Association Between Cardiovascular Health Score Based on Life' s Essential 8 and Incident Atrial Fibrillation: Postprint

Authors: Zhang Yuan, Hou Qiqi, Qi Qi, Jiang Yue, Wang Nan, Yue Bocheng, Chen Shuohua, Han Quanle, Wu Shouling, Kangbo Li, Han Quanle

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Abstract

Background In recent years, the global prevalence of atrial fibrillation (AF) has continued to rise, with AF increasing the risk of stroke, heart failure, myocardial infarction, chronic kidney disease, and other conditions. Research has confirmed that hypertension, diabetes, smoking, obstructive sleep apnea, obesity, and sedentary lifestyle are risk factors for AF, most of which fall within the scope of the "Life' s Essential 8" (LE8) proposed by the American Heart Association.

Objective To investigate the association between the cardiovascular health (CVH) score based on LE8 and atrial fibrillation.

Methods A prospective cohort study was conducted, selecting 91,131 employees from the Kailuan Group in Tangshan City, Hebei Province, who underwent health examinations between June 2006 and October 2007 as study subjects. The LE8 score was evaluated according to the algorithm developed by the American Heart Association and adapted to the specific context of the Kailuan Study to form the LE8 Kailuan Study version, including 4 health behaviors (diet, physical activity, tobacco exposure, and sleep) and 4 health factors (BMI, blood lipids, blood glucose, and blood pressure). Based on the LE8 score, subjects were divided into 3 groups: LE8 score <50 as the low CVH group (8,407 subjects), 50 ≤ LE8 score <80 as the medium CVH group (73,493 subjects), and LE8 score $ $80 as the high CVH group (9,231 subjects). The first participation in the Kailuan health examination was taken as the starting point of follow-up, with annual follow-ups conducted. The occurrence of AF was taken as the endpoint event, and the end of follow-up was the time of AF onset or the end of the follow-up period (December 31, 2020). Kaplan-Meier survival curves were used to analyze the cumulative incidence of new-onset AF in different groups, and

Log-rank test was performed to compare differences between groups; Cox proportional hazards regression analysis was used to explore the effects of different LE8 score groups and single-factor scores on the risk of new-onset AF.

Results There were statistically significant differences in age, gender, education level, family income, drinking history, and LE8 score among the three groups (P<0.001). During follow-up, there were 1,088 new-onset AF cases, including 133 cases (1.58%) in the low CVH group, 882 cases (1.20%) in the medium CVH group, and 72 cases (0.78%) in the high CVH group; the median follow-up time was 15.0 (14.7, 15.2) years; the comparison of survival curves for cumulative incidence of new-onset AF among the three groups showed statistically significant differences (P<0.0001). After adjusting for age, gender, education level, family income, and drinking history, Cox proportional hazards regression analysis showed that compared with the low CVH group, both the medium CVH group (HR=0.697, 95%CI=0.579~0.841, P<0.001) and the high CVH group (HR=0.609, 95%CI=0.454~0.816, P=0.001) could reduce the risk of new-onset AF; increased LE8 score could reduce the risk of new-onset AF (HR=0.859, 95%CI=0.804~0.918, P<0.001); LE8 single-factor BMI score (HR=0.762, 95%CI=0.717~0.809, P<0.001) and blood pressure score (HR=0.824, 95%CI=0.776~0.876, P<0.001) were negatively correlated with the risk of new-onset AF.

Conclusion The LE8 score for CVH is negatively correlated with the risk of new-onset AF, and both the BMI score and blood pressure score as single factors of LE8 are negatively correlated with the risk of new-onset AF.

Full Text

Relationship Between Cardiovascular Health Score of Life' s Essential 8 and New-onset Atrial Fibrillation

ZHANG Yuan[1], HOU Qiqi[2], QI Qi[2], JIANG Yue[3], WANG Nan[3], YUE Bocheng[1], CHEN Shuohua[4], HAN Quanle[1]*, WU Shouling[4], LI Kangbo[5]

[1]Department of Cardiology, Tangshan Gongren Hospital, Tangshan 063000, China
[2]Department of Cardiology, Tangshan Gongren Hospital Affiliated to Hebei Medical University, Tangshan 063000, China
[3]Department of Invasive Technology, Tangshan Gongren Hospital, Tangshan 063000, China
[4]Department of Cardiology, Kailuan General Hospital, Tangshan 063000, China
[5]College of Clinical Medicine, North China University of Science and Technology, Tangshan 063000, China

Corresponding Author: HAN Quanle, Chief Physician/Associate Professor; E-mail: hanquanle@126.com

Abstract

Background The global prevalence of atrial fibrillation (AF) has continued to rise in recent years, and AF increases the risk of stroke, heart failure, myocardial infarction, chronic kidney disease, and other conditions. Studies have identified hypertension, diabetes, smoking, obstructive sleep apnea, obesity, and sedentary lifestyle as risk factors for AF, most of which fall within the scope of "Life' s Essential 8" (LE8) proposed by the American Heart Association. **Objective** To investigate the association between cardiovascular health (CVH) score based on LE8 and new-onset AF. **Methods** We conducted a prospective cohort study of 91,131 employees from the Kailuan Group in Tangshan, Hebei Province, who underwent health examinations between June 2006 and October 2007. The LE8 score was evaluated according to the algorithm developed by the American Heart Association and adapted to the Kailuan study context, forming the Kailuan version of LE8. This version includes four health behaviors (diet, physical activity, tobacco exposure, and sleep) and four health factors (BMI, blood lipids, blood glucose, and blood pressure). Participants were divided into three groups based on LE8 scores: low CVH group (score <50, n=8,407), medium CVH group (50≤ score <80, n=73,493), and high CVH group (score $ $80, n=9,231). Follow-up began at the time of the first Kailuan health examination and was conducted annually, with AF occurrence as the endpoint event. The follow-up ended at the time of AF diagnosis or study conclusion (December 31, 2020). Kaplan-Meier survival curves were used to analyze the cumulative incidence of new-onset AF across groups, with log-rank tests for intergroup comparisons. Cox proportional hazards regression analysis was performed to examine the impact of different LE8 score groups and individual factor scores on new-onset AF risk. **Results** Significant differences were observed among the three groups in age, gender, education level, family income, alcohol consumption history, and LE8 scores (P<0.001). During follow-up, 1,088 cases of new-onset AF were identified: 133 cases (1.58%) in the low CVH group, 882 cases (1.20%) in the medium CVH group, and 72 cases (0.78%) in the high CVH group. The median follow-up duration was 15.0 (14.7, 15.2) years. The cumulative incidence curves of new-onset AF differed significantly among the three groups (P<0.0001). After adjusting for age, gender, education level, family income, and alcohol consumption history, Cox regression analysis showed that both the medium CVH group (HR=0.697, 95%CI=0.579-0.841, P<0.001) and high CVH group (HR=0.609, 95%CI=0.454-0.816, P=0.001) had reduced risks of new-onset AF compared with the low CVH group. Each standard deviation increase in LE8 score reduced new-onset AF risk (HR=0.859, 95%CI=0.804-0.918, P<0.001). Among individual LE8 components, BMI score (HR=0.762, 95%CI=0.717-0.809, P<0.001) and blood pressure score (HR=0.824, 95%CI=0.776-0.876, P<0.001) were negatively associated with new-onset AF risk. **Conclusion** The LE8-based CVH score is negatively associated with new-onset AF risk. Specifically, BMI score and blood pressure score, as individual components of LE8, are both negatively correlated with new-onset AF risk.

Keywords Atrial fibrillation; Cardiovascular health; Life's Essential 8; Cumulative incidence; Kaplan-Meier survival curves; Cox proportional hazards models

Introduction

Atrial fibrillation (AF) is a common arrhythmia encountered in clinical practice [1]. Global disease and health risk assessment reports indicate that from 1990 to 2019, the worldwide incidence of AF continued to rise, with approximately 8.39 million people affected and the disease burden doubling [2]. Patients with AF often seek repeated medical care due to symptoms such as palpitations and chest tightness, which not only increases healthcare costs but also severely impacts quality of life [3]. Furthermore, studies have confirmed that AF increases the risk of ischemic stroke, dementia, heart failure, myocardial infarction, and chronic kidney disease [4-7]. Established risk factors for AF include hypertension, diabetes, smoking, obstructive sleep apnea, obesity, and sedentary lifestyle, all of which can induce structural and electrical remodeling of the atria, promoting AF development and progression [8]. The American Heart Association (AHA) previously introduced the concept of cardiovascular health (CVH) behaviors and factors (Life' s Simple 7, LS7) [9], and subsequent research demonstrated that ideal LS7 status is significantly negatively associated with cardiovascular events and all-cause mortality [10]. However, current domestic and international studies on whether LS7 increases new-onset AF risk have yielded inconsistent results [11-13]. In 2022, the AHA updated LS7 to "Life' s Essential 8" (LE8), which includes diet, physical activity, tobacco exposure, sleep, body mass index (BMI), blood lipids, blood glucose, and blood pressure [14]. This study aims to explore the association between CVH score based on LE8 and new-onset AF, providing scientific and systematic management strategies to reduce AF incidence and contribute to the "Healthy China 2030" initiative.

Methods

Study Population

We initially selected 101,510 employees from the Kailuan Group who underwent health examinations between June 2006 and October 2010, including 81,110 men and 20,400 women aged 18-98 years. After applying inclusion and exclusion criteria, 91,131 participants were ultimately enrolled, comprising 72,387 men (79.43%) and 18,744 women (20.57%) with a mean age of 51.0$±$12.3 years. Inclusion criteria were: (1) age $ $18 years; (2) no cognitive impairment and ability to complete questionnaires; and (3) provision of informed consent. Exclusion criteria included: (1) history of AF, myocardial infarction, stroke, or malignant tumors; and (2) incomplete data on CVH behaviors and factors. The study was approved by the Ethics Committee of Kailuan General Hospital ([2006] Medical Ethics No. 5), and all participants provided informed consent.

General Data Collection

Trained researchers collected data through questionnaires covering age, gender, smoking, alcohol consumption, physical exercise, education level, medical history, and medication use. Anthropometric measurements (height, weight, blood pressure) were obtained, and biochemical tests were performed on blood and urine samples. Detailed protocols for epidemiological surveys, anthropometric measurements, and biochemical testing have been published previously [5].

Definitions and Diagnostic Criteria

AF was defined as episodes recorded by standard 12-lead electrocardiography, ambulatory ECG monitoring, or other cardiac recording devices lasting >30 seconds [15].

LE8 Score [14]: The score was evaluated according to the AHA algorithm and adapted to the Kailuan study context, with definitions and scoring for each component forming the Kailuan version of LE8 (Table 1). This version includes four health behaviors (diet, physical activity, tobacco exposure, and sleep) and four health factors (BMI, blood lipids, blood glucose, and blood pressure), and has been validated and utilized in previous studies [16-19]. Each CVH behavior or factor is scored from 0-100 points, with the overall score calculated as the unweighted average of individual components, yielding a total score ranging from 0-100.

The diet score was adapted from the AHA' s Dietary Approaches to Stop Hypertension (DASH) diet, incorporating vegetables, fruits, nuts, legumes, whole grains, salt, sugar-sweetened beverages, red meat (pork, beef, mutton), and processed meat intake. Based on epidemiological characteristics of the Chinese population and Kailuan study data, adjustments were made for salt, high-fat foods, and tea consumption [16-18]. The BMI scoring was adjusted according to Chinese population standards [20]: BMI <23.0 kg/m^2: 100 points; 23.0-24.9 kg/m^2: 75 points; 25.0-29.9 kg/m^2: 50 points; 30.0-34.9 kg/m^2: 25 points; \$ 35.0$kg/m\hat{}\{2\}$\$: 0 points. The blood lipid score used non-high-density lipoprotein cholesterol (Non-HDL-C), calculated as total cholesterol minus HDL cholesterol. The blood glucose score referenced fasting blood glucose (FBG) levels, while the blood pressure score considered both systolic and diastolic blood pressure values.

Grouping

Participants were divided into three groups based on total LE8 scores: low CVH group (LE8 score <50, n=8,407), medium CVH group (50≤ score <80, n=73,493), and high CVH group (score \$ \$80, n=9,231).

Endpoint Events

Follow-up began at the time of each participant' s first Kailuan health examination and was conducted annually. The endpoint event was AF occurrence, with follow-up ending at AF diagnosis or study conclusion (December 31, 2020). AF cases were identified by trained medical staff through review of the Kailuan social security information system, with diagnoses confirmed by International Classification of Diseases (ICD-10) code I48.

Statistical Analysis

Data analysis was performed using SAS 9.4 software. Normally distributed continuous variables are presented as mean±standard deviation and compared using one-way ANOVA. Non-normally distributed continuous variables are expressed as median (P25, P75) and compared using nonparametric rank-sum tests. Categorical data are presented as percentages and compared using chi-square tests. Kaplan-Meier survival curves were used to analyze cumulative incidence of new-onset AF across groups, with log-rank tests for intergroup comparisons. Cox proportional hazards regression analysis examined the impact of LE8 score groups and individual factor scores on new-onset AF risk. A two-sided P<0.05 was considered statistically significant.

Results

General Characteristics

After excluding 529 participants with AF history, 6,311 with missing LE8 data, 3,216 with prior myocardial infarction or stroke, and 323 with malignant tumors, 91,131 participants were included in the final analysis. Among the LE8 components, sleep score was highest (87.61$±21.90), $followed by FBG score (85.34±24.18), $while diet score was lowest (38.64±$15.07). Significant differences were observed among the three groups in age, gender, education level, family income, alcohol consumption history, and LE8 scores (P<0.001) (Table 2).

New-onset AF Across Groups

During follow-up, 1,088 cases of new-onset AF were identified: 133 cases (1.58%) in the low CVH group, 882 cases (1.20%) in the medium CVH group, and 72 cases (0.78%) in the high CVH group. The median follow-up duration was 15.0 (14.7, 15.2) years. The cumulative incidence curves of new-onset AF differed significantly among the three groups (P<0.0001) (Table 3 , Figure 1 [Figure 1: see original paper]).

Cox Regression Analysis of LE8 Score Groups

Cox proportional hazards regression analysis was performed with new-onset AF (no=0, yes=1) as the dependent variable and LE8 score groups (low CVH=0,

medium CVH=1, high CVH=2) as the independent variable, adjusting for age (continuous), gender (female=0, male=1), education level (junior high or below=0, high school or above=1), family income (monthly per capita income $ $1,000 yuan=0, >1,000 yuan=1), and alcohol consumption history (no=0, yes=1). Compared with the low CVH group, both the medium CVH group (HR=0.745, 95%CI=0.621-0.894, P=0.002) and high CVH group (HR=0.469, 95%CI=0.352-0.624, P<0.001) showed reduced new-onset AF risk, with a significant trend across groups (Ptrend<0.001). After full adjustment, the medium CVH group (HR=0.697, 95%CI=0.579-0.841, P<0.001) and high CVH group (HR=0.609, 95%CI=0.454-0.816, P=0.001) both demonstrated reduced AF risk compared with the low CVH group, with a significant dose-response relationship (Ptrend<0.001) (Table 4).

Further analysis using LE8 score as a continuous variable showed that each standard deviation increase in LE8 score reduced new-onset AF risk (HR=0.859, 95%CI=0.804-0.918, P<0.001) after adjusting for age, gender, education level, family income, and alcohol consumption history.

Individual LE8 Component Analysis

Cox proportional hazards regression analysis examined the impact of individual LE8 component scores on new-onset AF risk. After adjusting for age, gender, education level, family income, and alcohol consumption history, BMI score (HR=0.762, 95%CI=0.717-0.809, P<0.001) and blood pressure score (HR=0.824, 95%CI=0.776-0.876, P<0.001) were negatively associated with new-onset AF risk (Table 5).

Discussion

This study, based on the Kailuan cohort and adjusting for age, gender, education level (high school or above), high income, and alcohol consumption, found that the medium CVH group had a 30.3% lower risk of new-onset AF compared with the low CVH group, while the high CVH group had a 39.1% lower risk. Each standard deviation increase in LE8 score was associated with a 14.1% reduction in new-onset AF risk. These findings align with international studies showing that ideal CVH status based on LS7 reduces new-onset AF risk. One such study included white, Chinese American, African American, and Hispanic populations, with similar results observed across racial/ethnic groups, strongest among Hispanic Americans [11]. LE8 adds sleep evaluation compared with LS7, and research has demonstrated an association between impaired sleep quality and AF occurrence [21]. Obstructive sleep apnea shares genetic susceptibility with AF, though the exact pathogenic mechanisms require further investigation [22].

Obesity represents a comorbidity for both AF and obstructive sleep apnea. Whether obesity directly causes AF or mediates AF development in patients with obstructive sleep apnea remains debated. Some studies suggest elevated

BMI is a causal factor for AF independent of obstructive sleep apnea [23], while others indicate obesity contributes to AF pathogenesis except in cases where more severe obstructive sleep apnea directly triggers AF [24]. Considering regional differences and BMI distribution in the study population, the Kailuan version adjusted BMI scoring criteria from the AHA reference [14-15]. Research has shown higher BMI increases AF risk [25]. Our analysis of individual BMI score impact demonstrated that each standard deviation increase in BMI score reduced new-onset AF risk by 23.8% after adjustment, consistent with previous findings.

A cross-sectional study of 4,477 northern Chinese community residents aged >40 years similarly found that ideal health behaviors and factors were negatively associated with AF prevalence [12]. However, that study could not establish temporal relationships and found no significant association between ideal blood pressure and AF prevalence, contradicting prospective studies that identified hypertension as a major contributor to AF [26-27]. Our prospective analysis revealed that each standard deviation increase in blood pressure score reduced new-onset AF risk by 17.6% after adjustment. We did not detect an association between Non-HDL-C and new-onset AF risk, similar to findings from a multi-ethnic study [28], suggesting limited involvement of serum cholesterol in AF pathogenesis. No association was observed between tobacco exposure and new-onset AF risk, contrasting with studies linking smoking to increased AF risk [29]. This discrepancy may arise because our study population was younger with shorter cumulative tobacco exposure, and our quantitative scoring approach may have obscured qualitative differences between smokers and non-smokers.

Previous studies demonstrated that balanced diet and moderate physical activity reduce AF risk [30-32], but our results showed no association between diet, physical activity, and new-onset AF. This may be because the Kailuan LE8 version included limited dietary components and categorized physical labor as physical activity, though these are distinct. We also found no association between FBG score and new-onset AF risk, possibly because treating blood glucose as a continuous variable weakened the effect compared with categorical classification.

One prospective study found no significant association between LS7 and AF risk, with only ideal BMI (<25 kg/m^2) showing a 64% risk reduction in single-component analysis [13]. Other studies showed modest AF risk reduction with higher LS7 scores [11,33-34]. Potential reasons for these inconsistent findings include: self-reported AF events without precise timing; strict AF event criteria focusing on hospitalized severe cases while missing paroxysmal AF or cases with low AF burden not captured on ECG.

Study Strengths and Limitations

This study's large sample size and long follow-up duration provide high scientific value. However, several limitations exist: (1) The Kailuan cohort has a male

predominance (nearly 4:1), and future analyses with gender matching are needed to minimize potential bias; (2) Transient AF episodes may have been missed; (3) A small number of hypertensive patients taking beta-blockers for blood pressure control were included. While we deducted points for treated hypertension in scoring, the direct anti-arrhythmic effect of beta-blockers was not considered. These factors may introduce some bias.

Conclusion

The LE8-based CVH score is negatively associated with new-onset AF risk, with BMI score and blood pressure score as individual components showing independent negative correlations. These findings provide robust evidence for AF risk reduction strategies, potentially improving quality of life and longevity.

Author Contributions: ZHANG Yuan, HAN Quanle, and WU Shouling conceived the study and designed the protocol. HOU Qiqi, QI Qi, and JIANG Yue were responsible for participant selection, sample collection, and laboratory testing. WANG Nan, CHEN Shuohua, and LI Kangbo handled data collection, processing, and statistical analysis. ZHANG Yuan, HOU Qiqi, and YUE Bocheng drafted the manuscript. HAN Quanle revised the final version and takes responsibility for the paper.

Conflict of Interest: None declared.

ORCID IDs:
ZHANG Yuan: https://orcid.org/0009-0004-0542-9399
HAN Quanle: https://orcid.org/0000-0002-3200-9224

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Note: Figure translations are in progress. See original paper for figures.