.30-0.46)
High CVH	338	18 (5.33)	0.39 (0.20-0.76)	1080	27 (2.50)	0.20 (0.13-0.32)
Per 10-point higher CVH score			0.74 (0.66-0.82)			0.66 (0.61-0.72)

Adjusted for age, sex, residential area, household income, educational attainment, and drinking

Low CVH was defined as a LE8 score of 0–<50, moderate CVH of 50–<80, and high CVH of 80–100.

8. Sensitivity analyses

The sensitivity analyses were performed to the robustness of the finding. First, Table 8 shows the unweighted association of the LE8 CVH score with CKD, decreased eGFR, and albuminuria. When the CVH score was classified as moderate, the OR for CKD was 0.44 (95% CI: 0.38-0.52), and for those with a high CVH score, the OR for CKD was 0.23 (95% CI: 0.16-0.32). In the decreased eGFR group, the OR for CKD was 0.60 (95% CI: 0.45-0.79) for moderate CVH score and 0.17 (95% CI: 0.07-0.41) for high CVH score. For albuminuria, the OR for CKD was 0.41 (95% CI: 0.35-0.48) for moderate CVH score and 0.23 (95% CI: 0.16-0.32). Additionally, a per 10-point higher CVH score also showed significant associations with all results. Furthermore, as the CVH score increased from moderate to high, there was a trend of decreasing ORs for all results.

Second, the Sensitivity analysis was conducted based on LE8 CVH scores categorized by quintiles. The characteristics of the quintile for the LE8 CVH score are provided in Appendix Table 4. Table 9 shows the association of the LE8 CVH score categorized by quintiles with CKD, decreased eGFR, and albuminuria. Using CVH Q1 (<54) as a reference, the ORs for CKD displayed a decreasing trend from CVH Q2 (OR: 0.56, 95% CI 0.46-0.68) to CVH Q5 (OR: 0.31, 95% CI 0.23-0.41). The ORs for decreased eGFR exhibited a decline from CVH Q2 (OR: 0.69, 95% CI 0.50-0.95) to CVH Q5 (OR: 0.25, 95% CI 0.13-0.48), while using

CVH Q1 (0−<54) as the reference, the ORs for albuminuria show a decreasing trend from CVH Q2, at 0.50 (95% CI: 0.41-0.61), to CVH Q5, at 0.29 (95% CI: 0.21-0.40). Similarly, a decrease in OR values was observed as the CVH score increased for all results.

Third, to assess reverse causation, we conducted sensitivity analyses based on CKD stages. In Appendix Table 5, individuals with high CVH showed decreased odds ratios compared to those with low CVH in eGFR categories. The Appendix Table 6 demonstrated that individuals with high CVH scores had significantly lower odds ratios for albuminuria categories compared to the reference group of low CVH. Therefore, when examined based on CKD stages, the results consistently confirmed an inverse association with CKD, indicating that higher CVH scores were associated with lower risks of CKD.

Finally, looking at the association between each nutrient and CKD, decreased eGFR, and albuminuria in Appendix Table 7. Protein and sodium exhibited inverse associations with odds ratios of 0.88 and 0.94, respectively, while other nutrient were observed for their associations with CKD.

Table 8. Unweighted association of the Life's Essential 8 cardiovascular health score with chronic kidney disease, decreased eGFR, and albuminuria

Disease / CVH score	No. of people	No. (%) of people with chronic kidney disease	OR (95% CI)		
			Model 1	Model 2	Model 3
Chronic kidney disease					
Low CVH	1478	287 (19.42)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	9368	953 (10.17)	0.47 (0.41-0.54)	0.43 (0.37-0.50)	0.44 (0.38-0.52)
High CVH	1418	45 (3.17)	0.14 (0.10-0.19)	0.21 (0.15-0.29)	0.23 (0.16-0.32)
Per 10-point higher CVH score			0.65 (0.63-0.68)	0.67 (0.64-0.71)	0.68 (0.65-0.72)
Decreased eGFR					
Low CVH	1478	80 (5.41)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	9368	338 (3.61)	0.65 (0.51-0.84)	0.62 (0.47-0.81)	0.60 (0.45-0.79)
High CVH	1418	6 (0.42)	0.07 (0.03-0.17)	0.17 (0.07-0.39)	0.17 (0.07-0.41)
Per 10-point higher CVH score			0.69 (0.65-0.73)	0.74 (0.68-0.81)	0.73 (0.67-0.81)
Albuminuria					
Low CVH	1478	246 (16.64)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	9368	728 (7.77)	0.42 (0.36-0.49)	0.40 (0.34-0.47)	0.41 (0.35-0.48)
High CVH	1418	41 (2.89)	0.15 (0.11-0.21)	0.21 (0.15-0.29)	0.23 (0.16-0.32)
Per 10-point higher CVH score			0.65 (0.61-0.68)	0.66 (0.62-0.70)	0.67 (0.63-0.71)

Model 1: Unadjusted model
Model 2: Adjusted for age, sex
Model 3: Adjusted for model 2 + residential area, household income, educational attainment, and drinking

Low CVH was defined as a LE8 score of 0–<50, moderate CVH of 50–<80, and high CVH of 80–100.
CVH, cardiovascular health; eGFR, estimated glomerular filtration rate.

Table 9. Association of the Life's Essential 8 cardiovascular health score categorized by quintiles with chronic kidney disease, decreased eGFR, and albuminuria

Disease / CVH score	No. of people	No. (%) of people with chronic kidney disease	OR (95% CI)		
			Model 1	Model 2	Model 3
Chronic kidney disease					
CVH Q1 (lowest)	2490	442 (17.75)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
CVH Q2	2739	362 (13.22)	0.66 (0.55-0.79)	0.55 (0.45-0.66)	0.56 (0.46-0.68)
CVH Q3	2135	205 (9.60)	0.46 (0.37-0.57)	0.42 (0.34-0.52)	0.44 (0.35-0.55)
CVH Q4	2643	188 (7.11)	0.34 (0.27-0.42)	0.36 (0.29-0.45)	0.38 (0.30-0.47)
CVH Q5 (highest)	2257	88 (3.90)	0.20 (0.16-0.27)	0.29 (0.22-0.38)	0.31 (0.23-0.41)
P for trend			<.0001	<.0001	<.0001
Decreased eGFR					
CVH Q1 (lowest)	2490	135 (5.42)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
CVH Q2	2739	127 (4.64)	0.89 (0.65-1.22)	0.71 (0.51-0.97)	0.69 (0.50-0.95)
CVH Q3	2135	84 (3.93)	0.68 (0.49-0.95)	0.65 (0.46-0.91)	0.64 (0.45-0.91)
CVH Q4	2643	62 (2.35)	0.36 (0.26-0.50)	0.43 (0.31-0.61)	0.42 (0.29-0.59)
CVH Q5 (highest)	2257	16 (0.71)	0.12 (0.06-0.21)	0.24 (0.13-0.46)	0.25 (0.13-0.48)
P for trend			<.0001	<.0001	<.0001
Albuminuria					
CVH Q1 (lowest)	2490	372 (14.94)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
CVH Q2	2739	275 (10.04)	0.57 (0.47-0.69)	0.49 (0.41-0.60)	0.50 (0.41-0.61)
CVH Q3	2135	149 (6.98)	0.40 (0.31-0.51)	0.37 (0.29-0.48)	0.39 (0.30-0.50)
CVH Q4	2643	144 (5.45)	0.32 (0.25-0.41)	0.34 (0.27-0.44)	0.36 (0.28-0.46)
CVH Q5 (highest)	2257	75 (3.32)	0.21 (0.16-0.28)	0.27 (0.20-0.37)	0.29 (0.21-0.40)
P for trend			<.0001	<.0001	<.0001

Model 1: Unadjusted model
Model 2: Adjusted for age, sex
Model 3: Adjusted for model 2 + residential area, household income, educational attainment, and drinking

CVH Q1 was defined as a LE8 score of 0–<54 points, CVH Q2, 54–<62 points, CVH Q3, 62–<68 points CVH Q4, 68–<76 points, and CVH Q5 of 76–100 points.
CVH, cardiovascular health; eGFR, estimated glomerular filtration rate.

IV. DISCUSSION

1. Summary of findings

We investigated the association between CVH scores and the risk of CKD, as well as decreased eGFR and albuminuria. A consistent inverse association was found between CVH scores and CKD risk. Individuals with moderate or high CVH scores exhibited a reduced association with CKD compared to those with low scores. This trend was consistently observed across various demographic subgroups, including age and gender. When stratified by quintiles of CVH scores, a clear pattern emerged showing a decreasing risk of CKD as CVH scores increased. Importantly, the observed associations remained robust across various subgroups, reinforcing the generalizability and validity of our results.

2. Comparison with previous studies

Several studies have supported the finding that higher CVH scores are associated with lower all-cause and CVD-specific mortality rates. Participants with moderate or high scores have significantly reduced mortality risks compared to those with low CVH scores, and another study focusing on middle-aged men without pre-existing CVD also finds that elevated CVH scores correlate with reduced risks of mortality from all causes and CVD.[30,31]

To our knowledge, several studies have assessed the association between CVH metrics and CKD. In CKD research, higher LE8 CVH scores are linked to lower mortality risk from all causes, confirmed by reduced eGFR and albuminuria. Studies on LS7 and CKD indicate that ideal health behavior and factors are associated with lower ESRD and overall mortality rate.[32] Another study using CRIC cohort data in the United States indicates that including healthy lifestyle factors in CKD risk more effectively than based on age, sex, race, and eGFR. Individuals with six or seven ideal health lifestyle factors had a significantly lower risk of developing CKD compared to those with none. These findings highlight the need for preventive and intervention strategies in CKD, especially considering FBG and BP.[33] Similarly, this study focusing on ideal CVH in middle age, based on LS7, assessed its association with the risk of developing CKD and CVD in later middle age. Individuals who had a gradual decrease to substandard CVH levels had a reduced risk of the disease compared to those who had continuously poor CVH levels.[34] In a Chinese study, each 1-unit increase in ideal CVH was associated with an 11% reduction in CKD incidence.

3. Possible mechanisms

The association between blood glucose, blood pressure, and CKD has been established through previous studies.[35-42] When examining each component individually, previous studies have shown variations in the prevalence of CKD based on dietary patterns, with reports linking potassium. However, Other research has also found no association between dietary patterns and the onset of CKD or a significant decline in eGFR.[43] Therefore, it becomes that a variety of approaches and research methods are required to fully understand the relationship between diet and CKD.[44] Moreover, some studies indicate that all forms of physical activity, regardless of age or non-occupational engagement, are associated with a reduced risk of CKD. These findings underscore the vital role of physical activity in mitigating CKD risk.[45,46] Extreme nighttime sleep duration and poor sleep quality in middle-aged and older Chinese populations are linked to an increased CKD risk, emphasizing the crucial role of optimal sleep in reducing CKD risk and underscoring the need to consider sleep duration and quality in prevention strategies.[47,48] This study suggests that heavy cigarette smoking increases the risk of CKD overall, particularly for CKD classified as hypertensive nephropathy and diabetic nephropathy.[49] Additionally, the study showed that smoking was associated with a higher risk of incident CKD among healthy middle-aged adults.[50] In a cohort study involving the Taiwanese population,

obesity was identified as an independent risk factor for CKD.[51] Additionally, the study indicated that metabolically unhealthy obese individuals were at the highest risk of incident CKD, demonstrating that a healthy metabolic profile does not protect obese adults from incident CKD. Therefore, it is crucial to consider metabolic health along with obesity in evaluating CKD risk.[52] The findings indicate that dyslipidemias increase the risk of CKD in the middle-aged and elderly Chinese population, with hypercholesterolemia playing an important role in reducing total eGFR. Both low HDL-C and hypercholesterolemia are associated with an increased risk for albuminuria.[53] Additionally, the study demonstrated that certain levels of dyslipidemia were independently associated with renal replacement therapy and rapid kidney progression in CKD stages 3–5. Assessment of the lipid profile may help identify high-risk groups with adverse kidney outcomes.[54] Moreover, the management of low HDL-C levels could potentially benefit in reducing the long-term risk of CKD.[55] Therefore, this study's findings emphasize the connection with physical activity, blood glucose, and blood pressure. It is important to note potential inaccuracies in self-reported data on diet, sleep health, and nicotine exposure. This highlights the necessity of using varied approaches in further research.

4. Strengths and Limitations

This study has some strengths. First, we based our analysis on the KNHANES dataset, an extensive national survey, bolstering the applicability of our findings. Secondly, through this representative survey of the Korean demographic, we identified a link between CVH score and CKD. Several potential limitations to our current findings exist. First, this study utilized a cross-sectional design, precluding us from confirming a definitive causal relationship between CKD and its associated risk factors. Second, our data only examined one's daily food intake from 24-hour dietary recalls, making it challenging to obtain long-term information that accurately reflects an individual's normal consumption. Third, factors like smoking, alcohol consumption, and exercise were estimated based on self-reports, introducing a potential risk of inaccuracies due to recall bias. Fourth, the categorization of CKD was solely based on eGFR calculated by the CKD-EPI equation. While eGFR via the CKD-EPI equation is a commonly accepted tool for kidney function evaluation, it's not an absolute benchmark. Fifth, it's essential to highlight that the gold standard for albuminuria assessment is a 24-hour urine collection, but we depended on single urine samples, which might lead to some inaccuracies. It is necessary to interpret the study considering its limitations.

V. CONCLUSION

In conclusion, this research explored the association between Cardiovascular Health by Life's Essential 8 and the risk of CKD in the Korean population. Overall, a higher CVH score and classification as CVH high were correlated with decreasing the burden of CKD. This implies that managing health behavior and health factors effectively can mitigate the risk of CKD.

REFERENCES

1. Lloyd-Jones DM, Hong Y, Labarthe D, Mozaffarian D, Appel LJ, Van Horn L, et al. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association's strategic Impact Goal through 2020 and beyond. Circulation 2010;121:586-613.
2. Liu M, Kou F, Yang S, Wang S, He Y, Zhang W. Ideal cardiovascular health in the oldest-old and centenarians and its association with disability and health-related quality of life. Frontiers in Cardiovascular Medicine 2021;8:603877.
3. Fang N, Jiang M, Fan Y. Ideal cardiovascular health metrics and risk of cardiovascular disease or mortality: A meta-analysis. Int J Cardiol 2016;214:279-83.
4. Shetty NS, Parcha V, Patel N, Yadav I, Basetty C, Li C, et al. AHA Life's essential 8 and ideal cardiovascular health among young adults. American Journal of Preventive Cardiology 2023;13:100452.
5. Lloyd-Jones DM, Allen NB, Anderson CAM, Black T, Brewer LC, Foraker RE, et al. Life's Essential 8: Updating and Enhancing the American Heart Association's Construct of Cardiovascular Health: A Presidential Advisory From the American Heart Association. Circulation 2022;146:e18-e43.
6. St-Onge MP, Grandner MA, Brown D, Conroy MB, Jean-Louis G, Coons M, et al. Sleep Duration and Quality: Impact on Lifestyle Behaviors and Cardiometabolic Health: A Scientific Statement From the American Heart Association. Circulation 2016;134:e367-e86.
7. Jackson CL, Redline S, Emmons KM. Sleep as a potential fundamental contributor to disparities in cardiovascular health. Annual review of public health 2015;36:417-40.
8. Lloyd-Jones DM, Ning H, Labarthe D, Brewer L, Sharma G, Rosamond W, et al. 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. Circulation 2022;146:822-35.

9. Global, regional, and national burden of chronic kidney disease, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet 2020;395:709-33.
10. Sarnak MJ, Levey AS, Schoolwerth AC, Coresh J, Culleton B, Hamm LL, et al. Kidney disease as a risk factor for development of cardiovascular disease: a statement from the American Heart Association Councils on Kidney in Cardiovascular Disease, High Blood Pressure Research, Clinical Cardiology, and Epidemiology and Prevention. Circulation 2003;108:2154-69.
11. Couser WG, Remuzzi G, Mendis S, Tonelli M. The contribution of chronic kidney disease to the global burden of major noncommunicable diseases. Kidney Int 2011;80:1258-70.
12. Matsushita K, Coresh J, Sang Y, Chalmers J, Fox C, Guallar E, et al. Estimated glomerular filtration rate and albuminuria for prediction of cardiovascular outcomes: a collaborative meta-analysis of individual participant data. Lancet Diabetes Endocrinol 2015;3:514-25.
13. Consortium CKDP. Association of estimated glomerular filtration rate and albuminuria with all-cause and cardiovascular mortality in general population cohorts: a collaborative meta-analysis. The Lancet 2010;375:2073-81.
14. Thompson S, James M, Wiebe N, Hemmelgarn B, Manns B, Klarenbach S, et al. Cause of Death in Patients with Reduced Kidney Function. J Am Soc Nephrol 2015;26:2504-11.
15. Ruilope Urioste LM, Ruiz Hurtado G, Miranda B, Ortiz Arduan A. Use of chronic kidney disease blind spot to prevent cardiorenal outcomes. 2022.

16. Kweon S, Kim Y, Jang MJ, Kim Y, Kim K, Choi S, et al. Data resource profile: the Korea National Health and Nutrition Examination Survey (KNHANES). Int J Epidemiol 2014;43:69-77.
17. Kim Y. The Korea National Health and Nutrition Examination Survey (KNHANES): current status and challenges. Epidemiol Health 2014;36:e2014002.
18. Mellen PB, Gao SK, Vitolins MZ, Goff DC, Jr. Deteriorating dietary habits among adults with hypertension: DASH dietary accordance, NHANES 1988-1994 and 1999-2004. Arch Intern Med 2008;168:308-14.
19. Bull FC, Maslin TS, Armstrong T. Global physical activity questionnaire (GPAQ): nine country reliability and validity study. J Phys Act Health 2009;6:790-804.
20. Chun MY. Validity and reliability of korean version of international physical activity questionnaire short form in the elderly. Korean J Fam Med 2012;33:144-51.
21. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004;363:157-63.
22. Yang YS, Han BD, Han K, Jung JH, Son JW. Obesity Fact Sheet in Korea, 2021: Trends in Obesity Prevalence and Obesity-Related Comorbidity Incidence Stratified by Age from 2009 to 2019. J Obes Metab Syndr 2022;31:169-77.
23. Hur KY, Moon MK, Park JS, Kim SK, Lee SH, Yun JS, et al. 2021 Clinical Practice Guidelines for Diabetes Mellitus of the Korean Diabetes Association. Diabetes Metab J 2021;45:461-81.
24. Cardiology ACo, Cardiology ACo, Association AH. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults a report of the American College of Cardiology/American Heart Association Task Force on Clinical practice guidelines. Hypertension 2018;71:E13-E115.

25. Choi S, Kim Y-M, Shin J, Lim Y-H, Choi S-Y, Choi B-Y, et al. Comparison of the accuracy and errors of blood pressure measured by 2 types of non-mercury sphygmomanometers in an epidemiological survey. Medicine 2018;97.
26. Murton M, Goff-Leggett D, Bobrowska A, Garcia Sanchez JJ, James G, Wittbrodt E, et al. Burden of Chronic Kidney Disease by KDIGO Categories of Glomerular Filtration Rate and Albuminuria: A Systematic Review. Adv Ther 2021;38:180-200.
27. Levin A, Stevens PE. Summary of KDIGO 2012 CKD Guideline: behind the scenes, need for guidance, and a framework for moving forward. Kidney Int 2014;85:49-61.
28. Stevens PE, Levin A, Members* KDIGOCKDGDWG. Evaluation and management of chronic kidney disease: synopsis of the kidney disease: improving global outcomes 2012 clinical practice guideline. Annals of internal medicine 2013;158:825-30.
29. Levey AS, Stevens LA, Schmid CH, Zhang YL, Castro AF, 3rd, Feldman HI, et al. A new equation to estimate glomerular filtration rate. Ann Intern Med 2009;150:604-12.
30. Sun J, Li Y, Zhao M, Yu X, Zhang C, Magnussen CG, et al. Association of the American Heart Association's new "Life's Essential 8" with all-cause and cardiovascular disease-specific mortality: prospective cohort study. BMC Med 2023;21:116.
31. Isiozor NM, Kunutsor SK, Voutilainen A, Laukkanen JA. Life's Essential 8 and the risk of cardiovascular disease death and all-cause mortality in Finnish men. European Journal of Preventive Cardiology 2023;30:658-67.
32. Muntner P, Judd SE, Gao L, Gutiérrez OM, Rizk DV, McClellan W, et al. Cardiovascular risk factors in CKD associate with both ESRD and mortality. Journal of the American Society of Nephrology: JASN 2013;24:1159.

33. Ricardo AC, Anderson CA, Yang W, Zhang X, Fischer MJ, Dember LM, et al. Healthy lifestyle and risk of kidney disease progression, atherosclerotic events, and death in CKD: findings from the Chronic Renal Insufficiency Cohort (CRIC) Study. Am J Kidney Dis 2015;65:412-24.
34. Cho SMJ, Jeon JY, Yoo T-H, Lee H-Y, Lee Y-h, Kim HC. Ideal cardiovascular health duration and risk of chronic kidney disease and cardiovascular disease. Heart 2022;108:523-8.
35. Greene E, Kren S, Hostetter T. Role of aldosterone in the remnant kidney model in the rat. The Journal of clinical investigation 1996;98:1063-8.
36. Koomans H, Roos J, Boer P, Geyskes G, Mees E. Salt sensitivity of blood pressure in chronic renal failure. Evidence for renal control of body fluid distribution in man. Hypertension 1982;4:190-7.
37. Vlachopoulos C, Aznaouridis K, Stefanadis C. Prediction of cardiovascular events and all-cause mortality with arterial stiffness: a systematic review and meta-analysis. Journal of the American College of Cardiology 2010;55:1318-27.
38. Kim ED, Tanaka H, Ballew SH, Sang Y, Heiss G, Coresh J, et al. Associations between kidney disease measures and regional pulse wave velocity in a large community-based cohort: the Atherosclerosis Risk in Communities (ARIC) study. American Journal of Kidney Diseases 2018;72:682-90.
39. Lin Y-P. Albuminuria in hypertension. Hypertension Research 2013;36:762-4.
40. Kang SH, Jung DJ, Choi EW, Cho KH, Park JW, Do JY. HbA1c levels are associated with chronic kidney disease in a non-diabetic adult population: a Nationwide survey (KNHANES 2011–2013). PLoS One 2015;10:e0145827.
41. Toyoda M, Najafian B, Kim Y, Caramori ML, Mauer M. Podocyte detachment and reduced glomerular capillary endothelial fenestration in human type 1 diabetic nephropathy. Diabetes 2007;56:2155-60.
42. Weil EJ, Lemley KV, Mason CC, Yee B, Jones LI, Blouch K, et al. Podocyte detachment and reduced glomerular capillary endothelial fenestration promote

kidney disease in type 2 diabetic nephropathy. Kidney international 2012;82:1010-7.

43. Crews DC, Kuczmarski MF, Miller III ER, Zonderman AB, Evans MK, Powe NR. Dietary habits, poverty, and chronic kidney disease in an urban population. Journal of Renal Nutrition 2015;25:103-10.
44. Hao Q, Xie M, Zhu L, Dou Y, Dai M, Wu Y, et al. Association of sleep duration with chronic kidney disease and proteinuria in adults: a systematic review and dose-response meta-analysis. Int Urol Nephrol 2020;52:1305-20.
45. Shi K, Zhu Y, Lv J, Sun D, Pei P, Du H, et al. Association of physical activity with risk of chronic kidney disease in China: A population-based cohort study. Journal of Sport and Health Science 2023.
46. Parvathaneni K, Surapaneni A, Ballew SH, Palta P, Rebholz CM, Selvin E, et al. Association between midlife physical activity and incident kidney disease: the Atherosclerosis Risk in Communities (ARIC) study. American Journal of Kidney Diseases 2021;77:74-81.
47. Sun H, Qin K, Zou C, Wang HH, Lu C, Chen W, et al. The association of nighttime sleep duration and quality with chronic kidney disease in middle-aged and older Chinese: A cohort study. Sleep Medicine 2021;86:25-31.
48. Bo Y, Yeoh E-k, Guo C, Zhang Z, Tam T, Chan T-C, et al. Sleep and the risk of chronic kidney disease: a cohort study. Journal of Clinical Sleep Medicine 2019;15:393-400.
49. Yacoub R, Habib H, Lahdo A, Al Ali R, Varjabedian L, Atalla G, et al. Association between smoking and chronic kidney disease: a case control study. BMC public health 2010;10:1-6.
50. Jo W, Lee S, Joo YS, Nam KH, Yun H-R, Chang TI, et al. Association of smoking with incident CKD risk in the general population: A community-based cohort study. PloS one 2020;15:e0238111.

51. Lai Y-J, Hu H-Y, Lee Y-L, Ku P-W, Yen Y-F, Chu D. Association between obesity and risk of chronic kidney disease: A nationwide Cohort study in Taiwan. Nutrition, Metabolism and Cardiovascular Diseases 2017;27:1008-14.
52. Jung CH, Lee MJ, Kang YM, Hwang JY, Kim EH, Park J-Y, et al. The risk of chronic kidney disease in a metabolically healthy obese population. Kidney international 2015;88:843-50.
53. Liu D-w, Jia W, Liu Z-s, Pei W, Cheng G-Y, Shi X-Z. Association between dyslipidemia and chronic kidney disease: a cross-sectional study in the middle-aged and elderly Chinese population. Chinese medical journal 2013;126:1207-12.
54. Chen S-C, Hung C-C, Kuo M-C, Lee J-J, Chiu Y-W, Chang J-M, et al. Association of dyslipidemia with renal outcomes in chronic kidney disease. PLoS One 2013;8:e55643.
55. Wang Y, Zhang L, Zhang W, Tang M, Cui H, Wu X, et al. Understanding the relationship between circulating lipids and risk of chronic kidney disease: a prospective cohort study and large-scale genetic analyses. Journal of Translational Medicine 2023;21:671.

Appendix Table 1. Scoring criteria for the American Heart Association's Life's Essential 8 cardiovascular health metrics

Domain	CVH Metric	Measurement	Quantification and Scoring of CVH Metric
Health Behaviors	Diet	DASH diet score percentile[18]	Quantiles of DASH-style diet adherence **Scoring (Population):** Points Quantile 100 ≥95th percentile (top/ideal diet) 80 75th – 94th percentile 50 50th – 74th percentile 25 25th – 49th percentile 0 1st – 24th percentile (bottom/least ideal quartile)
	Physical activity	Self-reported minutes of moderate or vigorous physical activity per week	**Metric:** Minutes of moderate (or greater) intensity activity per week **Scoring:** Points Minutes 100 ≥150 90 120 – 149 80 90 – 119 60 60 – 89 40 30 – 59 20 1 – 29 0 0
	Nicotine exposure	Self-reported use of cigarettes or inhaled nicotine-delivery system	**Metric:** Combustible tobacco use and/or inhaled NDS use; or secondhand smoke exposure **Scoring:** Points Status 100 Never smoker 75 Former smoker, quit ≥5 yrs 50 Former smoker, quit 1 - <5 yrs 25 Former smoker, quit <1 year, or currently using inhaled NDS 0 Current smoker Subtract 20 points (unless score is 0) for living with active indoor smoker in home

	Sleep health	Self-reported average hours of sleep per night	**Metric:** Average hours of sleep per night **Scoring:** Points Level 100 7– <9 90 9 – <10 70 6 – <7 40 5 – <6 or ≥10 20 4 – <5 0 <4
Health Factors	Body mass index	Body weight (kg) divided by height squared (m^2)	**Metric:** Body mass index (kg/m^2) **Scoring:** Points Level 100 <23.0 70 23.0 – 24.9 30 25.0 – 29.9 15 30.0 – 34.9 0 ≥35.0
	Blood lipids	Plasma total and HDL-cholesterol with calculation of non-HDL cholesterol	**Metric:** Non-HDL-cholesterol (mg/dL) **Scoring:** Points Level 100 <130 60 130 – 159 40 160 – 189 20 190 – 219 0 ≥220 If drug-treated level, subtract 20 points

	Blood glucose	Fasting blood glucose or casual hemoglobin A1c	**Metric:** Fasting blood glucose (mg/dL) or Hemoglobin A1c (%) **Scoring:** Points Level 100 No history of diabetes and FBG <100 (or HbA1c < 5.7) 60 No diabetes and FBG 100 – 125 (or HbA1c 5.7-6.4) (Pre-diabetes) 40 Diabetes with HbA1c <7.0 30 Diabetes with HbA1c 7.0 – 7.9 20 Diabetes with HbA1c 8.0 – 8.9 10 Diabetes with Hb A1c 9.0 – 9.9 0 Diabetes with HbA1c ≥10.0
	Blood pressure	Appropriately measured systolic and diastolic blood pressure	**Metric:** Systolic and diastolic blood pressure (mm Hg) **Scoring:** Points Level 100 <120/<80 (Optimal) 75 120-129/<80 (Elevated) 50 130-139 or 80-89 (Stage I HTN) 25 140-159 or 90-99 0 ≥160 or ≥100 Subtract 20 points if treated level

Appendix Table 2. Nutrient components and criteria for calculating the DASH diet score in the reference population

Component	Quintile cutoffs				Scoring criteria	
	1st	2nd	3rd	4th		
Protein (%)	11.55	13.48	15.33	17.99		
Fiber (g)	9.12	11.96	14.94	18.69	Points	Quantile
Calcium (mg)	141.50	214.48	272.46	360.91	5	Q5 (≥4th cutoff)
Potassium (mg)	1069.22	1304.85	1541.59	1870.78	4	Q4 (3rd – <4th cutoff)
Magnesium (mg)	119.52	146.31	172.07	207.74	3	Q3 (2nd – <3rd cutoff)
					2	Q2 (1st – <2nd cutoff)
					1	Q1 (<1st cutoff)
Total fat (%)	13.94	18.89	23.53	29.68	Points	Quantile
Cholesterol (mg)	52.64	93.81	136.73	197.89	1	Q5 (≥4th cutoff)
Saturated fat (%)	3.83	5.55	7.30	9.82	2	Q4 (3rd – <4th cutoff)
Sodium (mg)	1144.79	1492.96	1821.56	2296.44	3	Q3 (2nd – <3rd cutoff)
					4	Q2 (1st – <2nd cutoff)
					5	Q1 (<1st cutoff)

DASH, dietary approaches to stop hypertension.

Appendix Table 3. The 25th, 50th, 75th and 95th centile of the DASH diet score in the reference population

Centile	Estimate (95% CI)	Cutoff	Scoring criteria	
95th	36.4 (36.2 - 36.6)	37	Points	Quantile
			100	≥95th centile
75th	31.0 (30.8 - 31.2)	32	80	75th – <95th centile
			50	50th – <75th centile
50th	26.4 (26.2 - 26.7)	27	25	25th – <50th centile
25th	21.7 (21.5 - 21.9)	22	0	<25th centile

DASH, Dietary Approaches to Stop Hypertension.

Appendix Table 4. Characteristics of the study population according to the Life's Essential 8 cardiovascular heath scores categorized by quintiles

Variables	Quintile of LE8 CVH score				
	Q1 (N=2,490)	Q2 (N=2,739)	Q3 (N=2,135)	Q4 (N=2,643)	Q5 (N=2,257)
Age, year	51.0 (50.2-51.8)	52.1 (51.2-53.0)	49.5 (48.5-50.4)	46.2 (45.4-47.1)	41.7 (40.9-42.4)
Gender, %					
Men	71.0 (69.0-72.9)	57.9 (55.7-60.1)	47.2 (44.8-49.6)	43.4 (41.2-45.5)	32.5 (30.0-34.9)
Women	29.0 (27.1-31.0)	42.1 (39.8-44.3)	52.8 (50.4-55.2)	56.6 (54.5-58.8)	67.5 (65.1-70.0)
Residential area, %					
Urban	83.6 (80.3-86.9)	82.4 (79.0-85.8)	86.2 (83.4-89.1)	86.5 (83.7-89.4)	89.8 (87.3-92.2)
Rural	16.4 (13.1-19.7)	17.6 (14.2-21.0)	13.8 (10.9-16.6)	13.5 (10.6-16.3)	10.2 (7.8-12.7)
Household income, %					
Low (<25%)	17.1 (15.3-18.9)	16.5 (14.7-18.2)	14.4 (12.6-16.3)	11.8 (10.2-13.4)	7.5 (6.1-8.9)
Moderate (25%–74%)	53.7 (51.0-56.4)	53.3 (50.8-55.9)	52.3 (49.4-55.2)	49.9 (47.2-52.6)	51.4 (48.5-54.3)
High (≥75%)	29.2 (26.5 - 31.9)	30.2 (27.5-32.8)	33.2 (30.2-36.3)	38.3 (35.4-41.1)	41.1 (38.0-44.2)
Educational attainment, %					
Low (<25%)	25.4 (23.3-27.6)	25.8 (23.6-28.0)	21.2 (19.2-23.3)	16.4 (14.6-18.2)	7.7 (6.6-8.8)
Moderate (25%–74%)	37.8 (35.4-40.2)	35.7 (33.5-38.0)	34.5 (32.1-36.9)	35.2 (32.8-37.5)	34.7 (32.2-37.3)
High (≥75%)	36.7 (34.0-39.4)	38.4 (35.9-41.0)	44.3 (41.6-47.0)	48.5 (45.8-51.2)	57.6 (54.9-60.3)
Drinking, %					
None	19.6 (17.8-21.5)	28.6 (26.5-30.6)	28.5 (26.1-30.9)	26.1 (24.2-28.0)	22.1 (20.2-24.1)
1 to 4 times/month	47.0 (44.7-49.4)	47.7 (45.5-49.9)	53.8 (51.2-56.5)	57.2 (54.9-59.6)	64.9 (62.8-67.1)
2 to greater than 4 times/week	33.3 (31.1-35.5)	23.8 (21.9-25.7)	17.7 (15.8-19.6)	16.7 (14.8-18.6)	13.0 (11.3-14.6)
DASH diet score quantiles, %					
1^{st}–24^{th} percentile	31.1 (28.8-33.4)	21.5 (19.4-23.6)	22.5 (20.2-24.8)	21.0 (19.1 - 22.9)	11.6 (9.9-13.2)
25^{th}–49^{th} percentile	32.9 (30.8-35.0)	27.6 (25.5-29.7)	23.6 (21.5-25.7)	23.0 (21.1-25.0)	22.9 (20.7-25.1)
50^{th}–74^{th} percentile	24.5 (22.6-26.4)	27.3 (25.3-29.3)	27.0 (24.8-29.3)	26.9 (25.0-28.9)	29.5 (27.2-31.7)
75^{th}–94^{th} percentile	9.3 (7.9-10.6)	18.5 (16.8-20.2)	20.8 (18.8-22.7)	21.6 (19.9-23.4)	26.8 (24.8-28.8)
≥95^{th} percentile	2.3 (1.7 - 2.9)	5.0 (4.1-5.9)	6.1 (4.9-7.2)	7.4 (6.3-8.4)	9.3 (7.9-10.7)
Smoking status, (%)					
Never	28.1 (26.1-30.1)	48.1 (45.9-50.4)	59.8 (57.1-62.4)	68.2 (66.0-70.4)	82.2 (80.5-84.0)
Former	26.7 (24.7-28.7)	29.0 (27.0-31.0)	27.5 (25.3-29.8)	24.1 (22.2-26.0)	15.8 (14.2-17.5)
Current	45.2 (42.9-47.6)	22.9 (20.8-25.0)	12.7 (10.8-14.5)	7.7 (6.4-9.0)	1.9 (1.2-2.7)

Appendix Table 4. Characteristics of the study population according to the Life's Essential 8 cardiovascular heath scores categorized by quintiles *(continued)*

Variables	Quintile of LE8 CVH score				
	Q1 (N=2,490)	Q2 (N=2,739)	Q3 (N=2,135)	Q4 (N=2,643)	Q5 (N=2,257)
Sleep hours, per night	6.5 (6.4-6.6)	6.9 (6.8-6.9)	7.0 (7.0-7.1)	7.2 (7.1-7.2)	7.3 (7.3-7.4)
Body mass index, kg/m^2	26.6 (26.4-26.8)	25.1 (24.9-25.3)	24.0 (23.8-24.2)	23.0 (22.8-23.1)	21.9 (21.7-22.0)
Non-HDL-Cholesterol, mg/dL	158.5 (156.6-160.4)	145.6 (143.9-147.2)	138.9 (137.1-140.6)	132.4 (130.9-133.9)	123.3 (121.9-124.6)
Lipid-lowering drugs, %	17.5 (15.8-19.3)	18.1 (16.4-19.8)	15.3 (13.5-17.0)	10.8 (9.6-12.0)	6.1 (5.0-7.2)
Blood glucose, %					
Normal	36.4 (34.1-38.7)	52.8 (50.6-55.1)	67.0 (64.6-69.3)	75.8 (73.9-77.7)	89.4 (88.0-90.7)
Prediabetes	44.9 (42.5-47.2)	39.0 (36.8-41.2)	27.0 (24.7-29.2)	21.6 (19.7-23.4)	10.1 (8.8-11.3)
Diabetes	18.8 (16.9-20.6)	8.1 (7.0-9.3)	6.1 (5.0-7.1)	2.6 (2.0-3.3)	0.6 (0.3-0.9)
SBP, mmHg	127.2 (126.5-128.0)	122.7 (122.0-123.4)	118.5 (117.6-119.3)	114.0 (113.4-114.7)	108.5 (107.9-109.0)
DBP, mmHg	81.6 (81.2-82.1)	77.2 (76.8-77.7)	75.3 (74.8-75.8)	73.1 (72.7-73.5)	70.1 (69.7-70.5)
BP-lowering drugs, %	29.9 (27.8-32.1)	25.4 (23.5-27.3)	18.8 (17.0-20.6)	12.4 (11.0-13.8)	4.3 (3.5-5.1)
LE8 CVH Score[a]					
Total CVH score	46.4 (46.1-46.7)	58.3 (58.2-58.4)	65.0 (64.9-65.1)	71.7 (71.6-71.8)	82.4 (82.2-82.7)
Health behavior score	38.3 (37.7-39.0)	51.3 (50.7-51.9)	57.2 (56.5-57.9)	63.3 (62.7-63.9)	75.8 (75.2-76.4)
Health factor score	54.5 (53.9-55.1)	65.2 (64.6-65.8)	72.9 (72.2-73.5)	80.1 (79.5-80.7)	89.0 (88.5-89.6)
Diet	30.1 (28.8-31.4)	40.4 (39.0-41.8)	42.1 (40.5-43.7)	43.9 (42.4-45.4)	51.2 (49.6-52.7)
Physical activity	10.4 (9.0-11.7)	20.1 (18.3-21.9)	28.0 (25.7-30.3)	40.1 (37.8-42.4)	69.2 (67.2-71.3)
Nicotine exposure	44.1 (42.2-46.1)	66.5 (64.5-68.5)	77.1 (75.1-79.1)	83.6 (82.2-85.0)	92.7 (91.8-93.7)
Sleep health	68.7 (67.5-70.0)	78.2 (77.1-79.4)	81.5 (80.3-82.6)	85.7 (84.8-86.6)	90.0 (89.2-90.9)
Body mass index	56.4 (55.3-57.5)	67.0 (65.9-68.1)	75.7 (74.4-77.0)	82.4 (81.4-83.4)	89.7 (88.9-90.6)
Blood lipids	49.4 (48.1-50.7)	59.4 (58.2-60.6)	66.1 (64.7-67.5)	72.8 (71.6-74.0)	82.6 (81.5-83.8)
Blood glucose	61.2 (60.0-62.3)	70.7 (69.7-71.7)	77.1 (75.9-78.3)	83.9 (82.9-84.8)	91.6 (90.9-92.4)
Blood pressure	51.2 (49.8-52.5)	64.0 (62.6-65.3)	72.6 (71.0-74.2)	81.3 (80.1-82.5)	92.2 (91.4-93.0)
eGFR, ml/min/1.73m^2	94.7 (93.8-95.5)	94.4 (93.5-95.2)	97.5 (96.6-98.4)	100.2 (99.4-101.0)	104.1 (103.4-104.9)
eGFR category, %					
G1	66.3 (63.9-68.6)	63.2 (60.8-65.5)	70.2 (68.0-72.4)	74.3 (72.2-76.4)	83.0 (81.2-84.8)
G2	29.8 (27.6-32.0)	33.3 (31.1-35.6)	27.2 (25.0-29.3)	24.3 (22.3-26.3)	16.5 (14.7-18.3)
G3	3.5 (2.7-4.2)	3.2 (2.5-3.9)	2.4 (1.8-3.0)	1.3 (0.9-1.7)	0.5 (0.2-0.7)
G4-G5	0.4 (0.1-0.7)	0.3 (0.1-0.5)	0.3 (0.1-0.5)	0.1 (0.0-0.2)	

Appendix Table 4. Characteristics of the study population according to the Life's Essential 8 cardiovascular heath scores categorized by quintiles *(continued)*

Variables	Quintile of LE8 CVH score				
	Q1 (N=2,490)	Q2 (N=2,739)	Q3 (N=2,135)	Q4 (N=2,643)	Q5 (N=2,257)
UACR, mg/g	32.1 (25.8-38.4)	23.6 (18.2-29.0)	17.0 (13.0-20.9)	15.5 (11.9-19.1)	8.9 (7.3-10.5)
UACR category, %					2.0 (1.14-2.6)
A1	87.0 (85.5-88.6)	92.2 (91.1-93.3)	94.4 (93.2-95.5)	95.4 (94.5-96.4)	97.0 (96.2-97.8)
A2	11.0 (9.5-12.4)	6.5 (5.6-7.5)	4.8 (3.8-5.8)	4.0 (3.1-4.9)	2.9 (2.1-3.7)
A3	2.0 (1.14-2.6)	1.2 (0.8-1.7)	0.9 (0.4-1.3)	0.6 (0.3-0.8)	0.1 (0.0-0.2)
Chronic kidney disease, %[b]	14.7 (13.2-16.3)	10.2 (9.0-11.5)	7.4 (6.2-8.7)	5.5 (4.6-6.5)	3.4 (2.6-4.2)

Values are presented as weighted % or mean (95% confidence interval).
Low CVH was defined as a LE8 score of 0–<50, moderate CVH of 50–<80, and high CVH of 80–100.
[a]LE8 CVH Score was entered as a continuous variable.
[b]Those with albumin-to-creatinine ratio (ACR) above 30 mg/g or estimated glomerular filtration rate (eGFR) below 60 mL/min/1.73 m^2 were defined as patients with chronic kidney disease (CKD).
CVH Q1, <54 points; CVH Q2, 54–<62 points; CVH Q3, 62–<68 points; CVH Q4, 68–<76 points; CVH Q5, ≥76 points
eGFR and UACR categories were based on the KDIGO 2012 Clinical Practice Guideline.

CVH, cardiovascular health; DASH, dietary approaches to stop hypertension; HDL, high-density lipoprotein; SBP, systolic blood pressure; DBP, diastolic blood pressure; BP, blood pressure; LE8, life's essential 8; eGFR, estimated glomerular filtration rate; UACR, urine albumin to creatinine ratio.

Appendix Table 5. Association of the Life's Essential 8 cardiovascular health score with eGFR category

Category / CVH score	No. of people	No. (%) of people with chronic kidney disease	OR (95% CI)		
			Model 1	Model 2	Model 3
G3-G5 vs G1-G2					
Low CVH	1478	80 (5.41)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	9368	338 (3.61)	0.68 (0.50-0.91)	0.62 (0.45-0.84)	0.60 (0.44-0.82)
High CVH	1418	6 (0.42)	0.06 (0.02-0.16)	0.13 (0.05-0.36)	0.14 (0.05-0.38)
Per 10-point higher CVH score			0.68 (0.64-0.73)	0.72 (0.65-0.79)	0.71 (0.64-0.79)
G3-G4 vs G1-G2					
Low CVH	1476	78 (5.28)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	9362	332 (3.55)	0.69 (0.51-0.93)	0.63 (0.46-0.86)	0.61 (0.45-0.85)
High CVH	1418	6 (0.42)	0.06 (0.02-0.17)	0.14 (0.05-0.37)	0.15 (0.05-0.40)
Per 10-point higher CVH score			0.68 (0.64-0.73)	0.72 (0.65-0.80)	0.72 (0.65-0.79)
G3 vs G1-G2					
Low CVH	1471	73 (4.96)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	9342	312 (3.34)	0.71 (0.52-0.97)	0.65 (0.47-0.89)	0.64 (0.46-0.89)
High CVH	1418	6 (0.42)	0.07 (0.03-0.18)	0.15 (0.06-0.41)	0.17 (0.06-0.45)
Per 10-point higher CVH score			0.69 (0.64-0.74)	0.73 (0.66-0.80)	0.73 (0.66-0.80)

Model 1: Unadjusted model
Model 2: Adjusted for age, sex
Model 3: Adjusted for model 2 + residential area, household income, educational attainment, and drinking

eGFR and UACR categories were based on the KDIGO 2012 Clinical Practice Guideline.
The categories for eGFR and UACR are defined as follows: G1, ≥90; G2, 60–89; G3, 30–59; G4, 15–29; G5, <15; A1, <30; A2, 30–300; A3, >300.
Low CVH was defined as a LE8 score of 0 –<50, moderate CVH of 50–<80, and high CVH of 80–100.
CVH, cardiovascular health; eGFR, estimated glomerular filtration rate.

Appendix Table 6. Association of the Life's Essential 8 cardiovascular health score with albuminuria category

Category / CVH score	No. of people	No. (%) of people with chronic kidney disease	OR (95% CI)		
			Model 1	Model 2	Model 3
A2-A3 vs A1					
Low CVH	1478	246 (16.64)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	9368	728 (7.77)	0.39 (0.32-0.46)	0.35 (0.29-0.42)	0.36 (0.30-0.44)
High CVH	1418	41 (2.89)	0.16 (0.11-0.24)	0.21 (0.15-0.32)	0.24 (0.16-0.35)
Per 10-point higher CVH score			0.65 (0.62-0.70)	0.66 (0.61-0.71)	0.67 (0.62-0.72)
G1-G2/A2-A3 vs G1-G2/A1					
Low CVH	1398	207 (14.81)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	9030	615 (6.81)	0.39 (0.32-0.47)	0.35 (0.28-0.43)	0.37 (0.30-0.45)
High CVH	1412	39 (2.76)	0.18 (0.12-0.27)	0.22 (0.15-0.33)	0.25 (0.17-0.38)
Per 10-point higher CVH score			0.67 (0.62-0.71)	0.66 (0.61-0.72)	0.68 (0.63-0.74)
G1-G2/A2-A3 vs G1-G2/A1					
Low CVH	1370	179 (13.07)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Moderate CVH	8976	561 (6.25)	0.40 (0.33-0.49)	0.35 (0.28-0.43)	0.37 (0.30-0.46)
High CVH	1410	37 (2.62)	0.20 (0.13-0.30)	0.23 (0.15-0.35)	0.26 (0.17-0.40)
Per 10-point higher CVH score			0.68 (0.63-0.73)	0.67 (0.61-0.73)	0.68 (0.63-0.75)

Model 1: Unadjusted model
Model 2: Adjusted for age, sex
Model 3: Adjusted for model 2 + residential area, household income, educational attainment, and drinking

eGFR and UACR categories were based on the KDIGO 2012 Clinical Practice Guideline.
The categories for eGFR and UACR are defined as follows: G1, ≥90; G2, 60–89; G3, 30–59; G4, 15–29; G5, <15; A1, <30; A2, 30–300; A3, >300.
Low CVH was defined as a LE8 score of 0–<50, moderate CVH of 50–<80, and high CVH of 80–100.
CVH, cardiovascular health;

Appendix Table 7. Association of the dietary components with chronic kidney disease, decreased eGFR, and albuminuria

Dietary components	OR (95% CI)		
	Chronic kidney disease	Decreased GFR	Albuminuria
Protein, (%)	0.88 (0.84-0.93)	0.87 (0.80-0.94)	0.89 (0.84-0.94)
Fiber, (g)	1.25 (1.19-1.32)	1.30 (1.21-1.40)	1.23 (1.16-1.31)
Calcium, (mg)	1.05 (1.00-1.10)	1.11 (1.02-1.20)	1.03 (0.97-1.09)
Potassium, (mg)	1.10 (1.05-1.16)	1.10 (1.02-1.18)	1.10 (1.04-1.17)
Magnesium, (mg)	1.18 (1.13-1.25)	1.20 (1.11-1.29)	1.18 (1.11-1.25)
Total fat, (%)	1.37 (1.30-1.45)	1.43 (1.29-1.57)	1.35 (1.28-1.43)
Cholesterol, (mg)	1.23 (1.16-1.29)	1.33 (1.22-1.45)	1.18 (1.12-1.25)
Saturated fat, (%)	1.35 (1.29-1.42)	1.43 (1.30-1.57)	1.33 (1.25-1.40)
Sodium, (mg)	0.94 (0.89-0.99)	0.98 (0.90-1.07)	0.92 (0.87-0.97)

Adjusted for age, sex, residential area, household income, educational attainment, drinking

ABSTRACT(KOREAN)

Life's Essential 8 심혈관건강 지표와 만성콩팥병의 연관성

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서예은

배경 및 목적:
미국심장협회에서는 심혈관건강에 대한 업데이트된 정의를 발표하였다. 새로운 LE8 심혈관건강지표 점수와 다양한 질병과의 연관성에 대한 연구가 새롭게 등장하고 있다. 또한, 만성콩팥병은 전 세계적인 건강 문제이며, 초기 예방의 중요성이 커지고 있다. 그러나 새로운 LE8 심혈관건강 지표와 만성콩팥병 사이의 연관성에 대한 연구는 부족하다. 따라서, 이 연구는 국민건강영양조사 데이터를 이용하여 대한민국 성인에서의 LE8 심혈관건강 지표점수와 만성콩팥병 사이의 연관성을 조사하는 것을 목표로 하였다.

연구 방법:
본 연구는 2019 년부터 2021 년까지의 국민건강영양조사의 제 8 차 주기를 기반으로 한 횡단면 연구이다. LE8 심혈관건강 지표의 구성요소에는 식이섭취, 신체활동, 니코틴 노출, 수면건강, 체질량지수, 혈중지질, 혈당, 혈압, 총 8 가지 구성요소를 포함하고 있다. 각각 0 부터 100 점까지로 구성된 LE8 심혈관건강점수는 8 개 구성 요소 점수의 평균으로 계산하였다. 80 점에서 100 점까지의 심혈관건강점수는 높은 수준의 심혈관건강으로 분류하며, 50 점에서 80 점미만은 중등도 수준, 0 점에서 50 점미만은 낮은 수준의 심혈관건강으로 분류하였다. 만성콩팥병은 추정 사구체 여과율이 분당 60mL/1.73m^2 미만이거나 소변 알부민-크레아틴 비율이 30mg/g 이상인 경우로 정의하였다. 다변량

로지스틱 회귀 모델을 사용하여 LE8 심혈관건강점수와 만성콩팥병 사이의 오즈비와 95% 신뢰 구간을 계산했다. 모든 통계 분석은 국민건강영양조사 데이터의 복합표본 설계를 고려하였다.

연구 결과:

분석결과 총 12,264 명이 포함되었고, 평균 연령은 48.1 세였다. 참가자 중 50.7%가 남성이었다. 다변량 조정 후, 심혈관건강점수가 높을수록 만성콩팥병, 추정 사구체 여과율, 그리고 알부민뇨와 낮은 연관이 있었다. 낮은 심혈관건강점수 그룹을 기준으로 했을 때, 중등도 심혈관건강점수 그룹의 만성콩팥병 오즈비는 0.41(95% CI: 0.34-0.49)이었고, 높은 심혈관건강점수 그룹의 오즈비는 0.25(95% CI: 0.17-0.36)이었다. LE8 심혈관건강점수가 10 점당 증가할 때마다 만성콩팥병 발생 오즈가 31% 낮아졌다 (OR, 0.69; 95% CI, 0.64-0.73). 또한, 큐빅 스플라인 곡선을 통해서, LE8 심혈관건강점수와 만성콩팥병 사이에 선형적이고 용량 의존적인 연관성을 관찰하였다.

결론 및 고찰:

심혈관건강점수가 높을수록 만성콩팥병 위험이 낮은 연관성이 관찰되었다. 이는 만성콩팥병의 부담을 줄이기 위해 개인에서 높은 심혈관건강점수를 유지의 중요성을 강조한다.

핵심어: 심혈관건강; 심혈관 건강지표; 만성신장질환; 조기예방