DOI: http://dx.doi.org/10.22122/arya.v16i5.2067 Published by Vesnu Publications



# The Recommended Food Score and Healthy Nordic Food Index in cardiovascular disease and stroke: A systematic review

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Review Article

## Abstract

**BACKGROUND:** Cardiovascular disease (CVD) includes a group of heart and coronary disorders that can be prevented by promoting the quality of an individual's diet. The Recommended Food Score (RFS) and Healthy Nordic Food Index (HNFI) are suggested for the assessment of diet quality and as indicators of dietary exposures related to disease. The aim of this study was to systematically review the association of the RFS and the HNFI with CVD and stroke.

**METHODS:** Articles were identified by searching PubMed, Google Scholar, and ScienceDirect using relevant keywords for articles published until December 2018. The inclusion criteria were all types of observational studies and English language. Non-English and irrelevant studies were excluded.

**RESULTS:** In total, 14 studies met the inclusion criteria. Of the 7 studies that investigated the association between the RFS and CVD, 6 articles showed a lower risk of CVD in individuals who obtained a higher RFS and lower non-RFS (n-RFS) score. Studies that investigated the relation between RFS and stroke (n = 2) showed that achieving a higher RFS could decrease the risk of stroke. Of the 4 studies that assessed the relationship between HNFI and CVD, 3 showed that adherence to HNFI were related with lower risk of CVD/stroke. However, one study did not show any relationship.

**CONCLUSION:** A higher RFS may result in a decrease in the risk of CVD and stroke. Due to the inconsistency of the findings related to HNFI, more studies are needed to approve the negative relationship between HNFI and CVD.

**Keywords:** Diet; Cardiovascular Diseases; Stroke

***Date of submission:*** 14 Sep. 2019, ***Date of acceptance:*** 02 May 2020

## Introduction

Cardiovascular disease (CVD) is defined as a group of diseases including heart and coronary disorders such as coronary heart disease (CHD), diseases related to brain vessels and/or peripheral vessels, and other conditions.[1] One third of the total mortality rate in the United States is attributed to CVD.[2] Incidence of myocardial infraction (MI) is 5 to 6 times higher in CHD patients. Every year, approximately 32 million people suffer from cerebral and heart vessels disorders and the risk of stroke recurrence is higher in people who have experienced stroke.[3] Stroke is one of the main causes of disability and mortality, so its primary prevention is important.[4]

Despite the undeniable effect of pharmacological treatment on the management of blood pressure and blood lipid, as the main risk factors of CVD, adherence to a healthy lifestyle such as healthy eating habits may be more effective with fewer side effects than that of medication.[5]

Low quality diet is a strong risk factor for all-cause mortality as well as CVD mortality. Moreover, assessment and recording of dietary intake, especially when nutrients data is needed, is difficult and can result in measurement bias.

**How to cite this article:** Hajjar M, Rezazadeh A. **The Recommended Food Score and Healthy Nordic Food Index in cardiovascular disease and stroke: A systematic review.** ARYA Atheroscler 2020; 16(5): 248-57.

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In modern epidemiological approach, assessing the overall diet quality is a better indicator of CVD risk than a single nutrient or a food group because foods are not consumed in isolation.[6] In recent decades, some indices such as the Recommended Food Score (RFS) and Healthy Nordic Food Index (HNFI) have been suggested for the assessment of diet quality. RFS separates "good" and "bad" foods to describe a healthy and unhealthy diet.[7] However, the HNFI includes only foods with healthy effects based on the traditional Nordic Diet.[8] These indices are suggested as strong indicators of dietary exposures related to disease.[8]

In the last two decades, the role of healthy eating has been emphasised in the prevention of CVD.[9] Dietary guidelines commonly focus on food patterns more than nutrients.[9] The common factors among these guidelines are promoting the consumption of fruits, vegetables, fish, grains, nuts, and olive oil.[9] The Western dietary pattern has become a common pattern which includes animal products, refined carbohydrates, and low consumption of vegetables and fruits.[9] Healthy dietary patterns try to reverse effect of the Western dietary pattern by increasing the consumption of vegetables and fruits. The purpose of this study was to systematically review the RFS and HNFI indices, which are related to healthy dietary patterns, and their relation with CVD and stroke.

## Materials and Methods

*Data source and search strategies:* Literature search was conducted by searching articles published on PubMed, Google Scholar, and ScienceDirect until December 2018. Moreover, reference lists of the included studies were also searched to find related articles. Terms and words used for the search included "cardiovascular disease", "heart diseases", "heart failure", "myocardial infraction", "coronary heart disease", "stroke", "Recommended Food Score", and "Healthy Nordic Food Score". The Search strategy is explained in detail in figure 1. The literature search was restricted to human studies written in the English language and all kind of observational studies (cross-sectional, cohort, case-control, and longitudinal). The Medical Subject Headings (MeSH) was checked for the selected keywords. Grey literature such as governmental and organizational reports and the reference list of the selected studies were also searched manually for relevant information and articles.

Studies were added to the review if they reported the RFS and HNFI score, but not food or nutrients.

The initial systematic search identified 535 potential articles. Two authors independently screened titles and abstracts based on the eligibility criteria according to the PICOS model (population, intervention, comparators, outcomes, and study design). The population criterion included all age groups and healthy people, intervention (exposure) included adherence to HNFI or RFS, the comparator consisted of the HNFI or RFS scores, the outcome criterion included the risk of CVD or stroke, or CVD or stroke mortality and morbidity, and observational studies (cross-sectional, cohort, longitudinal, etc.) was determined as the study design.

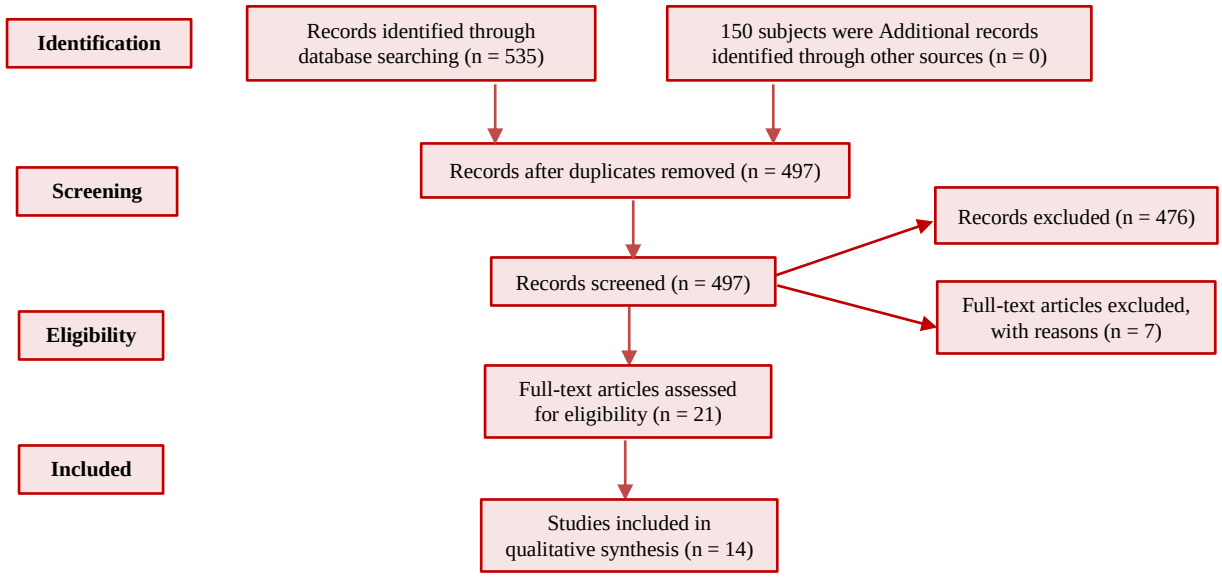


**Figure 1.** Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

Next, the full text of potential articles was reviewed by authors based on the inclusion criteria. Furthermore, the study selection process was followed based on the checklist of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[10] (Figure 1). The methodology of this systematic review was registered at the International Prospective Register for Systematic Reviews CRD42018095574. Methodology of quality assessment was checked based on PRISMA checklist.[11]

*Data extraction and quality assessment:* For each study, the information extracted included study design, the first author, year of publication, follow-up duration, and location, outcome of the study, study population, age, and dietary assessment tool.

## Results

In total, 14 articles were qualified to be included in the study.[2,4-6,12-21] The main results are presented in tables 1-3.

Of the selected articles, 11 were cohort studies,[4-6,13-15,17-21] 2 were cross-sectional studies,[17,18] and 1 was a cross-national study [a comparative study on cardiovascular health conducted in two different countries: Maine Syracuse Study (Central New York, USA) and ORISCAV-LUX (Luxembourg)].[2] The studies were conducted in Sweden (6 articles),[4,5,14,15,19,21] Denmark (2 articles),[12,13] Brazil (1 article),[17] USA (3 articles),[16,18,20] Luxembourg and New York (1 article),[2] 10 European countries (1 article).[6] A majority of the studies included both genders, except 4 articles that were performed only on women[4,14,15,21] and 2 that were conducted on men.[5,19] The age of the participants ranged from 39[14,15] to 62 years,[18] except in 1 article in which the food habits of 6-14-year-old school aged children was assessed.[17]

Moreover, 9 articles defined RFS,[2,4,5,16-21] and 5 HNFI.[6,12-15] CVD was studied in 11 articles[2,5,6,13-20] among which 2 assessed MI,[5,13] 1 examined ischemic heart disease, arrhythmias, thrombosis, and hypertensive disease,[15] 1 defined cardiovascular health arterial stiffness by pulse wave and pulse pressure,[16] and 3 assessed cardiovascular health by biochemical factors, blood pressure, body fat, and physical activity.[2,17,18] Furthermore, 3 articles assessed CVD mortality,[6,14,19] and 3 investigated the risk of stroke[4,12,21] by cerebral infarctions, hemorrhagic strokes (intracerebral hemorrhages and subarachnoid hemorrhages), unspecified strokes,[4,12,21] total stroke, ischemic stroke, large-artery atherosclerosis, and small-artery occlusion.[12]

Dietary intake was assessed using the Food Frequency Questionnaire (FFQ) in 11 studies[4-6,12-15,17,19-21] and the Nutrition and Health Questionnaire,[2,16,18] which was validated in the EPIC project in 2 studies.[6] In the pan-European cohort study, dietary intake was assessed using a questionnaire that was validated in those countries.[6]

Of the 7 studies that investigated the association between the RFS and CVD, 6 showed a lower risk of CVD in individuals who obtained higher scores in RFS and lower scores in the Non-Recommended Food Score (n-RFS) (Table 1).[2,5,16,18-20] Coelho et al.[17] found no associations between RFS and risk of CVD in students, but after stratifying the participants by age, RFS could predict systolic blood pressure (SBP) and Tetrapolar Percentage of Body Fat only in children (not in adolescents). Moreover, they found an inverse association between RFS and SBP in children after adjusting for family income, gender, biochemical factors, and body fat percentage.[17]

The results of 2 studies that investigated the relationship between RFS and stroke showed that achieving higher RFS could decrease the risk of a stroke in women (Table 2).[4,21]

The other reviewed index was the HNFI as a recently noticed index. The HNFI index and CVD were assessed in 4 studies (Table 3).[6,13-15] Roswall et al.[15] observed no association between HNFI and risk of CVD.[15] In another study, Roswall et al. observed that increment in HNFI score was associated with lower mortality rate of CVD, but the association was no longer present after adjusting for cofounding factors like alcohol, red meat, processed meat, and energy intake.[14] In 2 other studies, it was reported that adherence to HNFI may decrease the risk of CVD.[6,13]

Furthermore, Hansen et al.[12] conducted a cohort study on 28,997 women and 26,341 men in Denmark in 2017. After 13.5 years of follow-up, they found a statistically significant inverse relationship between HNFI and stroke, and higher adherence to this index resulted in a 14% decrease in the risk of stroke after adjustment for confounders (HR = 0.86; 95% CI: 0.76-0.98).

## Discussion

The present review study summarizes the relationship of adherence to RFS and HNFI with CVD and stroke incidence and mortality. This review showed that adherence to healthy food items in the RFS may be related to lower risk of CVD and stroke; furthermore, higher intake of food items in the n-RFS can increase the risk of CVD and stroke. The relation between HNFI and CVD was inconsistent.

**Table 1.** Characteristics of studies (n = 7) examining the relationship between the Recommended Food Score and cardiovascular disease

| Reference | Age (year) | Participants/ gender | Country/ year of publication | Design | Aim of study | Duration of study (year) | Results | OR/HR/ percent change | Dietary assessment method |
|---|---|---|---|---|---|---|---|---|---|
| McCullough et al.[20] | USA 2002 | 38615 men 67271 women | 40-75 | Cohort | Diet quality and major chronic disease risk in men and women: moving toward improved dietary guidance | 8-12 | FFQ (130 items) RFS score = 23 | (RR = 0.77; 95%CI: 0.64-0.93) | 23% reduction in risk of CVD |
| Kaluza et al.[19] | Sweden 2009 | 40 837 men | 45-79 | Cohort | Diet quality and mortality: a population-based prospective study of men | 7 | FFQ (96 items) RFS score = 36 n-RFS score = 16 | (RR = 0.71; 95% CI: 0.54–0.93) | Adherence to RFS can decrease mortality due to CVD by 29%. There was no significant association between n-RFS and CVD mortality. |
| Akesson et al.[5] | Sweden 2014 | 20721 men | 45-79 | Cohort | Low-Risk Diet and Lifestyle Habits in the Primary Prevention of MI in Men | 10 | FFQ (96 items) RFS score = 25 n-RFS = 21 scores | (RR = 0.82; 95% CI: 0.69-0.96) | 18% reduction in risk of MI |
| Crichton et al.[16] | Syracuse, New York and surrounding counties 2014 | 201 men 304 women | 18-83 | Cohort | Cardiovascular health and arterial stiffness: The Maine-Syracuse Longitudinal Study | 4-5 | Nutrition and Health Questionnaire RFS score = 23 n-RFS score = 15 | | Individuals who have higher CHS (5-8), have higher mean RFS score (11.6 ± 2.8) and lower mean n-RFS score (2.9 ± 1.6). |
| Crichton et al.[18] | New York 2014 | 399 men 573 women | 18-83 | Cross-sectional | Cardiovascular Health and Cognitive Function: The Maine-Syracuse Longitudinal Study | | Nutrition and Health Questionnaire RFS score = 23 n-RFS score = 15 | | Individuals who have higher CHS (5-8), have a higher mean RFS score (12 ± 2.9) and lower mean n-RFS score (2.8 ± 1.8). |

**Table 1.** Characteristics of studies (n = 7) examining the relationship between the Recommended Food Score and cardiovascular disease (continue)

| Reference | Age (year) | Participants/ gender | Country/ year of publication | Design | Aim of study | Duration of study (year) | Results | OR/HR/ percent change | Dietary assessment method |
|---|---|---|---|---|---|---|---|---|---|
| Crichton et al.[2] | Luxembourg and Central New York, USA 2014 | Luxembourg: 1145 New York: 673 | 30-69 | Cross-national | Cardiovascular health: a cross-national comparison between the Maine Syracuse Study (Central New York, USA) and ORISCAV-LUX (Luxembourg) | Luxembourg: 2 New York: 5 | Luxembourg: semi-quantitative FFQ (134 items) New York: Nutrition and Health Questionnaire RFS score = 18 n-RFS score = 13 | | Individuals with ideal RFS (12-18) and ideal n-RFS (0-2), have higher CHS. |
| Coelho et al.[17] | Brazil 2015 | 738 students | | Cross-sectional | Food habits and risk of cardiovascular disease in school children from Ouro Preto, Minas Gerais | 6-14 | FFQ (120 items) RFS score = 50 | SBP: β= -0.112; 95%CI, -0.462; -0.001. BFP-T: β= -0.131; 95%CI, -0.301; -0.015 | After adjusting for age, RFS predicted SBP and BFP-T. |

OR: odds ratio; HR: Hazard ratio; CI: Confidence interval; FFQ: Food Frequency Questionnaire; RFS: Recommended Food Score; MI: Myocardial infarction; CHS: Cardiovascular health score; SBP: Systolic Blood Pressure; BFP-T: Tetrapolar Percentage of Body Fat

**Table 2.** Characteristics of studies (n = 2) examining the relationship between the Recommended Food Score and stroke

| Reference | Country /year of publication | Participants/ gender | Age (year) | Design | Aim of study | Duration of study (year) | Dietary assessment method | OR/HR/ percent change | Results |
|---|---|---|---|---|---|---|---|---|---|
| Larsson et al.[4] | Sweden 2014 | 31696 women | 49-83 | Cohort | Healthy diet and lifestyle and risk of stroke in a prospective cohort of women | 10.4 | FFQ (96 items) RFS score =25 n-RFS score = 21 | (RR = 0.85;95% CI: 0.76-0.95) | The risk of stroke reduced by 15%. |
| Larsson et al.[21] | Sweden 2014 | 31696 women | 49-83 | Cohort | Overall diet quality and risk of stroke: A prospective cohort study in women | 11 | FFQ (96 items) RFS score =25 n-RFS score = 21 | (RR = 0.80; 95%CI: 0.67-0.95) | After adjusting for confounders, the risk of total stroke in the top quartile of RFS was 20% lower than other quartiles. |

OR: odds ratio; HR: Hazard ratio; CI: Confidence interval; FFQ: Food Frequency Questionnaire; RFS: Recommended Food Score

**Table 3.** Characteristics of studies (n = 4) examining the relationship between the Healthy Nordic Food Index and cardiovascular disease

| Reference | Country/ year of publication | Participants/ gender | Age (year) | Design | Aim of study | Duration of study (year) | Dietary assessment method | OR/HR/ percent change | Results |
|---|---|---|---|---|---|---|---|---|---|
| Roswall et al.[15] | Sweden 2015 | 43310 women | 29-49 | Cohort | No association between adherence to the HNFI and CVD amongst Swedish women: a cohort study | 21 | FFQ | (HR = 1.00; 95% CI: 0.98-1.01) | A 1-point increase in the HNFI score was not associated with incidence of CVD. |
| Roswall et al.[14] | Sweden 2015 | 446961 women | 29-49 | Cohort | Adherence to the healthy Nordic food index and cause-specific mortality among Swedish women | 21.3 | FFQ (80 items) | (MRR = 1.01; 95%CI: 0.92-0.1) | In the fully adjusted models, a 1-point increase in the HNFI score was not associated with incidence of CVD. |
| Lassale et al.[6] | European countries: Denmark, France, Germany, Greece, Italy, the Netherlands, Norway, Spain, Sweden, and the United Kingdom, 2016 | 130370 men 320886 women | 40-60 | Cohort | Diet Quality Scores and Prediction of All-Cause, Cardiovascular and Cancer Mortality in a Pan-European Cohort Study | 8 | Validated country-specific dietary questionnaires | (HR = 0.88; 95%CI: 0.85-0.91) | Adherence to HNFI decrease mortality due to CVD by 12%. |
| Gunge et al.[13] | Denmark 2017 | 57053 men and women | 50-64 | Cohort | Adherence to the HNFI and risk of MI in middle-aged Danes: the diet, cancer, and health cohort study | 4 | FFQ (192 items) | (men: HR = 0.77; 95%CI: 0.62-0.97; woman: HR = 0.55; 95%CI: 0.37-0.82) | Risk of MI significantly decreased in individuals with a score of 5-6 (45% in women and 23% in men). |

OR: odds ratio; HR: Hazard ratio; CI: Confidence interval; FFQ: Food Frequency Questionnaire; HNFI: Healthy Nordic Food Index; CVD: Cardiovascular disease; MRR: Mortality rate ratio; MI: Myocardial infarction

RFS is a kind of healthy diet comprising a combination of consumption of fruit, vegetables, nuts, fish, and low fat dairy, which have beneficial effects on cardiovascular health.[5] The HNFI is a Swedish method[7] developed by Kant et al.;[22] it separates "good" and "bad" food to describe healthy and unhealthy diets based on the foods recommended by dietary guidelines.[22] Michels and Wolk completed the RFS by developing the n-RFS.[7] The items of the RFS and n-RFS, and the method of their calculation are included in table 4.

Studies showed that adherence to RFS could decrease 18% of the risk of MI.[5] In addition, individuals with higher RFS scores and lower n-RFS scores had lower blood pressure, fasting blood glucose, and total cholesterol.[2,16,18]

Almost all studies were carried out among adults. Only 1 study was carried out on children and adolescents, which reported a significant negative relationship between RFS and CVD only in children. This result may be due to the fact that parents and family members have a controlling role in the adherence of children to a healthy diet, but this role was weaker in adolescents because they want to experience more independence ; so, they disobey of their parents rules.[17]

Adherence to RFS can decrease the risk of cerebral infraction, hemorrhagic stroke, and total stroke by 13%, 23%, and 15%-20%, respectively.[4,21] High consumption of foods listed in the n-RFS could increase the risk of cerebral stroke and total stroke by about 22-27 percent.[21]

The risk of stroke is lower in women who have a high quality diet and consume all kinds of healthy foods, because the RFS is compatible with the primarily stroke prevention guidelines. These guidelines include low consumption of salt and saturated fat, high consumption of fruit and vegetables (high density of potassium), low-fat dairy, and fish all of which were included in the RFS.[21]

The HNFI was originally developed by Olsen et al.[8] and includes only healthy food based on the traditional Nordic Diet. The items of the HNFI and its calculation method are provided in table 4. The association of HNFI score with risk of CVD was inconsistent. The average HNFI score in European countries was 2-3.[6,12-15] In 2 studies, it was reported that adherence to HNFI may decrease the risk of MI mortality.[6,13]

**Table 4**. Recommended and non-Recommended Food Score and Healthy Nordic Food Index items and scoring

| Index | | Items | Calculation |
|---|---|---|---|
| RFS | Fruits | apples or pears; oranges; cantaloupe; orange or grapefruit juice; grapefruit, other fruit juices | The RFS score is obtained by calculating the sum of the scores of these 23 items that are consumed at least once a week.* |
| | Vegetables | dried beans; tomatoes; broccoli; spinach; mustard, turnip or collard greens; carrots or mixed vegetables with carrots; green salad; sweet potatoes or yams; other potatoes | |
| | Lean meat or poultry | baked or stewed chicken or turkey; baked or boiled fish | |
| | Whole grains | dark breads like whole wheat, rye, or pumpernickel; cornbread, tortillas, grits; high-fiber cereals, such as bran, granola, or shredded wheat; cooked cereals | |
| | Low fat dairy: | 2% milk and 1% or skim milk | |
| n-RFS | Meat | meat; meat stew; minced meat | The n-RFS score is obtained by calculating the sum of the scores of these 21 items that are consumed at least 1-3 times per month.* |
| | Processed meat | bacon; sausages; blood pudding/sausages; cold cuts; pate | |
| | Visceral meat | liver, kidney | |
| | Fried potatoes | French fries; chips | |
| | High-fat dairy | cheese (high saturated fat); butter; margarine; | |
| | White bread | pancakes, Belgian waffle | |
| | Cookies | | |
| | Ice cream | | |
| | Candy | | |
| | Sugar | | |
| HNFI | fish | | One point was given for each of the food items that were consumed above the sex-specific median intake of the whole study. |
| | cabbages | | |
| | whole grain rye | eaten as rye bread | |
| | whole grain oats | oatmeal | |
| | apples and pears | | |
| | root vegetables | | |

RFS: Recommended Food Score; n-RFS: non-Recommended Food Score; HNFI: Healthy Nordic Food Index

* The numbers of the items in RFS, n-RFS, and the calculation of the score could differ among the studies assessed in this systematic review

However, no association was found between HNFI and CVD (e.g., ischaemic heart disease, arrhythmias, and thrombosis) risk in the study by Roswall et al.[15] This finding can be attributed to the type of FFQ that was used in the study, which did not separate whole-grain and non-whole grain items. Thus, whole grains that have an important role in HNFI score and CVD prevention were disregarded.[6,15,23,24] Furthermore, in the study by Roswall et al., with a 1-point increase in HNFI score no change was observed in CVD mortality that may be due to the low power of the study and use of self-reported cofounders such as BMI.[14]

Components of the HNFI include CVD preventive factors such as ω-3 in fish, β-carotene in root vegetables (carrot), isothiocyanates in cabbage, carotenoid in apple and pears, and fiber in whole grains.[13,23,25] Omega-3 can decrease plasma triglyceride and hepatic very-low-density lipoprotein (VLDL) synthesis as a result of decreasing de novo lipogenesis (DNL) and increasing β-oxidation. Moreover, ω-3 can decrease blood pressure and resting heart rate.[26] Macrophages, which are rich in β-carotene, decrease the cellular cholesterol synthesis and increase the activity of LDL receptors in macrophages. Therefore, dietary consumption of Beta carotene decreases the cholesterol.[27] In addition, carotenoids destroy free radicals, so they can decrease the risk of atherosclerosis.[28] The fiber of the grain group is another preventive factor that decreases LDL and blood pressure.[23]

Down-regulation of messenger ribonucleic acid (mRNA) of the interleukin-18 that is a pre-inflammatory cytokine and has an important role in the incidence of CVD in the elderly is enhanced in individuals with a high HNFI score.[29] Furthermore, SBP, plasma triglyceride, total cholesterol, and VLDL are lower in individuals who earned higher HNFI scores.[30] Most studies showed that despite the fact that a healthy diet is an important determinant of a healthy lifestyle, other factors such as not smoking, higher physical activity, moderate alcohol consumption, and low abdominal adiposity may increase the protective effect of a healthy diet that should be addressed in future studies.[4,5,19,21]

The strengths of the articles reviewed in this study was the cohort design of most studies, their reasonable follow-up period (range: 4-21 years), and their large sample sizes. The reviewed articles had several limitations. First, some studies did not study both genders and the power of some of them was low.[4,5,14,15,21] Second, in some studies, dietary intake information were obtained through self-reporting methods, which may not be as accurate as assessment by trained nutritionists, or they were only measured in one occasion, which may have reduced the precision of the study.[5,12,16,21]

## Conclusion

RFS and HNFI may decrease the risk of CVD and stroke. Due to the inconsistency in the present study results, it is suggested that the relation between HNFI and CVD be further studied. In addition, it is suggested that clinical trials be carried out in order to examine the effect of RFS on CVD control as the potential ecological benefits of the HNFI were discovered in non-experimental studies.

## Acknowledgments

This study is related to project NO. 1397/58544 approved by the Student Research Committee, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

We would like to thank the "Student Research Committee" and "Research & Technology Chancellor" of Shahid Beheshti University of Medical Sciences for their financial support of this study.

## Conflict of Interests

Authors have no conflict of interests.

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