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

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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
Diet
Abdominal adiposity
Body fat percentage

Obesity is considered a significant concern for the development of several chronic diseases, such as type 2 diabetes[1]. 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 components[2,3]. 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 studies[4]. 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 CVD[5–8]. Various scores illustrating the Mediterranean diet pattern have been linked to weight reduction without energy restrictions or changes in physical activity[9], decreased waist circumference (WC) and better lipid fractions, fasting glucose levels and blood pressure[10].

Healthy diet promotion is an important aspect of obesity prevention policies[11]. 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 2004[12] and issued in Finland by the National Nutrition Council in 2005[13]. 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.

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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[14]. 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, 6258 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, 5024 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 2190 men and 2530 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[15–17]. 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®)[18]. 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[19].

Recommended Finnish Diet Score

The score was based on the latest Finnish nutrition recommendations (Table 1)[13]. 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[20,21]. Furthermore, four nutrients of the score include a ratio of PUFA to SFA + *trans*-fatty acids, salt (g/d), sucrose (as a percentage of energy (E%)) and alcohol (E%) intakes.

Table 1 Finnish nutrition recommendations[12]

Main aims of the Finnish nutrition recommendations
• Balance energy intake and energy consumption
• Ensure adequate intake of nutrients
• Increase the intake of fibrous carbohydrates
• Decrease intake of refined sugars
• Decrease intake of saturated fat and partially replace it with unsaturated fat
• Decrease intake of salt
• Maintain consumption of alcohol at a moderate level

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 points, 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[22]. 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 $\geq$ 25·0 kg/m^2 were classified as overweight and those with BMI $\geq$ 30·0 kg/m^2 as obese[23]. Participants with BF% > 20 % for men or

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>30 % for women were classified having an unhealthy amount of adipose tissue according to WHO[23]. Participants with WC ≥ 100 cm for men or WC ≥ 90 cm for women were classified as abdominally obese according to the Finnish Current Care guidelines[24].

Covariates

Participants filled in self-administered questionnaires inquiring about socio-economic characteristics and lifestyle factors. In the present study, age, education, 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[25]. $P < 0{\cdot}05$ 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 χ^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 ≥ 30·0 kg/m^2 or <30·0 kg/m^2, WC ≥ 100 cm or <100 cm for men and ≥90 cm or <90 cm for women, and BF% >20 % or ≤20 % for men and >30 % or ≤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 misreporting of EI, the ratio of reported EI to predicted BMR (EI:BMR) was calculated and participants were classified as under-reporters (EI:BMR ≤ 1·14) or plausible reporters (EI:BMR > 1·14) based on the cut-off points proposed by Goldberg *et al.*[26] as revised by Black[27]. 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 ≥54 years, women: <53 years and ≥53 years) and after stratification of BMI (men and women: <25·0 kg/m^2 and ≥25·0 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: 20·8 %, women: 14·5 %). EI did not differ between the score quintiles for either sex. The mean BMI of participants fell into the overweight category (men: 27·1 kg/m^2, women: 26·0 kg/m^2; Tables 2 and 3). In general, 60·8 % of men and 54·0 % 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

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Table 2 Characteristics of participants according to RFDS quintile: Finnish men (*n* 2190) aged 25–74 years, DILGOM Study, April–June 2007

	RFDS quintile												
	1 (low)		2		3		4		5 (high)		All		
Characteristic	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	*P*-trend*
RFDS (points), range	2–9		10–11		12–13		14–15		16–24		2–24		
n	511		481		486		381		331		2190		
Age (years)	48	0·6	51	0·6	53	0·6	55	0·6	59	0·6	53	0·3	<0·001
High education (%)†	26·7		36·2		38·9		42·5		41·7		37·0		<0·05
Low physical activity (%)†	28·3		19·5		17·1		14·2		9·9		18·7		<0·001
Current smoker (%)†	28·9		22·3		19·5		13·9		12·3		20·8		<0·001
Under-reporter (%)†	21·1		23·5		22·0		22·5		21·1		22·1		0·23
BMI (kg/m^2)†	27·2	0·2	27·2	0·2	27·0	0·2	27·1	0·2	27·1	0·2	27·1	0·1	0·58
WC (cm)†	97	0·5	96·5	0·6	95·5	0·5	95·4	0·6	94·7	0·7	96·4	0·3	<0·05
BF% (%)†	25·3	0·3	25·0	0·3	24·7	0·3	24·4	0·3	24·2	0·4	24·7	0·1	<0·01
EI (kJ/d)‡	11 548	180	11 632	184	11 811	184	11 807	209	11 924	226	11 724	88	0·32
EI (kcal/d)‡	2760	43	2780	44	2823	44	2822	50	2850	54	2802	21	0·32
Fruits (g/d)‡	138	8	181	9	226	9	280	10	364	10	242	5	<0·001
Vegetables (g/d)‡	208	7	250	8	275	8	337	9	410	9	297	4	<0·001
Rye (g/d)‡	61	2	67	2	70	2	71	2	75	2	72	1	<0·001
Meat ratio (g/g)†§	0·4	0	0·6	0	0·8	0	0·8	0	1·2	0	0·7	0	<0·001
Fat ratio (g/g)†‖	0·4	0	0·4	0	0·5	0	0·5	0	0·5	0	0·5	0	<0·001
Sugar (E%)†	9·1	0·2	9·1	0·2	9·2	0·2	9·7	0·1	9·5	0·2	9·0	0·2	<0·001
NaCl (g)‡	10·8	0·1	11·0	0·1	11·1	0·1	11·1	0·1	11·2	0·1	11·0	0·4	<0·001
Alcohol (E%)†	3·9	0·2	3·0	0·2	2·8	0·2	2·4	0·2	2·2	0·2	2·8	0·1	<0·001

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.
Data are presented as means with their standard errors except where noted.
**P* value was determined with linear regression between RFDS and participant's characteristics or intake of score components for continuous variables and with the χ^2 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.

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 < 0·0 0 1). 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 = 0·14, 95 % CI 0·04, 0·44, *P*-trend < 0·05 *v*. OR = 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

	RFDS quintile												
	1 (low)		2		3		4		5 (high)		All		
Characteristic	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	*P*-trend*
RFDS (points), range	2–9		10–11		12–13		14–15		16–24		2–24		
n	602		523		556		440		409		2530		
Age (years)	47	0·6	50	0·6	52	0·6	54	0·6	57	0·6	52	0·3	<0·001
High education (%)†	28·9		34·2		34·7		39·3		38·1		34·6		<0·01
Low physical activity (%)†	26·9		20·6		18·1		14·5		10·8		18·9		<0·001
Current smoker (%)†	20·4		8·5		12·4		10·9		7·6		14·5		<0·001
Under-reporter (%)†	39·9		36·7		29·8		33·4		28·4		34·0		<0·01
BMI (kg/m^2)†	27·2	0·2	26·6	0·2	26·5	0·2	26·8	0·3	26·6	0·3	26·0	0·6	0·55
WC (cm)†	88·0	0·5	86·7	0·6	86·2	0·6	85·9	0·6	86·3	0·7	86·7	0·3	0·05
BF% (%)†	36·1	0·3	35·3	0·3	35·2	0·3	35·2	0·3	35·2	0·4	35·4	0·1	0·10
EI (kJ/d)‡	9276	130	9247	138	9640	134	9393	151	9619	159	9427	63	0·08
EI (kcal/d)‡	2217	31	2210	33	2304	32	2245	36	2299	38	2253	15	0·08
Fruits (g/d)‡	198	8	258	9	314	9	368	10	432	10	304	4	<0·001
Vegetables (g/d)‡	240	8	307	8	354	8	419	9	531	9	352	4	<0·001
Rye (g/d)‡	44	1	59	1	69	1	74	2	85	2	64	1	<0·001
Meat ratio (g/g)†§	0·6	0·3	0·8	0·3	1·2	0·3	1·5	0·3	3·4	0·3	1·4	0·1	<0·001
Fat ratio (g/g)†‖	0·4	0	0·4	0	0·5	0	0·5	0	0·6	0	0·5	0·0	<0·001
Sugar (E%)†	11·9	0·1	10·5	0·1	10·4	0·1	9·6	0·2	8·9	0·2	10·0	0·1	<0·001
NaCl (g)‡	8·3	0·1	8·6	0·1	8·6	0·1	8·8	0·1	9·0	0·1	9·0	0·3	<0·001
Alcohol (E%)†	1·8	0·1	1·7	0·1	1·4	0·1	1·2	0·1	0·8	0·1	1·4	0·1	<0·001

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.
Data are presented as means with their standard errors except where noted.
**P* value was determined with linear regression between RFDS and participant's characteristics or intake of score components for continuous variables and with the χ^2 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.

less likely to have unhealthy body fat. In women, there was no significant difference between the highest *v.* lowest score quintile in the age- and energy-adjusted model (OR = 0·76, 95 % CI 0·54, 1·07, *P*-trend < 0·05), but in the fully adjusted model an inverse trend between the RFDS and BF% was observed (OR = 0·63, 95 % CI 0·37, 1·08, *P*-trend < 0·05). After excluding potential energy under-reporters (Model 3), the difference became significant (OR = 0·54, 95 % CI 0·30, 0·99, *P*-trend < 0·05). In the stratified analyses, the inverse trend between RFDS and BF% appeared significant only among women aged 53 years or older (OR = 0·62, 95 % CI 0·36, 1·09, *P*-trend < 0·05) and among women with normal BMI (OR = 0·62, 95 % CI 0·36, 1·09, *P*-trend < 0·05).

In single-nutrient analyses of RFDS components, BF% was inversely associated with high consumption of fruits (*P*-trend < 0·05) and with fat ratio (*P*-trend < 0·05) among men. Similarly, women who had high consumption of fruits were less likely to have unhealthy BF% compared with women with low consumption (*P*-trend < 0·05). Women in the highest quartile of sucrose intake (E%; i.e. had the lowest percentage of energy from sucrose) were less likely to have unhealthy BF% compared with women in the lowest quartile (OR = 0·61, 95 % CI 0·39, 0·95), even there was no significant trend (*P*-trend = 0·09).

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[28] 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].

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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

		RFDS (quintile)*									
		1 (low)	2		3		4		5 (high)		
Model	*n*	OR (ref.)	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	*P*-trend†
Men											
BMI (≥ 30·0 kg/m²)											
Model 1‡	2109	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§	2109	1·00	1·03	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	0·90	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	0·64	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‡	2530	1·00	0·75	0·56, 0·98	0·79	0·59, 1·05	0·66	0·48, 0·89	0·76	0·54, 1·07	<0·05
Model 2§	2530	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.
‖Adjusted for age, energy intake, leisure-time physical activity, smoking and education, excluding energy under-reporters. For WC and BF%, the model was also adjusted for BMI.

Also longitudinal studies have shown that dietary scores are related to lower incidence of overweight and obesity and weight reduction in adults[38,39]. Extensive evidence exists on the positive association of Mediterranean diet scores with lower BMI, smaller WC and weight loss[9,10,40], as well as with decreased risk of chronic diseases and overall mortality[41,42]. A recent study compared the AHEI, the Alternate Mediterranean Diet Score[43] and the DASH-diet score[44] and found that the scores are associated with a lower risk of type 2 diabetes[8]. Furthermore, the authors concluded that recommended diets may yield the greatest reduction in diabetes cases when followed by those with a high BMI.

In our study, high consumption of rye and vegetables and low consumption of alcohol (E%) were especially associated with lower WC values in men. Furthermore, high ratio of PUFA to SFA + *trans*-fatty acids and high consumption of fruits were associated with lower BF% in men. Women with high consumption of fruits and low intake of sucrose (E%) were less likely to have unhealthy BF%.

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[2,39,45]. 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

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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[53–55]. 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 $\geq 25 \cdot 0\,kg/m^2$ due to high muscle mass. Thus, no differences in women with BMI $\geq 25 \cdot 0\,kg/m^2$ 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 underestimate of the relationship between the recommended diet and body fatness measurements[58]. 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]. 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.

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References

1. World Health Organization (2003) *Diet, Nutrition and the Prevention of Chronic Diseases. Joint WHO/FAO Expert Consultation. WHO Technical Report Series* no. 916. Geneva: WHO.
2. Mozaffarian D, Hao T, Rimm EB *et al.* (2011) Changes in diet and lifestyle and long-term weight gain in women and men. *N Engl J Med* **364**, 2392–2404.
3. Aller EE, Abete I, Astrup A *et al.* (2011) Starches, sugars and obesity. *Nutrients* **3**, 341–369.
4. Waijers PM, Feskens EJ & Ocke MC (2007) A critical review of predefined diet quality scores. *Br J Nutr* **97**, 219–231.
5. McCullough ML, Feskanich D, Stampfer MJ *et al.* (2002) Diet quality and major chronic disease risk in men and women: moving toward improved dietary guidance. *Am J Clin Nutr* **76**, 1261–1271.
6. Belin RJ, Greenland P, Allison M *et al.* (2011) Diet quality and the risk of cardiovascular disease: the Women's Health Initiative (WHI). *Am J Clin Nutr* **94**, 49–57.
7. Fung TT, McCullough M, van Dam RM *et al.* (2007) A prospective study of overall diet quality and risk of type 2 diabetes in women. *Diabetes Care* **30**, 1753–1757.

8. de Koning L, Chiuve SE, Fung TT *et al.* (2011) Diet-quality scores and the risk of type 2 diabetes in men. *Diabetes Care* **34**, 1150–1156.
9. Esposito K, Kastorini C, Panagiotakos DB *et al.* (2011) Mediterranean diet and weight loss: meta-analysis of randomized controlled trials. *Metab Syndr Relat Disord* **9**, 1–12.
10. Kastorini CM, Milionis HJ, Esposito K *et al.* (2011) The effect of Mediterranean diet on metabolic syndrome and its components: a meta-analysis of 50 studies and 534,906 individuals. *J Am Coll Cardiol* **57**, 1299–1313.
11. Ministry of Social Affairs and Health (2008) *Government Resolution on Development Guidelines for Health-enhancing Physical Activity and Nutrition*. *Brochures of the Ministry of Social Affairs and Health* no. 2008:10eng. Helsinki: University Press.
12. Nordic Council of Ministers (2004) *Nordic Nutrition Recommendations 2004*, 4th ed. Copenhagen: Nord.
13. National Nutrition Council (2005) Finnish nutrition recommendations 2005. http://www.ravitsemusneuvottelukunta.fi/portal/en/nutrition_recommendations/ (accessed February 2012).
14. Vartiainen E, Laatikainen T, Peltonen M *et al.* (2010) Thirty-five-year trends in cardiovascular risk factors in Finland. *Int J Epidemiol* **39**, 504–518.
15. Paalanen L, Männistö S, Virtanen MJ *et al.* (2006) Validity of a food frequency questionnaire varied by age and body mass index. *J Clin Epidemiol* **59**, 994–1001.
16. Kaartinen NE, Tapanainen H, Valsta LM *et al.* (2011) Relative validity of a FFQ in measuring carbohydrate fractions, dietary glycaemic index and load: exploring the effects of subject characteristics. *Br J Nutr* (Epublication ahead of print version).
17. Männistö S, Virtanen M, Mikkonen T *et al.* (1996) Reproducibility and validity of a food frequency questionnaire in a case–control study on breast cancer. *J Clin Epidemiol* **49**, 401–409.
18. Reinivuo H, Hirvonen T, Ovaskainen ML *et al.* (2010) Dietary survey methodology of FINDIET 2007 with a risk assessment perspective. *Public Health Nutr* **13**, 915–919.
19. Meltzer HM, Brantsaeter AL, Ydersbond TA *et al.* (2008) Methodological challenges when monitoring the diet of pregnant women in a large study: experiences from the Norwegian Mother and Child Cohort Study (MoBa). *Matern Child Nutr* **4**, 14–27.
20. Paturi M, Tapanainen H, Reinivuo H *et al.* (2008) *The National FINDIET 2007 Survey*. *Publications of the National Public Health Institute* no. B23/2008. Helsinki: National Public Health Institute.
21. Pietinen P, Paturi M, Reinivuo H *et al.* (2010) FINDIET 2007 Survey: energy and nutrient intakes. *Public Health Nutr* **13**, 920–924.
22. Tolonen H, Koponen P, Aromaa A *et al.* (2008) *Recommendations for the Health Examination Surveys in Europe*. *Publications of the National Public Health Institute* no. B21/2008. Helsinki: National Public Health Institute.
23. World Health Organization (2000) *Obesity: Preventing and Managing the Global Epidemic*. *Report of a WHO Consultation*. *WHO Technical Report Series* no. 894. Geneva: WHO.
24. Working Group of Finnish Medical Society Duodecim & Finnish Association for the Study of Obesity (2011) Current Care guidelines for obesity (adults). http://www.kaypahoito.fi/web/kh/suositukset/naytaartikkeli/tunnus/ccs00087 (accessed February 2012).
25. R Development Core Team (2012) R: a language and environment for statistical computing. http://www.R-project.org/ (accessed February 2012).
26. Goldberg GR, Black AE, Jebb SA *et al.* (1991) Critical evaluation of energy intake data using fundamental principles of energy physiology: 1. Derivation of cut-off limits to identify under-recording. *Eur J Clin Nutr* **45**, 569–581.
27. Black AE (2000) Critical evaluation of energy intake using the Goldberg cut-off for energy intake:basal metabolic rate. A practical guide to its calculation, use and limitations. *Int J Obes Relat Metab Disord* **24**, 1119–1130.
28. Kanerva N, Kaartinen NE, Schwab U *et al.* (2012) Adherence to the Baltic Sea diet consumed in the Nordic countries is associated with lower abdominal obesity. *Br J Nutr* (Epublication ahead of print version).
29. Adamsson V, Reumark A, Fredriksson IB *et al.* (2011) Effects of a healthy Nordic diet on cardiovascular risk factors in hypercholesterolaemic subjects: a randomized controlled trial (NORDIET). *J Intern Med* **269**, 150–159.
30. Olsen A, Egeberg R, Halkjaer J *et al.* (2011) Healthy aspects of the Nordic diet are related to lower total mortality. *J Nutr* **141**, 639–644.
31. Osler M, Heitmann BL, Gerdes LU *et al.* (2001) Dietary patterns and mortality in Danish men and women: a prospective observational study. *Br J Nutr* **85**, 219–225.
32. Gao SK, Beresford SA, Frank LL *et al.* (2008) Modifications to the Healthy Eating Index and its ability to predict obesity: the Multi-Ethnic Study of Atherosclerosis. *Am J Clin Nutr* **88**, 64–69.
33. Romaguera D, Angquist L, Du H *et al.* (2011) Food composition of the diet in relation to changes in waist circumference adjusted for body mass index. *PLoS One* **6**, e23384.
34. Tande DL, Magel R & Strand BN (2010) Healthy Eating Index and abdominal obesity. *Public Health Nutr* **13**, 208–214.
35. McCullough ML & Willett WC (2006) Evaluating adherence to recommended diets in adults: the Alternate Healthy Eating Index. *Public Health Nutr* **9**, 152–157.
36. Levitan EB, Wolk A & Mittleman MA (2009) Relation of consistency with the dietary approaches to stop hypertension diet and incidence of heart failure in men aged 45 to 79 years. *Am J Cardiol* **104**, 1416–1420.
37. Fitzgerald KC, Chiuve SE, Buring JE *et al.* (2012) Comparison of associations of adherence to a Dietary Approaches to Stop Hypertension (DASH)-style diet with risks of cardiovascular disease and venous thromboembolism. *J Thromb Haemost* **10**, 189–198.
38. Wolongevicz DM, Zhu L, Pencina MJ *et al.* (2010) Diet quality and obesity in women: the Framingham Nutrition Studies. *Br J Nutr* **103**, 1223–1229.
39. Zamora D, Gordon-Larsen P, Jacobs DR Jr *et al.* (2010) Diet quality and weight gain among black and white young adults: the Coronary Artery Risk Development in Young Adults (CARDIA) Study (1985–2005). *Am J Clin Nutr* **92**, 784–793.
40. Kastorini CM, Milionis HJ, Goudevenos JA *et al.* (2010) Mediterranean diet and coronary heart disease: is obesity a link? – A systematic review. *Nutr Metab Carbiovasc Dis* **20**, 536–551.
41. Sofi F, Abbate R, Gensini GF *et al.* (2010) Accruing evidence on benefits of adherence to the Mediterranean diet on health: an updated systematic review and meta-analysis. *Am J Clin Nutr* **92**, 1189–1196.
42. Sofi F, Cesari F, Abbate R *et al.* (2008) Adherence to Mediterranean diet and health status: meta-analysis. *BMJ* **337**, a1344.
43. Fung TT, Rexrode KM, Mantzoros CS *et al.* (2009) Mediterranean diet and incidence of and mortality from coronary heart disease and stroke in women. *Circulation* **119**, 1093–1100.
44. Fung TT, Chiuve SE, McCullough ML *et al.* (2008) Adherence to a DASH-style diet and risk of coronary heart disease and stroke in women. *Arch Intern Med* **168**, 713–720.

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45. Rodriguez NR, DiMarco NM, Langley S *et al.* (2009) Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: nutrition and athletic performance. *J Am Diet Assoc* **109**, 509–527.
46. Melanson KJ, Angelopoulos TJ, Nguyen VT *et al.* (2006) Consumption of whole-grain cereals during weight loss: effects on dietary quality, dietary fiber, magnesium, vitamin B-6, and obesity. *J Am Diet Assoc* **106**, 1380–1388.
47. Vergnaud AC, Norat T, Romaguera D *et al.* (2012) Fruit and vegetable consumption and prospective weight change in participants of the European Prospective Investigation into Cancer and Nutrition-Physical Activity, Nutrition, Alcohol, Cessation of Smoking, Eating Out of Home, and Obesity study. *Am J Clin Nutr* **95**, 184–193.
48. Venn BJ, Perry T, Green TJ *et al.* (2010) The effect of increasing consumption of pulses and wholegrains in obese people: a randomized controlled trial. *J Am Coll Nutr* **29**, 365–372.
49. Ruxton CH, Gardner EJ & McNulty HM (2010) Is sugar consumption detrimental to health? A review of the evidence 1995–2006. *Crit Rev Food Sci Nutr* **50**, 1–19.
50. O'Neil CE, Fulgoni VL 3rd & Nicklas TA (2011) Candy consumption was not associated with body weight measures, risk factors for cardiovascular disease, or metabolic syndrome in US adults: NHANES 1999–2004. *Nutr Res* **31**, 122–130.
51. Malik VS, Schulze MB & Hu FB (2006) Intake of sugar-sweetened beverages and weight gain: a systematic review. *Am J Clin Nutr* **84**, 274–288.
52. Gautineau M & Mathrani S (2012) *Obesity and Alcohol: An Overview*. Oxford: National Obesity Observatory.
53. Enzi G, Gasparo M, Biondetti PR *et al.* (1986) Subcutaneous and visceral fat distribution according to sex, age, and overweight, evaluated by computed tomography. *Am J Clin Nutr* **44**, 739–746.
54. Geer EB & Shen W (2009) Gender differences in insulin resistance, body composition, and energy balance. *Gend Med* **6**, Suppl. 1, 60–75.
55. Harvie M & Howell A (2006) Energy balance adiposity and breast cancer – energy restriction strategies for breast cancer prevention. *Obes Rev* **7**, 33–47.
56. Kvist H, Chowdhury B, Grangard U *et al.* (1988) Total and visceral adipose-tissue volumes derived from measurements with computed tomography in adult men and women: predictive equations. *Am J Clin Nutr* **48**, 1351–1361.
57. Garaulet M, Perex-Llamas F, Fuente T *et al.* (2000) Anthropometric, computed tomography and fat cell data in an obese population: relationship with insulin, leptin, tumor necrosis factor-α, sex hormone-binding globulin and sex hormones. *Eur J Endocrinol* **143**, 657–666.
58. Livingstone MB & Black AE (2003) Markers of the validity of reported energy intake. *J Nutr* **133**, Suppl. 3, 895S–920S.
59. Jebb SA, Cole TJ, Doman D *et al.* (2000) Evaluation of the novel Tanita body-fat analyser to measure body composition by comparison with a four-compartment model. *Br J Nutr* **83**, 115–122.
60. Prentice AM & Jebb SA (2001) Beyond body mass index. *Obes Rev* **2**, 141–147.