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Ideal cardiovascular health metrics and risk of cardiovascular disease or mortality: A meta-analysis

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ABSTRACT

Background: Inconsistent findings have reported regarding ideal cardiovascular health metrics and cardiovascular disease (CVD) and mortality.
Objective: To investigate whether achieving a greater number of ideal cardiovascular health metrics was associated with a lower risk of CVD and mortality in the general population by conducting a meta-analysis of data from available prospective cohort studies.
Methods: A comprehensive literature search was conducted in PubMed, Embase, and Web of Science from their inception to February 2016. Only prospective cohort studies investigating the association between the ideal cardiovascular health metrics and CVD or mortality were eligible. The most-fully adjusted risk ratio (RR) and corresponding 95% confidence intervals (CI) was pooled to estimate the association.
Results: Nine prospective cohort studies involving 12,878 participants were analyzed. Meta-analyses showed that achieving a greatest ideal cardiovascular health metrics was associated with lower risk of all-cause mortality (RR 0.55; 95% CI 0.37–0.80), cardiovascular mortality (RR 0.25; 95% CI 0.10–0.63), cardiovascular disease (RR 0.20; 95% CI 0.11–0.37),and stroke (RR 0.31; 95% CI 0.25–0.38).
Conclusions: Ideal cardiovascular health metrics are inversely associated with all-cause mortality and cardiovascular events, supporting the use of cardiovascular health metrics as a useful tool to predict mortality and cardiovascular disease risk.

1. Introduction

Cardiovascular disease (CVD) remains the leading cause of death worldwide [1]. In order to promote CVD reduction, the American Heart Association (AHA) established a simplified 7-item tool including smoking status, physical activity, healthy dietary intake, body mass index, total cholesterol, blood pressure, and fasting plasma glucose to promote ideal cardiovascular health in 2010 [2]. Ever since then, the concept of ideal cardiovascular health (CVH) has been used to measure population health [3].

Achieving a greater number of ideal CVH metrics was associated with lower risk of cardiovascular events [4–11]. However, relationships between ideal CVH metrics and stroke [6,10–12] or all-cause mortality [5,7–9] remain conflicting. Differences in subject's characteristic, geographic area, socioeconomic status, follow-up duration, adjustment for covariates may explain these inconsistent findings. Therefore, we performed this meta-analysis of available prospective studies to estimate the association between ideal CVH metrics and risk of CVD, stroke, cardiovascular and all-cause mortality in the general population.

2. Method

2.1. Search strategy

We searched all relevant articles indexed in PubMed, Embase, and Web of Science from their inception to February 2016. The following searching keywords were applied: cardiovascular health metrics OR ideal cardiovascular health AND mortality OR death OR cardiovascular disease OR stroke OR cerebrovascular disease AND prospective. Moreover, the reference lists of retrieved papers were manually searched for the possible studies. In addition, we also manually screened the references of the included articles to identify additional studies.

2.2. Study selection

Studies were eligible if: 1) prospective observational studies investigating the ideal CVH metrics and cardiovascular events (CVD, stroke or cardiovascular mortality) or all-cause mortality in the general population; and 2) reporting adjusted risk estimates for the greatest attainment of ideal CVH metrics and cardiovascular events or all-cause

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mortality comparing the greatest to least ideal CVH metrics. Studies were excluded if 1) CVH metrics as a continuous variable; 2) CVH metrics change as exposure; and 3) greatest CVH metrics as reference. For the multiple articles from the same study, we only selected the article with the complete data.

2.3. Data extraction and quality assessment

Two reviewers (N Fang and ML Jiang) independently extracted the data from the included articles. The following information were extracted: author, publication year, origin of the study, study design, sample size, percentage of men, mean age or age range of subjects, ideal CVH comparison, number of events, the most fully-adjusted risk estimate, duration of follow-up, and adjustments for covariates. Discrepancies in the data extraction were resolved by discussion and consensus. Methodological quality of included studies was examined using the Newcastle–Ottawa Scale (NOS) for cohort studies [13]. The NOS was judged on three dimensions including selection of the study groups, comparability of the groups, and ascertaining of outcome. Studies achieving a rating of 6 or more were judged to be at low risk of bias.

2.4. Statistical analyses

All the analyses were performed using the STATA statistical software version 12.0 (STATA Corp LP, College Station, TX, USA).The multivariate-adjusted risk ratio (RR) or hazard ratio (HR) with 95% confidence interval (CI) was pooled comparing the greatest to the least ideal CVH metrics. Heterogeneity across studies was accessed by using the Cochrane Q test and I^2 statistic. A p-value in the Cochrane Q test ≤0.10 or I^2>50% were considered as evidences of substantial heterogeneity [14]. We chose a random effect model in the pooled analysis when the substantial heterogeneity was observed; otherwise, a fixed-effect model was selected. Publication bias was not performed owing to the number of studies was less than the recommended arbitrary minimum number of ten studies [15].

3. Results

3.1. Literature search and study characteristics

Briefly, a total of 379 potentially relevant records were initially identified. After applying our predefined inclusion criteria, nine prospective studies [4–12] finally included in this meta-analysis. Fig. 1 shows a flow chart of the detailed literature searches. Of 9 studies, 2 studies [9,11] analyzed data from the same studied population but addressed on mortality and stroke/CVD risk separately. The included studies were published between 2011 and 2015. The sample sizes of included studies varied from 2981 to 91,968, follow-up duration ranged from 4.02 to 18.7 years. Overall, the methodological quality of the included studies was generally high according to the 9-star NOS scales. Table 1 summarizes the characteristics of the individual studies.

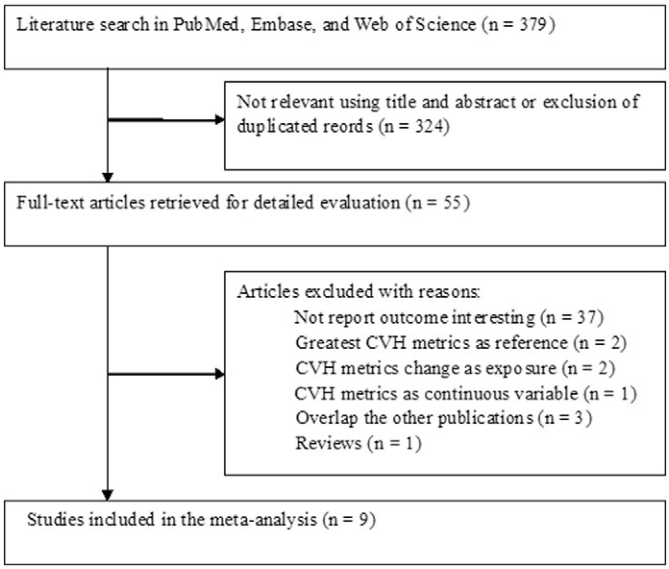

Fig. 1. Flow chart of study selection process.

3.2. Ideal CVH metrics and all-cause or cardiovascular mortality risk

Four studies [5,7–9] involving 126,700 subjects reported 3541 all-cause mortality events and 838 cardiovascular mortality events. As shown in Fig. 2, achieving a greatest number of ideal CVH metrics was associated with lower risk of all-cause mortality (RR 0.55; 95% CI 0.37–0.80; $I^2 = 73.6\%$, $P = 0.010$) and cardiovascular mortality (RR 0.25; 95% CI 0.10–0.63; $I^2 = 73.4\%$, $P = 0.010$) in a random effects model. When we changed to a fixed-effect model, the pooled RR was 0.59(95% CI 0.50–0.71) for all-cause mortality and 0.40 (95% CI 0.28–0.59) for cardiovascular mortality.

3.3. Ideal CVH metrics and CVD risk

As shown in Fig. 3, meta-analysis from four studies [4,6,10,11] showed that achieving the greatest number of ideal cardiovascular health metrics was associated with lower risk of CVD (RR 0.20; 95% CI 0.11–0.37; $I^2 = 87.6\%$, $P < 0.001$) in a random effects model. The pooled RR and corresponding 95% CI had no change when we applied a fixed-effect model.

3.4. Ideal CVH metrics and stroke risk

Four studies [6,10–12] involving 127,536 subjects reported 3390 stroke events. As shown in Fig. 4, the pooled RR for stroke was 0.31 (95% CI 0.25–0.38; $I^2 = 0.0\%$, $P = 0.744$) comparing the greatest to the least ideal CVH metrics in a fixed-effect model. Moreover, the pooled RR and corresponding 95% CI were unchanged when we selected a random effect model.

3.5. Sensitivity analyses

Sensitivity analyses were conducted by sequentially omitting one study at each turn. There were few changes in the quantitative summary measure of RR and corresponding 95%CI of each specific outcome.

4. Discussion

This meta-analysis suggests that ideal CVH metrics are inversely associated with cardiovascular events and all-cause mortality. Subjects having greatest ideal CVH metrics led to 80% lower risk of overall CVD, 69% lower risk of stroke as well as 75% and 45% markedly lower risks for cardiovascular and all-cause mortality. In addition, the Framingham Offspring Study reported that per 1-unit increase in CVH score was associated with 13% lower risk of CVD [16]. These findings indicated that there were incremental benefits to increase the number of ideal CVH metrics.

In the Tromsø Study of 22,121 participants, a graded association was shown between the cardiovascular health metric score and incident myocardial infarction [17]. The Northern Manhattan Study showed that the presence of a greater number of the ideal CVH metrics at baseline was associated with a markedly lower risk of myocardial infarction [6]. In the Framingham Offspring Study, per 1-point higher CVH score was inversely associated with 23% lower risk of heart failure [18]. Each increase in CVH metrics was associated with 13% lower risk of total stroke among 64,373 participants in the Kailuan study [19]. In the Women's Health Initiative study of 161,809 women, those with the