RESEARCH ARTICLE

The Efficacy of Web-based and Print-delivered Computer-tailored Interventions to Reduce Fat Intake: Results of a Randomized, Controlled Trial

Continuing Education Questionnaire available at www.sne.org/ Meets Learning Need Codes for RDs and DTRs 4010, 6050, and 4000.

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ABSTRACT

Objective: To test and compare the efficacy of interactive- and print-delivered computer-tailored nutrition education targeting saturated fat intake reduction.

Design: A 3-group randomized, controlled trial (2003-2005) with posttests at 1 and 6 months post-intervention.

Setting: Worksites and 2 neighborhoods in the urban area of Rotterdam.

Participants: A convenience sample of healthy Dutch adults (n = 442).

Interventions: An interactive, computer-tailored intervention delivered on a CD-ROM (interactive-tailored condition); a print-delivered, computer-tailored intervention (print-tailored condition); and print-delivered, generic information.

Main Outcome Measures: Total and saturated fat intake (grams/day and percentage-energy) and energy intake per day assessed with validated food frequency questionnaires at 1 and 6 months post-intervention.

Analysis: Multilevel linear regression analyses.

Results: Mean total fat, saturated fat, and energy intakes were significantly lower in both tailored conditions compared to the generic condition at 1-month follow-up. These differences were still significant for the print-tailored condition at 6-months follow-up. Effects were most pronounced among participants with unfavorable fat intakes at baseline. There were no significant differences between the 2 tailoring conditions.

Conclusions and Implications: The results indicate that interactive and print-delivered computer-tailored interventions can have similar short-term effects on fat intake and that the effects of the print-delivered tailored feedback are maintained in the longer term.

Key Words: Web-based, computer tailoring, nutrition education

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INTRODUCTION

Computer-tailored health education, the technique by which the educational information is matched to each individual's unique characteristics, behaviors, perceptions of behavior, and/or motivation to change as derived from an individual assessment,[1] is a promising health education technique, particularly for nutrition education.[2] However, the evidence regarding the efficacy of computer-tailored interventions is mainly based on studies of print-delivered interventions, whereas the Internet is becoming an increasingly popular medium for the delivery of nutrition education interventions.

Providing computer-tailored interventions through interactive delivery channels such as the Internet is recommended, because such interactive media allow for a greater extent of interactivity in providing the computer-tailored feedback, which may potentially enhance the efficacy of the intervention.[3] Second, Internet delivery enables access to up-to-date interventions wherever there is an Internet con-

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nection.[4,5] Third, population-wide distribution is possible with relatively low cost.

Despite these promising characteristics, there is a lack of empirical evidence on the merits of interactive computer tailoring. The few studies that have evaluated the effects of Web-based or multimedia computer-tailored nutrition interventions targeting dietary intake have had mixed results.[6-12] There is a need for additional well-designed studies to evaluate the efficacy of interactive computer-tailored nutrition interventions compared to generic nutrition education and to print-delivered computer tailoring. Print-delivered interventions may have advantages over interactive delivery modes, because it may be easier to read and process information from paper than from a computer screen.[13,14] and people may be more likely to save and reread such print-delivered feedback.[13] To date, differential effects of computer-tailored nutrition interventions through print or interactive delivery modes have not been examined.

This study aimed (1) to evaluate the effects of an interactive computer-tailored fat reduction intervention (delivered on a CD-ROM, but ready to be disseminated through the Internet) and a print-delivered version of identical content, compared to generic fat reduction information: and (2) to compare the efficacy between both computer-tailored interventions, especially among people for whom it is particularly important to reduce their fat intake, namely, people with higher than recommended fat intake levels at baseline (called "risk consumers").

The study focused on saturated fat intake as the target behavior, because this is one of the prominent dietary risk factors associated with a number of chronic diseases (cardiovascular diseases in particular)[15,16] and because undesirable intake levels have a high prevalence in Western countries.[17-19] Moreover, computer tailoring is a technique well suited to include behavior change strategies (eg, feedback) that are appropriate for modifying complex health-related behaviors such as saturated fat intake. A problem often observed in relation to complex health-related behaviors is that many people are not aware of their own risk behavior.[20-22] According to the Precaution Adoption Process Model,[23] awareness of one's risk behavior is a prerequisite for the intention to change. Feedback about one's risk behavior is an appropriate strategy for improving awareness, an important first step toward behavior change. To proceed from intention to actual performance of a behavior, improved self-efficacy and skills for how to change are needed, and individualized feedback about personal change options can be provided.

METHODS

Design and Procedure

This study involves 3 arms of a larger randomized, controlled trial with 5 study arms. The aim of the larger study (conducted between 2003 and 2005) was to investigate different aspects of computer-tailored interventions aimed at dietary fat reduction. The current study included the study groups that received CD-ROM or print-delivered computer-tailored nutrition education or generic nutrition education and used self-reported total and saturated fat intake, measured by a food frequency questionnaire (FFQ), as outcome measures. The groups in the other 2 study arms not included in this study received less extensive forms of the print-delivered computer-tailored information.

All participants gave written informed consent after receiving written information about the study. After completion of the baseline paper screening questionnaire, respondents were randomized to 1 of 5 study conditions in a computer-determined sequence, stratified by source (each company or community). The intervention materials were sent to the respondents' home addresses within weeks of returning the screening questionnaire. One and 6 months later, posttest questionnaires were completed. Participants who did not return their questionnaires were contacted once by e-mail or telephone. Approval for the research project was obtained from the medical ethics committee of Erasmus University Medical Center (MC), Rotterdam.

Recruitment of Participants

Recruitment was conducted in 2003 and 2004 using 2 strategies: recruiting employees through large companies and door-to-door advertising in 2 neighborhoods in the Rotterdam area, the second largest city in the Netherlands. The information packages contained an invitation letter, an information leaflet, a declaration of approval of the study by the medical ethics committee of Erasmus MC Rotterdam, an application form, an informed consent form, and information on health insurance for participants. Eligibility criteria were: 18-65 years of age, sufficient understanding of the Dutch language, no diet prescribed by a dietitian or physician, and no treatment for hypercholesterolemia.

Nine companies agreed to distribute the information package among their employees, and 574 employees volunteered to participate. Nine thousand leaflets with brief information about the study were spread door-to-door among citizens in the 2 neighborhoods. Citizens who expressed their interest in participating (by pre-stamped response card, telephone, or e-mail) received the information package, and 224 respondents enrolled in the study. Recruitment activities resulted in a total of 798 (574 + 224) participants who started the study, of whom 764 filled out the screening questionnaire (Figure 1). A total of 442 respondents (310 from companies and 132 from communities) were assigned to the 3 conditions presented in this paper: 151 to the CD-ROM condition, 141 to the print condition, and 150 to the generic information condition.

A power calculation showed that with 82 participants in each condition at posttest, a relative difference of 8.7 grams/day (g/d) in saturated fat intake (with an assumed intake of saturated fat in the generic information group of 43.5 g/d) could be detected, with a statistical power of 0.90 (2-tailed; $P < .05$).

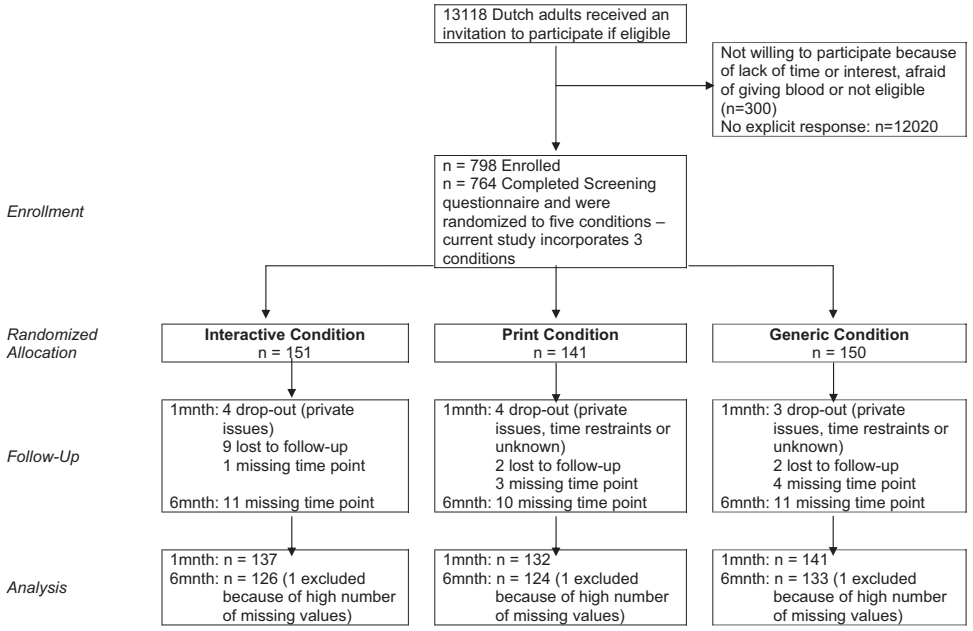

Figure. Recruitment and retention flow chart. Drop-out and lost to follow-up, cases with missing data at 1 month and 6 months. Drop-out notified us, lost to follow-up did not. Missing time point reflects cases with missing data on specific time point. n = sample size; mnth = month(s).

Intervention Materials

Computer-tailored interventions. All necessary components for generating a computer-tailored intervention (screening instrument, tailoring algorithms, and feedback library) were adapted from earlier work of Brug et al[24] and Oenema et al.[10] The computer-tailored interventions were informed by the Precaution Adoption Process Model and the Theory of Planned Behavior, as previously described in more detail in these studies.[10,24]

The screening instrument. Fat intake was assessed with a short, validated FFQ of 35 questions covering the 19 (categories of) food items that contribute most to saturated fat intake in the Dutch diet (Pearson correlation with a 7-day diet record = 0.70). Participants could indicate how frequently, how much, and what type (high-, medium-, or low-fat) of food items they usually consumed in the past 4 weeks. An individual fat score can be calculated by adding up the 19 fat scores for each subject (ranging from 0 to 80).[25]

In addition, perception of own fat intake in terms of high and low, attitude (bad or good to eat less fat), self-efficacy (difficult or easy to eat less fat), and readiness to reduce fat intake were assessed, as well as self-efficacy (difficult or easy to eat less fat), in 4 potentially difficult situations (eating out, eating at someone else's home, eating at parties, eating snacks). This screening instrument was used for generating the tailored feedback.

The feedback library. The feedback library contained messages aimed at increasing awareness of own fat consumption by providing feedback on fat intake. Messages were tailored on fat score, and the recommended intake for a person of the recipient's gender and age (intake is good or higher than recommended) and his or her own perception of that intake (underestimator, realist, or overestimator). Feedback about the fat intake of peers of the same age and the same sex was given when personal fat consumption was higher than the fat consumption of peers. The consumption levels of peers were derived from national consumption data of Dutch adults.[26] The feedback was visualized in a graph with bars for personal fat score, recommended fat score, and (if relevant) the fat score of peers.

Another series of messages addressed motivational feedback, based on attitude (reducing fat intake is good, neutral, or bad), self-efficacy (reducing fat intake is difficult, neutral, or easy), and readiness to reduce fat intake.

To provide suggestions for how to change, practical product feedback addressed the most important sources of fat (based on frequency of consumption and type of products derived from the screening instrument) in the recipients' diet and provided information on low-fat alternatives. Furthermore, feedback was given on how to lower fat intake in situations perceived as difficult, such as eating out or being at a party. A schematic overview of the computer-tailored information and some examples of feedback messages are given in Table 1.

The interactive-tailored condition. In the "interactive-tailored condition," the whole program consisted of html pages and appeared as a Web-based intervention, but it was stored on a CD-ROM for the present study to improve exposure and avoid contamination between groups. The program started with a home page, which explained the nature and goal of the program and how to use it. By clicking the button on the menu bar, the screen-

Table 1. Overview of the Computer-tailored Information and Examples of Individualized Messages for a 29-Year-old Male

Section	Content of the Messages, and Examples	Diagnostic Variables for Tailored Feedback
Introduction	• Personalized (name, gender) heading and introduction • Generic basic information on dietary fat and health; emphasis that the information and feedback following this introduction is based on and tailored to the personal answers provided on the questionnaire	Name and gender
	Example: *Dear Mr. Doe* • Encouragement to take responsibility for own consumption and to discuss the information with the person who does the shopping and/or cooking (if applicable) − 1 message/person	Cooking (yes/no) and grocery shopping (yes/no)
	Example: *You have indicated that you do not cook meals or do the grocery shopping regularly. Maybe you wonder if this information can therefore be of use to you. Well, in the end it is you who decides what you eat, and how much. So do discuss the information and feedback with the person who does most of the cooking and shopping for you.*	
Feedback about personal fat intake	• Increase awareness of own fat intake by providing feedback on personal fat score compared to recommended intake level for someone of his/her gender and age and to his/her own perception of that intake level − 1 message/person • Reduce optimistic bias ("My consumption is better than that of my peers") by comparing the personal fat score to the average fat score of peers in case fat score was higher than fat score of those peers − maximum 1 message/person • Graphical representation of fat score with a bar for personal fat score, recommended fat score, and fat score of peers (if relevant)	Gender; age (< 30y; 30 y − 40 y; 40 y-50 y; > 50 y); fat score; recommended fat score; fat score of peers; perception of own intake ("How much fat do you think you eat?" 5-point scale very little/very much)
	Example (a): *You have indicated that you think that you eat a lot of fat. Indeed, from your answers to the questionnaire it appears that you probably eat more fat than recommended by experts. You have 21 fat points. One fat point is the equivalent of about 4 grams of fat per day. You should not eat more, and preferably less, than 19 fat points a day. This is also shown in the graph.*	
	Example (b): *You have indicated that you think that you eat little fat. However, from your answers to the questionnaire it appears that you do eat more fat than recommended by experts. You also eat more fat than most other men of your age. You have 25 fat points. One fat point is the equivalent of about 4 grams of fat per day. You should not eat more, and preferably less, than 19 fat points a day. This is also shown in the graph.*	

Table 1. Overview of the Computer-tailored Information and Examples of Individualized Messages for a 29-Year-old Male *(continued)*

Section	Content of the Messages, and Examples	Diagnostic Variables for Tailored Feedback
Motivation and suggestions for changing fat intake	• Motivational feedback; feedback tailored to readiness to reduce fat intake and cognitions regarding reduction of fat intake, related to evaluation of personal fat score with an encouragement to reduce fat intake (if necessary) — 1 message/person	Readiness to eat less fat than you do now (motivation to reduce fat intake within half a year, within a month, already trying to reduce fat intake, past attempt, maintenance of past attempt); attitude ("Do you think that it is bad or good to eat less fat than you do now?" 5-point scale very bad/very good); self-efficacy ("Do you think it is difficult or easy to eat less fat than you do now?" 5-point scale very difficult/very easy)
	Example: *You indicated in the questionnaire that you do not intend to eat less fat. That is unfortunate. However, you did indicate that you do not find it difficult to eat less fat. After reading the information about the amount of fat you eat, you have possibly changed your mind about reducing fat intake. If so, please read more below on the most important sources of fat in your diet and how you can replace these with low-fat products.*	
	• Action feedback; practical behavior change information addressing the most important sources of fat in the personal diet and suggestions for low-fat alternatives with encouragement to change — 0 to 17 messages/person	Sources of fat identified based on the screening instrument categorized by milk and milk products, sandwich fillings, dinner entrees, and snacks (examples of products: whole milk, porridge, butter, cheese, meat eaten at dinner, gravy, cake, chocolate)
	Example: *You use whole milk. Semi-skimmed milk contains less fat; it saves almost 4 grams of fat per glass of milk. If you drink low-fat milk, it saves up to 7 grams of fat per glass. However, many people do not really like low-fat milk. You could at least use low-fat milk when cooking sauces, porridge, or pancakes. Further, buttermilk contains much less fat compared to whole or semi-skimmed milk..*	
	• Feedback on how to deal with perceived difficult situations — 0 to 4 messages/person	Situational self-efficacy for 4 specific situations ("Do you think that it is difficult or easy for you to eat less fat when: eating out / eating at someone else's home / at parties / eating snacks in between meals?")

Table 1. Overview of the Computer-tailored Information and Examples of Individualized Messages for a 29-Year-old Male *(continued)*

Section	Content of the Messages, and Examples	Diagnostic Variables for Tailored Feedback
	Example fragment (a): *Making your choice from the menu; grilled or roasted meat, fish, or poultry usually contains less fat.*	
	Example fragment (b): *When you would like to order a dish with a sauce, ask if they can serve the sauce in a separate bowl. That way, you can decide yourself how much sauce you would like to take. In addition, red sauces usually contain less fat than "white" sauces.*	
	Example fragment (c): *Do you think it is hard to refuse a snack at a party? Save a bit of the snack you already have as long as possible so you have an easy excuse when saying no (you already have something).*	
Recipes	• Recipes tailored to preferences — 0 to 10 recipes/person in the print condition; participants in the interactive could choose from a Web page with a list of 56 recipes	Interest in recipes for starters (yes/no), main courses (yes/no), and desserts (yes/no); per-course recipe options for main ingredients chicken, meat, fish, or vegetarian and for rice, potatoes, or pastas

Abbreviation: y, years.

ing questionnaire started. Immediately after completion, the individualized computer-tailored information appeared on the screen. The information started with a personalized opening, followed by a general introduction to the topic of fat in the diet and its relationship to health. The program also contained a page with low-fat recipes for appetizers, main courses, and desserts. It was possible to print the feedback, but the program did not (automatically) save the generated advice. Respondents in the interactive condition received the CD-ROM at their home address with the request to use the program that same week. The program could be used on any computer with Internet Explorer 5.0 or higher.

The print-tailored condition. The paper screening questionnaires from the computer-tailored print condition ("print-tailored condition") were scanned and imported into the computer-tailoring program that generated individualized, computer-tailored print feedback letters, which were 1.5 to 4 pages in length. The information started with a personalized opening, followed by a general introduction to the topic of fat in the diet and its relationship to health. If interested, respondents received recipe suggestions for low-fat appetizers, main courses, or desserts. The letter was sent to the home address of the respondent within 2 weeks after returning the screening instrument.

Generic condition. The control condition consisted of nonpersonalized, nontailored generic nutrition information (generic condition). The information explained the importance of a healthful diet and more specifically, the importance of a limited amount of fat in the diet. It also stressed that the fat intake of the average Dutch person is generally higher than recommended and higher than they expect and that this might be the case for the reader, as well. Practical information on high-fat products and suggestions to reduce fat intake were provided. The length of the generic information was 2 pages in print. The layout of the generic condition and the print-condition letters was the same.

Measurements

Baseline characteristics. The paper screening questionnaire included questions on gender, age, education level, height and weight (to calculate body mass index [BMI]), and fat score. Based on the fat score assessed with the screening instrument, participants were categorized as "risk consumers" when their fat intake exceeded the recommended level of fat intake for their gender and age.

Food frequency outcome measures. Daily intake of total fat and saturated fat (grams and percentage of daily energy intake [en%]) and energy (megajoules) at 1 month and 6 months post-intervention were assessed using an extensive paper FFQ. This questionnaire was validated (Pearson correlations compared to dietary history were 0.83, 0.78, and 0.75 for the intakes of energy, total fat, and saturated fat, respectively)[27] and last revised according to the Dutch National Food Consumption Survey of 1998.[26] The questionnaire consisted of 104 food items and was organized according to meal pattern. Participants recorded their frequency of consumption and portion size for a selection of food items eaten during meals or between meals. This more extensive FFQ was used for posttest measurements, since it allows calculation of total energy intake and percentage energy from fat.

Process evaluation outcome measures. Use of the intervention materials at 1 month post-intervention was measured in terms of whether the information was read ("I read all of the nutrition information" [yes/no]), saved ("I saved the nutrition information" [yes/no]), and discussed ("I discussed the nutrition information with others" [yes/no]).

Table 2. Baseline Population Characteristics (mean [SD]) of the Interactive and Print Computer-tailored Conditions and the Generic Information Condition

	Interactive (n = 151)	Print (n = 141)	Generic (n = 150)	Differences between Study Groups (*P* values)
Gender (% female)	53.6	55.3	56.0	.915*
Age (y)	44.0 ± 10.56	43.4 ± 10.1	44.1 ± 9.7	.815†
Education (%) elementary	2.6	3.6	2.0	.985*
lower secondary	19.2	18.6	18.4	
higher secondary	33.8	35.0	37.4	
tertiary	44.4	42.9	42.2	
BMI (kg/m^2)	25.5 ± 3.8	25.5 ± 4.3	25.3 ± 3.8	.864†
Fat score (%)	17.5 ± 6.2	16.9 ± 5.5	17.9 ± 6.6	.422†
Risk consumers‡ (%)	48.3	50.7	50.0	.917*

SD indicates standard deviation; BMI, body mass index.
**P* value derived from Pearson chi-square
†*P* value derived from 1-way analysis of variance (ANOVA)
‡Percentage with pretest fat score above gender-age–specific cutoff point

Table 3. Daily Consumption of Total Fat, Saturated Fat, and Energy in Computer-tailored and Generic Conditions

	1 Month Posttest			6 Months Posttest		
	Interactive	**Print**	**Generic**	**Interactive**	**Print**	**Generic**
Population (n)	137	132	141	126	124	133
Total fat (g, mean [SD])	77.4 (30.9)	80.5 (25.7)	88.4 (39.9)	77.9 (30.4)	76.1 (26.9)	83.0 (34.2)
Saturated fat (g, mean [SD])	28.3 (12.9)	28.9 (9.8)	31.4 (15.0)	28.5 (10.0)	27.0 (10.0)	29.5 (13.7)
Energy (MJ, mean [SD])	8.6 (2.5)	8.3 (2.7)	9.4 (3.1)	8.4 (2.5)	8.2 (2.4)	8.9 (3.0)
Total fat (en%, mean [SD])	35.1 (6.2)	35.6 (6.4)	35.0 (6.7)	34.8 (5.9)	34.9 (5.6)	35.0 (5.7)
Saturated fat (en%, mean [SD])	12.7 (3.0)	12.8 (3.1)	12.4 (2.8)	12.6 (2.9)	12.4 (2.5)	12.4 (2.5)
Risk consumers (n)	68	66	72	63	63	69
Total fat (g, mean [SD])	87.9 (35.1)	86.6 (23.6)	104.2 (44.1)	86.1 (32.5)	79.6 (26.7)	96.7 (36.8)
Saturated fat (g, mean [SD])	32.8 (15.2)	31.3 (9.4)	37.1 (16.9)	32.2 (14.3)	28.1 (9.5)	35.0 (15.3)
Energy (MJ, mean [SD])	9.1 (3.0)	8.8 (2.2)	10.7 (3.4)	8.9 (2.7)	8.3 (2.3)	10.2 (3.2)
Total fat (en%, mean [SD])	36.1 (6.1)	37.5 (6.8)	36.5 (6.5)	36.2 (6.0)	36.1 (5.1)	35.9 (5.6)
Saturated fat (en%, mean [SD])	13.4 (3.0)	13.6 (3.4)	13.0 (2.7)	13.4 (3.1)	12.8 (2.3)	12.9 (2.4)

SD indicates standard deviation; MJ, megajoules; en%, proportion of total energy intake.

Table 4. Results of Multilevel Regression Analysis, Testing Posttest Differences in Daily Fat and Energy Intake Levels between the Interactive and Print Computer-tailored Conditions and the Generic Condition

	Interactive vs Generic						Print vs Generic					
	1 Month			6 Months			1 Month			6 Months		
	b	**95% CI**		**b**	**95% CI**		**b**	**95% CI**		**b**	**95% CI**	
Total Population												
Total fat (g)	**−10.93**	**−18.63**	**−3.23**	−5.14	−12.61	2.33	**−7.82**	**−15.59**	**−0.04**	−6.90	−14.40	0.60
Saturated fat (g)	**−3.15**	**−6.15**	**−0.15**	−1.08	−4.06	1.91	−2.43	−5.46	0.60	−2.48	−5.47	0.51
Energy (MJ)	**−1.07**	**−1.72**	**−0.43**	−0.52	−1.16	0.12	**−0.78**	**−1.43**	**−0.12**	**−0.70**	**−1.34**	**−0.05**
Total fat (en%)	0.10	−1.40	1.59	−0.17	−1.56	1.21	0.60	−0.90	2.11	−0.16	−1.55	1.23
Saturated fat (en%)	0.10	−1.40	1.59	0.22	−0.42	0.86	0.60	−0.90	2.11	0.03	−0.67	0.61
Risk Consumers												
Total fat (g)	**−16.45**	**−27.84**	**−5.05**	−10.83	−21.77	0.12	**−18.79**	**−30.32**	**−7.27**	**−17.62**	**−28.57**	**−6.67**
Saturated fat (g)	−4.40	−9.03	0.23	−2.71	−7.26	1.84	**−6.21**	**−10.89**	**−1.52**	**−6.77**	**−11.32**	**−2.23**
Energy (MJ)	**−1.51**	**−2.46**	**−0.57**	**−1.25**	**−2.18**	**−0.31**	**−1.87**	**−2.83**	**−0.92**	**−1.85**	**−2.78**	**−0.91**
Total fat (en%)	−0.54	−2.63	1.54	0.14	−1.72	2.00	0.68	−1.43	2.79	−0.10	−1.97	1.76
Saturated fat (en%)	0.39	−0.61	1.39	0.47	−0.41	1.35	0.62	−0.38	1.63	−0.15	−1.03	0.73

b indicates unstandardized regression coefficient; 95% CI, 95 % confidence interval; MJ, megajoules; en%, proportion of total energy intake.

Note: Model – multilevel linear regression analyses with random intercept at company/neighborhood level. Significant outcomes are printed in bold font. Interpretation example: Among the total population, participants in the interactive-tailored condition ate almost 11 grams of total fat/day less compared to participants in the generic condition 1 month after the intervention; this difference was significant.

Statistical Analyses

To explore equality between groups at baseline, chi-square tests for categorical variables (gender, education, percentage risk consumers) and 1-way analysis of variance (ANOVA) (2-tailed, $P < .01$) for continuous variables (age, BMI, and fat score) were conducted. Logistic regression analyses were conducted to examine intervention condition, gender, age, and fat score as predictors of dropout at both 1 and 6 months posttest (2-tailed, $P < .05$) (SPSS version 11.0, Chicago, Ill, 2001).

Participants were nested within companies or communities, with the probability of interdependence between participants and their source. To take this situation into account, multilevel linear regression analyses with random intercepts for the 2 levels (companies/communities and individual) were conducted to test for differences between the conditions on daily total fat intake, saturated fat intake (both in grams and en%), and energy intake at 1 and 6 months post-intervention. For each outcome measure, 1 regression analysis was conducted with the intervention condition variable dummy-coded (generic condition was the reference group), to test the effects of both tailoring interventions compared to the control group. In a second regression analysis, the intervention condition variable was dummy-coded with the print computer-tailored condition

as the reference group to compare both tailoring conditions. The complete case analyses were performed for the total study population and for the risk consumers subgroup (2-tailed, $P < .05$) (MLwiN version 1.10.0007, Institute of Education, University of London, UK, 1998). Chi-square tests were used to examine group differences in use (read, saved, and discussed—discussed only among respondents who had read the information) of the information among the total population and among the risk consumers.

RESULTS

Participants

A total of 410 respondents (93% response) completed and returned the 1-month posttest questionnaire, and 386 respondents completed and returned the 6-month posttest questionnaire (87% response). No baseline differences in gender, age, education level, BMI, fat score, and percentage of risk consumers were found between the study conditions (Table 2). No differences in dropouts were found between study conditions, but older respondents (OR = 1.03; 95% CI = 1.001-1.061) and women (OR = 2.01; 95% CI = 1.100-3.676) were more likely than younger and male respondents, respectively, to have dropped out 6 months post-intervention.

Effects On Total Fat, Saturated Fat, and Energy Intake

Descriptive statistics for 1 and 6 months follow-up are presented in Table 3.

Interactive tailoring vs generic information. At 1 month post-intervention, mean total fat, saturated fat, and energy intake were significantly lower in the interactive-tailored condition in the total study population (Table 4). Total fat and energy intake also were significantly lower for the interactive-tailored condition in the subgroup of risk consumers. At 6 months post-intervention, energy intake was significantly lower for the interactive-tailored condition only in the risk consumer subgroup.

Print tailoring vs generic information. At 1 month post-intervention, mean total fat and energy intake were significantly lower in the print-tailored condition among the total study population and among the risk consumers. Saturated fat was also significantly lower in this subgroup (Table 4). At 6 months post-intervention, energy intake remained significantly lower in the print-tailored condition in the total study population. Total fat, saturated fat, and energy intake also were significantly lower in the print-tailored condition among the subgroup of risk consumers.

Interactive vs print tailoring. No significant differences were found between the interactive-tailored condition and the print-tailored condition on any of the outcome measures, at any point in time, in the total population or among risk consumers (results not shown).

Use of the Intervention Materials

There was a significant difference between the groups with respect to information read. Of the participants, 81% in the interactive-tailored condition, 95% in the print-tailored condition, and 94% in the generic condition reported to have read all the information (Pearson chi-square = 17.35, $P = .00$). With respect to information saved, 77% in the interactive-tailored, 97% in the print-tailored, and 84% in the generic condition saved the information (Pearson chi-square = 20.67, $P = .00$). No significant differences were found between the groups with respect to information discussed (Pearson chi-square = 2.12, $P = .35$). The same patterns of use were found among the risk consumers.

DISCUSSION

This study provides evidence that, in the short-term, interactive and print-delivered computer-tailored fat reduction education have similar effects on total fat, saturated fat, and energy intakes compared to generic information. Effects for saturated fat intake were found for the interactive-tailored group in the total study population and for the print-delivered intervention among the risk consumers. In both tailoring conditions, the effects were most pronounced in the subgroup of risk consumers. Even though these effects on the fat outcome measures were maintained at longer term only in the print-delivered condition, there were no significant differences between the interactive-tailored and the print-tailored condition at any point in time.

These findings are consistent with previous studies and add to the body of evidence of efficacy of computer-tailored interventions delivered through both interactive and print media. A systematic review of computer-tailored dietary interventions showed that 5 out of 9 included studies evaluating interactive-tailored programs against a no-information control group found significant effects on fat intake up to 6 months post-intervention in favor of the computer-tailored interventions.[2] The majority of the included print-tailored interventions also reported significant effects compared to no-information or generic information.

In the current study, the effects were found especially among the subgroup of risk consumers, that is, the group that preferably should profit most from the intervention. This finding is probably owing to the fact that this group received feedback that clearly stated that it would be important for them to change (as opposed to those who already comply with the guidelines). Further, among the risk consumers, there was more room for improvement in their diet, resulting in a larger choice of products in which

changes could be made. We did, however, not explore in further detail exactly what changes this group made.

This study is novel in that it simultaneously evaluated the effects of an interactive and an identical content print-delivered, computer-tailored intervention compared to generic information. This design provides the opportunity to compare the efficacy of both delivery modes. We did not find differences between the delivery modes, which implies that either mode can be chosen for an intervention aimed at promoting lower-fat diets in adults. The finding that the effects of the interactive-tailored intervention were not maintained over the longer term warrants further investigation. One possible explanation that has been advanced is that participants are more likely to keep and reread print-delivered information.[10] In this study there seems to be evidence to support this explanation. Process evaluation data indicate that the print-delivered information (and even the generic information) is read and saved more often. Other explanations, however, should be considered, such as greater memorability and/or cognitive processing of printed information compared to on-screen information.

To the best of the authors' knowledge, there are no studies comparing the effect of a Web-based intervention with an identical content intervention delivered in print format aimed at improvement of diet. There are 2 studies in the domain of physical activity that compared Web- and print-delivered information.[28,29] Marshall et al compared stage-targeted interactive with print-delivered information among adults,[28] and Marks and colleagues compared generic interactive with print-delivered information among adolescent girls[29]; both found print information to be more effective. Their explanations for these findings include that the use of a Web-based intervention might be more complicated and therefore limited,[28] or that differences in the mode of delivery may account for the variability in outcomes because the characteristics of the print intervention may elicit greater attention to and processing of messages than the Web-based intervention.[29]

The strengths of the current study include the use of a randomized design, comparing identical content computer-tailored interventions delivered in interactive format or print format, using a control group receiving generic information (ie, "standard practice").

This study also has limitations. First, this was a self-selected sample of volunteers, from mostly white-collar companies and middle-class communities, who were relatively highly educated compared to the Dutch adult population at large (43% vs 25% had completed a bachelor's degree or higher)[30] and had a lower fat score at baseline (53% vs 90% with a higher than recommended saturated fat intake).[31] Furthermore, only a small percentage of potentially eligible people volunteered, and it can be assumed that people who were more engaged in the topic of healthful eating were more likely to participate. This selective sample may limit the external validity of the results. To reduce the burden for respondents to participate in this study, the authors decided not to do a pretest with the extensive FFQ used at the 2 posttests. However, a pretest is basically not necessary for evaluation because of the randomized, controlled design, assuming equal groups at baseline, as was indicated based on the fat score of the screening instrument.

Even though the authors found some significant effects of both computer-tailored interventions on absolute total and saturated fat intake, there were no significant group effects for the proportion of total energy intake. A potential explanation for this finding is that respondents reduced their total energy intake, rather than the intake of specific nutrients in the diet. As a result, the proportions of the different nutrients did not change.

In addition, only 1 dose of the tailored intervention was provided. Heimendinger and colleagues have shown that compared to only 1 dose, multiple doses of a tailored dietary intervention produced greater behavioral effects.[32]

Finally, although the interactive-tailored intervention was designed and ready to be Web-delivered, to improve exposure and avoid possible between-group contamination, it was not provided over the Internet during the present study. Therefore, the authors cannot be sure whether the effects found in this study would also apply if the intervention were provided over the Internet, where browsing other Web sites is more likely.

IMPLICATIONS FOR RESEARCH AND PRACTICE

To conclude, compared to generic information, interactive and print-delivered computer-tailored interventions can have similar short-term beneficial effects on total fat and saturated fat intake in specific subgroups. The results of this study indicate that the differences in total and saturated fat intake between the print-delivered tailored feedback and the generic information may persist longer. Future studies should explore the users' preference for channel (interactive or print) and investigate strategies to sustain the effects of interactive interventions over the longer term, for instance, by using multiple feedback sessions. In addition, data on cost-effectiveness of computer-tailored interventions should be collected.

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