Overall diet quality and risk of stroke: A prospective cohort study in women

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Data on overall diet quality in relation to stroke risk are sparse. We examined the association between consumption of a diversity of recommended and non-recommended foods and risk of stroke. The study population comprised 33 911 Swedish women who had completed a questionnaire in 1997 and were free from cardiovascular disease and cancer. We calculated a Recommended Food Score (RFS) based on 25 healthy food items and a Non-Recommended Food Score (NRFS), consisting of 21 food items considered less healthy. Stroke cases were identified through linkage to Swedish registers. During 11 years of follow-up, we ascertained 1687 stroke cases. The multivariable relative risks of stroke for the highest versus lowest quintile were 0.80 (95% CI, 0.67–0.95) for RFS and 1.22 (95% CI, 1.02–1.46) for NRFS. In conclusion, these findings suggest that a diet including a variety of healthy foods and few less healthy foods may reduce stroke risk.

1. Introduction

Stroke is a major cause of morbidity and mortality in Western countries. It has been estimated that 80% of stroke events can be prevented (secondary prevention) through modifiable risk factors, including diet [1]. Most studies on diet and stroke have focused on the role of specific nutrients, foods, or food groups rather than the whole diet. Because foods are consumed in combination, the combined effect of diet on stroke risk may be assessed by considering the entire eating pattern, which accounts for interactions between foods containing different nutrients.

The aim of this study was to investigate the association between a Recommended Food Score (RFS), derived from food-based recommendations [2], and stroke risk in the Swedish Mammography Cohort (SMC). We also assessed whether consumption of a diversity of non-recommended foods (Non-Recommended Food Score; NRFS), i.e., foods considered less healthy, was associated with an increased risk of stroke.

2. Methods

2.1. Study population

The SMC provided data for the present analyses. Detailed information about this cohort has been published previously [3]. The study population for the present analysis included 33 911 participants of the SMC study who had completed a questionnaire in 1997 and were free from cardiovascular disease and cancer. The study was approved by the Regional Ethical Review Board at Karolinska Institutet in Stockholm, Sweden.

2.2. Data collection

In 1997, all participants had completed a questionnaire that sought information on education, weight, height, smoking, physical activity, aspirin use, history of hypertension, family history of myocardial infarction, alcohol consumption, and diet. Pack-years of smoking history were calculated as the number of cigarette packs smoked daily multiplied by the number of years of smoking. Calculation of total physical activity has been described previously [3].

2.3. Dietary assessment

Diet was assessed using a 96-item food-frequency questionnaire (FFQ). Participants were asked to indicate how often, on average, they had consumed various foods over the past year, with 8 pre-defined frequency categories ranging from never to ≥3 times/day. For commonly consumed foods, such as dairy products and bread, participants were asked to indicate the exact number of servings per day or week. A diet with a variety of healthy foods was defined according to a RFS, which is a way to define the overall diet quality by separating ‘healthy’ from ‘less healthy’ foods based on current...
knowledge and dietary guidelines [4]. The RFS was developed by Kant et al. [2] to measure dietary diversity in the National Health and Nutrition Examination Survey and later adapted for our FFQs [4,5]. The RFS included foods with a benefit of cardiovascular health [6–8], i.e., fruits (apples and pears); bananas; citrus fruits; and berries), vegetables (spinach; lettuce and green salad; cabbage; cauliflower; broccoli and Brussels sprouts; carrots; beetroots; tomatoes and tomato juice; sweet pepper; green peas; and mixed vegetables), legumes, nuts, low-fat dairy products (reduced-fat milk, reduced-fat cultured milk/yogurt), whole grains (whole grain bread, crisp/hard bread, oatmeal), and fish (herring/mackerel, salmon/whitefish/char, cod/saithe/ﬁsh ﬁsh). A food score of one (adding up to a maximum of 25) was assigned for 1 or more servings per week of any of two low-fat milk products, whole grain bread, and crisp/hard bread. For the remaining food items (fruits, vegetables, legumes, oatmeal, nuts, and fish), a food score was assigned if the consumption frequency was at least 1–3 times/month. We extended the evaluation of overall diet quality to also include a NRFS, as proposed by Michels and Wolk [4]. NRFS values were based on 21 food items including red meat (minced meat, pork, beef/beef, liver/kidney), processed meat (sausage/hot dogs, ham/salami/processed meat cuts, liver paté, blood sausage), fried potatoes, French fries, potato crisps, solid fats (butter/margarines), whole fat milk products (full-fat milk, cheese, ice cream, cream), whole bread, refined cereals (spaghetti/macaroni), sugar, sweets, and buns/cookies [4]. The FFQ used in this study has been validated for nutrients and showed high validity (mean of 0.65 for macro-nutrients) [9].

2.4. Case ascertainment and follow-up

Information on the dates of stroke diagnosis was obtained by linkage of the study population to the Swedish Hospital Discharge Register and the Swedish Cause of Death Register. The International Classification of Diseases 10th revision was used to classify strokes. The stroke cases were classified as cerebral infarction (ICD-10 code I63), intracerebral hemorrhage (I61), subarachnoid hemorrhage (I60), and unspecified stroke (I64). Information on dates of death was obtained from the Swedish Cause of Death Register.

2.5. Statistical analysis

Participants accrued follow-up time from January 1, 1998 until the date of diagnosis of first stroke, death, or December 31, 2008. Cox proportional hazards regression models (with age as time scale) were used to estimate relative risks (RR) with 95% confidence intervals (CI) by quintiles of RFS and NRFS. Multivariable models were adjusted for the variables shown in Table 1 and Fig. 1 footnotes. All analyses were conducted using SAS (SAS Institute, Cary, NC). All statistical tests were 2-sided. P values <0.05 were considered statistically significant.

Table 1

<table>
<thead>
<tr>
<th>Score/no. of foods (mean)</th>
<th>Total stroke</th>
<th>Cerebral infarction</th>
<th>Hemorrhagic stroke†</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of cases</td>
<td>Person-years</td>
<td>RR (95% CI)</td>
<td>No. of cases</td>
</tr>
<tr>
<td>RFS</td>
<td>1–16 (14)</td>
<td>463</td>
<td>65 825</td>
</tr>
<tr>
<td></td>
<td>17–18 (18)</td>
<td>251</td>
<td>42 200</td>
</tr>
<tr>
<td></td>
<td>19–20 (20)</td>
<td>325</td>
<td>66 586</td>
</tr>
<tr>
<td></td>
<td>21–22 (22)</td>
<td>378</td>
<td>91 803</td>
</tr>
<tr>
<td></td>
<td>23–25 (23)</td>
<td>270</td>
<td>85 944</td>
</tr>
<tr>
<td>P for trend</td>
<td>0.02</td>
<td>0.03</td>
<td>0.15</td>
</tr>
<tr>
<td>NRFS</td>
<td>1–10 (9)</td>
<td>374</td>
<td>55 632</td>
</tr>
<tr>
<td></td>
<td>11–12 (12)</td>
<td>255</td>
<td>48 728</td>
</tr>
<tr>
<td></td>
<td>13–14 (14)</td>
<td>365</td>
<td>73 547</td>
</tr>
<tr>
<td></td>
<td>15–16 (15)</td>
<td>374</td>
<td>90 187</td>
</tr>
<tr>
<td></td>
<td>17–21 (18)</td>
<td>319</td>
<td>84 064</td>
</tr>
<tr>
<td>P for trend</td>
<td>0.56</td>
<td>0.02</td>
<td>0.02</td>
</tr>
</tbody>
</table>

RFS = recommended food score (variety of healthy foods); NRFS = non-recommended food score (variety of foods considered unhealthy).

† Intracerebral hemorrhage and subarachnoid hemorrhage.

‡ Multivariable relative risks were estimated using Cox proportional hazards regression model (with age as time scale) and were adjusted for education (less than high school, high school, or university), smoking (never; past <20, 20–39, or >40 pack-years; or current <20, 20–39, or >40 pack-years), body mass index (<20, 20–24.9, 25–29.9, or >30 kg/m²), total physical activity (MET h/d, quartiles), aspirin use (never, 1–6 tablets/wk, >7 tablets/wk), history of hypertension (yes/no) or diabetes (yes/no), family history of myocardial infarction before 60 years of age (yes/no), and intakes of total energy (kcal/d, continuous variable) and alcohol (nondrinkers, <3.4, 3.4–9.9, or >10.0 g/d). RFS and NRFS were included in the same multivariable model.

* Tests for trends were conducted by modeling RFS and NRFS as continuous variables.

Fig. 1. Relative risks† of total stroke according to joint tertiles of Recommended and Non-recommended Food Scores (RFS, NRFS) among 33 911 Swedish women. *Relative risks were estimated using Cox proportional hazards regression model (with age as time scale).
3. Results

Baseline characteristics of the study population according to quintiles of RFS and NRFS are presented in Supplementary Table. Over 11 years of follow-up, 1687 stroke cases, including 1260 cerebral infarctions, 163 intracerebral hemorrhages, 93 subarachnoid hemorrhages and 171 unspecified strokes were identified. The multivariable relative risks of total stroke for the highest versus lowest quintile were 0.80 (95% CI, 0.67–0.95) for RFS and 1.22 (95% CI, 1.02–1.46) for NRFS (Table 1). After excluding women with diabetes, the corresponding RR for RFS and NRFS were 0.79 (95% CI, 0.65–0.94) for RFS and 1.21 (95% CI, 1.01–1.45) for NRFS. Results for stroke types were similar as for total stroke but generally not statistically significant (Table 1).

We next examined the joint association of RFS and NRFS (both scores were categorized into tertiles) with total stroke risk. Compared with women in the lowest tertile of RFS and highest tertile of NRFS (overall low-quality diet), women in the highest tertile of RFS and lowest tertile of NRFS (overall high-quality diet), had a 34% (95% CI, 9–52%) lower risk of stroke (Fig. 1). Compared with women in the low-quality diet group, those in the high-quality diet group consumed (servings/wk, mean) about twice as much fruits and vegetables (23.2 vs. 47.5), more low-fat milk products (8.5 vs. 13.6), half as much red and processed meat (8.9 vs. 5.3), and nearly one-third as much sugar-sweetened foods (19.9 vs. 7.5) and fried potatoes/French fries (1.4 vs. 0.5).

4. Discussion

Results from this prospective study showed that women with a high-quality diet, i.e., those who consumed a diversity of healthy foods and few less healthy foods, had a 34% lower risk of stroke than women with a low-quality diet. The diet among women in the high-quality diet group overlaps with the guidelines for the primary prevention of stroke with reduced intake of sodium and saturated fat and a diet rich in fruits and vegetables (thereby high in potassium), low-fat milk products, and fish [10,11]. We found no linear dose–response relationships of RFS and NRFS with risk of stroke. Rather stroke risk decreased significantly when moving from the 4th to 5th quintile of RFS and increased when moving from the 4th to 5th quintile of NRFS.

In a previous analysis of the SMC, with a different follow-up period (1987–1998) and shorter questionnaire (67 foods), we observed that women in the highest category of RFS had a significant 60% lower stroke mortality (n = 342 deaths) [4]. Results from the current study, with follow-up from 1998 through 2008 and much more stroke cases, confirm and extend our previous findings.

We are not aware of any other investigations of the association of RFS or NRFS with stroke risk. However, a few previous studies have examined the relation between other dietary patterns and risk of stroke [12–16]. In the Nurses’ Health Study, a prudent (“healthy”) diet was significantly inversely associated with risk of stroke, whereas a Western diet was associated with an increased risk [12]. In the same cohort, adherence to a Dietary Approaches to Stop Hypertension (DASH)-style diet was associated with a significant 18% lower risk of stroke [13]. Results from an Italian cohort study showed that several dietary patterns, including a DASH-style diet, Greek Mediterranean Index, and Italian Mediterranean Index were inversely associated with stroke risk [15]. Two Japanese cohort studies found no association between an animal food pattern and stroke mortality but observed inverse associations with either a dairy product pattern [14] or a Japanese pattern [16].

Strengths of this study include its prospective and population-based design, large sample size, large number of stroke cases, and the almost complete follow-up of participants. Because of the observational design, we cannot exclude the possibility that residual confounding due to unmeasured or imprecise measurement of other stroke risk factors affected our results. A limitation is that diet was self-reported and measured only once (at baseline), leading to some measurement error. However, because diet was assessed before the diagnosis of stroke, any measurement error would be non-differential and most likely lead to an underestimation of the true associations.

In conclusion, findings from this prospective study provide further support to the dietary recommendations to consume a large variety of nutrient-dense foods such as fruits, vegetables, whole grains, low-fat dairy, fish and legumes and to reduce consumption of red and processed meat, solid fats, full-fat dairy, sugar-sweetened foods and refined grains [17].

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Conflict of interest

None.

Appendix A. Supplementary data

Supplementary data related to this article can be found online at http://dx.doi.org/10.1016/j.atherosclerosis.2013.11.072

References