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The Mediterranean Eating in Scotland Experience project: evaluation of an Internet-based intervention promoting the Mediterranean diet

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A 6-month intervention study with a quasi-experimental design was conducted to evaluate the effectiveness of an Internet-based, stepwise, tailored-feedback intervention promoting four key components of the Mediterranean diet. Fifty-three (intervention group) and nineteen (control group) healthy females were recruited from the Universities of Glasgow and Glasgow Caledonian, Scotland, respectively. Participants in the intervention group received tailored dietary and psychosocial feedback and Internet nutrition education over a 6-month period, while participants in the control group were provided with minimal dietary feedback and general healthy-eating brochures. Internet education was provided via an innovative Mediterranean Eating Website. Dietary changes were assessed with 7 d estimated food diaries at baseline and 6 months, and data were analysed to calculate the Mediterranean Diet Score, a composite score based on the consumption of eight components of the traditional Mediterranean diet. The 'intention-to-treat' analyses showed that, at 6 months, participants in the intervention group had significantly increased their intake of vegetables, fruits and legumes, as well as the MUFA:saturated fatty acid ratio in their diet, and had significantly increased plasma HDL-cholesterol levels and a reduced ratio of total:HDL-cholesterol. Participants in the control group increased their intake of legumes but showed no other favourable significant changes compared with baseline. This Internet-based, tailored-feedback intervention promoting components of the Mediterranean diet holds promise in encouraging a greater consumption of plant foods, as well as increasing monounsaturated fat and decreasing saturated fat in the Scottish diet; it also shows that the Mediterranean diet can be adopted by healthy individuals in northern European countries.

Mediterranean diet: Internet: Nutrition interventions: Tailored feedback: Dietary behaviour

The Internet is widely accessible to the general public and is a primary method of obtaining health information (Patrick *et al.* 1999; Williams *et al.* 2002). As the Internet is also one of the most preferred sources of nutrition information (van Dillen *et al.* 2003), its use offers a promising way of delivering nutrition education. Disseminating information via the Internet is likely to be less costly and time-consuming than face-to-face interventions, and some studies suggest that this method is more effective than printed information (Scherrer-Bannerman *et al.* 2000; Young *et al.* 2002). Studies using Internet technology and email education show that this is a feasible approach to deliver behavioural weight loss (Tate *et al.* 2001), physical activity (Napolitano *et al.* 2003) and smoking cessation (Lenert *et al.* 2003) programmes, as well as to provide reliable medical information for patients with chronic diseases (Wilson *et al.* 2001; Young *et al.* 2002; Pinnock *et al.* 2003).

Feedback that is tailored to individuals' needs according to their specific behaviours, and the psychosocial and environmental factors that may affect these behaviours, is another strategy that can be used to modify eating habits in a relatively inexpensive and time-saving manner (Skinner *et al.* 1993; Dijkstra & De Vries, 1999; Brug & Van Assema, 2000). Over the past decade, this approach has been applied in several computer-tailored nutrition interventions and has been shown to be more effective in promoting favourable dietary changes compared with general, non-tailored nutrition education (Campbell *et al.* 1994; Brug *et al.* 1996, 1998; Brug, 1999). Tailored feedback is suggested to be less redundant and evaluated more positively by recipients, thus facilitating the change of dietary behaviours that are potentially health-threatening or maintaining food habits that are beneficial for health (Brug *et al.* 1999*b*).

The need to address beliefs, attitudes and psychosocial factors that may affect dietary behaviour by tailoring dietary feedback is important because research suggests that there is a considerable gap between one's awareness of what one should eat and actual behaviour when it comes to healthy eating (Food Standards Agency Scotland, 2002). This might be the result of people not being aware of their unhealthy dietary behaviour and often thinking that their diets are healthier than other people's diets (Lloyd *et al.* 1995; Paisley *et al.* 1995; Oenema *et al.* 2001). Therefore, and in order to increase awareness of dietary intake, it is important for feedback to include a comparison of dietary behaviour with dietary targets. Furthermore, a recent report commissioned by the Food Standards Agency Scotland revealed that consumers often perceive healthy eating to be a strict eating pattern that requires will-power and planning (Food Standards Agency Scotland, 2002). The Mediterranean diet, however, is a dietary pattern that is recognised for both its health benefits and its palatability

Abbreviations: MDS, Mediterranean Diet Score; SFA, saturated fatty acid.

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(Nestle, 1995), and research suggests that it is transferable to other Western populations (Kouris-Blazos *et al.* 1999).

Although it is difficult to establish a definition of the 'typical' traditional Mediterranean diet (Hakim, 1998), Mediterranean dietary patterns share eight characteristics that differentiate them from northern European food cultures. In particular there is: a high ratio of monounsaturated:saturated fat; a high intake of vegetables; fruits, nuts and seeds; legumes (including beans, lentils, peas and chickpeas); (mainly unrefined) cereals; a low-to-moderate intake of dairy products; a low intake of meat, meat products and poultry; moderate alcohol consumption (Trichopoulou *et al.* 2003). In contrast, the average Scottish diet is relatively low in fruits and vegetables, cereals and legumes, and high in saturated fat, and is recognised as contributing to Scotland's high rates of CHD, stroke and cancer mortality (Scottish Office, 1996). The traditional Mediterranean diet is consistent with the recommendations of the Scottish Diet Action Plan (Scottish Office, 1996), but it may be more attractive to consumers as it is an established, and thus acceptable, eating pattern. In addition, Scottish people regularly holiday in Mediterranean countries. As a result, they have been exposed to and enjoy the Mediterranean cuisine and associate it with tastiness and good times. They may not, however, realise that it is a healthy eating pattern, aspects of which can be relatively easily incorporated into their everyday lives in Scotland.

The aim of the present study was to explore the effects on dietary behaviour of an Internet-based, stepwise, tailored-feedback nutrition intervention that promotes four key components of the traditional Mediterranean diet. We hypothesised that this intervention would be a more effective and acceptable way of promoting healthy eating to the general public than general nutrition information and minimally tailored dietary feedback.

Materials and methods

Participants

Fifty-three women were recruited from the University of Glasgow to serve as the intervention group, and nineteen women from Glasgow Caledonian University to serve as the control group. Recruitment strategies included advertisements in newsletters, flyers, postings on the worksites' Intranet and email advertisements. Eligibility criteria included females aged 25–55 years, with Internet and email access at work, who were born in or had lived in Scotland for more than 15 years. Participants were ineligible if they had a history of CVD, cancer, diabetes or hypertension. Those who met the study criteria were sent an information sheet that described the study procedure in detail. Once their willingness to participate had been verified, participants signed an informed consent form. Participation was voluntary, and anonymity was ensured. The study was conducted from May 2003 to January 2004 and was approved by the Faculty of Medicine Ethics Committee of the University of Glasgow.

Study design and procedures

A 6-month intervention trial, employing a quasi-experimental design with a pretest–post-test evaluation was conducted in order to compare the effect on a change in dietary behaviour of dietary and psychosocial tailored feedback and Internet nutrition education (intervention group), and minimally tailored dietary feedback and general nutrition education (control group). The intervention was based on concepts from the precaution adoption process model (Weinstein, 1988) by providing information on current dietary intake in the form of tailored feedback letters, in order to increase the awareness of personal dietary behaviour. The tailored feedback letters and the website provided tips on how to overcome barriers, improve attitudes and increase confidence towards improving food choices, as well as obtaining support from family and friends, in keeping with the principles of social cognitive theory (Bandura, 1986). Advice was also provided on developing skills to improve eating habits and changing dietary behaviour across the stages of behaviour change, based on the transtheoretical (stages of change) model (Prochaska & Velicer, 1997). In addition, the study focused on setting reasonable and realistic goals, in a stepwise manner, in order to encourage a gradual dietary change, which is more likely to lead to long-term changes (Fletcher & Rogers, 1985).

After consent had been obtained, all participants were screened to determine their current eating habits and assess psychosocial factors that might affect their diet. Particular attention was focused on their consumption of four key components of the Mediterranean diet: vegetables (excluding potatoes), fruits (including nuts and seeds), legumes and MUFA:saturated fatty acid (SFA) ratio, as the intake of vegetables, fruits and legumes is particularly low, and the intake of saturated fat high, in the Scottish diet (Scottish Office, 1996). The intake of these components was compared with the median intake of a group of elderly Greek women consuming a traditional Greek diet (Trichopoulou *et al.* 1995). Depending on their current dietary intake, participants in the intervention group were encouraged to attempt to increase or maintain the consumption of these components (Mediterranean goals) over the 6-month intervention, by focusing on a single goal for a period of 6 weeks. Individual participants chose the order in which they would tackle their goals (e.g. focus on achieving the vegetable goal for the first 6 weeks, the legume goal for the next 6 weeks and so on). Participants in the intervention group were then given access to the Mediterranean Eating Website, which they were requested to visit at least once a week.

Participants in the intervention group received tailored dietary and psychosocial feedback via an email letter, this being based on the results of their baseline dietary and psychosocial assessment. The tailored feedback letter was approximately ten pages long, identified areas for dietary improvement and provided information on participants' current dietary intake and comparison with the Mediterranean diet. The letter then focused on the participants' first selected Mediterranean goal and provided advice to tackle perceived barriers, improve attitudes and self-efficacy skills, as well as tips to achieve or maintain the recommended intake of the selected food component, depending on current intake and stage of change regarding the consumption of this component.

During the course of the intervention, the participants completed four short food questionnaires, every 6 weeks, to assess their progress towards their selected Mediterranean goal. These food questionnaires were interactively completed on the Mediterranean Eating Website, and responses were delivered to the researcher's (A. P.) email address, from where they were analysed in order to generate the tailored feedback letters. Participants were then invited to tackle a second (third, fourth) goal in a stepwise manner. The 6-weekly assessments provided tailored feedback, which gave information on the achievement of previous selected

goals and provided encouragement to tackle a new goal in the manner described above. The short food questionnaires were validated among participants in the intervention group against their baseline 7 d estimated food diaries during the early weeks of the intervention and prior to their use in generating tailored dietary feedback. All four short food questionnaires were found to have fair agreement (Altman, 1992) with the diaries (kappa = 0·24 for vegetables; 0·35 for fruits, nuts and seeds; 0·26 for legumes; 0·23 for fat intake). These instruments were therefore considered acceptable as a means of assessing goal progress, which in turn informed the educational tailored feedback provided during the study course. Overall, participants in the intervention group received six tailored feedback letters over the 6-month intervention period.

Participants in the control group received minimally tailored dietary feedback, which was based on their baseline dietary assessment, via an email letter and were sent three brochures, produced by the Health Education Board of Scotland, that contained general healthy-eating information. The feedback letter was approximately five pages long and contained information about current dietary intake and tips to change dietary behaviours that were potentially health threatening or to maintain food habits that were beneficial for health, according to current recommendations for healthy eating. No further contact was made with the control group until the end of the 6-month intervention, when they received a second feedback letter based on their 6-month dietary assessment.

The Mediterranean Eating Website

A Mediterranean Eating Website was available to participants in the intervention group via the Department of Human Nutrition's web page during the 6-month intervention period. A personal password was assigned to each participant in order to monitor their entry into the website, which provided a measure of website login frequency and use. Participants were emailed on a weekly basis and encouraged to visit the website and the sections that had been updated. They were also directed to the website sections relevant to their current selected Mediterranean goal.

The content of the website was informed by a web-based search to identify the range and content of existing websites promoting healthy eating and consisted of:

- nutrition information related to the health benefits of the Mediterranean diet in general, and of each of the Mediterranean food components promoted by the study in particular;
- tips for simple, easy-to-make dietary changes, using a stepwise approach to change (i.e. attempt and master one behaviour change before attempting a second);
- regularly updated shopping tips, highlighting the availability of low-cost, seasonal items;
- regularly updated Mediterranean-style recipes, requiring minimal cooking skills and using seasonal produce;
- self-assessment quizzes, which allowed participants to evaluate their progress towards their chosen goal;
- a website bulletin board, which was developed to facilitate social support among participants assigned to the intervention group.

The website addressed some of the barriers to healthy eating identified in the Food Standards Agency Scotland report (Food Standards Agency Scotland, 2002), namely: cost (the belief that healthy eating is expensive); time (the perception that preparing healthy food is time-consuming); taste (the perception that healthy foods are boring and tasteless); lack of cooking skills (easy-to-prepare recipes with relatively few, easy-to-obtain ingredients).

Measurements

All participants were seen at baseline and 6 months, at which time their body weight, height, waist circumference, blood pressure and fasting plasma lipid levels were measured. These assessments were carried out at the participants' workplace. At these time points, all participants also completed a 7 d estimated food diary to assess dietary behaviour. Readiness to change and psychosocial variables that might affect diet (including attitudes, motivation, social support, the perceived benefits of, and barriers to, a healthy diet, and self-efficacy skills) were assessed using a previously validated psychosocial questionnaire (Glanz *et al.* 1993), which also incorporated a validated nutrition knowledge questionnaire (Parmenter & Wardle, 1999). This information was used to tailor the feedback in the intervention group only.

Data from the 7 d food diaries were analysed to calculate the Mediterranean Diet Score (MDS), a composite score based on the consumption of the eight components of the traditional Mediterranean diet. The cut-off point for each dietary component represents the median intake, specific for sex, of a group of elderly Greeks consuming a traditional Greek diet, on which the score was originally based (Trichopoulou *et al.* 1995). Energy intake was adjusted to 8368 kJ (2000 kcal), and a score of 1 or 0 was given for each of the food components depending on whether or not the cut-off point was met. Consequently, the score range was 0–8, with a high score defined as ≥4 (Trichopoulou *et al.* 1995).

Statistical analysis

Using a level of 0·05 (two-tailed) and power of 80 %, a sample size of thirty-six was needed to detect statistically significant differences in the mean MDS of the intervention group from baseline of the order of 0·5. It has been shown that a 1 unit increase in total MDS is associated with a significant 17 % reduction in overall mortality (Trichopoulou *et al.* 1995).

As this study promoted only four components of the Mediterranean diet, a change of 0·5 in the mean MDS was considered to be an important difference.

All analyses were performed using the Statistical Package for the Social Sciences (SPSS for Windows, release 11.5, 2002; SPSS, Chicago, IL, USA). Baseline measurements for participants completing the 6-month assessments were compared with the measurements for those not completing the trial for both groups using the Mann–Whitney and Kruskal–Wallis tests for continuous and categorical variables, respectively. Descriptive statistics were used to report baseline and sociodemographic characteristics. To detect changes in mean food group intake, mean MDS and mean plasma lipid concentrations for both groups at baseline and 6 months, the Wilcoxon signed ranks test and paired-samples *t* test were used for non-normal and normally distributed variables, respectively. The Mann–Whitney test was used to examine the changes from baseline in mean dietary intake and plasma lipids between the intervention and control group. The McNemar test was performed to compare the

proportion of participants achieving an MDS of 1 for each food group at baseline and 6 months.

Results

Attrition at 6 months was 20 % (*n* 12) and 21 % (*n* 4) for the intervention and control groups, respectively. With the exception of education, there were no baseline differences in any of the sociodemographic, dietary, anthropometric or biochemical measurements between participants who completed the 6-month assessments and participants who withdrew before the end of the 6-month intervention period for either group. Participants in the intervention group who completed the 6-month trial were, however, more likely to have a university or higher degree compared with participants who did not complete the intervention ($P<0{\cdot}001$; data not shown). Results are presented based on 'intention-to-treat' analyses, using the last available recorded value for participants in both groups who withdrew from the study at some stage before the end of the 6-month intervention. In this respect, dietary analyses were performed for fifty-three participants in the intervention group and nineteen participants in the control group, and analysis of biomarkers for the forty-six participants in the intervention group and sixteen participants in the control group who provided fasting blood samples at baseline.

Baseline sociodemographic and lifestyle characteristics of participants in both groups are presented in Table 1. The mean age of participants in the intervention group was 40·3 years (SD 7·2) and of participants in the control group 40·9 (SD 6·9). There were no baseline differences between the groups in age, anthropometric and blood pressure measurements, eating habits, percentage of participants achieving a high MDS (≥ 4) or mean total MDS, but participants in the intervention group had higher baseline cereal intake (251·3 *v.* 213·3 g/d; $P=0{\cdot}015$) and lower baseline HDL-cholesterol levels (1·42 *v.* 1·75 mmol/l; $P=0{\cdot}005$).

Table 1. Baseline characteristics of participants in both groups (*n* and percentage)

	Intervention group (*n* 53)		Control group (*n* 19)	
Variable	*n*	%	*n*	%
Ethnicity				
Caucasian	53	100·0	17	89·5
Indian	–		2	10·5
Level of education				
Technical training	18	34·0	2	10·5
University or higher	35	66·0	17	89·5
Occupation				
Managerial and professional	32	60·4	17	89·5
Intermediate	18	34·0	2	10·5
Routine and manual	3	5·7	–	
Marital status				
Married/living with partner	35	66·0	12	63·2
Single/divorced/widowed	18	34·0	7	36·8
Smoking				
Current smoker	8	15·1	3	15·8
Never smoked	33	62·3	13	68·4
Ex-smoker	12	22·6	3	15·8
Vitamin supplement user				
Yes	16	30·2	8	42·1
No	37	69·8	11	57·9

Table 2 presents the comparison of daily consumption of the eight components of the Mediterranean diet at baseline and at the end of the 6-month intervention for both groups. Participants in the intervention group significantly increased the amount of vegetables, fruits, nuts and seeds, and legumes, and the MUFA:SFA ratio, in their diet. Participants in the control group also showed a significant increase in legume, as well as dairy product, intake.

The between-group comparison of changes in mean daily consumption of the eight components of the Mediterranean diet over the 6-month trial is presented in Fig. 1. At the end of the trial, participants in the intervention group had significantly increased their intake of fruits, nuts and seeds, whereas participants in the control group had a reduced intake (34·9 *v.* −23·2 g/d; $P=0{\cdot}022$). There was also a less desirable significant increase in dairy products for participants in the control group (−4·1 *v.* 42·3 g/d; $P=0{\cdot}033$) and a slightly less desirable decrease in cereals for participants in the intervention group (−15·6 *v.* 14·3 g/d; $P=0{\cdot}059$). Changes from baseline to 6 months in MUFA:SFA ratio and the mean total MDS were not significant between the groups (data not shown).

The proportion of participants in both groups achieving an MDS of 1 for each dietary component at baseline and 6 months is presented in Table 3. In the control group, the proportion of participants achieving a score of 1 increased for five of the eight components, but none of these increases reached statistical significance. In contrast, the proportion of participants in the intervention group achieving a score of 1 at 6 months increased for six components, including the four 'Mediterranean goals'. This increase was statistically significant for the legume and MUFA:SFA ratio components. There was no significant difference for the proportion of participants achieving a high MDS (≥ 4) at baseline compared with 6 months for either group or between the groups. There was, however, a significant post-intervention increase in the mean total MDS for both the intervention (3·21 *v.* 3·60; $P=0{\cdot}035$) and control (2·74 *v.* 3·21; $P=0{\cdot}047$) groups.

No significant differences were observed within the groups or over the 6-month trial between the groups in anthropometric and blood pressure measurements (data not shown). The fasting plasma lipid levels at baseline and 6 months are presented in Table 4 for both groups. At 6 months, participants in the intervention group had significantly higher HDL-cholesterol levels and a lower total:HDL-cholesterol ratio compared with baseline. By the end of the trial, participants in the intervention group showed a significantly higher increase in HDL-cholesterol levels compared with participants in the control group (0·22 *v.* 0·06 mmol/l; $P=0{\cdot}036$) as well as a higher decrease in the total:HDL-cholesterol ratio (−0·44 *v.* −0·04; $P=0{\cdot}008$).

Process evaluation

Process evaluation of the study, to be reported in detail separately (A. Papadaki, unpublished results), indicated that, regarding participants' reactions to the nutrition education materials (website *v.* general nutrition information brochures), participants in the intervention group were significantly more positive about the website materials they accessed, the majority finding them extremely interesting, informative, useful, attractive, encouraging, time-saving, helpful and not limited in information. In addition, a higher proportion of participants in the intervention group,

Table 2. Mean daily consumption (g/d, adjusted for energy*) of the eight components of the traditional Mediterranean diet

	Intervention group (*n* 53)					Control group (*n* 19)				
	Baseline		6-month			Baseline		6-month		
Food components	Mean	SD	Mean	SD	*P*	Mean	SD	Mean	SD	*P*
Vegetables (g/d)	172·2	84·0	210·6	101·9	0·002‡	191·3	59·1	201·5	93·6	0·776†
Fruits, nuts and seeds (g/d)	200·2	140·6	235·1	150·5	0·025‡	236·7	189·1	213·5	157·8	0·133†
Legumes (g/d)	15·9	17·6	30·6	28·7	0·001†	22·6	24·0	41·9	49·0	0·026†
MUFA:SFA ratio	1·47	1·8	1·79	0·9	<0·001†	1·48	0·4	1·59	0·6	0·408†
Cereals (g/d)	251·3	73·6	235·8	86·5	0·145†	213·3	45·2	227·6	71·8	0·184†
Meat and meat products (g/d)	89·6	39·6	97·3	47·5	0·237†	94·5	68·7	83·5	57·8	0·234†
Milk and milk products (g/d)	231·1	115·9	226·9	120·6	0·754‡	209·7	130·9	252·0	129·8	0·018†
Alcohol (g/d)	17·8	17·0	15·4	11·5	0·750†	18·0	18·6	16·1	13·5	0·649†

MUFA:SFA, MUFA:saturated fatty acid ratio.
* Intakes were adjusted to 8368 kJ (2000 kcal).
† Levels of significance were assessed using the Wilcoxon signed ranks test.
‡ Levels of significance were assessed using the paired-samples *t* test.

compared with participants in the control group, felt extremely satisfied with the nutrition education materials they had received (67·7 *v.* 33·3 %; $P=0·021$). Participants in the intervention group visited the website an average of 15·5 times over the 6-month trial. Usage patterns of the overall website and its sections, as obtained by statistical summaries of the University of Glasgow Web Server, showed that, on average, there were 150 hits on the website each month, 'Recipes' being the most visited section (135 hits/month). Sections of the website that were perceived as being 'very helpful' by the majority of participants in the intervention group were generally visited more frequently.

A higher proportion of participants in the control, compared with the intervention, group reported intending to read the feedback letters again in the future (61·3 *v.* 91·7 %; $P=0·043$), although they were more likely not to find the feedback letters attractive in appearance (6·5 *v.* 25·0 %; $P=0·029$). A higher proportion of participants in the intervention compared with the control group reported changing their diet (100·0 *v.* 66·7 %; $P=0·001$) as a result of the feedback letters they received. There were no other differences in reactions to or impact of the feedback letters on opinions or perceived dietary changes between the groups.

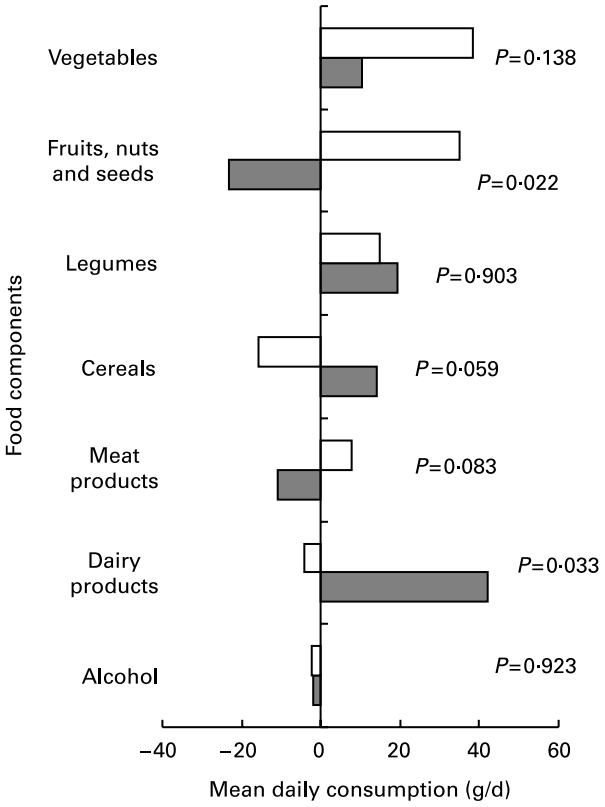

Fig. 1. Comparison of changes between intervention group (□) and control group (■) from baseline to 6 months in mean daily consumption (g/d) adjusted to 8368 kJ) of the eight components of the traditional mediterranean diet. The Levels of significance (*P* values) were assessed using the Mann–Whitney test.

Discussion

The Seven Countries study was the first study to raise interest in the health-promoting benefits of the Mediterranean diet, owing to the low overall and CHD mortality rates and high life expectancies demonstrated by people living in Greece and southern Italy, compared with northern Europe and the United States (Keys, 1970). In recent years, a number of researchers have used the Mediterranean diet recommendations as the nutritional basis of secondary interventions and shown that this eating pattern can be successfully adopted by patients who are motivated to change their diet (Renaud *et al.* 1995; de Lorgeril *et al.* 1998). The present study showed that the Mediterranean diet is also transferable to healthy, free-living women. Internet education and tailored dietary and psychosocial feedback led to more favourable dietary changes towards the traditional Mediterranean diet at 6 months compared with general healthy-eating information and minimally tailored dietary feedback. The dietary changes displayed by the intervention group were reflected in blood lipid profiles, indicating the health benefits of a Mediterranean-style diet. This study suggests that stepwise dietary changes towards the Mediterranean diet can be achieved by a northern European population.

Participants in the intervention group significantly increased their intake of the four Mediterranean target food groups promoted in this study. At the end of the 6-month intervention, their mean vegetable intake had increased by 0·5 servings/d, whereas an increase of 0·4 servings of fruits/d was also found.

Table 3. Percentage of participants achieving a Mediterranean Diet Score of 1* for each component of the traditional Mediterranean diet†

		Intervention group (*n* 53)			Control group (*n* 19)		
Food components	Score criteria	Baseline	6-month	*P*‡	Baseline	6-month	*P*
Vegetables	≥248 g/d	20·8	28·3	0·344	10·5	21·1	0·625
Fruits, nuts and seeds	≥216 g/d	39·6	45·3	0·375	47·4	36·8	0·500
Legumes	≥49 g/d	3·8	20·8	0·012	5·3	26·3	0·125
MUFA:SFA ratio	≥1·6 /d	34·0	49·1	0·039	36·8	36·8	1·000
Cereals	≥248 g/d	50·9	39·6	0·180	15·8	31·6	0·453
Meat and meat products	≤91 g/d	58·5	49·1	0·267	52·6	68·4	0·375
Milk and milk products	≤194 g/d	41·5	49·1	0·424	42·1	26·3	0·250
Alcohol	5–25 g/d	71·7	79·2	0·289	63·2	73·7	0·500
% achieving a score of ≥4		35·8	47·2	0·238	21·1	31·6	0·500

MUFA:SFA, MUFA:saturated fatty acid ratio.
* A Mediterranean Diet Score of 1 for each food component is achieved when the dietary intake of this component meets the median daily intake (cut-off point/score criteria) of the traditional Greek diet (Trichopoulou *et al.* 1995).
† Components of the diet score were adjusted to 8368 kJ (2000 kcal).
‡ Levels of significance were assessed using the McNemar test.

As the original study that defined the traditional Greek diet (Trichopoulou *et al.* 1995) included nuts and seeds in the fruit group, we grouped these foods together in our analyses. However, a separate analysis showed that the contribution of nuts and seeds to the mean increase of this food component was insignificant, suggesting that this increase resulted mainly from fruit intake. At 6 months, mean fruit intake in the intervention group was slightly higher than the median intake of 216 g/d observed in elderly Greek women (Trichopoulou *et al.* 1995). In addition, a significant increase in mean legume intake was reported among these participants, while the mean MUFA:SFA ratio in their diet had increased to 1·79, well above the median intake of 1·6 observed in the group of elderly Greeks consuming a traditional Greek diet (Trichopoulou *et al.* 1995).

The minimally tailored feedback letters sent to participants in the control group included suggestions on how to eat more vegetables, fruits and legumes, as well as advice on how to increase the MUFA:SFA ratio in their diet. This might have accounted for the dietary changes towards the Mediterranean diet made by the control group, particularly the significant increase in legume consumption from baseline to the end of the trial. In addition, most interventions promoting healthy eating to free-living individuals focus on increasing their intake of fruits and vegetables, and decreasing their total and saturated fat intake, but the number of interventions suggesting a weekly consumption of two servings of legumes is limited and mainly involves secondary prevention trials (Renaud *et al.* 1995). Therefore, the significant increase in mean legume intake displayed by the control group might have resulted from the novelty of this particular intervention.

Previous studies examining the effect of tailored dietary and psychosocial feedback on dietary behaviour have focused mainly on fat and/or fruit and vegetable intake. To our knowledge, this is the first study to investigate the combined effect of a healthy-eating website, in the context of the traditional Mediterranean diet, and tailored dietary and psychosocial feedback delivered via electronic mail, on dietary behaviour change. Previous research has found decreases in total fat and saturated fat intake after providing participants with tailored dietary feedback on fat consumption (Campbell *et al.* 1994; Brug *et al.* 1996, 1998, 1999*b*). Direct comparisons regarding fat intake cannot be made, however, since the present study focused on increasing the MUFA:SFA ratio in the diet and not on decreasing total and/or saturated fat intake.

Participants in the intervention group in our study achieved greater increases in the mean daily consumption of both vegetables and fruits compared with employees of an oil company who received computer-generated feedback letters tailored to their dietary behaviour, attitudes, perceived social influences, self-efficacy expectations and awareness levels (Brug *et al.* 1996). Similarly to the present study, participants in the control group did not make significant changes to their vegetable and fruit consumption, and there were no significant differences

Table 4. Plasma lipid concentrations

	Intervention group (*n* 46)					Control group (*n* 16)				
	Baseline		6-month			Baseline		6-month		
Plasma lipid	Mean	SD	Mean	SD	*P*	Mean	SD	Mean	SD	*P*
Total cholesterol (mmol/l)	5·11	0·82	5·17	0·86	0·443†	5·19	0·75	5·21	0·86	0·780*
LDL-cholesterol (mmol/l)	3·10	0·75	2·96	0·86	0·077†	2·89	0·90	2·89	1·00	0·806*
HDL-cholesterol (mmol/l)	1·42	0·27	1·65	0·33	<0·001†	1·75	0·44	1·81	0·44	0·262*
Tricylglycerols (mmol/l)	1·16	0·55	1·11	0·40	0·606*	1·18	0·55	1·13	0·34	0·700*
Total:HDL-cholesterol	3·71	0·91	3·27	0·97	<0·001†	3·19	1·10	3·08	1·03	0·329*

*Levels of significance were assessed using the Wilcoxon signed ranks test.
† Levels of significance were assessed using the paired-samples *t* test.

observed between the two groups (Brug *et al.* 1996). In another study conducted by Brug *et al.* (1999*b*), it was found that providing tailored dietary feedback in a work-based setting led to an increase in fruit, comparable with the present findings, but no change in mean vegetable intake. We also observed greater changes in mean vegetable and fruit consumption compared with other studies employing tailored dietary feedback and involving primary care-setting adult patients (Campbell *et al.* 1994) and volunteers (Brug *et al.* 1998). Although the baseline fruit and vegetable consumption of participants in the present study was higher than the baseline consumption reported in previous research, the increase we observed in the mean intake of these food components was also higher. This finding suggests that Internet technology enhances the positive effect of tailored feedback.

Another possible explanation for the greater effect of our intervention on vegetable and fruit intake compared with previous research might derive from the manual procedure of tailoring feedback messages employed by our study. It is noteworthy that the majority of studies to date have used interactive computer programmes in order to provide tailored dietary feedback, whereby an individual completes and submits a questionnaire on a computer, which is programmed to read the responses and automatically generate individualised feedback messages, based on these responses (Brug, 1999). The results of our study cannot therefore be directly compared with these earlier studies, as feedback email letters in the present study were tailored manually and, although this was more time-consuming, it may have provided more individualised feedback messages than computer-generated messages. However, tailoring feedback messages manually cannot be sustained in the long term, particularly when larger population samples are involved. It might be necessary therefore for future studies to sacrifice some of the favourable changes associated with manually generated feedback in favour of a more sustainable intervention.

There are a number of limitations to this study, which limit the generalisability of our results and the external validity of the study. Despite employing similar recruitment techniques at both universities, we were unable to recruit an equivalently sized control group. This is possibly because the intervention offered to the control group was not innovative enough to motivate them to participate. The decision to recruit the intervention and control groups from different universities was made to avoid the potential for cross-contamination between the groups. As several participants were often recruited from the same department, recruiting and randomising employees from the same department into an intervention and a control group might have resulted in participants in the intervention group sharing their personal website passwords with friends assigned to the control group. In addition, no attempt was made to randomise the workplaces into the intervention and control groups for reasons of convenience as we had easy access to the intervention site intranet and associated website usage tracking procedures. Future applications of this intervention should ideally conduct such a randomisation.

Although the results from this study are promising, our sample consisted of a self-selected group of relatively well-educated women, who might have been more motivated to make dietary changes than average members of the general public. It is noteworthy that participants in this study had, at baseline, a more favourable average daily consumption of the four components of the Mediterranean diet that the study was promoting compared with Scottish average intakes (Office for National Statistics, 2002). However, their intakes were still lower compared with the median intakes of elderly Greek women consuming a traditional Greek diet (Trichopoulou *et al.* 1995). In addition, the total sample size was small, which was necessitated by the relatively labour-intensive dietary assessment and manual tailoring procedures. In the future, the use of a fully computer-generated procedure will make it possible for studies to recruit a larger and also more diverse sample, taking into consideration regional, socio-economic, educational and other demographic characteristics. Female participants were recruited because research suggests that women are more responsible for meal planning, food shopping and preparation (Harnack *et al.* 1998). It would, however, be useful to examine the effect of such an intervention on male participants.

A further limitation of this study is that it is difficult to isolate effects achieved from the two components of the intervention. Therefore, it cannot be clearly determined whether it was the Mediterranean Eating Website or the theory-based, stepwise behaviour change approach with tailored dietary and psychosocial feedback, or the combination of the two approaches, that was associated with the dietary changes in the intervention group.

The time frame of the study did not permit the focused promotion of more components of the Mediterranean diet. The inclusion of additional goals related, for example, to cereal, meat and dairy product intake would have either increased the duration of the intervention from 6 months to almost 12 months, or reduced the length of time that participants had to attempt and achieve their goals. Because this study adopted a stepwise approach, a 6-week period was considered to be appropriate for tackling a single Mediterranean goal, in order to encourage a gradual and sustained dietary change, therefore allowing the promotion of only four components of the Mediterranean diet in the 6-month intervention period. Although a longer intervention would allow a more extensive focus on all eight components of the Mediterranean diet, such an intervention would probably not be sustainable from a participant's perspective, resulting in an increased attrition rate. However, since intervention periods in other similar studies have varied from 3 weeks to 4 months (Campbell *et al.* 1994; Brug *et al.* 1996; Brug & Van Assema, 2000), future applications of this intervention could include the promotion of other components of the Mediterranean diet by reducing the time assigned to tackle each goal. This might also result in a more favourable post-intervention effect in the total MDS for participants in the intervention group.

In addition, although the Mediterranean Eating Website offered advice on the promotion of fish, particularly oily fish, consumption, according to current recommendations for healthy eating (Scottish Office, 1996), fish was not included as one of the food components contributing to the MDS. This is because fish consumption in the traditional Mediterranean diet depends on proximity to the sea (Trichopoulou *et al.* 2003), and a median intake for fish was not defined in the original article that described the traditional Greek diet, on which the MDS was based (Trichopoulou *et al.* 1995).

Despite these limitations, the present study included objective measures of blood lipid levels for impact evaluation, which are lacking in previous studies (Campbell *et al.* 1994; Brug *et al.* 1996, 1998). In addition, the intervention period was longer than that reported in previous research (Brug *et al.* 1996, 1998). A further strength of this study is the provision of psychosocial feedback based on behaviour change theories, including goal-setting, as

well as feedback on how personal dietary intake compares with recommendations and feedback on how participants progress between different screening moments (Brug *et al.* 1999*a*; De Vries & Brug, 1999). Supplementing dietary feedback with behavioural, theory-based tailored advice on lowering risks, and providing psychosocial information and strategies on how to alter social outcomes and self-efficacy skills, is suggested to motivate people further to change their eating behaviours (Brug, 1999).

A rising number of people in the UK have Internet and email access at work or at home (Linke *et al.* 2004), and electronic access to health information has increased (Williams *et al.* 2002). Internet-based, tailored interventions, such as the one described here, have the potential to reach and promote healthy diet behaviour change to a large number of people at a relatively low cost. This paper reports the results of the evaluation of a nutrition intervention that utilised the first prototype of a Mediterranean Eating Website. However, before the intervention can be widely disseminated on the World Wide Web, it needs to be further developed and evaluated. The next stage in the development of the Mediterranean Eating Website is to evaluate its effectiveness among a larger group of free-living adults in the general community and/or a primary care setting. If it is shown to be effective, the Mediterranean Eating Website could be promoted to general practitioners and other health professionals as a reputable, non-commercial tool for use by their patients and clients wishing to make simple improvements to their diet.

The Mediterranean diet is recommended to the Western world as a dietary pattern that is both palatable and healthy, and that can be easily incorporated within a modern lifestyle (Willett *et al.* 1995). Although our results should be interpreted with caution, owing to the limitations discussed, this Internet-based, stepwise tailored intervention used to promote healthy eating in the context of the traditional Mediterranean diet presents a realistic approach to dietary behaviour change. As information technology systems improve and general access to computers has increased (Velicer & Prochaska, 1999), such interventions have the potential to promote a greater consumption of plant foods in Scotland, as well as decreasing saturated fat and increasing monounsaturated fat intake in the Scottish diet, in agreement with current dietary recommendations for health promotion and disease prevention.

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