The use and evaluation of self-regulation techniques can predict health goal attainment in adults: an explorative study

Jolien Plaete, Ilse De Bourdeaudhuij, Maite Verloigne, Geert Crombez

Background. Self-regulation tools are not always used optimally, and implementation intention plans often lack quality. Therefore, this study explored participants' use and feasibility evaluation of self-regulation techniques and their impact on goal attainment.
Methods. Data were obtained from 452 adults in a proof of concept (POC) intervention of 'MyPlan', an eHealth intervention using self-regulation techniques to promote three healthy behaviours (physical activity(PA), fruit intake, or vegetable intake). Participants applied self-regulation techniques to a self-selected health behaviour, and evaluated the self-regulation techniques. The quality of implementation intentions was rated by the authors as a function of instrumentality (instrumental and non-instrumental) and specificity (non-specific and medium to high specific). Logistic regression analyses were conducted to predict goal attainment.
Results. Goal attainment was significantly predicted by the motivational value of the personal advice (OR:1.86), by the specificity of the implementation intentions (OR:3.5), by the motivational value of the action plan (OR:1.86), and by making a new action plan at follow-up (OR:4.10). Interaction-effects with behaviour showed that the specificity score of the implementation intention plans (OR:4.59), the motivational value of the personal advice (OR:2.38), selecting hindering factors and solutions(OR:2.00) and making a new action plan at follow-up (OR:7.54) were predictive of goal attainment only for fruit or vegetable intake. Also, when participants in the fruit and vegetable group made more than three plans, they were more likely to attain their goal (OR:1.73), whereas the reverse was the case in the PA group (OR:0.34).
Discussion. Feedback on goal feasibility, coping implementation intentions, further research to investigate the optimal number of plans for different behaviours, the optimal frequency and timing of follow-up modules and new ways to incorporate social support in eHealth interventions, are recommended.

The use and evaluation of self-regulation techniques can predict health goal attainment in adults: an explorative study

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Abstract

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Methods. Data were obtained from 452 adults in a proof of concept (POC) intervention of 'MyPlan', an eHealth intervention using self-regulation techniques to promote three healthy behaviours (physical activity(PA), fruit intake, or vegetable intake). Participants applied self-regulation techniques to a self-selected health behaviour, and evaluated the self-regulation techniques. The quality of implementation intentions was rated by the authors as a function of instrumentality (instrumental and non-instrumental) and specificity (non-specific and medium to high specific). Logistic regression analyses were conducted to predict goal attainment.

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38 **Background**

39 Physical activity (PA) and a varied diet with fruits and vegetables are associated with decreased
40 risk of cardiovascular diseases and cancer(1-3). Therefore, adults are recommended to perform
41 at least 30 minutes of PA at moderate- to vigorous intensity on most, preferably all days of the
42 week, and to consume at least 400 g of fruit and vegetable per day(4). However, many people do
43 not meet these recommendations(5). Despite the efforts to promote these health behaviours in
44 adults, fruit and vegetable intake have been decreasing, and PA levels have remained the same
45 since 2008 in Belgium(6). A recent meta-analysis focusing on these health behaviours indeed
46 stated that changing unhealthy lifestyle is difficult, and there is room for improvement(7).

47

48 Interventions most often targeted motivational determinants that are important during the early
49 stages of behaviour change, such as attitude and knowledge. However, interventions based upon
50 theories of intentions are often more effective in changing intentions than in changing
51 behaviour(8, 9), resulting in a so-called intention-behaviour "gap". This gap can be targeted by
52 adopting self-regulation techniques. One useful framework is the Health Action Process
53 Approach model that includes both pre-intentional processes that lead to a behavioural intention
54 and post-intentional processes that lead to the actual health behaviour(10). The model states that
55 individuals first have to become conscious of their own health behaviour and have to be become
56 motivated to change their behaviour, where after they have to initiate the new health behaviour to
57 bridge the gap between intentions and behaviour. This can be achieved by defining specific
58 action plans on 'when', 'where', and 'how' to perform the health behaviour, and by stating
59 implementation intentions in which strategies to initiate the action are stated (i.e. "If situation Y
60 is encountered, then I will initiate goal-directed behaviour X")(11). Finally, in order to be able to
61 adopt health behaviours people may make coping plans in which they cope with anticipated

barriers and problems that may hinder goal attainment(10, 12, 13). Research has shown that interventions that applied self-regulation techniques (i.e. specific goal setting, implementation intentions, providing feedback on performance, prompting review of behaviour goals, social support and self-monitoring) were more effective in changing health behaviour than other interventions(14-17). The meta-analysis of Michie et al. (2009) offers support to prompt intention formation, prompt goal setting, provide feedback on performance, and prompt review of goal progress and self-monitoring(14). Another meta-analysis of Gollwitzer and Sheeran(2006) also showed that implementation intention plans were effective in goal achievement(18). Based on the findings we developed an eHealth intervention 'MyPlan', which included self-regulation techniques (e.g. goal setting, prompting monitoring of behaviour, implementation intentions), guided by the Health Action Process Approach (HAPA) theory(10). 'MyPlan' provides the opportunity to select one out of three health behaviours (fruit, vegetables and PA), helps adults to set personal goals for that health behaviour and guides them to anticipate barriers and hindering situations during goal pursuit. To help participants to attain their goals, the following self-regulation techniques were implemented: tailored feedback, action planning, implementation intentions, problem solving, sharing action plans with friends/family for social support, stimulating self-monitoring and goal evaluation and adjustment.

A limitation of self-regulation interventions is that many tools (e.g. action planning, implementation intentions) may be used suboptimally by participants (19-21). For example, Michie et al. (2004) found that more than one-third of participants did not formulate implementation intentions despite being prompted to do so(22). Furthermore, when self-regulation tools are used, participants may not optimally apply them. Van Osch et al. (2010) reported that plans that are relatively broad and non-specific resulted in less successful

behavioural change(20). Ziegelmann, Lippke and Schwarzer (2006) also found that plans that were incomplete (lacking action planning or coping planning) were associated with less physical activity during rehabilitation at 6 months post-test(23).

The first aim of this study was to evaluate whether the use of several self-regulation techniques (e.g. selecting hindering factors and solutions, monitor behaviour) and feasibility evaluation of the self-regulation techniques (e.g. the difficulty experienced when making an action plan, the feasibility of the action plan) predicted goal attainment. Second, we rated the quality of implementation intention plans and evaluated if the coded total number of instrumental plans and the specificity score of the implementation intention plans predicted goal attainment. Finally, the moderating effect of the selected behaviour (fruit intake, vegetable intake, PA) on the predictions of use and feasibility rating of the self-regulation techniques on goal attainment was examined, as previous research showed that the effect of behaviour change techniques varies for different behaviours(12).

Methods

Participants and procedure

Data were obtained from participants in a proof of concept (POC) intervention of 'MyPlan'. 'MyPlan' provides personal feedback and helps adults to set and monitor personal and attainable health goals in order to increase either PA level, fruit or vegetable intake. Participants were recruited by distributing flyers to parents of adolescents in secondary schools, by using Facebook and Twitter advertisements and by recruiting university students. Eligible participants were over 18 years, were able to understand Dutch, and had access to Internet. Potential participants were invited to visit the website. A computer log in system was used to allocate adults to the control or intervention condition. The present study only used data from participants in the intervention

group who applied at least one of the self-regulation tools of 'MyPlan'. In the 'MyPlan' intervention programme, adults themselves chose a health behaviour that they wanted to change (fruit, vegetables or PA), where after they filled in online questions about demographic variables (age, gender, socio economic status) and questions about the selected health behaviour. Next, adults had access to the computer-tailored intervention module (T1). After one week (T2) and one month (T3), adults received an email with an invitation for the follow-up modules. These follow-up models evaluated whether they had reached their health goals and whether they attained the recommended health norms. Figure 1 shows the flow of the participants through the intervention modules as a function of the selected health behaviour. The study was approved by the Ghent University Ethics Committee (approval number of the Ghent University Ethics Committee: 670201319313), and an informed consent statement was obtained from each participant.

[Insert figure 1 (flow chart) here]

'MyPlan' intervention

'MyPlan' is informed by self-regulation and Health Action Process Approach theory. After logging in at the website (www.mijnactieplan.be), participants selected a behaviour of interest (fruit intake, vegetable intake, or PA) and completed the first module for that behaviour, which consisted of several components.

Tailored feedback is based upon the answers provided on a questionnaire about the selected behaviour. For PA, the International Physical Activity Questionnaire (IPAQ) was used(24). Tailored feedback consisted of reporting the actual level of PA in different domains (i.e. leisure time PA, active transportation, PA at work, house hold PA), providing feedback about these levels taking into account the health norms, and suggestions to increase PA. For Fruit

intake, the average portion of fruit per day was calculated using the Flemish 'Fruit Test'(25). Participants were asked to indicate how many pieces of each type of fruit that they ate during the previous week. The average portion of fruit per day was calculated. Participants received a report of this average portion and a comparison of this portion with the health norms in the personal feedback. For vegetables, the average grams of vegetables was calculated by means of the 'Vegetable Test'(25). Participants were asked to indicate the amount of portions of each type of vegetable they ate during the previous week. Average grams of vegetables per day was reported and compared with health norms in the personal feedback.

Action plans were formulated by answering a series of questions. For example, participants were asked *what* they want to do (e.g. being more physically active by walking), *when* they want to do this (e.g. every Monday evening), *where* they want to do this (e.g. local park), *how long* they want to do this (e.g. 60 minutes) and *with whom* they want to do this (e.g. friends). For PA, adults chose in which domain they wanted to increase their PA level (i.e. leisure time, active life style or both), and defined their goal by selecting activities (e.g. walking, swimming, biking) and by indicating the frequency (days per week) and time (minutes per activity) they wanted to spend on the chosen activity. For fruit and for vegetables, participants indicated the number of days and portions of vegetables they wanted to eat.

Next, *implementation intentions* were stated. Participants were guided to formulate their action plan into an implementation intention plan format (e.g. If it is Monday evening, then I will go to the aerobic lessons, in the local gym).

Problem solving was prompted by indicating hindering factors from a predefined list, or –when not listed- to write down the hindering factors in an open-ended question format. Participants had to reflect upon solutions to overcome these difficulties. This was also done by

providing a predefined list of solutions for each hindering factor that could be selected, or –when not listed- adults could write down their own solutions in an open-ended question format.

Sharing action plans was made possible by providing the participants the opportunity to send their action plan to family or friends for social support.

Stimulating self-monitor of behaviour was done by motivating participants to monitor their behaviour between the follow-up modules and by providing a list of possibilities (e.g. tracking behaviour change in an agenda) to do so.

Evaluating feedback was provided in the follow-up modules. After one week (T2) and one month (T3), participants had access to follow-up modules, in which it was evaluated whether their behaviour changed and goals were reached. After the evaluation feedback, participants could adapt or maintain their action plan. Action plans could be adapted by stating new goals (easier goals or more difficult goals) and by selecting new difficult situations, hindering factors and solutions, in the same way as in the first module. Both follow-up modules were similarly constructed. An overview of the intervention programme is given in figure 2.

[Insert figure 2 here]

Measures

Demographics

Participants provided information on age, gender and educational level. Participants with a university or college degree were classified as having a 'high educational level' whereas participants with a secondary school degree or lower were classified as having a 'low educational level'. Age was dummy coded into younger adults (≤40 years) and older adults (>40 years).

Outcome variables

176 Goal attainment at T2 and at T3 was operationalised in terms of whether participants attained at
177 least their goal set at T1.

178 *Use and feasibility evaluation of behaviour change techniques*

179 Participants indicated whether they used particular techniques (selecting hindering factors and
180 solutions, selecting different domains and activities (for PA only), sharing the action plan,
181 monitor behaviour and making a new action plan at T2) (See table 1). These variables were
182 dummy code into used (1) or not used (0) the technique (See table 1).

183 To evaluate the feasibility of the self-regulation techniques, additional questions were assessed at
184 the end of the questionnaire in T1. All variables regarding the feasibility of the self-regulation
185 techniques were dummy coded for the analyses. Table 1 provides an overview of the predictors
186 about the use and feasibility evaluation of the self-regulation techniques.

187 [Insert Table one here.]

188 *Quality of implementation plans*

189 Plan quality of implementation intentions (if-then plans) was evaluated by rating plan
190 instrumentality and specificity. We used the rating method of van Osch et al. (2010), plans were
191 rated as (1) instrumental or (0) non-instrumental. Plans were rated as instrumental when they
192 could facilitate the chosen behaviour (fruit intake or vegetable intake, PA) and when they were
193 applicable in the situation that was mentioned. The total number of instrumental plans was used
194 for the analysis by dummy coding it into (0) one or two instrumental plans and (1) more than two
195 instrumental plan. Frequent reasons for scoring a plan as not instrumental were nonsense plans,
196 or plans that did not target the chosen behaviour. Non-instrumental plans were not rated for
197 specificity. Specificity was only scored for plans considered instrumental, and was coded as (0)
198 non-specific, (1) medium specific, and (2) highly specific. 'Non-specific plans' were vague

plans, which were often applicable to various behaviours, e.g. “When it is Friday, I am going to sport”. Plans that were described with a certain amount of detail and direction, but that were still general and applicable to several actions and/or lacked one of the following elements (when, how long and where) were rated as ‘medium specific’, e.g. “When I come home after work, I will go playing basket”. Plans were coded as ‘highly specific’ if a sufficient amount of precision and direction of time (Monday evening 8 am) and place (the local swimming pool) was used and if all elements (when, how long and where) were included, e.g. “When it is Monday evening 8 am, I go swimming for 45 minutes in the local Swimming pool”. Participants had the possibility to make several implementation plans. ‘The mean specificity score’ of all plans was calculated and used in the analysis by dummy coding it into (0) low specific plans and (1) medium/high specific plans. Two researchers independently evaluated all plans on instrumentality and specificity. The interrater reliability was high for instrumentality (Cohen’s κ 0.89) and substantial for specificity (Cohen’s κ=0.76)(26).

Statistical analyses

Baseline characteristics of participants were described using descriptive statistics. Logistic regression analyses were performed to predict whether participants reached their goal (= goal attainment) at T2 and T3. Various predictors were taking into account. These included several self-ratings of the feasibility of the self-regulation techniques: the awareness of own behaviour, the motivational value of the personal advice, the instructive value of the personal advice, the motivational value of the action plan, the feasibility of the action plan and the difficulty experienced when making an action plan. Also, selecting hindering factors and solutions, selecting different domains and activities for PA, sharing the action plan, monitor behaviour and making a new action plan at T2, were added as predictors to take into account the use of these

self-regulation techniques. Furthermore, the coded total number of instrumental plans and the mean specificity score of the implementation intention plans were taking into account. All predictors were dummy coded (See Table 1).

First we evaluated whether the evaluation of the self-regulation techniques, use of particular self-regulation techniques, and plan quality of implementation intentions could predict whether health goals were attained across the three groups. Next, interaction terms (predictor X behaviour) were included to investigate whether the predictors of goal attainment differed as a function of the chosen behaviour ('PA' or 'fruit and vegetables') of participants. Fruit and vegetables were taken together in one category. In case of a significant interaction effect, the estimated predictive main effect of the predictor only applies to the group that was indicated as the reference category (0). For ease of interpretation, we reported odds ratio's and confidence intervals for PA indicated as reference category and also for fruit and vegetables indicated as reference category (See Table 3 and 4). Statistical significance was set at a level of 0.05, p-values between 0.05 and 0.1 were considered borderline significant.

Results

Baseline characteristics

In the intervention condition, 225 participants started the intervention module for fruit, 84 for vegetables and 267 for PA. Table 2 presents the baseline characteristics for the sample that completed the intervention programme at baseline (T1). Descriptive percentages regarding the use and evaluation of the behaviour change methods are given in Table 1.

Logistic regression analysis revealed that younger participants (OR = 0.38; 95% CI = 0.24-0.62; $p<0.001$), men (OR = 0.63; 95% CI = 0.43-0.92; p = 0.018) and participants with high SES (OR

= 1.75; 95% CI = 1.15-2.66; p = 0.009) had a significant higher probability of responding at follow-up.

Goal attainment

For all predictors, odds ratios and confidence intervals of the logistic regression analyses are shown in table 3 and 4. In what follows, only significant and borderline significant predictors are reported.

Tailored feedback

The motivational value of the tailored feedback was a borderline significant predictor of health goal attainment at T2. There was also a borderline significant interaction-effect with behaviour (p=0.090), possibly indicating that this only applied for participants in the fruit or vegetable group. Participants in the fruit or vegetable group who perceived the personal advice about fruit or vegetables as motivating were two times more likely to attain their goal at T2 compared to participants in the fruit or vegetable group who did not perceive the personal advice as motivating(OR=2.38, 95% CI = 1.15-4.94; p <0.10).

Action planning

Borderline significance was found for *the motivational value of the action plan* for health goal attainment at T2. Participants who perceived making their action plan as motivating were more likely to attain their goal at T2 than participants who did not perceive this as motivating (OR=2.25, 95% CI = 1.08-4.69; p <0.05).

Problem solving

Selecting hindering factors and solutions was a significant predictor, after including the interaction term with behaviour (p=0.019). Participants in the fruit or vegetable group who selected hindering factors and solutions, were two times more likely to reach their goal at T2

267 compared to participants in the fruit or vegetable group who did not select hindering factors and
268 solutions.

269 *Implementation intentions*

270 No significant main effects were found for *the coded total number of instrumental plans.*
271 However, a significant interaction effect was found with behaviour ($p<0.001$). Indicating that
272 participants in the fruit or vegetable group who made more than two instrumental
273 implementation plans for fruit or vegetable intake were three times more likely to attain their
274 goals compared to participants in the fruit and vegetable group that made one or two
275 implementation plans (OR=1.73, 95% CI = 0.92-3.27; $p<0.10$). In contrast, participants in the
276 PA group who made one or two instrumental implementation plans for PA were three times
277 more likely to attain their goals compared to participants that made more than two
278 implementation plans for PA (OR=0.34, 95% CI = 0.15-0.73; $p<0.05$). Furthermore, separate
279 analysis solely in the PA group indicated that *stating goals in different PA domains* (e.g. free
280 time and active living style) was also a significant predictor for PA goal attainment. Participants
281 who stated goals in different PA domains (i.e. goals for their free time and goals for an active
282 living style (e.g. at work) and goals for active transport) were less likely to attain their PA goals
283 compared to participants that stated goals for only one PA domain (i.e. goals for their leisure
284 time only or for active transport only) (OR=8.07, 95% CI = 2.20-29.55; $p<0.05$). *The amount of*
285 *activities selected for goals in the free time* could also predict PA goal attainment. Participants
286 who chose two different physical activities (e.g. walking and swimming) were less likely to
287 attain their PA goals at T2 compares to participants who chose only one activity (OR=0.21, 95%
288 CI = 0.08-0.59; $p<0.05$). At T3, *the coded total number of instrumental plans* was a significant
289 predictor of health goal attainment, when adjusting for behaviour ($p=0.003$). Participants in the

PA group who made more than two instrumental plans for PA were less likely to succeed in their health goal than participants in the PA group who made one or two instrumental plans (OR=0.40, 95% CI = 0.16-1.03; p<0.10).

Borderline significance was found for *the mean specificity score of the implementation intention plans* for goal attainment at T2. However, the significant interaction-effect with behaviour (p=0.016) indicates that the estimated effect only counts for participants in the fruit or vegetable group. Participants in the fruit or vegetable group who made specific plans were five times more likely to attain their health goal at T2 (OR=4.59, 95% CI = 1.26-16.79; p<0.05).

Adapting plans

Stating new goals at T2 was found to be a significant predictor. However, the significant interaction-effect with behaviour indicates that the estimated effect only counts for participants in the fruit or vegetable group. Participants in the fruit and vegetable group who did not state new health goals at T2 were more likely to attain their health goal at T3 than participants who stated new goals at T2 (OR=7.54, 95% CI = 1.96-28.99; p<0.05).

Discussion

The results of this study provide further information on how the design, feasibility and applicability of health promotion interventions can be improved to promote optimal behaviour outcomes for different health behaviours. Based on the results, feasible behaviour change techniques can be identified and the content of self-regulation interventions can be improved by further including and optimizing the different behaviour change techniques that can predict goal attainment.

Our study revealed several significant predictors of health goal attainment. Goal attainment of health behaviours was positively predicted by the motivational value of the personal advice, the

motivational value of the action plan, selecting hindering factors and solutions, the specificity score of the implementation intention plans, the coded total number of instrumental plans, selecting different PA activities and making a new action plan after one week.

Our results also showed that the efficacy of particular behaviour change techniques varies as a function of type of health behaviour. Some predictors were only significant for fruit and vegetable intake, and other predictors only for PA. The estimated effect of the specificity score of the implementation intention plans, the motivational value of the personal advice, selecting hindering factors and solutions and making a new action plan after one week to attain the health goal was only applicable for participants who chose for fruit or vegetable intake and not for those who chose PA. In line with our results the meta-analysis of Bélanger-Gravel et al. (2013) revealed 'small-to-medium' effect size of implementation intentions on PA compared to 'medium-to-large' effect sizes reported by Gollwitzer and Sheeran (2006) on a variety of health-related behaviours(12, 18).

Moreover, there was one predictor (i.e. the coded total number of instrumental plans) that was positively related to goal attainment for one behaviour, and inversely related for the other health behaviour. The results for fruit intake, are in line with those of Wiedemann, Lippke and Schwarzer (2012), who found that forming a large number of plans may be more effective in changing fruit intake than forming few plans(27). However, our results also implicate that 'the more plans, the better' cannot be generalised for all health behaviours, as our study showed opposite results for PA goals. The study of Wiedemann et al. (2011) also showed that better intervention effects were associated with two rather than three PA action plans(28). Due to our small sample group, we could not investigate the optimal number of plans. Therefore, future

335 research may further focus on the optimal number of plans for different behaviours, especially
336 for PA.
337 In our study, we also conducted separate analysis for the PA group, because participants who
338 choose the PA module had also the opportunity to make plans for the different domains.
339 However, we found that participants who stated goals in different PA domains (i.e. goals for
340 their free time and goals for active transport) were less likely to attain their PA goals compared
341 to participants that stated goals for only one PA domain (i.e. goals for their free time only or
342 goals for active transport only). The amount of activities selected also negatively predicted PA
343 goal attainment. Participants who chose two different physical activities (e.g. walking and
344 swimming) were less likely to attain their PA goals at T2 compared to participants who chose
345 only one activity. This could perhaps be attributed to the fact that PA is a rather complex
346 behaviour to change (12, 29). This also shows that the feasibility of PA goals and plans may be
347 important. However, the feasibility of the action plan was not a significant predictor of PA goal
348 attainment. It may be that adults have difficulties to formulate feasible PA plans, due to the
349 complexity of incorporating PA goals(12, 29). Therefore, it would be beneficial to incorporate
350 computerized feedback that gives advice on the feasibility by comparing the current health
351 behaviour with goals (especially for PA). For example, adults who never ran before and who
352 state a plan to run every day for one hour, may better receive prompt feedback about the
353 unfeasibility of their plan, if this results in lower physical activity levels. It seems that a small
354 group was already aware that their plans were not feasible, as they indicated this in their self-
355 report. It may make no sense to pursue a such goal, and in such situations adults are probably
356 better prompted to adapt their goals. It may be a good idea to implement an evaluation of the
357 feasibility of plans by participants in eHealth interventions. Another idea is to give participants

advice to start with only one or two plans in one PA domain, and to make repeated and/or additional plans after the first goal is achieved.

Making implementation intentions of medium to high quality predicted goal attainment. The mean specificity score of the implementation intention plans could only predict goal attainment at short-term (at T2, after one week) in the fruit and vegetable group. In our study, implementation intentions were used to let adults make action plans. Bélanger-Gravel et al. (2013) stated that using implementation intentions for PA only for action planning and not for coping planning (i.e. management of barriers) can decrease the efficacy of implementation intentions(12). This may explain why the use of implementation intentions could not predict goal achievement for PA goals and after a longer period. We did let participants select difficulties/barriers/hindering factors and solutions (i.e. problem solving) but this was not applied in an implementation intention format (i.e. if-then plans) and could also only predict goal attainment in the fruit and vegetable group at short-term. By using the implementation intention format, critical cues in coping plans will be linked to the goal-directed behaviour, which creates a strong and automatic cue-response. Previous studies observed the 'if-then' format to yield better behaviour outcomes (30, 31). Thus, our results strengthen the suggestion of Bélanger-Gravel et al. (2013) to incorporate coping plans into an implementation intention format(12).

The timing and frequency of follow-up modules might be important as well. Adults in the fruit and vegetable group who already adapted their plan after one week, had less chance to achieve their goals after one month compared to those who did not adapt their plans yet. In the PA group, adapting plans after one week could not predict goal attainment. This indicates that giving people the possibility to adapt their goals after one week, is maybe too early. To our knowledge, no studies have already investigated the optimal frequency and timing of follow-up modules in

self-regulation interventions. So, it is important to further investigate this to develop an optimal follow-up system for eHealth interventions that target health behaviour change.

Only a small group sent their action plan for social support as part of 'MyPlan', and this could not predict goal attainment. This result shows that further investigation on how to include social support in eHealth interventions is warranted. Morrison et al. (2012) reported in their review study that social context and support mediates eHealth intervention outcomes(17). To increase intervention effectiveness, they suggest to provide social support by using automated dialogue, peer-to-peer–mediated communication, or information about other real users. Ziegelmann, Lippke, & Schwarzer (2006) reported more complete action plans and a longer duration of physical activities when participants were assisted by an interviewer trained in motivational interviewing(23). This suggests that additional personal support by health counsellors trained in motivational interviewing could also lead to additional effects of future planning interventions (23, 29).

There are some limitations to this study. Our results should be interpreted with caution due to the small sample. The choice options (e.g. choosing to only form plans for PA in leisure time) have led to some small sample groups, making it not possible to perform moderator analyses. Also, the high drop-out led to a low response at T3, which may have influenced the results for the impact on goal attainment at T3. Studies with larger samples are needed to confirm our results. Next, a longer trial to measure the long-term impact on goal attainment (e.g. after 6 months and 1 year) is needed. Furthermore, it is also important to note that other factors (e.g., quality of theoretical content, combination of behaviour change techniques, participants characteristics) and the combination of factors might also have important effects on intervention outcome and needs further investigation(14, 17). The impact of the behaviour change techniques on

intervention effectiveness should also be further evaluated by conducting experimental studies with different conditions that do and do not include specific behaviour change techniques(1414).

Conclusion

In conclusion, we recommend to integrate feedback on the feasibility of adults' goals (especially for PA goals) and to incorporate coping planning into a implementation intention format. We also suggest further research to investigate the optimal number of plans for different behaviours, the optimal frequency and timing of follow-up modules and ways to incorporate social support in eHealth interventions.

REFERENCES

1. WHO. Global recommendations on physical activity for health. Geneva: World Health Organisation. 2010.
2. WHO. Global Health Risks Mortality: and burden of disease attributable to selected major risks. 2009.
3. Lock K, Pomerleau J, Causer L, Altmann D, McKee M. The global burden of disease attributable to low consumption of fruit and vegetables: implications for the global strategy on diet. Bulletin of the World Health Organisation. 2005;83(2):100-8.
4. Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Med Sci Sports Exerc. 2007;39(8):1423-34.
5. WHO. Diet, Nutrition and the prevention of Chronic diseases, Report of Joint WHO/FAO Expert Consultation. 2003.
6. Gisle L, Demarest S. Gezondheidsenquête 2013. Rapport 2: Gezondheidsgedrag en leefstijl. WIV-ISP, Brussel: 2014.
7. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U. Global physical activity levels: surveillance progress, pitfalls, and prospects. The Lancet. 2012;380(9838):247-57.
8. Sheeran P, Milne S, Webb TL, Gollwitzer PM. Implementation intentions and health behaviour. In: Conner M & Norman P, editors. Predicting health behaviour. New York: Open University Press; 2005. p. 276-323.
9. Hagger MS, Lonsdale A, Koka A, Hein V, Pasi H, Lintunen T, et al. An intervention to reduce alcohol consumption in undergraduate students using implementation intentions and mental simulations: a cross-national study. Int J Behav Med. 2012;19(1):82-96.
10. Schwarzer R. Modeling Health Behavior Change: How to Predict and Modify the Adoption and Maintenance of Health Behaviors. Applied Psychology. 2008;57(1):1-29.

11. Gollwitzer P, Sheeran P. Implementation Intentions and Goal Achievement: A Meta-analyses of effects and processes. Advances in Experimental Social Psychology. 2006;38:69-119.
12. Bélanger-Gravel A, Godin G, Amireault S. A meta-analytic review of the effect of implementation intentions on physical activity. Health Psychology Review. 2013;7(1):23-54.
13. Sniehotta FF, Scholz U, Schwarzer R. Action plans and coping plans for physical exercise: A longitudinal intervention study in cardiac rehabilitation. British journal of health psychology. 2006;11(Pt 1):23-37.
14. Michie S, Abraham C, Whittington C, McAteer J. Effective Techniques in Healthy Eating and Physical Activity Interventions: A Meta-Regression. Health Psychology. 2009; 28 (6): 690–701.
15. Lara J, Evans HE, O'Brien N, Moynihan PJ, Meyer DT, Adamson AJ, Errington L, Sniehotta FF, White M, Mathers JC. Association of behaviour change techniques with effectiveness of dietary interventions among adults of retirement age: a systematic review and meta-analysis of randomised controlled trials. BMC Medicine. 2014;12:177.
16. Broekhuizen K, Kroeze W, van Poppel MN, Oenema A, Brug J. A systematic review of randomized controlled trials on the effectiveness of computer-tailored physical activity and dietary behavior promotion programs: an update. Ann Behav Med. 2012;44(2):259-86.
17. Morrison LG, Yardley L, Powell J, Michie S. What design features are used in effective e-health interventions? A review using techniques from Critical Interpretive Synthesis. Telemedicine journal and e-health : the official journal of the American Telemedicine Association. 2012;18(2):137-44.
18. Gollwitzer PM & Sheeran P. Implementation intentions and goal achievement: A meta-analysis of effects and processes. Advances in Experimental Social Psychology. 2006;38: 70–110.
19. Springvloet L, Lechner L, Oenema A. Planned development and evaluation protocol of two versions of a web-based computer-tailored nutrition education intervention aimed at adults, including cognitive and environmental feedback. BMC Public Health. 2014;14:47.
20. van Osch L, Lechner L, Reubsaet A, De Vries H. From theory to practice: An explorative study into the instrumentality and specificity of implementation intentions. Psychology & health. 2010;25(3):351-64.
21. van Genugten L: Prevention of weight gain among overweight adults: development and evaluation of a computer-tailored self-regulation intervention. PhD thesis. Erasmus University, Department of Public Health; 2011.
22. Michie S, Dormandy E, Marteau TM. Increasing screening uptake amongst those intending to be screened: the use of action plans. Patient education and counseling. 2004;55(2):218-22.
23. Ziegelmann JP, Lippke S, Schwarzer R. Adoption and maintenance of physical activity: Planning interventions in young, middle-aged, and older adults. Psychology & health. 2006;21(2):145-63.
24. Vandelanotte C, De Bourdeaudhuij I, Philippaerts R, Sjöström M, Sallis J. Reliability and Validityof a Computerized and Dutch Versionof the International Physical Activity Questionnaire (IPAQ). Journal of Physical Activity and Health. 2005; 2: 6-75.
25. VIG: Gezondheidsbevordering op het werk. Resultaten en verslag van de productevaluatie Voeding: fruittest, groententest en vochttest. [Health promotion at work. Results and report of product evaluation Nutrition: fruit and vegetable test] 2004.
26. Landis JR, Koch GG: The measurement of observer agreement for categorical data. Biometrics. 1977;33:159–174.
27. Wiedemann AU, Lippke S, Schwarzer R. Multiple plans and memory performance: results of a randomized controlled trial targeting fruit and vegetable intake. Journal of behavioral medicine. 2012;35(4):387-92.

28. Wiedemann AU, Lippke S, Reuter T, Ziegelmann JP, Schüz B. The More the Better? The Number of Plans Predicts Health Behaviour Change. Applied Psychology: Health and Well-Being. 2011;3(1):87-106.
29. De Vet E, Oenema A, Sheeran P, Brug J. Should implementation intentions interventions be implemented in obesity prevention: the impact of if-then plans on daily physical activity in Dutch adults. The international journal of behavioral nutrition and physical activity. 2009;6:11.
30. Chapman J, Armitage CJ, Norman P. Comparing implementation intention interventions in relation to young adults' intake of fruit and vegetables. Psychology & health. 2009;24(3):317-32.
31. Armitage CJ, Arden MA. A volitional help sheet to increase physical activity in people with low socioeconomic status: A randomised exploratory trial. Psychology & health. 2010;25(10):1129-45.

TABLES

Table 1

Behaviour change technique	Predictor	Question	Values (dummy coded)	n (%)
Tailored feedback (feasibility evaluation)	The motivational value of the personal advice	"I Think the personal advice is motivating"	Personal advice perceived as motivating (1) Personal advice not perceived as motivating (0)	141 (63.2) 82 (36.8)
	The awareness of own behaviour	"Did you expect the result of the personal advice in advance?"	Aware of their behaviour (1) Not aware of their behaviour (0)	129 (57.3) 96 (42.7)
	The instructive value of the personal advice	"I Think the personal advice is instructive"	Personal advice perceived as instructive (1) Personal advice not perceived as instructive (0)	142 (63.7) 81 (36.3)
Problem solving (use)	Selected barriers and hindering situations	"Select those barriers or hindering situations you want to apply or formulate it yourself"	No barriers or hindering situations (0) Selected/formulated barriers or hindering situations (1)	126 (31.3) 277 (68.7)
Action planning (feasibility evaluation)	Perceived difficulty of making an action plan	"I think it is difficult to make an action plan"	Perceived making an action plan as difficult (1) Perceived making an action plan not as difficult (0)	82 (37.3) 138 (62.7)
	The motivational value of the action plan	"The action plan motivates me to pursue my goals"	Action plan perceived as motivating (1) Action plan not perceived as motivating (0)	139(62.9) 82 (37.1)
	The feasibility of the action plan	"My action plan is feasible"	Action plan perceived as feasible (1) Action plan not perceived as feasible (0)	217 (98.2) 4 (1.8)
(use)	Selecting different domains for PA	"How do you want to improve you physical activity level?"	By being more active in my free-time (1) By choosing an active life style (0)	99 (54.1) 84 (45.9)
	Selecting different activities for PA	" Do you want to select a second activity for your free time plan?"	Yes, I want to perform a second activity (1) No, I do not want to perform a second activity (0)	84 (54.5) 70 (45.5)
Stimulating self-monitoring (use)	Monitoring behaviour	"Did you monitor your behaviour the past week?"	Did monitor behaviour (1) Did not monitor behaviour (0)	89 (39.6) 136 (60.4)
Sharing action plan for social support (use)	Sharing the action plan	"Select to share your action plan with friends and family and fill out their email address"	Sent action plan to family/friends (0) Did not sent action plan to family/friends (1)	57 (25.3) 168 (74.7)
Goal evaluation and adjustment (use)	Making a new plan at T2	Do you want to make a new plan?	Yes, I want to make a new plan (0) No, I want to keep the same plan (1)	28 (20.4) 109 (79.6)

507 **Table 2: Baseline characteristics for the total sample and the four conditions separately.**

	Total intervention group (n=452)	**Intervention Physical Activity (n=158)**	**Intervention Fruit intake (n=166)**	**Intervention Vegetable intake (n=50)**
Age (years)	30.5 ±12,5	30.5 ± 12,6	28.1 ± 10.9	33.8 ± 13.4
Gender (% male)	39,2	44.5	47.8	33.3
Education level (% high university or college)	72,1	73.6	75.8	66.6
Instrumentality n (%)				
No instrumental plan (N=6)	6 (1.7)	3 (1.9)	2 (1.4)	1 (2.3)
One instrumental plan (N=159)	159 (45.7)	57 (36.3)	60 (40.5)	42 (97.7)
Two instrumental plans (N=102)	102 (29.3)	54 (34.3)	48 (32.4)	0 (0)
Three instrumental plans (N=68)	68 (19.5)	30 (19.1)	38 (25.7)	0 (0)
Four instrumental plans (N=8)	8 (2.3)	8 (5.1)	0 (0)	0 (0)
Five instrumental plans (N=3)	3 (0.9)	3 (1.9)	0 (0)	0 (0)
Six instrumental plans (N=2)	2 (0.6)	2 (1.3)	0 (0)	0 (0)
Specificity n (%)				
Low specificity (N=28)	28 (8.0)	21 (13.0)	3 (2.0)	4 (9.5)
Medium specificity (N=219)	219 (62.2)	87 (53.7)	98 (66.2)	34 (81.0)
High specificity (N=105)	105 (29.8)	54 (33.3)	47 (31.8)	4 (9.5)

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516 **Table 3 predicting goal attainment at T2**

Predictor	Goal attainment T2 (n=274)			
	Main effect[a] Predictor OR(95%CI)	**Interaction effect** predictor X behaviour (p-value)	**Main effect**[b] Predictor OR(95%CI)	**Main effect**[c] Predictor OR(95%CI)
The motivational value of the personal advice	1.86(1.06-3.27)*	0.090	2.38(1.15,4.94)**	1,16(0.48,2.78)
The awareness of own behaviour	1.22(0.64-2.31)	0.077	1.65(0.80-3.40)	0.77(0.33-1.76)
The instructive value of the personal advice	0.89(0.47-1.70)	0.045	1.20(0.59-2.42)	0.49(0.20-1.19)
Selecting hindering factors and solutions	1.45(0.80-2.65)	0.019	2.00(1.04-3.85)**	0.89(0.43-1.86)
The coded total number of instrumental plans	0.89(0.52-1.55)	<0.001	1.73(0.92-3.27)*	0.34(0.15-0.73)**
The mean specificity score of the implementation intention plans	3.50(0.97-12.57)*	0.016	4.59(1.26-16.79)**	2.20(0.58-8.37)
The difficulty experienced when making an action plan	1.22(0.63-2.34)	0.058	1.68(0.81-3.49)	0.48(0.15-1.60)
The motivational value of the action plan	1.86(1.06-3.27)*	0.210	2.25(1.08-4.69)**	1.34(0.57-3.13)
The feasibility of the action plan	1.30(0.62-2.74)	0.516	1.06(0.40-2.81)	1.63(0.59-4.51)
Sharing the action plan	1.66(0.89-3.08)	0.394	1.97(0.94-4.11)*	1.20(0.46-3.16)

517 *[a]No interaction term included for behaviour, with fruit and vegetables as reference category (0);*
518 *[b]With included interaction term (predcitorXbehaviour), with fruit and vegetables as reference category (0);*
519 *[c] With included interaction term (predcitorXbehaviour), with physical activity as reference category (0)*
520 *** p<0.05: significant predictor; * p<0.1: borderline significant predictor*
521 *CI, confidence interval; OR, odds ratio*
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527 **Table 4 predicting goal attainment at T3**

Predictor	Goal attainment T3 (n=137)			
	Main effect[a] Predictor OR(95%CI)	**Interaction effect** predictor X behaviour (p-value)	**Main effect**[b] Predictor OR(95%CI)	**Main effect**[c] Predictor OR(95%CI)
The motivational value of the personal advice	1.24(0.55,2.78)	0.230	1.52(0.63-3.68)	1.88(0.67,5.30)
The awareness of own behaviour	1.09(0.49,2.40)	0.188	1.41(0.57,3.45)	0.70(0.26,1.93)
The instructive value of the personal advice	0.68(0.29,1.59)	0.101	0.38(0.14,1.05)	0.35(0.12,1.04)
Selecting hindering factors and solutions	0.97(0.44,2.17)	0.019	1.44(0.60,3.47)	0.486(0.18,1.29)
The coded total number of instrumental plans	0.99(0.46,2.10)	0.003	1.70(0.70,4.11)	0.40(0.16, 1.031)*
The mean specificity score of the implementation intention plans	1.91(0.41,8.95)	0.035	2.57(0.53,12,41)	1.10(0.22,5.57)
The difficulty experienced when making an action plan	0.76(0.34,1.69)	0.327	0.458(0.096,2.179)	0,41(0.09,1.78)
The motivational value of the action plan	1.05(0.46,2.36)	0.228	1.29(0.53,3.17)	0.70(0.25,1.96)
The feasibility of the action plan	0.66(0.26,1.62)	0.994	0.65(0.20,2.18)	0.66(0.20,2.18)
Sharing the action plan	1.73(0.74,4.03)	0.243	0.40(0.09,1.86)	0.94(0.26,3.36)
Monitoring between T1 and T2	1.18(0.57,2.45)	0.618	0.74(0.23,2.39)	0.96(0.32,2.84)
Making a new action plan at T2	4.10(1.33,12.64)**	0.022	7.54(1.96,28.99)**	1.35(0.34,5.36)

528 *[a]No interaction term included for behaviour, with fruit and vegetables as reference category (0);*
529 *[b]With included interaction term (predcitorXbehaviour), with fruit and vegetables as reference category (0);*
530 *[c] With included interaction term (predcitorXbehaviour), with physical activity as reference category (0)*
531 *** p<0.05: significant predictor; * p<0.1: borderline significant predictor*
532 *CI, confidence interval; OR, odds ratio*
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Figure 1(on next page)

Figure 1: Flow chart response rate

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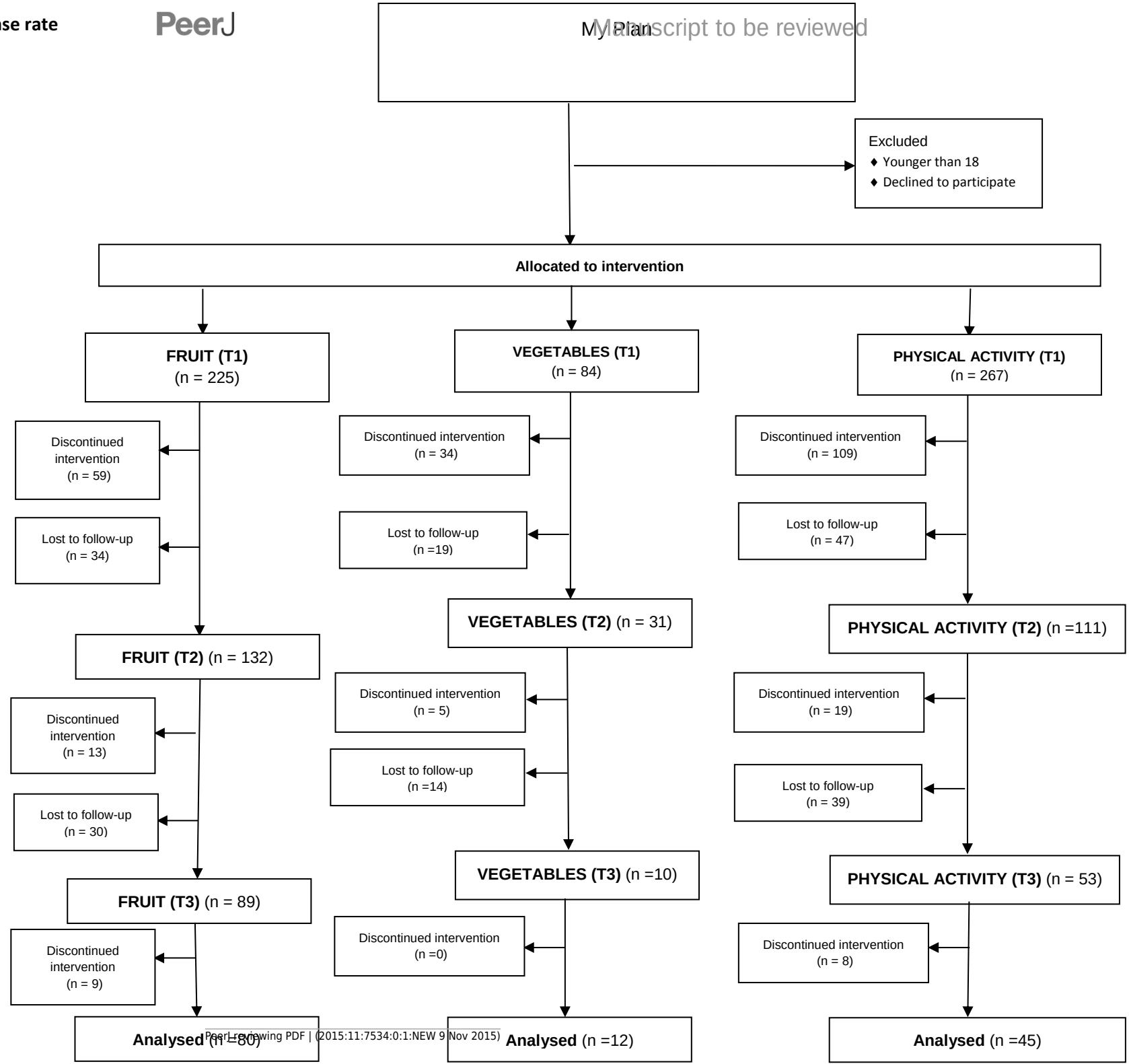

Figure 2(on next page)

Figure 2: An overview of the intervention programme

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