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The Impact of Computer-Tailored Feedback and Iterative Feedback on Fat, Fruit, and Vegetable Intake

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A randomized trial was conducted to study the impact of individualized computer-generated nutrition information and additional effects of iterative feedback on changes in intake of fat, fruits, and vegetables. Respondents in the experimental group received computer-generated feedback letters tailored to their dietary intake, intentions, attitudes, self-efficacy expectations, and self-rated behavior. After the first feedback letter, half of the experimental group received additional iterative feedback tailored to changes in behavior and intentions. The control group received a single general nutrition information letter in a format similar to the tailored letters. Computer-tailored feedback had a significantly greater impact on fat reduction and fruit and vegetable intake than did general information. Iterative computer-tailored feedback had an additional impact on fat intake. The results confirm that computer-generated individualized feedback can be effective in inducing recommended dietary changes and that iterative feedback can increase the longer term impact of computer-tailored nutrition education on fat reduction.

INTRODUCTION

There are clear indications from epidemiological research that diets high in (saturated) fat and low in fruits and vegetables can increase risk for cardiovascular diseases and certain cancers.[1] In most countries in Europe as well as in the United States, large proportions of the population eat more fat and fewer fruits and vegetables than is

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recommended by health authorities.[2-4] Therefore, health promotion to encourage healthier diets has become an important strategy for preventing chronic diseases.

Dietary Guidelines and Eating Practices in the Netherlands

In the Netherlands, the Dutch Nutrition Council has given priority to a 10% reduction in mean fat intake. At the time this public health goal was made official in 1989, mean fat intake in the Netherlands was approximately 40% energy from fat,[3] while the Dutch dietary guidelines recommend a maximum of 35% energy from fat. Furthermore, nationwide food consumption research in the Netherlands revealed that between 1987 and 1992, mean fruit and vegetable consumption had dropped 10%.[5] This caused much concern and resulted in a stronger emphasis on fruit and vegetables in nutrition education activities during recent years. In the Netherlands, the official recommendation is to eat from 150 to 200 grams of vegetables per day and at least 150 grams of fruit. For communication purposes, these recommendations have been operationalized as two pieces of fruit and 200 grams of vegetables. At the time of the latest Dutch national food consumption survey, mean fruit intake was 114 grams and mean vegetable intake was 128 grams (potatoes, one of the main staple foods in the Netherlands, are similar to, for example, the United Kingdom, not included in these consumption figures or in the recommendations; mean vegetable intake would almost double if potatoes were included).[6]

Guidelines in number of servings, as used in the United States and nowadays also in the United Kingdom, were not adopted, so as to avoid disagreement and/or lack of clarity about serving sizes.[7] The Dutch recommendations seem to be less ambitious than the U.S. guidelines (< 30% energy from fat, ≥ five servings of fruit and vegetables). The Dutch guidelines do not reflect the ideal healthy diet but try to give realistic and attainable goals for dietary change with respect to present dietary habits. The normal eating pattern in the Netherlands is three meals per day, of which two consist mainly of bread with butter or margarine, cheese, meat products, jam or other sweet spreads, with which milk is often drunk. Fruits are mainly eaten between meals (55% of total fruit intake), and vegetables are almost exclusively eaten at the main (hot) meal (92% of total vegetable intake).[6] A typical Dutch hot meal includes (boiled) potatoes with one or two vegetables, some meat, and a dairy product dessert. During recent years, alternatives such as pasta meals and convenience foods are getting more popular, which has been identified as the main reason for the decrease in vegetable consumption.[5]

Rationale for Computer Tailoring

Stimulated by the Dutch Nutrition Council and the results of food consumption surveys, a nationwide 4-year campaign to reduce fat intake and similar activities to stimulate fruit and vegetable intake were conducted.[8] These initiatives did not result in a significant increase in people motivated to change their consumption.[8] From further studies, it became clear that a majority of the Dutch population is not aware of the fact that their diets are too high in fat or too low in fruits and vegetables.[9,10] The essential role of awareness of personal risk behavior in achieving motivation to change has been recognized in behavior change models such as the Transtheoretical Model[11] and in Weinstein's Precaution Adoption Process.[12] According to Weinstein's model, only after people are aware of personally participating in certain risk behavior, they may be

motivated to change that behavior. The phenomenon that people overestimate the adequacy of their personal diet and that this lack of awareness is a barrier toward dietary change has been found in relation to both fat[9,13] and fruit and vegetable consumption.[10,14,15] Based on these studies, it was concluded that nutrition education should focus on making people aware of their dietary intake levels before making specific suggestions for change.

This conclusion is supported in a recent review of the literature on effectiveness of nutrition education in which it was concluded that the chances for an intervention to result in dietary change were higher when three criteria were met:[16] (1) Attention was given to motivators and reinforcers that are personally relevant to the people in the target group; (2) personalized self-evaluation or self-assessment techniques were used, preferably combined with feedback; and (3) people in the target group had the opportunity to actively participate in the intervention. Not surprisingly, therefore, interpersonal counseling and education, based on empirical knowledge about the behavioral change process and tailored to specific needs of individuals, proved to be an effective means to dietary change.[16] Interpersonal counseling, however, is relatively expensive and time consuming since it requires well-trained counselors and person-to-person, or small group sessions. It is therefore not realistic to expect that interpersonal counseling can be used to stimulate large populations to adopt healthier diets.

A recent development is the use of computer-generated personalized feedback in health education. Using computer technology makes personalized feedback feasible for large target groups. This way of providing respondents with personalized feedback is referred to as computer tailoring.[17,18]

In computer-tailored nutrition education, respondents are provided with nutrition education information that is relevant for their personal (dietary) habits and/or personal beliefs about healthy eating. The process of computer-tailored nutrition education is somewhat similar to person-to-person dietary counseling in that individual respondents are interviewed or surveyed and the results are used to develop individual dietary advice. In computer tailoring, the survey is often self-administered and the expertise of the nutrition educator is programmed into a computer that reads the survey responses and generates individualized feedback messages.

There are clear indications that computer tailoring improves the impact of nutrition education messages.[17,19] In recent years, three studies have been published in which the impact of computer-tailored nutrition education was studied.[17,19,20] The first study, conducted by Campbell and colleagues[17] among patients who visited a general practitioner, compared the impact of computer-tailored nutrition education letters to letters with general nutrition information and to a no-intervention control group. The results showed that participants in the tailored condition reacted more positively to the letter they received and reduced their fat consumption more, although the difference in mean fat consumption compared to the group who received general information was not statistically significant. The impact of the tailored letters was assessed approximately 4 months after the intervention. No short-term impact assessment was conducted. A similar tailored intervention was also tested by Kreuter and Strecher[20] to study whether tailored information about multiple health risk behaviors improved the effectiveness of a health risk appraisal. The tailored feedback significantly enhanced the impact of the intervention on self-reported fat reduction.

Two other studies were conducted in the Netherlands, of which one has been published.[19,21] The first of these studies demonstrated that computer-tailored nutrition education was significantly more effective in motivating people to improve their diet than was general nutrition education.[19] Significant differences between respondents who received

computer-tailored feedback and respondents who received general feedback were found for changes in fat consumption and attitudes and intentions toward increasing fruit and vegetable intake. Only short-term impact was assessed since the posttest was conducted within 4 weeks after the intervention. The second study investigated differences in impact between two computer-tailored interventions: (1) an intervention in which computer-tailored dietary feedback was provided and (2) a computer-tailored intervention in which dietary feedback plus psychosocial information was given. It was concluded that extensive psychosocial information was not essential for computer-tailored feedback to be effective but that respondents who received the comprehensive feedback appreciated the feedback significantly more.[21]

In the present study, the impact of computer-tailored nutrition education was compared to general nutrition information. Furthermore, the impact of iterative feedback letters, tailored to changes in intentions and diet that respondents made after initial computer-tailored feedback, was assessed. The present study contributes to our further understanding of the potential of personalized computer-generated feedback by studying the impact of computer-tailored nutrition education beyond the short term and by assessing the impact of computer-tailored iterative feedback in sustaining or improving the longer term impact.

It was hypothesized that (1) computer-tailored feedback would be more effective in stimulating participants to reduce their consumption of fat and increase their consumption of fruits and vegetables than general feedback and that (2) computer-tailored iterative feedback would significantly enhance the longer term dietary changes.

METHOD

Procedure

Participants were recruited through advertisements in 35 local newspapers in various Dutch regions, in two national newspapers, and through appeals on local radio stations, in which potential respondents were asked to participate in a research project that would include free nutrition information. Registration was stopped after 800 participants had enrolled based on power analysis that was based on a 5% difference in fat score between study groups at posttest and a 20% expected dropout between registration and second posttest. Participants were randomly assigned to one of three study groups and received a screening questionnaire at their home addresses. Baseline data were collected on dietary intake, self-rated intake, and psychosocial factors. In all groups, participants received personal letters mailed to their home addresses after they completed and returned the baseline questionnaires. Based on their answers to the screening questionnaire, the first two groups received a computer-tailored nutrition education letter. The third group received a letter with general nutrition information. All participants were surveyed again with self-administered written questionnaires approximately 4 weeks after the first feedback (first posttest). The first group received an iterative feedback letter based on their answers to the first posttest questionnaire and the differences between first posttest and baseline measurements. All participants were surveyed a third time approximately 4 weeks after participants in Group 1 had received the second feedback letter (second

posttest). Other respondents did not receive any additional contact between the first and second posttests.

The Questionnaires and Intervention

Computer-tailored nutrition education requires three related components: an instrument to assess variables on which the tailored feedback will be based, a message source file with feedback messages tailored to all possible screening results, and a computer program that selects specific feedback messages for each respondent from the source file.

The Screening Questionnaire

A 69-item self-administered questionnaire was used to survey participants at baseline. The questionnaire took about 15 minutes to complete. The first part of the questionnaire included questions about the participants' gender, age, height, weight, education, whether they were vegetarians, whether they were dieting, and whether they were responsible for food shopping and preparation in their household. The second part was a food-frequency questionnaire (32 items), which assesses fat scores and number of servings of fruits and vegetables. The validity and reliability of the food-frequency questionnaire have been established.[22,23] The fat score that ranges between 12 and 60 is the result of a short food frequency questionnaire in which the frequency of use and portion size of the 12 main fat sources in the Dutch diet are assessed.[23] This fat score instrument was developed for use in intervention research in which short instruments, which are easy to administer and process, are essential to avoid low response rates and to ensure practical applicability of the intervention. Inclusion of such a limited number of food groups proved to be sufficient to rank respondents according to individual fat intake and to detect changes in individual fat scores,[23] but this does not allow computation of percentage energy from fat since nonfat energy sources were not included in the fat score instrument.

In the third part of the questionnaire, a number of psychosocial variables were assessed (27 items). Respondents were asked to rate their own intake levels of fat and of fruits and vegetables and to compare their intake levels to those of others in their age-gender group. Furthermore, they were asked about their attitudes related to reducing fat intake and increasing fruit and vegetable intake with single items on 7-point scales (*very bad* to *very good*), and about self-efficacy expectations toward these dietary changes on 7-point scales (*very difficult* to *very easy*). Finally, intentions and past and present efforts to change fat, fruit, and vegetable consumption were assessed on 7-point scales (*definitely not* to *definitely so*). The psychosocial questions were derived from questionnaires used in earlier research on psychosocial determinants of fat intake[13,24] and of fruit and vegetable intake[22] with good predictive validity.

Posttest Questionnaires

Both posttest questionnaires were similar to the baseline questionnaire. Questions about the participants' gender, age, education, and other background factors were ex-

cluded from the posttests; additional questions about participants' reactions to the nutrition information letters were included.

The Message Source File

The message source file consisted of 223 different feedback messages. Different dietary feedback messages were written for various categories of dietary behavior for fat, fruit, and vegetables. For example, for fat, the source file included messages for respondents eating more fat than is recommended but less than most of their peers, for respondents eating more fat than is recommended as well as more than most of their peers, and for respondents who were eating according to the recommendations for fat. The messages were also tailored to the way participants rated their own consumption: Messages for participants who had high fat scores but thought that their fat consumption was low differed from those for participants who were aware of their high fat consumption.

Further messages were included that addressed seven different important dietary fat sources in the Dutch diet (milk and milk products, meat and meat products, gravy and sauces, spreads, cheese, hot snacks, and sweet snacks), for which low-fat alternatives for high-fat choices were suggested. Participants received only information about fat sources that were salient in their personal diet. Fat scores of 22 for women and 25 for men were used to operationalize the upper limits of the Dutch recommended intake of 35% energy from fat.

Fruit and vegetable messages were included for participants eating less than the recommended amount of fruits and vegetables and respondents eating according to recommendations. Since in the typical Dutch diet almost all vegetables are eaten at dinner, one serving of vegetables per day was used to operationalize the Dutch recommendations and participants were motivated to eat more than one serving. Messages also included suggestions on when and how to eat more fruits and vegetables. Because vegetables were almost exclusively eaten at dinner, and fruit was mostly eaten between meals, these messages focused especially on including vegetables at other meals and drinking fruit juices at meals or eating fruit as dessert. Respondents were advised to change those dietary behaviors that were not in accordance with recommendations and to sustain and if possible further improve their dietary behaviors that already met the recommendations.

Further messages were included in the source file that addressed respondents with negative attitudes toward the recommended dietary changes. These messages addressed the most prevalent and salient negative beliefs about eating less fat and more fruits and vegetables. Attitudinal messages for fat, for example, included suggestions for good-tasting low-fat meals and for saving money by eating low-fat meals. For respondents with low self-efficacy expectations, messages were selected from the source file with suggestions on how to eat less fat or more fruits and vegetables in various "high-risk" situations (when eating out, when eating alone, at parties, when in a hurry, etc.).

A typical computer-tailored feedback letter would start with an introduction on the importance of fat, fruits, and vegetables, proceed with information (in words as well as in a graph) about the respondent's individual fat score as compared to recommended intake and peer group average intake levels. Subsequently, the respondent's main fat sources were presented with low-fat alternatives and attitudinal and self-efficacy information was given. Similar paragraphs on vegetables and fruits would follow this fat paragraph.

Iterative Feedback Messages

A separate message source file was created with messages for the second tailored iterative feedback letters. Messages were included that addressed fat, fruit, and vegetable consumption and intentions at the first posttest as compared to baseline levels. Specific tailored messages were written for participants who reduced their fat consumption or increased their fruit and vegetable intake between baseline and first posttest, for participants who increased their consumption of fat or decreased their fruit and vegetable intake, and for participants who did not change their consumption. Finally, messages were included for participants who changed their intentions to adopt a healthier diet. Also, messages with information about the most important dietary fat sources and their low-fat alternatives, similar to those included in the initial tailored feedback, were included in the iterative feedback source file.

The Tailoring Computer Program

A computer program was written in Turbo Pascal,[25] which linked individual screening results to specific feedback messages from the source file. The program consisted mainly of a number of if-then statements which were the decision rules for the selection of specific feedback messages from the source file for individual respondents based on their answers on the screening questions. The computer program regulated the production of personal feedback letters from the selected messages.

General Nutrition Information Letters

In the general nutrition information letters, information from leaflets from the Dutch Nutrition Education Bureau was presented. This included information about why healthy nutrition is important, the positive health consequences of low fat intake and high fruit and vegetable intake, low-fat alternatives for high-fat food products, and suggestions on how to include more fruits and vegetables in the daily diet.

Both tailored and general information letters were printed on identical paper. The participant's name was printed in the letter's introduction and in the final paragraph of the tailored letters. In both the tailored letters and the general nutrition information letters, illustrative cartoons and recipes for low-fat meals were included. The initial tailored letters consisted of four to eight pages. The general nutrition information letters were five pages long. The iterative feedback letters were between two and four pages long.

Statistics

Analysis of variance (ANOVA) was used to test for baseline differences between the three study groups to detect possible confounding variables. To test whether there were differences in baseline scores between respondents who participated in the entire experiment and respondents who dropped out before the final posttest and to test whether study group was a significant determinant of dropout, logistic regression analysis was conducted with dropout (yes/no) as the dependent variable and gender, age, consumption scores, and study group as independent variables.

Chi-square tests were used to study differences in the participants' reactions to the nutrition information letters between the three study groups. One-way ANOVAs were used to study differences in the participants' opinions of the nutrition information letters. Descriptive statistics were used to describe the reactions of the participants to the iterative feedback letters.

Repeated measures ANOVAs were conducted to study differences in mean consumption of fat, fruits, and vegetables at the two posttests, with study group as a between-subjects factor, the two posttest as a within-subjects factor, and consumption scores at baseline as covariate. When a significant time-by-group interaction effect was found (implying that the mean difference between the two posttests depended on study group), analysis of covariance was used to study differences in mean consumption scores between the three study groups at each posttest separately, again with consumption scores at baseline as covariate. When a significant group effect was found, pairwise comparisons were conducted to study which specific groups differed significantly in mean consumption scores.

RESULTS

Participants and Response Rate

The baseline questionnaire was completed and returned by 762 respondents. The first posttest questionnaire was returned by 704 respondents (92.4%). The final posttest questionnaire was returned by 646 respondents (91.8%) who therefore completed the entire experiment. All analyses were conducted using these participants. Mean age was 44 (SD = 14) years. Most participants (82%) were female. In all, 42% of the study population had a college degree. Mean body mass index was 23.7 (SD = 5.9) for women and 24.6 (SD = 3.7) for men. The mean fat score at baseline was 27.2 (SD = 5.2). The mean number of daily servings of vegetables and fruit were 1.0 (SD = 0.4) and 2.2 (SD = 1.7), respectively. Mean attitude scores at baseline (on a –3 to 3 scale) were 2.0 (SD = 1.4) toward fat reduction and 2.5 (SD = 0.8) and 2.3 (SD = 0.9) toward increasing vegetables and fruit. Self-efficacy (range –3 to 3) expectations were 0.6 (SD = 1.8), 1.3 (SD = 1.7), and 1.2 (SD = 1.9) toward reducing fat and increasing vegetables and fruit, respectively.

Differences at Baseline

No significant differences between the study groups in age, education, body mass index, or gender distribution were found at baseline. Also, no differences in mean intake of fat, fruits, and vegetables or in attitudes and intentions were found between the three study groups. Study group, gender, age, and consumption scores were not significantly associated with dropout in logistic regression analysis.

Differences in Impact Across the Three Interventions

Table 1 presents the mean fat, fruit, and vegetable intake at baseline, first posttest, and final posttest for the three study groups. In the repeated measures ANOVA, significant

Table 1. Mean (standard deviation) Fat, Fruit, and Vegetable Intake at Baseline (T1), First Posttest (T2), and Second Posttest (T3)

	Tailored + Iterative Feedback (IF) (n = 215)	Tailored Feedback (TF) (n = 211)	General Information (GI) (n = 220)
Fat (fat points per day)			
T1	28.3 (5.4)	28.0 (5.3)	28.2 (5.2)
T2	27.0 (4.9)	26.4 (5.3)	28.3 (5.4)
T3	25.6 (4.6)	26.2 (5.2)	27.5 (5.6)
Fruit (servings per day)			
T1	2.13 (1.70)	2.18 (1.72)	2.09 (1.75)
T2	2.42 (1.66)	2.25 (1.51)	2.09 (1.56)
T3	2.45 (1.69)	2.18 (1.47)	2.02 (1.59)
Vegetables (servings per day)			
T1	1.06 (0.38)	1.06 (0.41)	1.02 (0.36)
T2	1.14 (0.38)	1.13 (0.41)	1.05 (0.37)
T3	1.20 (0.36)	1.15 (0.41)	1.08 (0.41)

group effects were found for consumption of fat, $F(2) = 17.1, p < .001$; fruit, $F(2) = 5.5$, $p < .01$; and vegetables, $F(2) = 5.2, p < .01$. This indicates that significant differences in mean posttest consumption scores (the average of the two posttests) were found between the three study groups. Pairwise comparison indicated that for fat and vegetables, the two tailored groups did significantly better than the control group ($p < .001$). No significant differences between the two tailored groups were found for these dietary behaviors ($p = .38$). For fruit, the iterative feedback group had higher mean intake averaged over the two posttests than did the group receiving one tailored letter ($p = .03$) and the general information group ($p = .002$). No difference between the single-tailored intervention group and the general information group was found ($p = .31$). A significant group-time interaction was found for fat consumption, $F(2) = 5.5$, $p < .01$, which indicates a significant difference between the study groups in changes in fat consumption between the first and second posttest. The group-time interaction effect for vegetables was of borderline significance, $F(2) = 2.13, p = .12$. Therefore, for fat and vegetables, the group effect was analyzed for the two posttests separately.

At the first posttest, a significant group effect on mean fat scores was found, $F(2) = 13.0, p < .001$. Pairwise comparison of the three groups indicated that both tailored groups had significantly lower mean fat scores than the general advice group ($p < .001$), but no significant difference between the two tailored groups was found ($p = .40$). A significant group effect was also found at the second posttest, $F(2) = 15.4$, $p < .001$. Pairwise comparison showed that both the iterative feedback group ($p < .001$) and the group receiving one tailored letter ($p = .001$) had significantly lower mean fat scores than the general advice group. Furthermore, the iterative feedback group had a significantly lower mean fat score at the second posttest than did the group who received initial tailored feedback only ($p = .02$).

At the first posttest, a significant group effect for differences in mean vegetable intake was found, $F(2) = 3.1, p = .05$. Pairwise comparison of the three study groups showed that both the iterative feedback group ($p = .02$) and the initial tailored-letter group ($p =$

Table 2. Participants' Reactions to, and the Subjective Impact of, the Tailored Letters (percentage yes)

	Tailored Feedback ($n = 426$)	General Information ($n = 220$)
Have you read the letter?	99	93**
Have you saved the letter?	85	80
Have you discussed the letter with others?	71	45**
As a result of the nutrition information . . .		
have you changed your opinion about your diet?	62	26**
have you changed your diet?	56	19**
have you reduced your fat intake?	55	18**
have you increased your fruit intake?	20	13*
have you increased your vegetable intake?	29	18**
do you intend to change your diet?	69	46**

*Significant difference, $p < .05$. **Significant difference, $p < .01$.

.04) had significantly higher mean vegetable scores than the control group. The two tailored groups were not significantly different ($p = .83$). A significant group effect was also present at the second posttest, $F(2) = 5.8$, $p < .01$. Pairwise comparison showed a significant difference between the iterative feedback group and the control group ($p = .001$). The difference between the iterative feedback group and the initial tailored group was of borderline significance ($p = .07$). No significant difference between the initial tailored group and the control group was found at the second posttest ($p = .12$). The repeated measures analyses were also conducted among respondents "at risk," that is, respondents who did not meet the recommended intake levels at baseline. The results of these analyses were very similar to the results described above.

Reactions to the First Nutrition Information Letters

The respondents' reactions to the nutrition information they received after the screening are shown in Table 2. Respondents who received a tailored letter (groups 1 and 2) were more likely to have read the letter and to have discussed it with others. They more often reported changing their diet, their opinion about their diet, or intending to change their diet as a result of the nutrition information letter they received.

The respondents' opinions of the nutrition information letters at the first posttest are shown in Table 3. Respondents who received tailored feedback letters rated their letters as more interesting, more personally relevant, and they thought that it contained more information that was new to them. The general information letters were rated as more credible. Additional analysis showed that this difference was due to respondents with a relatively large discrepancy between their self-rated fat intake and fat score in the tailored group. These respondents rated their feedback as significantly less credible than other participants, $F = 5.14(1)$, $p = .02$.

Table 3. Participants' Opinions of the Tailored Letters (mean scores and standard deviations)

Range = –3 (*very negative*) to 3 (*very positive*)	Tailored Feedback ($n = 426$)	General Feedback ($n = 220$)
How interesting was the tailored letter?	1.73 (1.58)	0.79** (1.86)
How personally relevant was the nutrition information letter?	1.15 (1.84)	– 0.17** (1.85)
How much of the information was new for you?	– 0.44 (1.81)	– 1.60** (1.45)
How credible was the information?	1.49 (1.80)	1.98** (1.54)
How difficult or easy to understand was the information?	2.51 (0.91)	2.60 (0.80)

**Significant difference, $p < .01$.

Reactions to the Iterative Feedback

A large proportion of respondents who received iterative feedback were positive about these feedback letters. In the iterative feedback group, 99% of the respondents reported reading the iterative feedback letter, 84% said they saved the letter, while 65% stated having discussed the letter with other people. Equally large proportions found the iterative feedback letter interesting (71%) and personally relevant (68%), and they reported having changed their diet as a result of the nutrition information (73%).

DISCUSSION

A significant impact of computer-generated personalized feedback on fat reduction and increasing fruit and vegetable intake was found. The results are in line with earlier studies on the impact of computer-tailored nutrition education.[17,19,20] Furthermore, in the present study, a second feedback letter, tailored to changes that respondents made in intake and intention after receiving their first tailored letter, led to a further significant reduction in fat. Similar results were also found among respondents who did not meet the dietary recommendations at baseline, indicating that the intervention was effective among respondents with a specific need to change but also possibly with a greater resistance to change. Earlier research has indicated that people in different stages of change need different information.[9-12] Respondents in precontemplation should first be made aware of their dietary intake, should subsequently be provided with information about the pros and cons of dietary change to create positive attitudes, and should finally be provided with practical (skills) information to help respondents to actually implement the required changes.[9,10] The results indicate that computer-tailored nutrition education that addresses awareness, attitudes, and self-efficacy can guide respondents through different stages of change.

Respondents who received tailored feedback were also more positive about the feedback they received: They perceived their feedback to be personally relevant and interesting. This might explain the higher impact of tailored feedback as compared to general information. Since people have a limited capacity to process information, it is important to provide them with information that is worth the processing effort.[26] Furthermore, personally relevant feedback is less likely to contain redundant information. People

are therefore more likely to pay attention to the information that is provided to them. Attention to the message is an essential prerequisite for effective health messages.[27]

Respondents who received general information judged the information they received to be more credible than did respondents who received tailored feedback. This could be explained by the fact that many respondents in the tailored group who received a message to reduce their fat intake because it was higher than recommended perceived their personal fat intake to be low or moderate. This discrepancy between their self-assessed fat intake and their actual fat score, which was presented to them in their personal feedback letter, may have caused the relatively low mean credibility score among respondents in the tailored groups.

Iterative feedback, which informed the respondents about possible progress they made toward the recommendations after they had received an initial feedback letter, proved to significantly enhance the longer term impact of tailored feedback on fat intake. The impact of iterative feedback on vegetable intake was of borderline significance, but iterative feedback prevented a lapse to the control group intake level.

The changes in consumption that were found between baseline and final posttest were reasonably large. Mean fat score decreased approximately 10% between baseline and final posttest among respondents who received iterative feedback. The increase in fruit intake in this group was about 15%, while vegetable intake increased 13%. These changes do certainly seem to be relevant from a public health perspective. A 10% reduction in fat intake is the main official target for dietary change of the Dutch Nutrition Council and the aim of a multiyear government sponsored national intervention in the Netherlands.[8] Furthermore, the computer-tailored intervention appears to have the potential to compensate for the 10% decrease in fruit and vegetable intake that was found between 1987 and 1992 in the Netherlands.[5] Nevertheless, the comparison between the impact of the present intervention and public health goals should be made with caution since the present study was conducted among a self-selected population and a decrease in fat score cannot be directly translated to a decrease in percentage energy from fat.

Feedback, or knowledge about the results of one's performance, is regarded as an important determinant of motivation to change or to maintain changes made in the past. Feedback has been found to have this positive effect, especially in combination with goal setting.[28] In the present study, respondents were motivated to change their diet by, among other things, our suggesting specific aims for fat reduction and increasing fruit and vegetable intake. The positive impact of the iterative feedback letters suggests that a fair number of respondents adopted these suggestions as personal goals.

A limitation of the study is that participants who did not receive computer-tailored iterative feedback were not provided with an alternative intervention activity or a control for the amount of contact or attention. It remains, therefore, unclear whether the tailoring in the second feedback letter was responsible for the additional impact among the iterative feedback group or whether the additional contact alone would have been enough to cause the significant effect. Nevertheless, the lack of impact in the general advice group at the first posttest suggests that a general nutrition information letter does not have the potential to significantly reduce fat intake. Therefore, there is no reason to believe that a second general information letter would lead to significant changes in consumption. Also, since the general nutrition information letters were not evaluated very positively by the respondents, providing them with another general nutrition information letter may have resulted in negative reactions and to an overestimation of the appreciation and impact of iterative feedback.

In earlier studies on the impact of computer-tailored nutrition education, respondents were derived from, for example, work sites[19,21] or general practices.[17] In these earlier studies, employees or patients did not have to register before being provided with a screening questionnaire. In the present study, subjects were recruited through advertisements in local newspapers. People who were interested in participating had to register by calling a telephone number before they received a screening questionnaire. This selection procedure may have had consequences for the generalizability of the results, since a specific group of individuals may have enrolled in the present study. We expected that respondents specifically interested in healthy nutrition, or those with specific diet-related problems, such as, for example, being overweight, would be oversampled with the present selection procedure. Nevertheless, mean intake of fat, fruits, and vegetables was comparable to consumption levels found in an earlier study in which the same instruments to assess food consumption were used,[13] and the mean body mass index among the study population was not substantially different from a recent representative sample of healthy Dutch adults.[29] This indicates that the selection procedure in the present study did not result in a study population with specifically healthy or unhealthy eating practices, but the fact that women were overrepresented in the present study is probably a result of the selection procedure. Furthermore, the high response rates at both posttests are probably also the result of the self-selection procedure.

Implications for Practice

The results of the present study confirm and extend earlier findings that computer-generated individualized nutrition education is received well and is more effective in inducing dietary change than is general nutrition information. Furthermore, the results suggest that iterative feedback may enhance the impact of computer-tailored nutrition education. Computer-tailored nutrition education can be used in different settings, such as work sites[19] and general practices.[17] Computer-tailored nutrition education can be implemented among large population groups and may therefore be used to personalize traditional general self-help materials, such as leaflets, brochures, and self-help guides. Since in computer-tailored interventions specific nutrition and health education expertise is documented, these intervention materials can help public health professionals who have no specific expertise in the nutrition field to provide their clients with personalized dietary advice. Although computer tailoring mimics certain characteristics of person-to-person counseling, it does not make use of personal interaction. Computer tailoring may, therefore, not be suited to replace person-to-person counseling with an expert nutrition educator, although no studies are yet available comparing computer tailoring to person-to-person counseling.

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