Effect of a tailored behavior change program on a composite lifestyle change score: a randomized controlled trial

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Abstract

To evaluate the effect of a tailored behavior change program on a composite lifestyle change score. A randomized controlled trial conducted in Belgium in 2007–08 with 314 participants allocated to a control and an intervention condition. The intervention was a tailored behavior change program (web-based and individual coaching). The dose of the coaching was chosen by the participants and registered. Outcome measures were weight, saturated fat intake, fruit and vegetable intake, physical activity, smoking status and a composite lifestyle change score. Mann–Whitney U-tests, Kruskal–Wallis tests, t-tests and one-way analyses of variance were used to compare the study conditions and three intervention dose groups (no/low, medium and high intervention dose). There were no significant differences between the study conditions or between the intervention dose groups for the individual lifestyle factors. The composite lifestyle change score was significantly higher in the high intervention dose group compared with the no/low intervention dose group (P = 0.009). The composite lifestyle change score was positively related to the intervention dose, while the individual lifestyle factors were not. Behavior change programs that target multiple lifestyle factors could be evaluated by using a composite lifestyle change score taking into account the intervention dose.

Introduction

Chronic diseases such as cardiovascular disease (CVD) are caused by multiple biomedical and lifestyle factors [1]. The European guidelines on cardiovascular prevention emphasize the importance of smoking cessation, taking sufficient exercise and adhering to a balanced diet exercise. Overweight and obesity are associated with a raised blood pressure and dyslipidemia and ultimately with an increased CVD risk [1]. Studies showed that dietary lifestyle factors such as fat, fruit and vegetable intake are related to cardiovascular disease or risk factors such as elevated blood pressure and lipid levels [1, 2]. Low levels of physical activity are associated with an increased cardiovascular risk and mortality [3]. Finally, smoking is the only lifestyle factor that directly is included in the determination of the 10-year risk of cardiovascular death using the SCORE model [4]. The factors taken into account in this algorithm are age, sex, smoking status, cholesterol level and blood pressure level. Based on this model, people can be classified to have a low, average or high risk.
Guidelines recommend to target interventions at people at low, average and high risk (mixed population) and this is considered to be cost-effective [1, 5].

The INTERHEART study showed that lifestyle factors contribute for 55% to the risk of myocardial infarction [6]. The lifestyle factors considered in that study were eating fruit and vegetables on a daily basis, taking regular exercise, and avoiding smoking and abdominal obesity. The association of six core protective lifestyle factors with a lower prevalence of hypertension and a raised cholesterol was confirmed in a recent cross-sectional study [7]. The core protective lifestyle factors were having a normal body mass index (BMI), having a waist-hip-ratio below the current threshold for central obesity, never smoking, low alcohol consumption, a healthy diet and adequate levels of physical activity. Behavior change programs targeting more than one lifestyle factor simultaneously are warranted and were found to be effective in provoking positive lifestyle changes [8]. It is important for multiple behavior change interventions to find a way of communicating the complete behavior change effect [9]. They can be evaluated accordingly using a composite lifestyle score. Nevertheless, consensus on how to report changes in multibehavioral interventions is lacking. Several methods to calculate a composite lifestyle score such as combined change scores or an index can be used. A number of cohort studies with large population samples included a composite lifestyle score [10–12]. However, no randomized controlled trial of a behavior change intervention program for mixed populations has used a composite lifestyle score as outcome measure yet. One randomized trial in patients with established coronary heart disease used a composite lifestyle score as an outcome measure of an intensive lifestyle program [13].

The present study tested the effect of a tailored behavior change program targeted at multiple lifestyle factors using a randomized controlled study design with a composite lifestyle change score as an outcome measure. Moreover, the received intervention dose was considered because it is related to the effect size of behavior change interventions [14].

Methods

Participants and study design

Study recruitment began in Belgium in February 2007 and ended in April 2007 [15]. Requests for study participation were sent to customers from an insurance company that insures self-employed professionals (e.g. lawyers) against loss of income due to sickness (n = 737) (Fig. 1). Eligible participants were 25–75 years old with Internet access. Informed consent was obtained from 314 overall healthy and highly educated adults (Master’s degree in Law).

They were randomized using to a control and an intervention condition using a non-stratified randomization technique with a 1:3 versus 2:3 ratio in order to keep enough power to study dose–response effects [15]. The randomization was performed by hand by an independent person. The participants were blinded to group assignment. The informed consent form stated that participation meant that the participant would be offered a cardiovascular prevention program. Participants in both conditions received a medical assessment to determine the cardiovascular risk using the SCORE algorithm and a profile with a risk summary [4]. Two hundred and eighty-seven participants completed a questionnaire in April 2007. Next, participants in the intervention condition received access to a tailored behavior change program (web-based and individual coaching) aimed at reducing overweight, reducing saturated fat intake, increasing fruit and vegetable intake, increasing physical activity and quitting smoking. After 6 and 12 months, the participants completed the questionnaire again. The 6-month results are published elsewhere [16]. The present study examines the 12-month results. The study was approved by the Hasselt University Ethics Committee (ISRCTN23940498).

Intervention

The behavior change program was based on leading behavior change and motivational theories such as the Theory of Planned Behavior (TPB) and Self-Determination Theory (SDT) [17–19]. TPB is
a theory that describes and predicts behavior using theoretical constructs such as attitudes, subjective norms, perceived behavioral control and intentions [17]. SDT complements TPB because it distinguishes between qualities of motives that regulate behavior and influence TPB constructs [19]. One of the recommendations from SDT is to offer choice to increase motivation [19]. Hence, the participants could freely compose their own individual coaching with regard to the targeted lifestyle factors, the dose and the delivery mode (e-mail; regular mail; telephone; face-to-face). A health psychologist telephoned the participants before the intervention to ask them how they wanted their coaching to look like. This information was used to individually tailor the coaching to the needs of the participants. The coaching was given by a health psychologist who used behavior change techniques (e.g. set graded tasks; provide instruction) and an autonomy-supportive inter-personal style (e.g. avoiding a controlling language, taking the perspective of the individual) to stimulate lifestyle change [18]. The autonomy-supportive inter-personal style is an example of an SDT recommendation that was followed in this intervention. The participants in the intervention condition that preferred no coaching received no intervention dose. The participants in the intervention condition could also make use of web-based coaching. The participants could log in to a tailored website including a cardiology section by default. Participants were free to subscribe to sections with information on individual lifestyle factors (e.g. fat intake, fruit and vegetable intake, physical activity and quitting smoking), behavior change techniques (e.g. self-monitoring), self-tests and tailored advice.

**Intervention dose registration**

The intervention dose registration for individual coaching consisted of a prospective registration of the targeted lifestyle factor, the delivery mode and the duration of each contact (in minutes) by the study personnel alongside the trial. This registration can be considered to be reliable since this information was used for the determination of intervention costs in a cost-utility study of this cardiovascular prevention program [20]. The total duration of all contacts to promote a healthy lifestyle per participant was calculated and was used as a measure for the intervention dose in this study. Tailored website traffic was also registered but the effect of the web-based coaching was not included in the present study.
study because website use naturally declines over time and an exploration of website use was described elsewhere [21]. Participants in the intervention condition were divided into three intervention dose groups using the 50th and 75th percentiles of the total duration of all contacts of 1 year. These percentiles were chosen because about half of the participants underused the program (no or a low dose) and in the present study, the aim was to gain more insight into actual intervention exposure and its effects individual lifestyle factors and a composite lifestyle change score. Hence, there were three groups: no or a low intervention dose (less than 5 hours), a medium intervention dose (between 5 and 7 hours) and a high intervention dose (more than 7 hours). The no or low-dose group received a mean of 227.81 min of intervention [standard deviation (SD) 4.23], the medium-dose group received a mean of 343.74 min of intervention (SD 5.20) and the high-dose group received a mean of 727.03 min of intervention (SD 58.01). The dose–response effects were only examined for the intervention condition.

**Lifestyle factors**

The questionnaire included self-reported weight, height and questions on the smoking status. Weight was reported in kilograms, height in centimeters. Saturated fat intake was assessed in grams of fat per day with a validated food frequency questionnaire [22]. Fruit and vegetable intake was assessed using a short food frequency questionnaire [23]. The latter questionnaire was validated in a sample of children but was chosen because of its brevity only consisting of six items: (i) How often do you eat fresh fruits? (ii) How often do u usually eat salads? (iii) How often do u usually eat raw vegetables? (iv) How often do u usually eat potatoes? (v) How often do u usually eat boiled vegetables? and (vi) How often do you drink fresh orange juice? [answer categories: Never, less than 1 day a week, 1 day a week, 2–4 days a week, 5–6 days a week, every day (1×), every day (2×), every day (≥2×)]. A summed score of daily portions of fruit and vegetables was calculated. Total physical activity in minutes per week was assessed using a validated questionnaire, the International Physical Activity Questionnaire (IPAQ) (long version, usual week) [24]. The IPAQ has been used to monitor changes in physical activity computer-tailored and whole-community interventions before [25, 26]. Proportional differences were calculated for each lifestyle factor (weight, saturated fat intake, fruit and vegetable intake and physical activity) by subtracting the baseline score from the 12-month follow-up score and multiplying it by 100. For all these factors and for smoking, net effects were calculated by subtracting the change in the control condition from the change in the intervention condition and dividing it by the mean baseline score in the control condition.

**Composite lifestyle change score**

A score ranging from −2 to +2 was calculated using the quintiles of the proportional differences of each lifestyle factor. This method was used before to recode individual lifestyle factors into categorical variables to determine a composite lifestyle score [10, 12]. For weight, the 20% of the participants that gained most weight received a score of −2. The next 20% received a score of −1 and so on. The 20% participants that improved this lifestyle factor most received a score of +2. The same procedure was followed for saturated fat intake, fruit and vegetable intake and physical activity. For smoking, a score of −2 was given to participants that started smoking, a score of zero was given to participants that never smoked, kept smoking or stayed abstinent and a score of +2 was given to participants that quitted smoking. For smoking, the scores of −1 and +1 were not used to account for the greater importance of this lifestyle factor for cardiovascular prevention. A composite lifestyle score was calculated by summing up the scores for each lifestyle factor. The composite lifestyle change score ranges from −10 (lifestyle worsened the most) to +10 (lifestyle improved the most).

**Sample size**

A two-group *t*-test with a 0.05 two-sided significance level had 80% power to detect a difference of 12.00 g of fat (common SD = 34.50 g day$^{-1}$) and 86% power to detect a difference of 122.00 min of
total physical activity (common SD = 323 min week\(^{-1}\)) (total sample size = 300) (Nquery Advisor 4.0®).

**Statistical analyses**

Mann–Whitney \(U\) and Kruskal–Wallis tests were used to compare the mean proportional differences between the two study conditions and the intervention dose groups (SPSS 16.0). These analyses were conducted separately for specific subgroups that were not in line with the recommendation for that particular lifestyle factor at baseline (BMI \(< 25\) kg m\(^{-2}\); saturated fat intake \(< 10\%\) total energy intake per day; four portions of fruit and vegetables per day; sports three times per week \(\geq 20\) min or moderate activity \(\geq 6\) days week\(^{-1}\); smoking abstinence) [1, 4, 27–29]. \(t\)-tests and one-way analyses of variance with a post-hoc Tukey test were used to compare the mean composite lifestyle change scores of the two study conditions and the intervention dose groups. These analyses were also conducted separately for people who smoked and/or were not in line with at least two other lifestyle recommendations. For individuals missing information on any lifestyle factor, the last observation was carried forward (intention-to-treat) (\(\alpha = 0.05\)). The net effects were calculated for the individual lifestyle factors by subtracting the mean 1-year change in the control condition from the mean 1-year change in the intervention condition and dividing this by the mean baseline score for that lifestyle factor in the control condition.

**Results**

At baseline, the participants that filled out the questionnaire in April 2007 (\(n = 287\)) consisted mainly of men (67%) and the mean age was 40.49 years (SD 10.55) (Table I). The response percentage was 39% (287/737). The dropout rate was 32% (34/106) for the control condition and 29% (61/208) for the intervention condition. Dropout analysis showed no significant differences for gender, age, study condition, cardiovascular risk, BMI, saturated fat intake, fruit and vegetable intake, physical activity and smoking. The control condition and intervention condition were also comparable with regard to these factors at baseline.

The composite lifestyle change score was significantly different for the intervention dose groups \((F = 5.89; \text{d.f.} = 2; P < 0.01)\). The lifestyle change score was higher in the high intervention dose group (\(n = 48\)) compared with the no/low intervention dose group (\(n = 97\)) \((P < 0.01)\).

The medium-dose group was not significantly different from the other intervention dose groups. Table II shows the composite lifestyle change score and individual lifestyle factor changes for the total sample and for subgroups that were not in line with lifestyle recommendations at baseline. The composite lifestyle change score was not significantly different for both study conditions \((t = -0.95; \text{d.f.} = 285; P = 0.34)\). There were no differences for the individual lifestyle factors between both study conditions or between the intervention dose groups. The results for the subgroups that were not in line with the recommendations were comparable to those for the total sample (Table II). The net effect of the intervention was \(-0.01\) for weight, \(-0.04\) for saturated fat intake, 0.004 for fruit and vegetable intake, 0.02 for physical activity and \(-0.33\) for smoking.

**Discussion**

Significant differences between the intervention dose groups were found for the composite lifestyle change score. A high intervention dose led to a significantly higher composite lifestyle change score compared with no or a low intervention dose. No differences, however, were found between the study conditions for the composite lifestyle score or the individual lifestyle factors. No differences were found between the intervention dose groups for the individual lifestyle factors either.

Previous studies including a composite lifestyle score differed with regard to the number and nature of the included factors and the formula for the composite score [10–12]. Except for the absence of alcohol consumption, the lifestyle factors included in the present study are comparable to those
described in the literature. Like in other studies, the composite score was determined by summing up the scores on separate lifestyle factors. These studies calculated a binary score (compliance versus non-compliance) for each lifestyle factor. In the present study, however, a categorical score with three to five categories was determined for each lifestyle factor. In this way, small behavioral changes can better be grasped. Composite lifestyle scores are determined in a pragmatic way and it is advised in the literature to apply different methods to come to a universal composite score [9, 11]. In other studies, the predictive value of the composite score for the risk of stroke and CVD was investigated and confirmed [10–12]. In spite of these findings, only one randomized study considered the direct effect of an intervention on a composite lifestyle score [13]. In the latter study, there was a significant difference between the study conditions for the composite score but not for each separate lifestyle factor. This is in line with the findings from the present study. The study of Ornish et al. [13], however, included patients with moderate to severe coronary heart disease, whereas the present study included a mixed population as recommended by the guidelines on CVD prevention [1]. The question is not whether cardiovascular prevention programs should be reserved for high-risk individuals, but how the content and costs of these programs should be adapted to the risk. A different ceiling of investment can be determined for healthy individuals, high-risk individuals and coronary patients.

The most important strengths of this study were the use of a randomized design and the analysis of the dose–response effects. A higher intervention dose was associated with significant lifestyle improvement. The fact that a higher intervention dose leads to greater interventions effects is generally accepted [14]. One could, however, be concerned that the difference between the intervention dose groups was caused by a selection bias (i.e. more motivated participants select a higher intervention dose and make more positive lifestyle changes). Randomization of the dose is the optimal strategy to examine dose–response effects [30]. However, the aim of the present study was to examine the effect of a self-selected intervention dose. As suggested by McGowan et al. [30], we explored

<table>
<thead>
<tr>
<th>Table I. Baseline characteristics (% or mean ± SD) of the total study sample, the two study conditions and the three intervention dose groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study sample (n = 287)</td>
</tr>
<tr>
<td>Gender (male)</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>BMI (kg m⁻²)</td>
</tr>
<tr>
<td>Cardiovascular risk</td>
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<tr>
<td>Low</td>
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<tr>
<td>Average</td>
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<tr>
<td>High</td>
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<tr>
<td>Unknown</td>
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<tr>
<td>Saturated fat intake (g day⁻¹)</td>
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<tr>
<td>Fruit and vegetable intake (portions per day)</td>
</tr>
<tr>
<td>Physical activity (min week⁻¹)</td>
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<tr>
<td>Smokers</td>
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</tbody>
</table>

Study conducted in Belgium in 2007–08; control condition = medical assessment only; intervention condition = medical assessment + tailored behavior change program.
Table II. Composite lifestyle change score and individual lifestyle factor changes (%) for the total sample and subgroups that were not in line with lifestyle recommendations at baseline

<table>
<thead>
<tr>
<th>Composite lifestyle change score</th>
<th>Control condition, ( n = 93 ) Mean (SD)</th>
<th>Intervention condition, ( n = 194 ) Mean (SD)</th>
<th>( t )</th>
<th>( P )-value</th>
<th>No/low-dose group, ( n = 97 ) Mean (SD)</th>
<th>Medium-dose group, ( n = 49 ) Mean (SD)</th>
<th>High-dose group, ( n = 48 ) Mean (SD)</th>
<th>( F )</th>
<th>( P )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite lifestyle change score (total sample)</td>
<td>(-0.09 (3.05))</td>
<td>(0.26 (2.76))</td>
<td>(-0.95)</td>
<td>0.34</td>
<td>(-0.28 (2.69))</td>
<td>(0.24 (2.61))</td>
<td>(1.35 (2.79))</td>
<td>(5.89)</td>
<td>0.003*</td>
</tr>
<tr>
<td>Composite lifestyle change score (smokers and/or not in line with at least two other individual lifestyle recommendations)</td>
<td>(-0.18 (3.02))</td>
<td>(0.43 (2.85))</td>
<td>(-1.49)</td>
<td>0.14</td>
<td>(-0.14 (2.81))</td>
<td>(0.45 (2.75))</td>
<td>(1.43 (2.79))</td>
<td>(4.45)</td>
<td>0.013*</td>
</tr>
<tr>
<td><strong>Individual lifestyle factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (% change)</td>
<td>(-0.01 (4.65))</td>
<td>(-0.63 (3.97))</td>
<td>(-1.48)</td>
<td>0.14</td>
<td>(-0.57 (4.40))</td>
<td>(-0.05 (3.64))</td>
<td>(-1.37 (3.28))</td>
<td>(2.84)</td>
<td>0.24</td>
</tr>
<tr>
<td>Weight—not in line with the recommendation (% change)</td>
<td>(-0.64 (3.69))</td>
<td>(-1.06 (3.91))</td>
<td>(-0.99)</td>
<td>0.32</td>
<td>(-1.39 (4.67))</td>
<td>(-0.20 (2.62))</td>
<td>(-1.15 (3.40))</td>
<td>(2.67)</td>
<td>0.26</td>
</tr>
<tr>
<td>Saturated fat intake (% change)</td>
<td>(0.32 (27.18))</td>
<td>(-0.54 (34.25))</td>
<td>(-0.65)</td>
<td>0.51</td>
<td>(1.10 (30.76))</td>
<td>(-2.57 (30.26))</td>
<td>(-1.78 (44.04))</td>
<td>(2.46)</td>
<td>0.29</td>
</tr>
<tr>
<td>Saturated fat intake—not in line with the recommendation (% change)</td>
<td>(-2.89 (25.47))</td>
<td>(-6.03 (31.56))</td>
<td>(-1.06)</td>
<td>0.29</td>
<td>(-4.29 (26.64))</td>
<td>(-9.02 (25.96))</td>
<td>(-6.34 (42.72))</td>
<td>(2.18)</td>
<td>0.34</td>
</tr>
<tr>
<td>Fruit and vegetable intake (% change)</td>
<td>(16.62 (95.50))</td>
<td>(23.93 (105.62))</td>
<td>(-0.25)</td>
<td>0.81</td>
<td>(10.58 (95.47))</td>
<td>(30.89 (102.94))</td>
<td>(43.78 (124.68))</td>
<td>(4.15)</td>
<td>0.13</td>
</tr>
<tr>
<td>Fruit and vegetable intake—not in line with the recommendation (% change)</td>
<td>(22.30 (103.46))</td>
<td>(33.62 (113.21))</td>
<td>(-0.59)</td>
<td>0.56</td>
<td>(19.48 (106.39))</td>
<td>(40.37 (108.76))</td>
<td>(51.12 (127.17))</td>
<td>(3.36)</td>
<td>0.19</td>
</tr>
<tr>
<td>Physical activity (% change)</td>
<td>(76.16 (200.87))</td>
<td>(83.25 (213.60))</td>
<td>(-0.78)</td>
<td>0.44</td>
<td>(60.74 (193.93))</td>
<td>(78.03 (203.83))</td>
<td>(134.06 (253.75))</td>
<td>(4.33)</td>
<td>0.12</td>
</tr>
<tr>
<td>Physical activity—not in line with the recommendation (% change)</td>
<td>(90.45 (229.02))</td>
<td>(99.39 (228.42))</td>
<td>(-0.03)</td>
<td>0.98</td>
<td>(83.24 (217.18))</td>
<td>(93.88 (230.83))</td>
<td>(137.47 (249.63))</td>
<td>(2.10)</td>
<td>0.35</td>
</tr>
</tbody>
</table>

Study conducted in Belgium in 2007–08; control condition = medical assessment only; intervention condition = medical assessment + tailored behavior change program.
*Significant difference between the lowest and the highest intervention dose (result from post hoc Tukey test). *\(P < 0.05\); **\(P < 0.01\), ***\(P < 0.001\).
pretreatment confounding variables for the three groups and found no differences for the behavioral outcomes used in the composite lifestyle change score at baseline (weight, saturated fat intake, fruit and vegetable intake, physical activity) and motivation to change physical activity, diet or smoking \((P > 0.05)\). Participants’ BMI at baseline, however, was higher in the high intervention dose group versus the no/low intervention dose group \((F = 8.17; \ d.f. = 2; \ P < 0.01)\). The high intervention dose group included two participants suffering from morbid obesity \((\text{BMI} \geq 40)\). There was no improvement for the individual lifestyle factors due to a higher intervention dose. Perhaps, an intervention designed to alter multiple behaviors at the same time is more likely to generate smaller changes in each behavior than a single-behavior intervention would provoke in one behavior. Regrettably, a large gap remains in our knowledge about the basic principles of multiple behavior change and efficacy of multiple behavior interventions \([31, 32]\). The literature holds information on the co-occurrence of behavior (i.e. clusters of behavior) but little is known about the covariation of behaviors \([33, 34]\). Covariation exists when taking effective action in one behavior increases the odds of taking effective action in a second behavior. There are several hypotheses on the underlying principles of multiple behavior change \([35]\). One example is the Global health/behavioral category approach. This approach suggests that there may be higher order constructs such as global health attitudes or global self-efficacy that predict attitudes or self-efficacy toward behavioral categories (physical activity attitudes, dietary attitudes and smoking attitudes). These attitudes toward behavioral categories, on their turn, predict attitudes toward specific behaviors (e.g. attitudes toward walking) and ultimately the latter attitudes predict actual behavior (e.g. walking behavior) \([35]\). This approach suggests interventions that, for instance, promote a healthy lifestyle as a route to multiple behavioral changes. In the present study, contacts with the participants were often targeted improving a healthy lifestyle, targeting multiple behaviors at the same time. For example, telephone calls were made wherein the health psychologist reviewed a subject’s goals for physical activity as well as for diet. For all that, an improved composite score is relevant for cardiovascular prevention since the effect of each individual lifestyle factor can strengthen the effect of another lifestyle factor, the composite score holds more information than separate factors.

There are limitations to our study. Firstly, the participants were motivated volunteers and all highly educated, limiting the generalizability of our findings. Nevertheless, it is generally known that lifestyle interventions are more effective in patient samples than in overall healthy or mixed samples \([36]\). Implementing the present intervention in the less healthy or lower educated may further improve its effectiveness. Secondly, the use of self-reported questionnaires could have led to over or under reporting. A lack of sensitivity of these questionnaires to measure individual behavior change could have led to an underestimation of the intervention effect on the composite lifestyle change score. Furthermore, the short fruit and vegetable questionnaire used in this study was only tested in a children’s sample and might not be valid in an adult sample but was chosen because of practical reasons. Nevertheless, Kim et al. \([37]\) stated that, despite validity issues, brief instruments can be used to monitor consumption trends over time. Thirdly, the difference between the intervention dose groups might partially be attributed to a regression toward the mean effect. Fourthly, the small sample size could be a limitation of the study and might have caused an underestimation of the intervention effect. Lastly, a negative score was given to gaining weight by default. One could argue that this is disadvantageous to people without overweight. Therefore, the composite lifestyle change score was determined separately for people who did not meet the recommendation for BMI at baseline. In this respect, it can be argued that weight should not even be included because it is highly connected with physical activity and diet. However, weight is a mediator or the effect of the latter behavioral risk factors on CVD, it is not included in the SCORE algorithm and was included in a composite lifestyle score before \([10]\).
The present study showed that the composite lifestyle change score only increased in the high intervention dose group compared with lower dose groups. This makes one think that there is a certain intervention dose that is crucial to alter the composite change score, whereas a lower dose fails to do this. However, clear-cut, causal inferences cannot be made without dose randomization. Nevertheless, studies targeted at multiple lifestyle factors would benefit from evaluating them accordingly, using a composite lifestyle score while taking into account the received intervention dose. Researchers in behavioral medicine should agree on a composite score that concurs with the scores that are used in cardiology to investigate the contribution of lifestyle to the risk of CVD. Moreover, future studies on composite scores might be beneficial with respect to other chronic diseases as well. Danaei et al. [38] described in their manuscript that CVDs, cancers and diabetes mellitus can be attributed to dietary risk factors, physical inactivity, smoking and overweight. Consequently, one can assume that the intervention and composite lifestyle change score from the present study might be of use in the context of other chronic diseases that can be attributed to unhealthy behaviors.

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**Conflict of interest statement**

None declared.

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