A diet following Finnish nutrition recommendations does not contribute to the current epidemic of obesity

Noora Kanerva1,*, Niina E Kaartinen1, Marja-Leena Ovaskainen1, Hanna Konttinen2, Jukka Kontto1 and Satu Männisto1

1National Institute for Health and Welfare, Department of Chronic Disease Prevention, PO Box 30, FI-00271 Helsinki, Finland; 2Department of Social Research, University of Helsinki, Finland

Abstract

Objective: Recently, the general public opinion is that nutritional recommendations promote obesity rather than prevent it. We created the Recommended Finnish Diet Score (RFDS) that illustrates the Finnish nutrition recommendations and assessed whether this score is associated with BMI, waist circumference (WC) and body fat percentage (BF%).

Design: Cross-sectional study included two phases of the National FINRISK 2007 Study. Diet was assessed using a validated FFQ. Height, weight, WC and BF% were measured, and BMI values were calculated. The RFDS was developed based on the national nutrition recommendations.

Setting: A large representative sample of the Finnish population.

Subjects: Men (n 2190) and women (n 2530) aged 25–74 years.

Results: The RFDS was inversely associated with WC in men (OR = 0.48, 95% CI 0.28, 0.81, P < 0.05) and BF% in both men (OR = 0.44, 95% CI 0.24, 0.82, P-trend < 0.05) and women (OR = 0.63, 95% CI 0.37, 1.08, P-trend < 0.05). The inverse association of RFDS and BF% appeared stronger among older age groups (men: OR = 0.21 CI 0.07, 0.64, P-trend < 0.01; women: OR = 0.56, 95% CI 0.25, 1.27, P-trend < 0.05) and among women with normal BMI (OR = 0.62, 95% CI 0.36, 1.09, P-trend < 0.05). The RFDS was not associated with BMI.

Conclusions: A diet following nutrition recommendations is likely to help to maintain normal WC and BF%. These findings could be useful for dietary counselling and the prevention of obesity.

Keywords

Dietary score
Abdominal adiposity
Body fat percentage

Obesity is considered a significant concern for the development of several chronic diseases, such as type 2 diabetes13. Diet, especially positive energy balance, plays a key role in obesity. However, the role of specific foods and nutrients in the aetiology of obesity has remained controversial, for example due to measurement errors and the inter-correlation among dietary components253. It has been suggested that the whole diet may have a greater effect on health than any single dietary component and may prove useful when determining public health recommendations. Therefore, dietary scores reflecting the quality of the whole diet have emerged in epidemiological studies44. For example, the Alternate Healthy Eating Index (AHEI), based on the US dietary recommendations, was associated with a 20–40% reduction in the risk of type 2 diabetes and CVD58. Various scores illustrating the Mediterranean diet pattern have been linked to weight reduction without energy restrictions or changes in physical activity99, decreased waist circumference (WC) and better lipid fractions, fasting glucose levels and blood pressure100. Healthy diet promotion is an important aspect of obesity prevention policies11. Recently however, the general public has argued that dietary recommendations could promote obesity rather than prevent it. This phenomenon has been also observed in Finland. The latest Finnish nutrition recommendations are based on Nordic Nutrition Recommendations, which were approved by the Nordic Council of Ministers in 200412 and issued in Finland by the National Nutrition Council in 200513. The recommendations include both food-based guidelines and recommendations for nutrient intakes. New Nordic nutrition recommendations are about to be released in 2012–2013 and they will have a focus on the whole diet while also setting recommended intakes for micronutrients.

We aimed to examine whether a diet following the Finnish nutrition recommendations is associated with healthy weight among Finnish men and women. We created a score that illustrates the Finnish nutrition recommendations and assessed whether this score is associated with general obesity, as defined by BMI values and body fat percentage (BF%), or abdominal obesity, as defined by WC values.
Methods

Study population
The study of Dietary, Lifestyle and Genetic determinants of Obesity and Metabolic syndrome (DILGOM Study) included men and women aged 25–74 years who participated in two phases of the National FINRISK 2007 Study. Between January and March, a random sample of 10,000 participants was drawn from the Finnish population register in five large geographical areas. The sample was stratified by sex, 10-year age group and area. The participants were mailed an invitation letter to a health examination with a self-administered health questionnaire. Of the adults invited, 6,258 participated in the health examination (participation rate of 63%).

To gather more precise information on obesity, all participants of the first phase were invited to the second study phase (= DILGOM Study) between April and June 2007, which included a detailed health examination and several questionnaires. Of the invited individuals, 5,024 participated (participation rate of 80%). After exclusions of participants with a missing FFQ or anthropometric data and women who were pregnant, the sample size for the present study was 2,190 men and 2,530 women.

The study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Ethics Committee of the Hospital District of Helsinki and Uusimaa. Written informed consent was obtained from all participants.

Dietary intake and the Recommended Finnish Diet Score

Dietary intake
Participants filled in a validated 131-item FFQ, which was designed to measure the habitual diet over the previous 12 months. The participants were asked to indicate the average consumption frequency of each FFQ item by using nine frequency categories ranging from never or seldom to six or more times daily. The predefined portion sizes appeared as household and natural units (e.g. glass, slice) on the FFQ. The participants were also able to report other frequently consumed foods not listed. The participants completed the FFQ at the study site, where a trained study nurse reviewed the questionnaire. Data were entered into the study database and the average daily food, nutrient and energy intakes were calculated using the Finnish National Food Composition Database (Fineli®). Participants with an incompletely filled FFQ (n 74) were excluded from analysis. In addition, participants (n 48) whose daily energy intake (EI; cut-offs) corresponded to 0–5% at both ends of the daily EI distribution were excluded.

Recommended Finnish Diet Score
The score was based on the latest Finnish nutrition recommendations (Table 1)\(^{(12)}\). The final score consists of eight variables, of which four are food groups and four represent nutrients. The four food groups include fruits (apples, citruses, and other fruits and berries such as bilberries and lingonberries); vegetables (leafy vegetables, fruit vegetables, cabbages, mushrooms, legumes, and roots, excluding potato); the ratio of white meat (poultry, fish and fish products) to red and processed meat (beef, pork, lamb, sausage, meat products, game and offal). Rye was selected to represent dietary fibre intake from wholegrain cereals due to the high contribution of rye to fibre intake. Furthermore, four nutrients of the score include a ratio of PUFA to SFA, trans-fatty acids, salt, and sucrose (as a percentage of energy (E%) and alcohol (E%) intakes.

The score was calculated according to the quartiles of consumption of each score component. For fruits, vegetables, rye, and meat and fat ratios, the lowest quartile of intake was given 0 points, the second 1 point, the third 2 points and the highest quartile of intake 3 points. For salt, sucrose (E%) and alcohol (E%), the highest quartile of intake was given 0 points, the second highest 1 point, the third 2 points and the lowest quartile of intake 3 points. The points given to the components were summed to construct the overall score. The resulting RFDS ranged from 0 to 24.

Anthropometric measures
Specially trained nurses measured weight, height, WC and hip circumference using the standardized international protocols. Body weight was measured to the nearest 0.1 kg using a bioelectric impedance scale (TANITA TBF-300MA; Tanita Corporation of America, Inc., Arlington Heights, IL, USA), with all participants wearing light clothing and no shoes. Height was measured using a wall-mounted stadiometer to the nearest 0.1 cm. BMI was calculated as weight in kilograms divided by the square of height in metres (kg/m\(^2\)). WC was measured at the midpoint between the lower ribs and iliac crest to the nearest 0.5 cm using a measuring tape. The bioelectric impedance scale was used to assess body composition, including BF%. Participants with a heart pacemaker did not undergo the bioelectric impedance scale measurement. Participants with BMI ≥ 25.0 kg/m\(^2\) were classified as overweight and those with BMI ≥ 30.0 kg/m\(^2\) as obese\(^{(23)}\). Participants with BF% > 20% for men or...
BMI, WC and BF% were calculated for RFDS quintiles, a dichotomous outcome variable: BMI each outcome at a time was included in the model as tested using logistic regression (Epicalc package in R). Adherence to the recommended diet and obesity was components and the final score were calculated. Age- and energy-adjusted variables (Base package in R). Age- and energy-adjusted smoking status and physical activity were used as covariates. Self-reported total years of education were categorized into tertiles (low, medium or high). To adjust for the extension of the basic education system and increase in average school years over time, the classification was done by participants’ birth year. Smoking status was assessed using four categories: never smokers, quit >6 months ago, quit <6 months ago and current smokers. Leisure-time physical activity assessed activities outside work using four categories: inactive (mainly light activities, e.g. reading and watching television), moderately active (e.g. walking, cycling or gardening for at least 4 h/week), active (physically demanding activities, e.g. running, cross-country skiing or swimming for at least 3 h/week) and highly active (competition sports aiming and physically demanding exercise several times per week).

Statistical analyses

Data were analysed separately for men and women. There was no significant interaction between sex and RFDS, but since it is generally known that both dietary habits and fat tissue accumulation are different between genders, we wished to present the results separately. All analyses were performed with the R statistical computing program, version 2.13.0. $P < 0.05$ was considered as significant. For the analyses, we divided the RFDS into quintiles where the highest quintile represented high adherence to the recommended diet. Age- (and energy-) adjusted means and standard errors for continuous variables (age, BMI, WC, BF%, EI, score components) and percentages for categorical variables (education, smoking, PA) are shown according to RFDS quintiles. The $P$ value for trend was obtained from linear regression analysis for continuous variables and from Pearson’s $\chi^2$ test for categorical variables (Base package in R). Age- and energy-adjusted Spearman correlation coefficients between the score components and the final score were calculated.

For all three obesity measures, the association between adherence to the recommended diet and obesity was tested using logistic regression (Epicalc package in R). Each outcome at a time was included in the model as a dichotomous outcome variable: BMI $\geq 30.0 \text{ kg/m}^2$ or $<30.0 \text{ kg/m}^2$, WC $\geq 100 \text{ cm}$ or $<100 \text{ cm}$ for men and $\geq 90 \text{ cm}$ or $<90 \text{ cm}$ for women, and BF% $>20\%$ or $\leq 20\%$ for men and $>30\%$ or $\leq 30\%$ for women. Odds of high BMI, WC and BF% were calculated for RFDS quintiles using participants in the lowest quintile as reference group, and the $P$ value for trend was determined using the RFDS in a continuous form in the model. First, we adjusted the model for age and EI. Second, we further adjusted the model controlling for education, smoking and physical activity. For the outcomes of WC and BF%, the second model was additionally adjusted for BMI to account for the influence of BMI on these adiposity measures.

In all analyses, to take into account possible mis-reporting of EI, the ratio of reported EI to predicted BMR (EI:BMR) was calculated and participants were classified as under-reporters (EI:BMR $\leq 1.14$) or plausible reporters (EI:BMR $> 1.14$) based on the cut-off points proposed by Goldberg et al. as revised by Black. Analyses were run both with and without possible under-reporters. Analyses were also run after stratification of age using the sex-specific median (men: $<54$ years and $\geq 54$ years, women: $<53$ years and $\geq 53$ years) and after stratification of BMI (men and women: $<25.0 \text{ kg/m}^2$ and $\geq 25.0 \text{ kg/m}^2$).

Results

Population characteristics

Participants in the higher RFDS quintiles tended to be older men and women ($P$-trend $< 0.001$; Tables 2 and 3). The proportion of highly educated participants increased and the proportions of current smokers and physically inactive participants decreased with higher scores in men ($P$-trend $< 0.05$) and women ($P$-trend $< 0.01$). About one-fifth of men and one-sixth of women were current smokers (men: $20\%$, women: $14\%$). EI did not differ between the score quintiles for either sex. The mean BMI of participants fell into the overweight category (men: $27.1 \text{ kg/m}^2$, women: $26.0 \text{ kg/m}^2$; Tables 2 and 3). In general, $60\%$ of men and $54\%$ of women were overweight or obese. No differences emerged for BMI between the score quintiles in either sex. The percentage of participants with large WC varied from $32\%$ to $40\%$ and those with unhealthy BF% ranged from $72\%$ to $78\%$ in RFDS quintiles. WC and BF% decreased with higher scores for men ($P$-trend $< 0.05$ and $P$-trend $< 0.01$, respectively). For women, the trends were similar, but resulted in borderline significance ($P$-trend $= 0.05$ and $P$-trend $= 0.10$, respectively).

Dietary intake and the Recommended Finnish Diet Score

The median RFDS was 12 points for men and women. As expected, participants’ consumption of healthy score components, such as fruits, vegetables, rye, meat ratio and fat ratio increased, and consumption of alcohol decreased, with higher RFDS ($P$-trend $< 0.001$; Tables 2 and 3). The difference in fruit and vegetable consumption, as well as in meat ratio, was at least twofold between the highest and...
the lowest RFDS quintile for both sexes. Among women, the difference in rye and alcohol consumption was also twofold. The consumption of salt increased with higher adherence to the recommended diet among both sexes (P-trend < 0.001). Women’s sucrose (%E) intake decreased with higher RFDS while in men it generally tended to increase.

RFDS was not correlated with EI in men (r = 0.01, P = 0.57) or women (r = 0.04, P = 0.08). Correlations between the score and food groups and nutrients varied between 0.12 (salt) and 0.60 (fat ratio). Within score components, the highest positive correlation was found between vegetables and fat ratio (r = 0.36, P < 0.001 for men; r = 0.33, P < 0.001 for women) and the highest negative correlation emerged between salt and sucrose (r = −0.46, P < 0.001 for men; r = −0.53, P < 0.001 for women).

**BMI and waist circumference**

In logistic regression analyses, the RFDS was not associated with BMI among either sex (Table 4). However, the RFDS was inversely associated with WC among men. In the age- and energy-adjusted model (Model 1), men in the highest v: lowest score quintile were 36% less likely to have large WC (95% CI 0.47, 0.87, P-trend < 0.01). The association was strengthened (OR = 0.48, 95% CI 0.28, 0.81, P-trend < 0.01) after adjusting for other covariates (Model 2). The results remained the same in model (Model 3) in which energy under-reporters were excluded. Furthermore, we assessed the risk of large WC stratifying by age. The inverse association between RFDS and WC was stronger for men under 54 years old (OR = 0.52, 95% CI 0.38, 0.72, 95% CI 0.38, 1.39, P-trend = 0.09 in the highest score quintile). No association between RFDS and women’s WC values was found.

We assessed which score components contributed the most to the associations of abdominal obesity with RFDS using logistic regression. In men, those who had high use of vegetables (P-trend < 0.05) and rye (P-trend < 0.05) and low use of alcohol (%E; P-trend < 0.05) were less likely to have large WC.

**Body fat percentage**

An inverse linear trend emerged between the RFDS and unhealthy BF% for both sexes (Table 4). Men in the highest v: the lowest RFDS quintile were 32% less likely to have unhealthy BF% (95% CI 0.47, 0.97, P-trend < 0.05). After further adjustments and after excluding energy under-reporters, the results remained. In age-stratified analyses, men aged 54 years or older in the top v: lowest score quintile were 79% (95% CI 0.07, 0.64, P-trend < 0.01).
Table 3 Characteristics of participants according to RFDS quintiles: Finnish women (n 2530) aged 25–74 years, DILGOM Study, April–June 2007

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>1 (low)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (high)</th>
<th>All</th>
<th>P-trend*</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFDS (points), range</td>
<td>2–9</td>
<td>10–11</td>
<td>12–13</td>
<td>14–15</td>
<td>16–24</td>
<td>2–24</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>602</td>
<td>523</td>
<td>556</td>
<td>440</td>
<td>409</td>
<td>2530</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>47</td>
<td>50</td>
<td>60</td>
<td>57</td>
<td>6</td>
<td>52</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>High education (%) t</td>
<td>28–8</td>
<td>34–2</td>
<td>36–1</td>
<td>39–3</td>
<td>38–1</td>
<td>38–6</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Low physical activity (%) t</td>
<td>26–9</td>
<td>20–6</td>
<td>18–1</td>
<td>14–5</td>
<td>10–8</td>
<td>16–9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Current smoker (%) t</td>
<td>20–4</td>
<td>8–5</td>
<td>12–4</td>
<td>10–9</td>
<td>7–6</td>
<td>14–5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Under-reporter (%) t</td>
<td>39–9</td>
<td>36–7</td>
<td>29–8</td>
<td>33–4</td>
<td>28–4</td>
<td>34–0</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>BMI [kg/m²]^t^</td>
<td>27–2</td>
<td>2–6</td>
<td>26–9</td>
<td>26–3</td>
<td>26–6</td>
<td>26–0</td>
<td>0.55</td>
</tr>
<tr>
<td>WC (cm) t</td>
<td>88–0</td>
<td>0–5</td>
<td>86–7</td>
<td>85–9</td>
<td>86–3</td>
<td>86–7</td>
<td>0.05</td>
</tr>
<tr>
<td>BF% (%) t</td>
<td>36–1</td>
<td>0–3</td>
<td>35–3</td>
<td>35–2</td>
<td>35–2</td>
<td>35–4</td>
<td>0.10</td>
</tr>
<tr>
<td>EI [kJ/d]^t^</td>
<td>9276</td>
<td>130</td>
<td>9247</td>
<td>9640</td>
<td>9393</td>
<td>9619</td>
<td>0.08</td>
</tr>
<tr>
<td>RFDS quintile (OR^0.01)</td>
<td>52</td>
<td>36</td>
<td>40</td>
<td>55</td>
<td>60</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Total energy intake (kcal/d)^t</td>
<td>2217</td>
<td>31</td>
<td>2210</td>
<td>2304</td>
<td>2245</td>
<td>2299</td>
<td>0.08</td>
</tr>
<tr>
<td>White meat (30% kcal)</td>
<td>198</td>
<td>8</td>
<td>258</td>
<td>9</td>
<td>314</td>
<td>368</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Whole grains (40% kcal)</td>
<td>240</td>
<td>8</td>
<td>307</td>
<td>8</td>
<td>354</td>
<td>419</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fruits and vegetables (50% kcal)</td>
<td>44</td>
<td>1</td>
<td>59</td>
<td>1</td>
<td>69</td>
<td>74</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Meat ratio (g/kg) C^*</td>
<td>0.6</td>
<td>0.3</td>
<td>0.8</td>
<td>0.3</td>
<td>1.2</td>
<td>1.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fat ratio (g/kg) F^*</td>
<td>0.4</td>
<td>0</td>
<td>0.4</td>
<td>0</td>
<td>0.5</td>
<td>0.5</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Sugar (E%) t</td>
<td>11.9</td>
<td>0.1</td>
<td>10.5</td>
<td>0.1</td>
<td>10.4</td>
<td>9.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Non-CG (g) t</td>
<td>8.3</td>
<td>0.1</td>
<td>8.6</td>
<td>0.1</td>
<td>8.6</td>
<td>8.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Alcohol (E%) t</td>
<td>1.8</td>
<td>0.1</td>
<td>1.7</td>
<td>0.1</td>
<td>1.4</td>
<td>1.2</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

RFDS, Recommended Finnish Diet Score; DILGOM, Dietary, Lifestyle and Genetic determinants of Obesity and Metabolic syndrome; WC, waist circumference; BF%, body fat percentage; EI, energy intake; E%, percentage of energy.

*P value was determined with linear regression between RFDS and participant’s characteristics or intake of score components for continuous variables and with the χ² test for categorical variables.

†Values are age-adjusted.
‡Values are age- and energy-adjusted.
§Ratio of white meat (poultry, fish) to red and processed meat (beef, pork, lamb, game, offal, processed meat products, sausage).
∥Ratio of PUFA to SFA + trans-fatty acids.

Discussion

According to our results, adherence to the recommended diet was not associated with BMI for either sex. Nevertheless, the recommended diet was inversely associated with WC and BF%. Men who adhered to the recommended diet were more likely to have healthy WC. Furthermore, men, especially those aged 54 years or older, with high adherence to the recommended diet were more likely to have healthy BF% than men with low adherence. In women, the recommended diet was inversely associated only with BF%. This association appeared especially among women aged 53 years or older and among women with BMI in the normal range.

The guidelines for healthy eating emphasize energy balance and high consumption of vegetables, fruits and whole grains similarly across countries. Studies on dietary scores indicate that obesity could be partly prevented with a diet following national nutrition recommendations. In Nordic countries, local recommendations and adherence to them might have a beneficial effect on abdominal obesity(26) and health(29–31). In cross-sectional studies, the Healthy Eating Index (HEI), AHEI and the DASH (Dietary Approaches to Stop Hypertension) diet have been related with a lower risk of abdominal adiposity(32–34) and with a lower risk of CVD and heart failure(5,6,35–37).
Table 4 Odds of high BMI, WC and BF% according to level of adherence to the RFDS (RFDS quintile): Finnish men (n 2190) and women (n 2530) aged 25–74 years, DILGOM Study, April–June 2007

<table>
<thead>
<tr>
<th>Model</th>
<th>n</th>
<th>1 (low)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (high)</th>
<th>P-trend†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>OR (ref.)</td>
<td>OR</td>
<td>95 % CI</td>
<td>OR</td>
<td>95 % CI</td>
<td>OR</td>
</tr>
</tbody>
</table>

**Men**

BMI (≥ 30.0 kg/m²)

Model 1 2019 1:00 0:90 0:66, 1:24 0:80 0:58, 1:11 0:95 0:68, 1:32 0:80 0:56, 1:15 0:39

Model 2 2019 1:00 0:93 0:74, 1:44 0:98 0:70, 1:38 1:20 0:84, 1:71 1:08 0:74, 1:59 0:41

Model 3 1952 1:00 0:99 0:62, 1:30 0:99 0:68, 1:42 1:16 0:79, 1:70 1:00 0:66, 1:54 0:52

WC (≥100 cm)

Model 1 2190 1:00 0:95 0:72, 1:24 0:91 0:70, 1:20 0:89 0:66, 1:18 0:64 0:47, 0:87 <0:01

Model 2 2190 1:00 1:04 0:66, 1:64 0:96 0:61, 1:51 0:85 0:52, 1:40 0:48 0:28, 0:81 <0:01

Model 3 1952 1:00 0:83 0:51, 1:35 0:78 0:48, 1:25 0:75 0:44, 1:27 0:42 0:24, 0:75 <0:01

BF% (>20%)

Model 1 2190 1:00 1:00 0:70, 1:36 0:99 0:72, 1:35 0:71 0:51, 1:00 0:68 0:47, 0:97 <0:05

Model 2 2190 1:00 1:08 0:65, 1:79 1:03 0:60, 1:77 0:59 0:33, 1:03 0:44 0:24, 0:82 <0:05

Model 3 1952 1:00 1:02 0:59, 1:76 1:13 0:65, 1:98 0:84 0:35, 1:16 0:46 0:24, 0:87 <0:05

**Women**

BMI (≥30.0 kg/m²)

Model 1 2530 1:00 0:96 0:72, 1:28 0:84 0:63, 1:12 0:92 0:68, 1:24 0:87 0:64, 1:18 0:35

Model 2 2530 1:00 1:08 0:80, 1:45 0:96 0:71, 1:30 1:19 0:87, 1:63 1:17 0:84, 1:62 0:25

Model 3 1669 1:00 0:98 0:65, 1:48 1:02 0:68, 1:51 1:22 0:80, 1:87 1:15 0:75, 1:76 0:53

WC (≥90 cm)

Model 1 2530 1:00 0:86 0:67, 1:10 0:76 0:59, 0:98 0:86 0:66, 1:13 0:88 0:67, 1:15 0:31

Model 2 2530 1:00 1:07 0:69, 1:67 0:90 0:59, 1:39 0:83 0:52, 1:31 1:18 0:74, 1:89 0:95

Model 3 1669 1:00 1:01 0:54, 1:88 0:87 0:49, 1:56 0:81 0:43, 1:50 1:05 0:56, 1:96 0:95

BF% (>30%)

Model 1 2550 1:00 0:76 0:55, 0:98 0:79 0:59, 1:05 0:66 0:48, 0:89 0:76 0:54, 1:07 <0:05

Model 2 2550 1:00 0:70 0:45, 1:11 0:61 0:39, 0:95 0:37 0:22, 0:63 0:63 0:37, 1:08 <0:05

Model 3 1669 1:00 0:57 0:33, 0:97 0:59 0:35, 0:99 0:38 0:21, 0:70 0:54 0:30, 0:99 <0:05

WC: waist circumference; BF%, body fat percentage; RFDS, Recommended Finnish Diet Score; DILGOM, Dietary, Lifestyle and Genetic determinants of Obesity and Metabolic syndrome ref; reference category.

Data are presented as odds ratios and 95 % confidence intervals.

*Cut-off points of the quintiles for men: 1st, 2–9 points; 2nd, 10–11 points; 3rd, 12–13 points; 4th, 14–15 points; 5th, 16–24 points. Cut-off points of the quintiles for women: 1st, 2–9 points; 2nd, 10–11 points; 3rd, 12–13 points; 4th, 14–15 points; 5th, 16–22 points.

†P-value for trend between the RFDS and obesity measures was determined with logistic regression using the score in a continuous form. Significance for testing: P < 0.05.

‡Adjusted for age and energy intake.

§Adjusted for age, energy intake, leisure-time physical activity, smoking and education. For WC and BF%, the model was also adjusted for BMI.

Potential mechanisms by which a recommended diet provokes desirable effects on body fatness could be the high fibre content together with low alcohol, saturated fat and sucrose consumption (24, 29, 35). Studies on single dietary components have related dietary fibre from cereals, vegetables and fruits to weight loss or at least weight maintenance and normal WC (46–48), but the role of sucrose (concerning mainly the consumption of sugar-sweetened beverages and sugary candies) and alcohol intake is not yet clear (49–52). It seems that dietary counselling on specific dietary components might be enough to prevent certain forms of obesity, but the whole-diet approach may be more convenient when evaluating the impact of foods on overall obesity or overall health.

Sex, age and BMI category seemed to modulate the association of recommended diet, WC and BF%. An inverse association between RFDS and WC was observed only in men. Furthermore, the inverse association between RFDS and BF% varied by BMI status in women but not in men. Among both sexes, the association of the
RFDS with unhealthy body fat occurred differently in age categories. These findings could partly stem from sex and growth hormones whose production and secretion might be modulated by dietary factors\(^{55-59}\). For example, the decrement in the ratio of lean tissue to body fat during ageing in both sexes is linked to changes in sex hormones. Generally, men tend to have a central and women a peripheral fat distribution\(^{56}\). Because men have more lean tissue compared with women\(^{54,57}\), women could be more likely to have a healthy BMI with unhealthy BF\(_\%\). Unlike men, it is rare that women have BMI \(\geq 25.0 \text{ kg/m}^2\) due to high muscle mass. Thus, no differences in women with BMI \(\geq 25.0 \text{ kg/m}^2\) could be identified in relation to BF\(_\%\) between RFDS quintiles.

Strengths of the present study include the high number of randomly selected participants. Although the participation rate was at a reasonable level, we cannot exclude the possibility that non-participation and the phenomenon that health-conscious people tend to participate more in health surveys affected the results. Since the study design was cross-sectional, we could examine the associations between diet and obesity but not the causal effects. We used a validated FFQ and various internationally standardized anthropometric measurements\(^{15-17,22}\). The FFQ might have influenced the exposure assessment because the questionnaire was filled in during a certain period of the year (spring), which means that some foods are remembered and reported more accurately than others. Misreporting and inaccurate estimation of EI that generally relates to FFQ can lead to results that are more an under-estimate of the relationship between the recommended diet and body fatness measurements\(^{56}\). However, all analyses were adjusted for EI and after exclusion of energy under-reporters, our results remained.

The measurements done using the Tanita bioelectric impedance scale may have some inaccuracy because the water and mineral contents of fat-free mass vary within a person during daytime\(^{59,60}\). In our study, however, all measurements were done between 07.00 and 10.00 hours. In a large population-based survey which can include several study centres, the bioelectric impedance scale is the only technique that meets the criteria of being simple, rapid, portable and free from operator variability, and it provides a more accurate assessment of body fat than solely predictive equations based on BMI\(^{59,60}\). The practical simplicity of the Tanita method is not associated with any clinically significant decrement in performance relative to a traditional bioelectric impedance device\(^{59}\).

A dietary index has also its weaknesses. Although a predefined index enables better capture of the exposure of interest and diminishes nutritional confounding, some confounding due to correlations in the intake of various dietary components and existing nutrient–nutrient interactions could remain\(^{4}\). Currently, there is no consensus on how to determine cut-offs to detect high consumption from low consumption of the score components. Furthermore, it is poorly understood how score components should be weighted when assessing diet–disease relationships.

Conclusions

Our study shows that it is possible to construct a diet to maintain healthy weight by following the Finnish nutrition recommendations, including high intakes of rye, vegetables, fruits and PUFA, and keeping the intakes of alcohol, SFA and sucrose at moderate levels. The recommended diet seems to be especially associated with healthy WC and BF\(_\%\) in sex- and age-specific ways. Our results also suggest that the nutrition recommendations are defendable as a healthy diet despite the claims presented in the media. These findings may be useful for dietary counselling and the prevention of abdominal obesity and unhealthy body fat. Further evidence from prospective cohort studies is needed to reveal a causal relationship.

Acknowledgements

Sources of funding: This study was supported by the Academy of Finland (grants 136895 and 263836). Conflicts of interest: The authors declare no personal or financial conflicts of interest. Authors’ contributions: N.E.K. and S.M. participated in the design and conduct of the research. N.K., S.M., M.L.O. and H.K. were responsible for creating the Recommended Finnish Diet Score. J.K. and N.K. performed the statistical analyses. N.K. wrote the manuscript and had primary responsibility for the final content. S.M. was responsible for the original study idea and revised the manuscript for publication. All authors have read and approved the final manuscript.

References

Diet, nutrition recommendations and obesity


