Effects of tailoring health messages on physical activity

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Abstract

Computer-tailored printed education can be a promising way of promoting physical activity. The present study tested whether computer-tailored feedback on physical activity is effective and whether there are differences between respondents with low and high motivation to change. Respondents (n = 487) were randomly assigned to a tailored intervention group or a no information control group. Physical activity and determinants were measured at baseline and after 3 months. At post-test, the motivated respondents in the control group were more likely not to meet the recommendation for physical activity than to meet it, and motivated respondents in the experimental group were more likely to engage in transport-related activities and showed more improvement over time for the total activity score than respondents in the control group (β = 0.24, P = 0.02). Both groups improved their behaviour over time. No group differences in physical activity were found for the unmotivated respondents.  

The results showed that the effects of the tailored feedback were restricted to respondents who had a positive motivation to change at baseline. Possible explanations could be that unmotivated respondents were unwilling to read and process the information because they felt ‘no need to change’. Alternatively, one tailored feedback letter may not have been sufficient for this unmotivated group.  

Introduction

Lack of physical activity is an important risk factor for cardiovascular diseases, Type 2 diabetes, obesity and various cancers [1–3]. Approximately 60% of Dutch adults do not participate in regular physical activity and thus do not meet the recommendation of 30 min of moderate physical activity a day, preferably on all days but at least on 5 days a week [4–6]. Hence, it is important to develop and implement effective physical activity promotion interventions for this population, for instance, using mass media approaches [7]. However, while generic mass media interventions may be suitable to draw attention to the issue, they are unlikely to lead to behaviour change [8]. Generic information is usually non-specific and not personally relevant to most individuals targeted by the intervention. Interventions that are closely tailored to individuals needs may include less redundant information and are more likely to be read, saved, remembered and discussed [9–11]. Tailored health education using computer technology thus enables developing individualized approaches and reaching large populations against relatively low costs per person [9, 12].  

The principle of tailoring has been applied to promote physical activity, with somewhat mixed results. Most published studies found that respondents who received computer-tailored physical...
activity information engaged in more physical activity or were more likely to increase their activities of daily living than respondents who received generic information or no intervention [13–16]. In one of these studies, this effect persisted at 12 months after the intervention [14]. In one study also positive effects on self-efficacy, cognitive and behavioural processes of change were also found at both short- and medium-term follow-up [17]. The effects on possible mediators of behaviour change were also explored and it was found that a transition from lower motivational stages of change at baseline to higher stages at post-test was more common among respondents who received the tailored intervention [15, 18, 19]. Some studies found no difference in physical activity between the intervention and control conditions, but these interventions combined personal verbal advice from a family physician with a tailored or non-tailored pamphlet [20, 21].

Since participation in computer-tailored interventions requires participants to complete questionnaires and sometimes to read extensive feedback, the effects may differ according to motivation at baseline. A computer-tailored nutrition intervention indeed showed that the intervention was more effective among people who were motivated to change [22]. Results of a computer-tailored smoking cessation intervention indicated that a single-tailored intervention only had no surplus value compared with a non-tailored look-alike intervention in a low-motivated population [23].

In sum, although promising, it is not yet clear how computer-tailored feedback can be best attuned to different segments of the population to increase physical activity levels.

The goal of the present study was to analyse the effectiveness of computer-tailored feedback on physical activity, to study differences between respondents with low and high motivation to change and to assess the respondents’ appreciation of the information letter. We hypothesize, firstly, that computer-tailored feedback on physical activity would be effective in increasing levels of physical activity in the population. Secondly, we hypothesize to find the greatest effects in respondents motivated to change.

Methods

Respondents
A random sample of 3000 addresses was obtained through the Dutch national telephone company. These selected addresses received a questionnaire with an accompanying introduction letter in January 2002, explaining the procedure and general aim of the study. Respondents had to be aged between 18 and 65 years. Respondents could enrol by returning the questionnaire with an informed consent form. In total, 936 respondents returned the questionnaire (response rate = 31%). After 3 months, respondents received the post-test questionnaire. A total of 516 respondents returned the post-test questionnaire. Twenty-nine respondents were excluded from participation because they did not meet the age inclusion criteria. The study population therefore consisted of 487 respondents (response rate = 52%).

Questionnaire
The present study was based on an updated version of the ASE model, now named Integrated model for explaining and changing behaviour change (abbreviated as the I-Change Model) [24]. Both models originate from the Theory of Reasoned Action [25] and Social Learning Theory [26], and used principles of the Transtheoretical Model [27] and the Precaution Adoption Process Model [28]. The models have been successfully applied to a variety of health behaviours, and evidence shows that it is well suited to predict a range of different health behaviours, including physical activity [29].

‘Physical activity’ was measured with the Dutch Short Questionnaire to Assess Health Enhancing Physical Activity (SQUASH), which determines whether people meet the physical activity recommendations. Reproducibility of the SQUASH was examined by calculating Spearman’s correlation between total activity scores from the questionnaires measured twice, showing to be fairly reliable ($r_{spearman} = 0.58$, 95% CI = 0.36–0.74). The relative validity was investigated by assessing Spearman’s correlation between the SQUASH and
the Godin, Baeke and NASA questionnaires, showing that SQUASH is a reasonably valid questionnaire ($r_{spearman} = 0.45, 95\% CI = 0.17–0.66$) [30]. Respondents had to indicate which activity they engaged in; for how many days, hours and minutes at a time and how strenuous the activity was. The total number of minutes of activity was calculated for each activity by multiplying frequency (days/week) by duration (min/day). Activity scores for individual questions were calculated by multiplying the total number of minutes of activity by the intensity score. The total activity score was calculated by summing the activity scores for individual questions [30]. An activity moment thus includes moments in which activities are executed for 30 min with an intensity with a MET value $>2$ [30].

Respondents were divided into three groups: those meeting the 30-min recommendation for 5 days a week, those almost meeting the recommendation (4 days a week) and those not meeting the recommendation. Furthermore, physical activity was divided into three kinds of activity; transport-related activities (e.g. commuting to work by bicycle), sports and leisure activities using the same calculation method as the total activity score.

‘Self-rated physical activity’ was measured by one question asking the respondents how they rated their activity level on a five-point scale (high–low).

‘Motivational factors’ were assessed by several constructs. Attitude was measured by 20 questions on a five-point scale, and divided into four categories. Cognitive pros were measured by five items, for example, ‘if I exercise at least 30 minutes a day, my health will improve’ ($\alpha = 0.83$). Affective pros were measured by five items, for example, ‘exercising at least 30 minutes a day helps me to relax’ ($\alpha = 0.87$). Cognitive cons were measured by six items, for example, ‘If I exercise at least 30 minutes a day, my muscles will ache’ ($\alpha = 0.78$); and affective cons by four items, for example, ‘I’m ashamed when I don’t exercise for 30 minutes a day’ ($\alpha = 0.79$). Social influence of partners, family and friends was measured by asking respondents whether they received support from their partners, family and friends to meet the guidelines for physical activity and whether they thought their partners, family and friends met the guidelines of 30 min of moderate physical activity a day for at least 5 days a week. Both questions used a five-point scale (agree very much to disagree very much). Social self-efficacy was measured by two questions assessing self-efficacy levels in situations where physical activity influenced their personal situation, for example, ‘it is difficult to meet the guidelines for physical activity if this means I have less time for my partner’ (Pearson correlation = 0.57). Emotional self-efficacy was measured by five items and referred to self-efficacy in situations characterized by certain emotions, for example, ‘it is difficult to meet the guidelines for physical activity when I feel tense’ ($\alpha = 0.76$). Information self-efficacy was measured by four questions assessing self-efficacy levels in situations where respondents were unable to find information about physical activities (e.g. on where and how they can engage in them). Answering categories ranged from ‘agree very much’ to ‘disagree very much’ ($\alpha = 0.82$).

‘Stage of change’ was classified by combining self-reported physical activity and intentions to change with the results from the SQUASH questionnaire. With regard to intention or motivational stage, respondents were asked to indicate whether they intended to change their behaviour. The following stages were distinguished.

‘Aware maintenance’: respondents correctly classifying themselves as being sufficiently physically active. ‘Unaware maintenance’: respondents incorrectly believing themselves to be not sufficiently active, while the SQUASH questionnaire indicated sufficient levels of activity. ‘Action’: respondents correctly classifying themselves as being sufficiently active, but indicating they had changed their activity level during the past year. ‘Preparation’: respondents correctly classifying themselves as being insufficiently active and motivated to increase activity levels in the next month. ‘Contemplation’: respondents correctly classifying themselves as being insufficiently active and motivated to increase activity levels in the next 6 months, but not in the next month. ‘Aware pre-contemplation’: respondents correctly classifying themselves as being insufficiently active but not motivated to increase activity levels in the
next 6 months. ‘Unaware pre-contemplation’: respondents incorrectly classifying themselves as being insufficiently active and thus not motivated to increase activity levels.

‘Demographics assessed’ were sex, age and level of education [no education beyond primary school (low), professional education or graduated from high school (medium) and a college or university degree (high)].

The post-test questionnaire was identical to the pre-test questionnaire, but also assessed how many respondents had read the information and ratings of interestingness, understandability, credibility and personal relevance. These items were measured on a five-point scale, ranging from ‘agree very much’ to ‘disagree very much’.

**Tailored intervention**

The generation of the computer-tailored educational material on physical activity was based on three elements: (i) a screening instrument to assess physical activity, as well as important determinants; (ii) a message file containing education messages tailored to the screening results; (iii) a computer program that analysed the individual screening results and selected the correct messages from the message file [31].

The message file used to generate computer-tailored feedback contained messages about awareness of physical activity, pros and cons of physical activity, social influence and suggestions to cope with barriers to physical activity (i.e. self-efficacy enhancing information), as well as links to internet pages where respondents could find more information on different kinds of physical activities they personally preferred. The score of the stages of change determined which parts of the feedback messages received most attention. For example, respondents in the preparation stage received more information about self-efficacy than respondents in the pre-contemplation stage and respondents in the pre-contemplation stage received more information about pros and cons than respondents in the preparation stage. The message file consisted of 128 different messages. The messages were written by professional health educators and pre-tested among experts and representatives of the target population.

A computer program combined the screening results of each individual respondent with the relevant feedback messages from the message file and put these messages in a logical order in a personalized tailored letter consisting of 3–5 pages. The personalized letter was sent to the respondents’ home address. Each tailored letter first introduced the subject of physical activity, after which it presented the respondent’s physical activity score and compared it with the respondent’s self-assessed physical activity level and the recommended minimum level. Furthermore, the individual positive and negative beliefs and perceived social support for physical activity were discussed and explained. The letter went on to discuss situations that the respondent perceived as difficult in terms of engaging in physical activity and to give suggestions about possibilities to cope with such situations. Finally, for those respondents who did not meet the recommendations for physical activity, the letter gave more information about activities that the respondents had indicated they would like to do. The goal here was to provide tailored feedback that matched respondents’ preferences for new activities. Figure 1 gives an example of one of the possible feedback messages in the program.

**Design**

A computer-tailored intervention was developed and tested in a post-test design against a control group who received no information. Respondents were randomly assigned to one of two conditions: no information (n = 222) or tailored information about physical activity (n = 265). Figure 2 shows the design in detail.

**Statistical analyses**

Similarity of study groups at baseline and predictors of dropout were tested by means of binary logistic regression. Sex, age, level of education, body mass index, motivation to change, self-rated activity levels, meeting recommendation, sports activities, transport activities and leisure-time activities were the independent variables in the equation for
similarity at baseline while study group, gender, age, level of education, motivation to change and activity level were the independent variables for examining predictors of dropout.

The analyses to detect the effects of tailoring were restricted to respondents who did not meet the recommendation for physical activity at baseline \((n = 283)\), since only these respondents were advised to change. All these respondents who did not meet the recommendation at baseline were divided into two groups; those motivated to change at baseline and those not motivated to change at baseline. Respondents in the preparation (7%) and contemplation stage (13%) at baseline were assigned to the ‘motivated to change’ group \((n = 97)\). Respondents in the pre-contemplation (7%) and unaware pre-contemplation stage (32%) at baseline were assigned to the ‘unmotivated to change’ group \((n = 186)\). Motivation at baseline and physical activity at baseline showed a medium correlation.

Fig. 1. An example of a feedback page in the computer-tailored intervention for a respondent motivated to change, indicating the above-mentioned situations were difficult.

You think that physical activity for 30 minutes a day is very difficult when...

THE WEATHER IS BAD
If you wear good protective clothing while exercising, you will not notice the bad weather. Being active will warm you up. It’s no problem if sportswear gets wet, because after exercising you usually change your clothes. Moreover, many activities can be practiced indoors.

YOU FEEL TIRED
After intense physical exertion, your body may be tired, but your mind will still work. You will notice that exercising gives you more energy and makes you more active than before.

YOU HAVE LITTLE TIME
Lack of time can be an important factor, but an active lifestyle doesn’t have to take a lot of time. For example; riding 5 km on your bike takes 15 minutes, while the same distance by car will take 5 minutes. The difference is 10 minutes. If you do this twice a day, you have had enough physical activity for that day. Using the stairs instead of the elevator doesn’t take extra time. If you park your car one block away and walk the rest of the way, you will not notice the time difference.
A sequential logistic regression analysis was performed to test for post-test group differences in the principal outcome measure of meeting the recommendation for physical activity and to explore differences in the effect for different levels of baseline motivation. This analysis used meeting the recommendation for physical activity as the dependent variable and added study group, motivation, the interaction of study group with motivation and the self-rated activity level as independent variables.

Stepwise multiple linear regression analyses were conducted to detect post-test group differences in the other principal outcome measures (e.g. transport-related activity, sports, leisure activities and difference between post-test and baseline score as dependent variables) and to explore differences in these effects for different levels of baseline motivation. In the first step, study group was entered as the independent variable, while the second step added motivation, the interaction of study group with motivation and the self-rated activity level as independent variables.

When a significant motivation-by-group interaction effect was found, separate sequential logistic regression analyses for meeting the recommendation or separate multiple regression analyses for transport-related activity, sports and leisure activities were conducted for motivated and unmotivated respondents.

Finally, multiple linear regression analyses were conducted with appreciation of the information letter as the independent variable and motivation at baseline and post-test as the dependent variables.

**Results**

**Baseline characteristics**

The mean age of the respondents was 44 years (SD = 12, range 18–65 years) and 46% were female. Thirteen per cent of the respondents had a low level of education, 51% a medium level and 36% a high level. The recommendation for physical activity was met by 40.7% of the respondents. The mean score on physical activity was 3 activity moments a week (SD = 1.8) ranging from 0 to 5.

The intervention and control group did not differ at baseline on most variables except for the variable ‘self-rated physical activity’ (OR = 1.28, CI = 1.04–1.57) as shown in Table I. Motivated and non-motivated respondents did only differ on the variables of ‘self-rated activity level’ (OR = 1.70, CI = 1.04–2.79) and ‘level of education’ (OR = 2.61, CI = 1.84–3.72) (Table I). Therefore, further tests were adjusted for self-rated physical activity and level of education.

Respondents who dropped out were more likely to be in the tailored intervention group (OR = 1.43, CI = 1.10–1.87) and were more likely to be younger (OR = 0.97, CI = 0.96–0.98).

**Physical activity**

No post-test group differences were found for meeting the recommendation of physical activity.
A significant interaction effect was found for motivation × study group on the likelihood of meeting the recommendation at post-test ($\beta = -2.28, P = 0.01$). Consequently, separate analyses for motivated respondents ($n = 97$) and non-motivated respondents ($n = 186$) at baseline were conducted.

The results show that at the post-test, the motivated respondents in the control group were more likely not to meet the recommendation for physical activity than to meet it (Table II). There were no significant differences between the motivated respondents who almost met the recommendation and those who met the recommendation. Although this is the case, both experimental and control condition improved their physical activity behaviour over time. Furthermore, no significant differences were found in meeting the recommendation between non-motivated respondents. Repeating these analyses for the total activity score showed the same results with significant effects for the motivated respondents ($\beta = 0.21, P < 0.05$) and no significant effects for unmotivated respondents.

Table III shows no effects of the computer-tailored intervention for the four subtypes of behaviours. Both study groups showed improvement over time in all subtypes of behaviours. A significant interaction was found between study group and motivation for transport-related activities and difference between post-test and baseline scores. The results revealed no effects in the unmotivated respondents, and more transport-related activities and more improvement over time in total activity scores in the motivated group in the intervention group (Table III).

Repeating the analyses in an intention-to-treat procedure resulted in smaller $\beta$-values and slightly higher but still significant $P$-values for transport-related activity and difference between post-test and

Table I. Mean values (and SD) for key variables at baseline for differences between study groups and differences between motivated and non-motivated respondents for the total population and for respondents with physical activity levels not in accordance with recommendations

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total study population</th>
<th>Respondents with physical activity levels not in accordance with recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tailored ($n = 265$)</td>
<td>Control ($n = 222$)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male (%)</td>
<td>52</td>
<td>50</td>
</tr>
<tr>
<td>Female (%)</td>
<td>48</td>
<td>50</td>
</tr>
<tr>
<td>Age</td>
<td>46 (12.09)</td>
<td>46 (12.64)</td>
</tr>
<tr>
<td>Level of education</td>
<td>2.26 (0.64)</td>
<td>2.27 (2.27)</td>
</tr>
<tr>
<td>Level of motivation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>24.93 (4.43)</td>
<td>24.76 (4.61)</td>
</tr>
<tr>
<td>Self-rated activity level</td>
<td>0.03 (1.03)</td>
<td>0.28 (1.04)$^d$</td>
</tr>
<tr>
<td>Meeting recommendation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do meet (%)</td>
<td>39.4</td>
<td>41.9</td>
</tr>
<tr>
<td>Almost meet (%)</td>
<td>7.2</td>
<td>9.8</td>
</tr>
<tr>
<td>Not meet (%)</td>
<td>53.4</td>
<td>48.3</td>
</tr>
<tr>
<td>Sports activities</td>
<td>0.66 (1.19)</td>
<td>0.76 (1.25)</td>
</tr>
<tr>
<td>Transport activities</td>
<td>0.57 (1.48)</td>
<td>0.47 (1.34)</td>
</tr>
<tr>
<td>Leisure-time activities</td>
<td>2.38 (2.62)</td>
<td>2.60 (2.80)</td>
</tr>
</tbody>
</table>

$^a$Level of education, 1 = low; 2 = medium; 3 = high. $^b$Significant difference between motivated and non-motivated respondents at baseline $P < 0.05$. $^c$Measured on a scale ranging from −2 to +2 (very much–very little). $^d$Significant difference between tailored and control group at baseline $P < 0.05$. $^e$Sport activity moments a week. $^f$Transport activity moments a week. $^g$Leisure-time activity moments a week.
Table II. Sequential logistic regression of the contrasts 'not meeting versus meeting the recommendation' and 'almost meeting versus meeting the recommendation' on difference between groups [experimental (E) and control (C)] for the total population, motivated and unmotivated respondents; OR with 95% CI

<table>
<thead>
<tr>
<th>Group</th>
<th>Total population not meeting recommendation (n = 283)</th>
<th>Motivated respondents (n = 97)</th>
<th>Unmotivated respondents (n = 186)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E</td>
<td>C</td>
<td>OR (CI)</td>
</tr>
<tr>
<td>Not meeting recommendation (%)</td>
<td>50.7</td>
<td>57.8</td>
<td>1.27 (0.85–1.98)</td>
</tr>
<tr>
<td>Meeting recommendation (%)</td>
<td>29.9</td>
<td>31.8</td>
<td>39.5</td>
</tr>
<tr>
<td>Almost meeting recommendation (%)</td>
<td>19.4</td>
<td>10.4</td>
<td>0.82 (0.45–1.49)</td>
</tr>
<tr>
<td>Meeting recommendation (%)</td>
<td>29.9</td>
<td>31.8</td>
<td>39.5</td>
</tr>
</tbody>
</table>

All tests were adjusted for level of education and self-rated physical activity.
*The experimental group is the reference group, a significant OR >1.0 means that the variable is significant in the non-reference group and not in the reference group. *P < 0.05.

Table III. Post-test mean scores (and SD) on the outcome measures for each study group

<table>
<thead>
<tr>
<th>Group</th>
<th>Total population not meeting recommendation (n = 283)</th>
<th>Motivated respondents</th>
<th>Unmotivated respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tailored (E) Control (C) β (CI)</td>
<td>E (n = 43)</td>
<td>C (n = 54)</td>
</tr>
<tr>
<td>Transport-related activities</td>
<td>0.29 (1.03)</td>
<td>0.20 (0.89)</td>
<td>0.10 (−0.13 to 0.32)</td>
</tr>
<tr>
<td>Sports</td>
<td>0.54 (0.97)</td>
<td>0.60 (1.23)</td>
<td>0.01 (−0.25 to 0.26)</td>
</tr>
<tr>
<td>Leisure activities</td>
<td>2.31 (2.23)</td>
<td>2.29 (2.35)</td>
<td>0.04 (−0.49 to 0.57)</td>
</tr>
<tr>
<td>Activity score t1 − t0</td>
<td>1.23 (3.66)</td>
<td>0.89 (3.09)</td>
<td>0.34 (−0.27 to 0.94)</td>
</tr>
</tbody>
</table>

Standardized regression coefficients (β) and CIs from the multiple regression analyses. All tests were adjusted for level of education and self-rated physical activity. Transport-related activities, moments engaging in transport-related activities a week; sports, moments engaging in sport activities a week; leisure activities, moments engaging in leisure-time activities a week; activity score t1 − t0, change in activity moment per week.
*No significant interaction between study group and motivation was detected. *P < 0.05.
baseline for total activity score. The effects on meeting the recommendation for physical activity remained only borderline significant.

**Evaluation of information**

The tailored information had been read by 85.8% of the respondents, while 37.2% had discussed the information with others and 35.3% had saved the letter. In general, all respondents were positive about the information letter, given an overall rating of 7.2 out of a possible 10. Respondents who did not meet the guidelines for physical activity at baseline were also positive about the letter, given an overall rating of 7.0 out of a possible 10. Multiple regression analysis showed that respondents motivated to change at post-test gave the tailored information letter a higher overall rating than respondents who were not motivated to change ($\beta = 0.21; P = 0.01$).

**Discussion**

The present study tested the impact of a computer-tailored intervention in encouraging people to engage in physical activity. Our results did not confirm our first hypothesis since tailored feedback had no significant impact for the total population. We found partly support for the second hypothesis, since the tailored condition resulted in increased levels of meeting the recommendation and transport-related physical activity levels, in respondents motivated to change. Bull *et al.* [16] found effects of tailoring on physical activities of daily living and no differences in leisure-time activity. Although the physical activities of daily living measured by Bull *et al.* did not include commuting to work by bicycle or on foot, this is an important part of daily living activities in the Netherlands. A study among 2149 Dutch adults aged between 16 and 65 years showed that of eight sources of physical activity (work, commuting by bicycle or on foot, sports, housework, gardening, bicycling, walking and other) commuting to work contributed 12% to the total amount of physical activity, making it—together with work-related activities—the largest single contributor [32]. The fact that respondents mostly changed their daily living activities may indicate that respondents try to fit physical activity into their everyday schedule, which may help to turn physical activity into a habitual behaviour. Although no significant effects were found for leisure-time activities and sports, both study groups improved their behaviour over time. The fact that the control condition also improved their behaviour may be explained by the change in season or the influence of the post-test questionnaire itself.

A possible explanation for finding no effects in the unmotivated group may be that they did not experience a ‘need to change’, resulting in being less motivated to seriously read and process the tailored information [12]. The elaboration likelihood model indicates that the involvement, the extent to which an individual is willing and able to ‘think’ about information, is important in the processing of the information. When people are motivated and able to think about the content of the message, the central persuasive route is likely to occur [33]. Furthermore, secondary analyses showed that motivated respondents were more likely to save the information and rated the information letter as more attractive than respondents not motivated to change. This could indicate that motivated respondents perhaps read the information again and thus processed the information more intensively. A study of differences in the use and impact of computer-tailored dietary fat feedback also showed that computer-tailored information was more effective, and better used and appreciated by people who were motivated to change at baseline [22]. Another possibility is that a single-tailored feedback letter may not be enough for initially non-motivated people to progress to behaviour change. While such a one-time intervention may raise awareness and general interest, further intervention moments may be needed for further progress. A study on smoking cessation found that among smokers with low motivation to quit, multiple-tailored interventions did lead to more stage transitions, a greater intention to quit and more quitting behaviour [23]. A study of fat intake reduction and increasing fruit and vegetable intake also found a positive effect of a second computer-tailored feedback letter among respondents not only with...
a specific need to change but also possibly with a greater resistance to change [34].

Both study groups improved their behaviour over time. The fact that also the control condition improved their physical activity behaviour without receiving any information could be explained by a possible testing effect due to the repeated measures or by the influence of the season.

Our findings suggest that single computer-tailored message may work for persons motivated to change. However, even then changes on all physical domains were unlikely to occur suggesting a need for additional interventions. Findings on ego depletion, suggesting that people have limited energy, further suggest that changes on all domains may be unlikely to be expected. Our findings furthermore suggest that a single letter for unmotivated respondents is not enough to realize changes and additional interventions are needed, for instance, booster tailored methods [35]. Moreover, our results revealed that many non-motivated persons are unaware pre-contemplators (82%), implying that they thought that they were sufficiently active. Hence, although letters tried to raise awareness in this group about their insufficient activity levels, our feedback may have been too discrepant from their perceptions. It is also conceivable that this group needs more time to prepare changes. More in-depth research for this group is therefore recommended to analyse their reactions to the feedback that they received.

Computer-generated tailoring using mailed printed materials has the limitation that it takes time to process the data from the questionnaires and to send the letter to the respondents. The time span between completing the questionnaire and receiving the letter at home varied from a few days to 2 weeks. In this period, respondents may have changed their beliefs, motivations or behaviour, which may have resulted in feedback letters that did not correspond to the individual needs. ‘Second generation’ tailoring, using interactive technology, can solve these problems, but has other challenges to overcome such as people’s tendency to ‘surf’ the internet rather than to spend concentrated time on one site or the question whether people read differently and/or are less persuaded by electronic text than by traditional text on paper [10, 12, 36].

The present study was subject to some limitations. The attrition rate of the present study was fairly low, and could have been subject to selection bias. The dropout rates in the tailored information group were higher than in the no information control group and were larger for younger respondents. This may have been due to the effort required to read the information. The control group received no information and therefore did not have to put in any effort reading it; they only had to fill in the questionnaire. Respondents who did not read the information may not have returned the questionnaire. Younger respondents may prefer information through the Internet or on CD-ROM. A study of web-based computer-tailored nutrition information also found that the dropout rates were higher in the tailored information group than in the no information group. On the other hand, the study found no effect for the younger respondents, indicating that second generation tailoring may be more effective for this group [37]. In the present study, those in the control condition did not receive any information. Evaluation of tailored communications can be done using a broad range of comparisons, for example, comparison with generic materials or attention only material or one-time versus iterative tailored feedback. Hence, further studies are required to test whether and when computer-tailored information can be more effective than other ways of providing information. Studies comparing general information and tailored feedback for smoking cessation and nutrition have found that the tailored intervention was more effective than the non-tailored intervention [34, 38, 39]. Further research, however, should explore whether these results can be replicated if those in the control condition receive general information or another way of providing information on physical activity, and should assess the long-term effects after 12 months.

In conclusion, a single-tailored information letter had no overall effects, but did show a significant effect on motivated respondents. It is likely that unmotivated respondents need more than one feedback letter to move from the unmotivated phase to
being motivated to change and undertake actions and information thus needs to be divided into more feedback letters to be best attuned to the motivation level of the participants.

**Practical implications**

Despite the limitations, our study suggests that computer-tailored information about physical activity can be effective for adults motivated to increase their activity levels. More research needs to be done, however, for adults not motivated to change their behaviour. It is conceivable that more elaborate information should be given to them to make them realize their risks, to better outline the advantages and to better discuss how to overcome barriers and to increase self-efficacy.

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**Conflict of interest statement**

None declared.

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