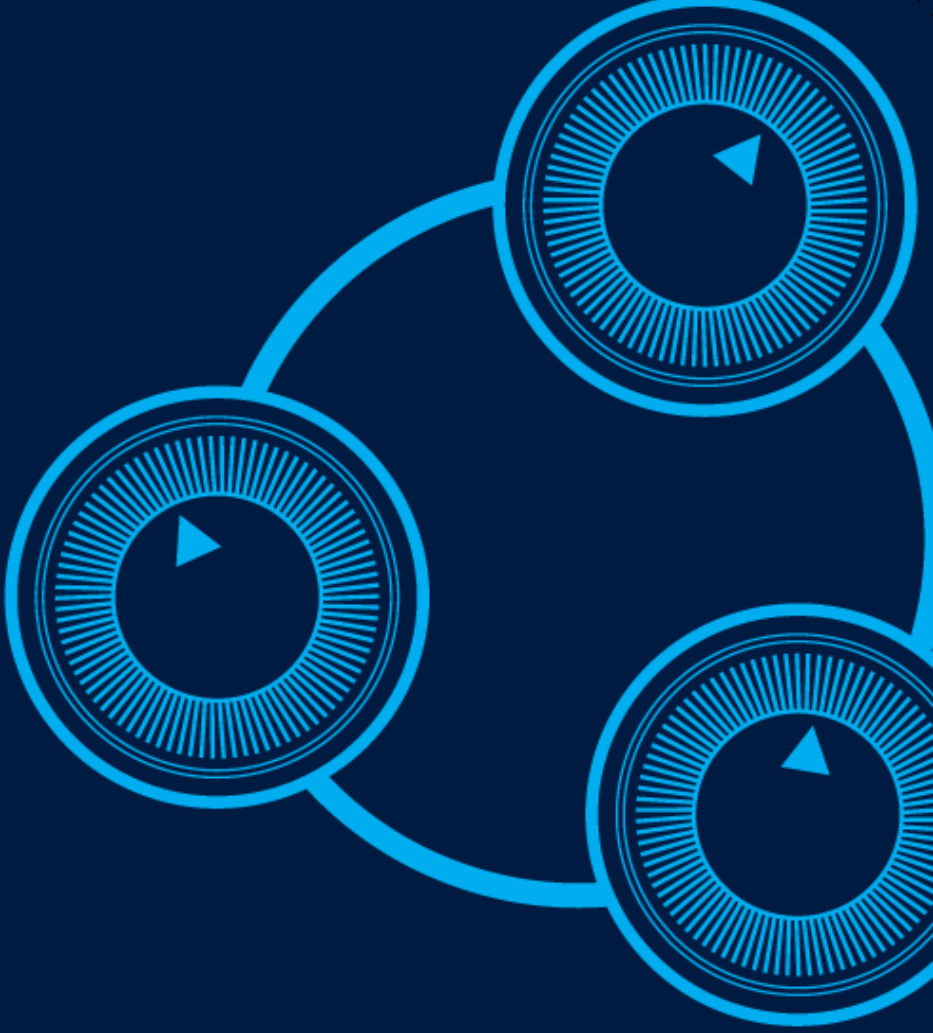

Lenneke van Genugten

Prevention of weight gain among overweight adults

development and evaluation of a computer-tailored self-regulation intervention

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Prevention of weight gain among overweight adults: development and evaluation of a computer-tailored self-regulation intervention

Preventie van gewichtstoename bij volwassenen met overgewicht: ontwikkeling en evaluatie van een advies-op-maat interventie gebaseerd op zelfregulatie

Proefschrift

Ter verkrijging van de graad van doctor aan de
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op gezag van de rector magnificus

Prof.dr. H.G. Schmidt

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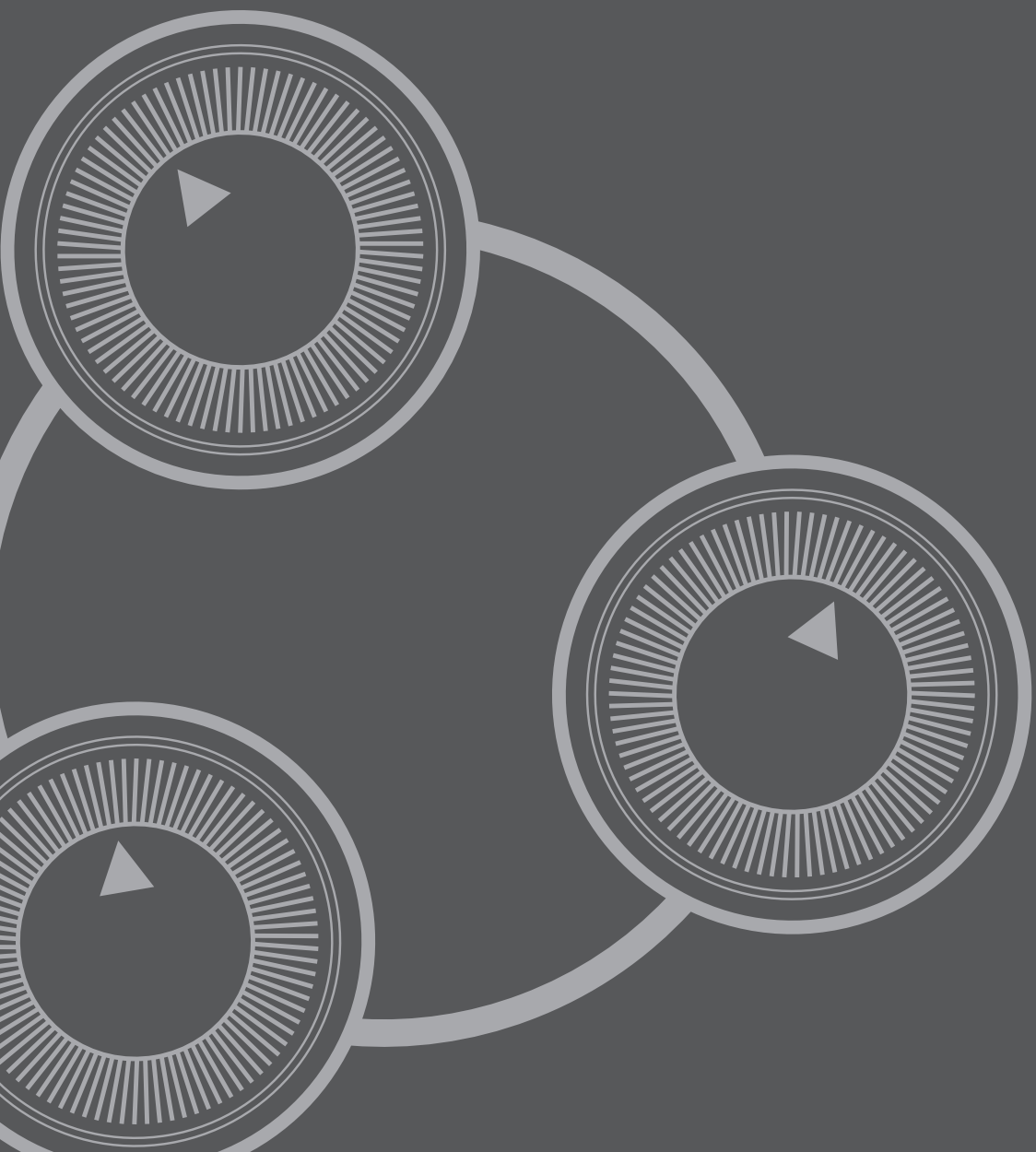
CONTENTS

Chapter 1



General introduction

BACKGROUND

The increasing prevalence of obesity is a major public health problem because of its negative effect on health. The long-term-effects of weight loss treatment for obesity are limited and therefore, prevention of obesity is very important. This might be achieved by weight gain prevention. This is especially relevant for overweight adults; they comprise a large group and are at high risk of becoming obese if they gain weight. Therefore, prevention of weight gain among this group has been postulated as an important strategy for preventing obesity.

At the start of this study there was no evidence as to whether overweight adults were motivated for weight gain prevention. The first aim of this thesis was to increase our understanding the population's acceptance of weight gain prevention and the determinants of motivation for weight gain prevention and change in energy-balance related behaviours among overweight adults.

In addition, no obesity prevention intervention that could potentially reach a large number of overweight adults existed. To be effective such an intervention should be able to reach many people in an individualised approach and support the complicated process of change in weight-related behaviours. Therefore, the second aim of this thesis was to develop and evaluate an online, computer-tailored intervention to achieve weight gain prevention among overweight adults. This introductory chapter provides background information to the studies presented in this thesis.

Obesity and health

The increasing prevalence of obesity (BMI > 30 kg/m^2) is a major public health concern around the world (Kopelman 2000). Obesity is associated with several health problems, such as a higher risk for type 2 diabetes, cardiovascular disease, some types of cancer, impairments in the locomotor system (Formiguera and Canton 2004) and mortality (Visscher and Seidell 2001). Furthermore, obesity increases the risk for depression (Roberts, Deleger et al. 2003; Stunkard, Faith et al. 2003) and it is associated with a lower quality of life (Han, Tijhuis et al. 1998; Burns, Tijhuis et al. 2001), unemployment, and disability (van den Berg, Schuring et al. 2010). Moreover, obesity significantly increases health care costs; in 1999 about 5% of the total health care costs in the Netherlands were related to being overweight (Polder, Takkern et al. 2002).

Obesity is a global problem with a high prevalence; 1.1 billion adults worldwide and over 20% of the adults in Europe are obese (Haslam and James 2005; Berghofer, Pischon et al. 2008). In the Netherlands, the prevalence of obesity among adults has increased from 9.4% in 2000 to 11.8% in 2009 (CBS 2011).

Poor long-term results of obesity treatment

Until relatively recently the focus of fighting the obesity epidemic has been on treatment of obesity. However, long-term results of treatment have been poor because patients often regain large amounts of lost weight (Jeffery, Drewnowski et al. 2000). Furthermore, as obesity rates continue to escalate, capacity to treat all these patients becomes increasingly limited. The treatment of obesity consists of weight loss which may be due to behavioural, pharmacological or surgical treatments. Behavioural treatment consists of lifestyle modification, including decreasing energy intake and increasing physical activity. Sometimes, cognitive therapy or physiotherapy are included in the treatment (Shaw, O'Rourke et al. 2005). Behavioural treatment makes it possible to lose up to 20% of the total bodyweight within six months of the start of the treatment. Typically though, about 70% of this loss is regained within two to five years (Jeffery, Drewnowski et al. 2000; Wu, Gao et al. 2009). Pharmacological treatments consist of the use of drugs, such as orlistat, during the intervention period. Pharmacological treatment does not appear to be effective in producing long-term weight loss because weight is often regained when the drugs are no longer taken (Glenny, O'Meara et al. 1997; O'Meara, Riemsma et al. 2001; Padwal, Li et al. 2003). Furthermore, use of such drugs is associated with side effects such as increased blood pressure and pulse rate (Padwal, Li et al. 2003; Ming-Fang and Cheung 2011). Surgical intervention either forces slower food intake, or decreases the stomach's capacity to hold food by approximately 90% (Glenny, O'Meara et al. 1997). Although surgical interventions such as a gastric bypass are often followed by greater weight loss, they are also often associated with complications due to surgery and changes in the gut's absorption processes (Buchwald, Avidor et al. 2004; Picot, Jones et al. 2009). Furthermore, a surgical intervention is usually only considered for people with morbid obesity and it is quite expensive (Glenny, O'Meara et al. 1997). Drop-out rates from weight-loss studies are often high; a drop-out rate of 30 to 40% is not uncommon (Douketis, Macie et al. 2005). In sum, the current options for obesity treatment have only a limited capacity to be effective in the long-term.

PREVENTION OF OBESITY

Given the poor results of obesity treatments, prevention of obesity has been postulated as an important strategy for fighting the obesity epidemic (Hill, Wyatt et al. 2003; Lombard, Deeks et al. 2009).

Obesity is the result of persistent weight gain; thus to prevent obesity, weight gain must be prevented. Weight gain is caused by an imbalance between energy intake (through dietary intake) and energy expenditure (mainly through physical activity) (Hill and Melanson 1999). Thus, in order to prevent weight gain, it is necessary to create a balance between energy intake and energy expenditure. According to Hill, most of the annual weight gain

(approximately 0.5 -1 kg) is caused by an inequality of 100 kcal daily in the energy balance. In reverse, it is expected that weight gain can be prevented or reduced by decreasing energy intake or increasing energy expenditure by about 100 kcal a day (Hill, Wyatt et al. 2003), (Winett, Tate et al. 2005). Weight loss interventions aim at large imbalances between energy intake and expenditure and thus large behavioural changes (e.g. drastic dieting). Weight gain prevention, however, only requires small changes of about 100 kcal a day and may, therefore, be relatively easy to implement in everyday life. Therefore, weight gain prevention (WGP) may result in better long-term outcomes than weight loss interventions. This process of preventing weight gain or causing modest weight loss is also referred to as weight management.

Behaviours to target to prevent weight gain

In order to prevent weight gain, it is essential to identify important and changeable behaviours that are related to weight gain. Although all dietary intake and physical activity (PA) influence the energy balance, there are dietary behaviours that are specifically associated with excessive energy intake and thus with weight gain (Swinburn, Caterson et al. 2004). The consumption of energy-dense foods (high in fat and/or sugar), sugar sweetened drinks and juices, alcoholic drinks as well as consuming large portions of food have all been associated with an increased risk for obesity (Swinburn, Caterson et al. 2004). To reduce energy intake by 100 kcal/ day, a small change in one of these behaviours would, for example, be drinking 1 less can of soft drink or replacing a high-fat sandwich filling with a fat-free one, on 4 sandwiches. A high intake of dietary fibre is a protective factor against weight gain (Swinburn, Caterson et al. 2004) and high-fibre products may be suitable replacements for energy-dense products.

Energy expenditure can be increased by increasing PA. In general, three categories of improving expenditure have been identified: active transportation, moderately intense leisure activity and vigorous physical activity (Swinburn, Caterson et al. 2004). Active transportation includes all activities during transportation, including cycling and walking (parts of the route). Leisure time moderate intensity physical activity includes activities such as walking, gardening and cleaning. Vigorous intensity physical activities are mainly sports activities. Vigorous intensity activities substantially increase energy expenditure, but moderately intense activity is also sufficient for WGP. For most types of PA, about 20 extra minutes of moderately intense activity per day is equivalent to an energy expenditure of about 100 kcal, and it can also be done in smaller blocks (e.g. 2 blocks of 10 minutes). Furthermore, sedentary behaviours such as television watching are associated with weight gain because the metabolic rate is low during these activities (Hu, Li et al. 2003).

In order to prevent weight gain, one should make and maintain one or more of the relevant changes in the above mentioned behaviours. When the change(s) is maintained for a long period of time without compensation in other behaviours, it will result in a change

in the energy balance, and weight gain will be prevented. If not, additional behavioural change is necessary.

Target groups for obesity prevention

Prevention of obesity is important among people with a healthy weight since weight gain is observed among the whole adult population (Visscher, Kromhout et al. 2002). However, overweight adults (BMI 25-30 kg/m^2) are an especially important group to target since they are the most at risk of becoming obese. Second, they comprise a large group; in the US, more than 30% of the adult population is overweight, and another 40% are obese (Ogden, Carroll et al. 2006). More than a quarter of the Dutch population is overweight, 30% of adult females and 41% of adult men (Bakel and Zantinge 2010). Another reason to target overweight adults is because although being overweight is associated with some health risks, these risks are significantly higher if a person becomes obese (Must, Spadano et al. 1999; Field, Coakley et al. 2001; Bianchini, Kaaks et al. 2002). For all of these reasons prevention of obesity is very important for this group. Therefore, prevention efforts should be aimed at preventing weight gain in overweight adults.

ACHIEVEMENT OF WEIGHT GAIN PREVENTION

Prevention of weight gain is not a one-time action; it requires goal setting, continuous action, evaluation and adaptation to achieve weight maintenance. This process is also referred to as self-regulation. Self-regulation is a goal-directed process aimed at the realization and continuation of personals goals (Maes and Karoly 2005), and it is important in weight management (Butryn, Phelan et al. 2007).

Self-regulation of health behaviour

Self-regulation theory originates from action control theory (Austin and Vancouver 1996) and is largely influenced by the Test-Operate-Test-Exit (TOTE) cycle, which was first described by Miller et al. in 1960 (Miller, Galanter et al. 1960). In this cycle, a stimulus input is compared to a standard (e.g. a goal), action takes place to bring the input in line with the standard, and then it is tested (compared) again. The loop is exited when the goal is achieved. Later, Carver introduced the 'negative feedback loop' (Carver and Scheier 1982), which describes a closed loop of behaviour control with continuous comparison between the goal and the behaviour performed to achieve the goal. Due to this ongoing testing, self-regulation may be especially useful for outcomes or goals that need to be achieved and maintained for a long time and that need adaptation when circumstances change. An example of such a goal would be the maintenance of a healthy glucose level. Self-regulation has often been applied in interventions related to health related behaviour. For example, it has been helpful in the

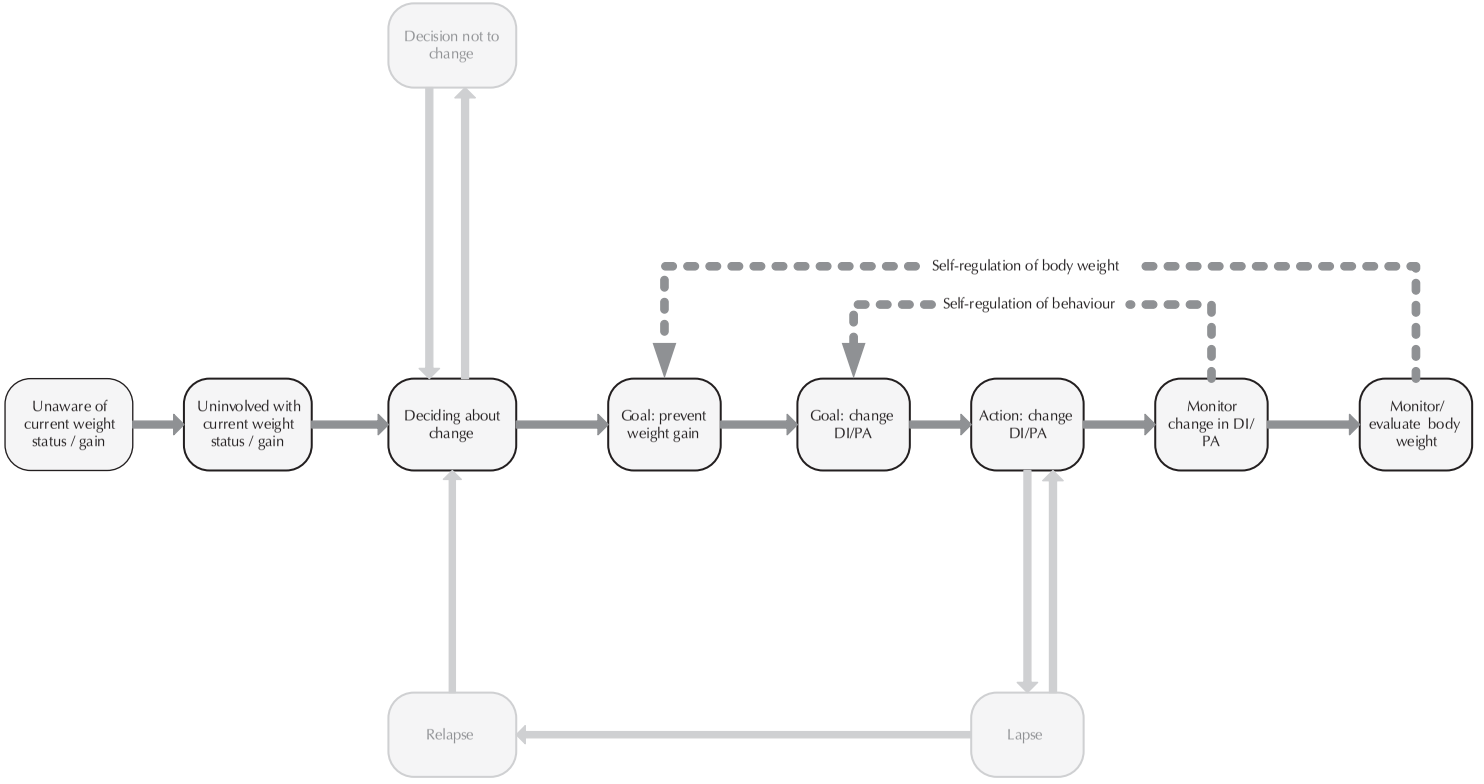
management of chronic illnesses (Lorig, Sobel et al. 1999; Warsi, Wang et al. 2004), such as asthma (Powell and Gibson 2003) and diabetes (Norris, Engelgau et al. 2001). Recently, the principles of self-regulation have also been applied to the promotion of healthy behaviours such as dietary intake in to cholesterol levels (Bandura 2005). Since weight gain prevention requires long-term control of body weight and behaviour, as well as adaptation during changing circumstances, self-regulation may be a useful solution (Lowe 2003; Butryn, Phelan et al. 2007). Moreover, previous studies have shown that face-to-face self-regulation training may enhance energy-balance related behaviour (Israel, Guile et al. 1994; Schnoll and Zimmerman 2001).

A conceptual model for self-regulation of body weight and weight-related behaviours

In weight gain prevention, two feedback loops (Carver and Scheier 2001) can be distinguished: one for the regulation of weight and one for the regulation of weight-related behaviour. Our aim is to describe a conceptual model that distinguishes the relevant steps (Bagozzi and Edwards 1998; Bagozzi, Bergami et al. 2003) of body weight regulation (see Figure 1).

For the regulation of weight, in this case to achieve weight maintenance, one must have a weight goal, (Maes and Karoly 2005), such as 'I want my weight to stay the same'. The means to achieve weight maintenance are the changes in energy intake and/or energy expenditure. For the regulation of behaviour (change), stating a goal for a small change is important (Conner and Norman 1996; Bagozzi and Edwards 1998). For example, stating 'I'll cycle to work every day for 20 minutes'. This should be followed by planning and active goal pursuit, that is, actual change of behaviour (Bagozzi, Dholakia et al. 2003), followed by monitoring and evaluation. Monitoring and evaluation are important in the regulation process in order to determine whether the change was successful (Boutelle and Kirschenbaum 1998). Monitoring refers to keeping track of the change process. In the evaluation phase, one compares the output of the monitoring phase with the previously set goal to determine whether the goal was achieved (Maes and Karoly 2005). If the goal was not achieved, one can choose to adapt the behavioural goal or the action, and then go through the steps again until behaviour change is successfully maintained. If the behaviour change is completely performed (and continued), it is likely to affect the weight-related goal. Monitoring (i.e. regular weighing) and evaluation of weight shows whether the weight-related goal was met (Vanwormer, French et al. 2008). When weight gain is observed, one needs to adapt the behaviour goal ('means') in order to effectively prevent weight gain. When the goal is achieved (e.g. weight gain prevention) one can maintain the current behaviour change. These loops of body weight and behaviour regulation should continue to take place over time, since the energy balance and thus weight are likely to change over time (Kremers, Visscher et al. 2005; Butryn, Phelan et al. 2007).

Figure 1. Conceptual model of body weight self-regulation: behavioural steps.



The behavioural steps are displayed in boxes and arrows represent the direction of influence. The black arrows indicate the influence of the main determinants on the transitions between steps. The dotted lines show the evaluating process in self-regulation, where (behaviour change) outcomes are compared to the goal. The lightest grey lines refer to a negative outcome of the decision process and the relapse process (both not described in this chapter).

Existing obesity prevention interventions

Currently, there are some effective interventions that focus on the prevention of weight gain (e.g. (Hunter, Peterson et al. 2008; van Wier, Arieëns et al. 2009)) and, in general, the results are small but promising (Lemmens, Oenema et al. 2008; Kremers, Reubsaet et al. 2009; Lombard, Deeks et al. 2009). There are some Dutch programs that effectively prevent weight gain (van Wier, Arieëns et al. 2009; Kwak, Kremers et al. 2010) but these are aimed at emplyees. Other successful interventions are aimed at weight gain prevention among the (non-overweight) population (Winett, Tate et al. 2005; Levine, Klem et al. 2007). Our aim, however, was to develop an intervention program that uses a self-regulation approach to prevent weight gain and that reaches many overweight people from the general adult population.

Online computer tailoring

An intervention aimed at the prevention of weight gain using self-regulation must be able to reach the large group of overweight adults in the general population. Furthermore, it has to take the large differences between individuals' behaviours, preferences and capabilities into account. Therefore, an individualized intervention approach is needed to successfully modify weight-related behaviours (Kreuter, Oswald et al. 2000). This can be done with tailored interventions. Tailored materials that are intended to help one person specifically are adapted to fit with the characteristics that are unique to that person. These materials are related to the outcome of interest, have been derived from an individual assessment (Kreuter, Stretcher et al. 1999), and are based on computerized algorithms. The computerized system makes it possible to reach many people at relative low costs. Thus, it allows for an individualized approach for many people and may therefore be a good method to achieve weight gain prevention.

Since the intervention needs to reach a large population of overweight adults, the internet would be a suitable medium to deliver the tailored materials. The internet is often used to obtain information about health (Leung 2008; Tu and Cohen 2008) and internet-delivered interventions have been effectively used to improve people's nutrition, physical activity and weight management (Kroeze, Werkman et al. 2006; Noar, Benac et al. 2007; Norman, Zabinski et al. 2007; Webb, Joseph et al. 2010). In 2010, more than 85% of the Dutch population had access to the internet (Stats 2011). Therefore, internet-delivered programs have the potential to reach a large population at a relatively low cost. Furthermore, online interventions also allow the delivery of individualized advice and feedback (Kreuter, Farrell et al. 2000; Oenema, Brug et al. 2008).

Environmental influences

It has been argued that the current obesity epidemic is the result of an environment that promotes the intake of high-energy products (e.g. the easy availability of fast food) and

that discourages physical activity (e.g. the television remote control) (French, Story et al. 2001; Papas, Alberg et al. 2007). Self-regulation theory describes regulation as an individual response to an environmental change. Consequently, self-regulation interventions do not influence the environment directly, but aim to provide strategies which the individual can use to cope with environmental influences and change. The aim of this study was to evaluate the effectiveness of an online, individualised approach that can reach many people in their home setting. As such, environmental changes are not a part of this online intervention, but self-regulation theory might provide the participant with strategies to respond to their (changing) environment.

Motivation for WGP

Researchers have proposed that the prevention of weight gain is in important strategy for fighting the obesity epidemic. However, in order for an intervention to be effective, the intended target group needs to accept and adopt this strategy as well. Furthermore, to be able to change behaviour, one has to know all relevant determinants (Bartholomew, Parcel et al. 2011). At the start of the project, information on the acceptability of prevention of weight gain among overweight adults was scarce and not much was known about the determinants of weight gain prevention. A previous study among 979 non-obese Dutch adults showed that 85% of the respondents intended to prevent weight gain, indicating high acceptability among the general population, and that this intention was positively correlated with BMI (Wammes, Kremers et al. 2005). However, studies among obese people have shown that they often strive for large weight loss (Blackburn 1995), such as losing 30% or more of their bodyweight and attempting to be slim (Parham 1999; Linde, Jeffery et al. 2004). It remains unclear whether overweight adults are motivated to prevent weight gain. It is also unclear which factors determine the motivation for weight gain prevention, and whether motivation for weight gain prevention is associated with the intention for changes in weight-related behaviours. Therefore, the first aim of this thesis was to explore the acceptance of and motivation for prevention of weight gain among overweight adults.

DEVELOPMENT OF AN ONLINE INTERVENTION THAT AIMS TO PREVENT WEIGHT GAIN

There is a lack of self-regulation interventions that focus on prevention of weight gain among overweight adults and that integrate an individualised approach with a wide reach. Thus, the second aim of this study was to develop such an intervention. Interventions are more likely to be effective when based on theory and evidence (Albarracin, Gillette et al. 2005; Webb, Joseph et al. 2010; Bartholomew, Parcel et al. 2011) and a planned development may help to achieve this. Therefore, the development of the intervention was guided by the

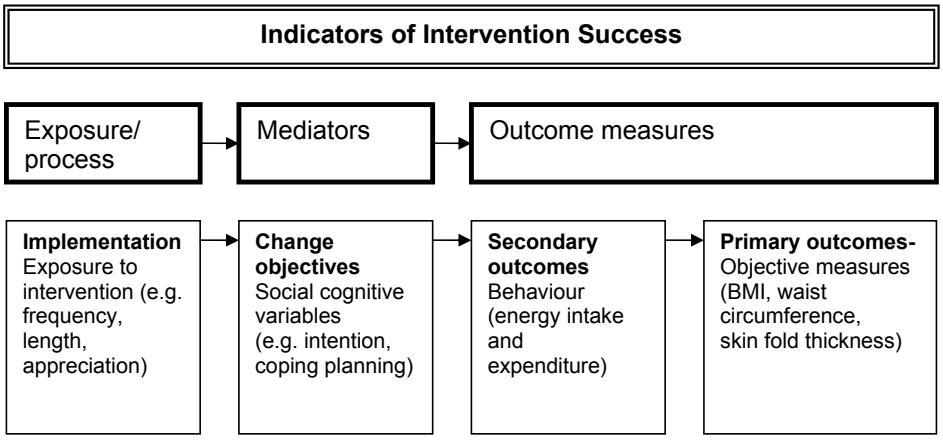
Intervention Mapping (IM) protocol to ensure that the intervention was grounded in theory and evidence, thereby maximising the likelihood of its effectiveness (Bartholomew, Parcel et al. 2006).

In order to support self-regulation of behaviour and weight, the intervention should support the steps of self-regulation: goal setting, action and evaluation. First, people need to be motivated to prevent weight gain. This can be achieved by making them aware of their future risk of weight gain and comparing the pros and cons of weight gain and weight gain prevention. Second, they need to choose a relevant behaviour change. Feedback on current behaviour (dietary intake and physical activity) may help to identify potential relevant changes. In order to make evaluation of the change possible, a clear goal must be stated. Planning the actual behaviour change may support goal-directed action. Then, the intervention should support the monitoring and evaluation of behaviour and weight change by providing feedback on behaviour and weight. In order to deliver these components at the right time, several instances of contact are necessary to teach the participant the steps of self-regulation.

Evaluating intervention effects

In order to draw conclusions about the effectiveness of the intervention, an evaluation study with a robust design is needed. Therefore, a randomized control trial was conducted. In such a design, the results of the new (experimental) intervention are usually compared to the results of receiving no care (natural development in the population) or the usual care. In this study, we compare the effects of the new, tailored intervention with the effects of generic information about weight management that is already available online (usual care). This comparison makes it possible to study the additional effects of tailored information and self-regulation components.

Figure 2. Indicators of intervention success: process measures and study outcomes.



The intervention is evaluated based on its effects on the relevant outcome measures, that is, the intervention goals and changes in the relevant behaviours (Bartholomew, Parcel et al. 2011).In this study, the main intervention goal is to prevent weight gain, and the relevant energy balance related behaviours are increasing physical activity or decreasing dietary intake. It is hypothesized that changes in energy-balance related behaviour are more favourable in the tailored intervention group than in the control group. Our hypothesis is that weight gain will be prevented among those who used the tailored intervention, but that the average annual weight gain will be observed in the control group.

Process evaluation

Previous studies haven shown that the use of online interventions is often low (Verheijden, Jans et al. 2007; Brouwer, Oenema et al. 2010; Robroek, Brouwer et al. 2010), which negatively influences their potential effectiveness (Eysenbach 2005). Furthermore, users tend to show more favourable behaviours than non-users (Dutta-Bergman 2004; Brouwer, Oenema et al. 2010), but these results are mixed (Dutta-Bergman 2004; Verheijden, Jans et al. 2007; Brouwer, Oenema et al. 2010; Robroek, Brouwer et al. 2010). Thus, it is important to think about how to maximise the participants' use of the intervention during the development phase. In order to maximize the use of our intervention, existing evidence on the use of interventions was taken into account during the development of our intervention (e.g. (Brouwer, Oenema et al. 2008)). Furthermore, focus group interviews were held with the target group and the intervention was adapted after it was pre-tested by 50 overweight adults.

When evaluating an intervention, it is important to know who used the intervention and whether the actual high-risk population was reached. For that reason, the inclusion of a process evaluation in the evaluation study is helpful (Bartholomew, Parcel et al. 2011). According to McGuire (McGuire 1969), information will only lead to the desired behaviour changes if it receives sufficient attention and it is appropriately 'processed' by the receiver. The Elaboration Likelihood Model suggests that people are more likely to process information if they perceive it as being personally relevant (Petty and Cacioppo 1986). Furthermore, participants also have to attend to the message, like the message to the extent that they become interested, comprehend the message, and finally translate the message into behaviour. Therefore, the use, appreciation, perceived personal relevance and novelty of the information are also assessed in the process evaluation.

AIMS AND OUTLINE OF THIS THESIS

It can be concluded that prevention of obesity is important, especially among those who are overweight because they are the most at risk of becoming obese. Prevention of weight gain has been postulated as a suitable means of preventing obesity but it was unknown

whether the target group was willing to strive for this as well. Therefore, the first aim of this thesis was to study the acceptance of WGP and the determinants of motivation for weight gain prevention and change in energy-balance related behaviours among overweight adults.

Weight gain prevention among a large group of overweight adults may be achieved using an online computer-tailored self-regulation intervention because online interventions are easily accessible for many people and a tailored intervention allows for individualisation of the intervention content. Particularly, it makes it possible to apply a tailored self-regulation approach, which may be helpful for maintaining changes in dietary intake and physical activity and preventing long-term weight gain. However, no such intervention existed. Therefore, the second aim of this study was to develop and evaluate an online, computer-tailored intervention to prevent weight gain among overweight adults.

The two main questions addressed in this thesis are:

1. Are overweight adults motivated for weight gain prevention and is this motivation an important determinant for subsequent dietary and physical activity behaviour changes?
2. Is an online, computer-tailored self-regulation intervention effective in prevention of weight gain and promotion of weight-related behaviour change among overweight adults, compared to online generic weight maintenance information?

The current thesis describes a series of studies that attempt to answer the main research questions. **Chapter 2** describes the results of focus group interviews regarding the acceptance of weight gain prevention that were held with overweight adults. **Chapter 3** describes a cross-sectional study that explores the target groups' motivation for weight gain prevention, the determinants of their motivation, and the importance of their motivation for behaviour change. The structured development of the intervention (following the Intervention Mapping approach) is described in **chapter 4**. In order to answer research question 2, the effects of the intervention were evaluated in a randomized controlled trial**. Chapter 5** describes these effects on the participants' body composition, dietary intake and physical activity. Furthermore, the use of the intervention, the characteristics of the users and the relation between use and effectiveness was studied in more detail and these findings are discussed in **chapter 6**.

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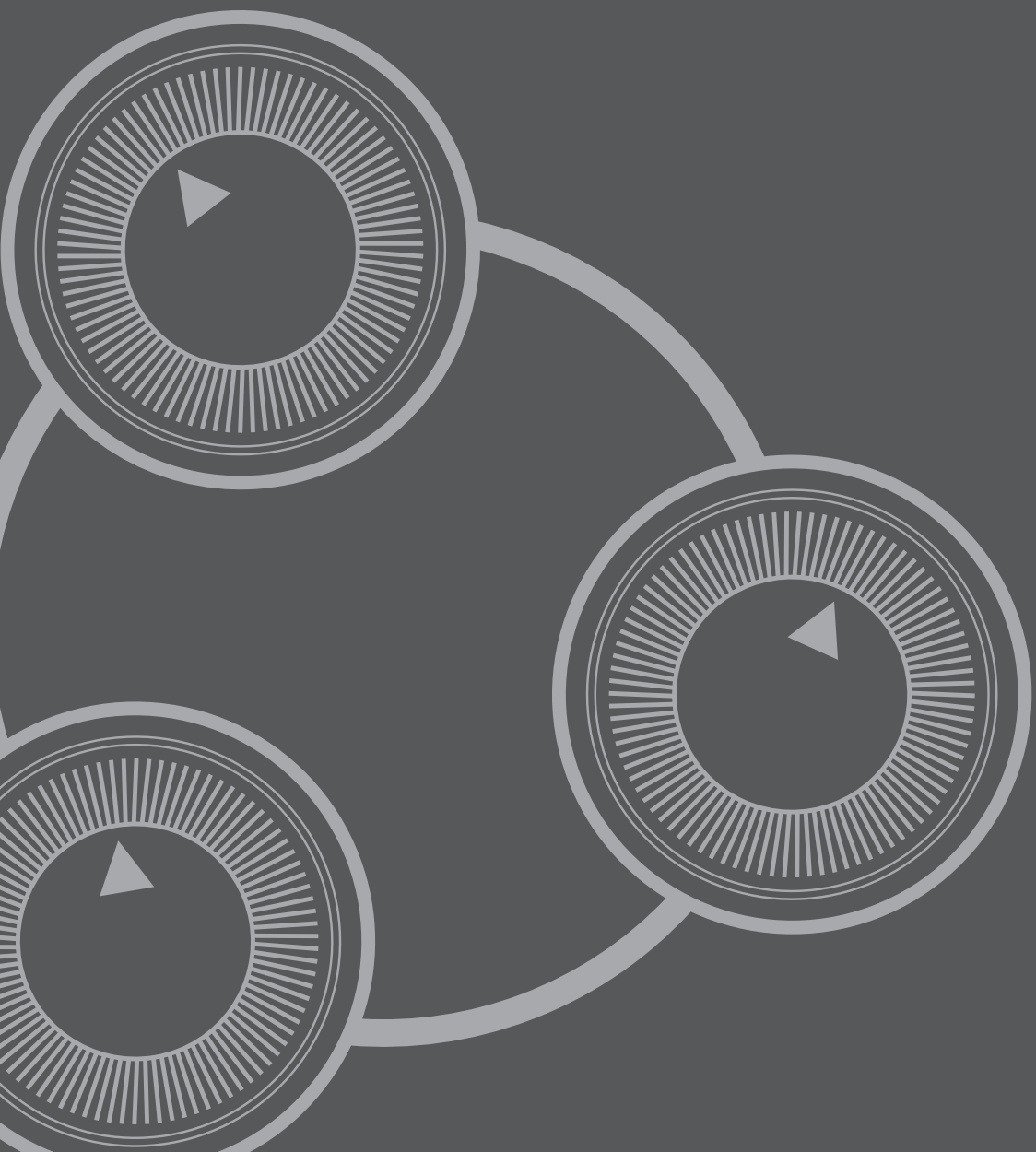
Chapter 2



Acceptance of weight gain prevention among overweight women

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Submitted

ABSTRACT

Purpose:

To examine whether overweight adults consider weight gain prevention (WGP) acceptable and what their reasons for (non-)acceptance are. WGP has been suggested as a promising approach to prevent obesity, however, it is unclear if WGP is an acceptable goal for overweight adults.

Method:

Four structured focus group interviews were conducted with overweight (BMI=25-30 kg/m^2) women (n=19), aged 28-62 years, from the general Dutch population. A structured interview questionnaire was used, and questions were related to ideas and opinions towards WGP. Content analysis was performed to detect common themes and key points.

Findings:

About half of the participants did not accept WGP as a goal. Reasons for non-acceptance were that they would first like to lose a considerable amount of weight, and that they believe that weight regulation was not under their control. Many were unaware of what is needed for WGP and suggested unrealistic strategies, such as having to participate in sports every day. Women who were positive towards WGP were tired of weight-cycling and preferred a stable weight. Only two women were currently involved in WGP. These women emphasised that lifestyle changes should fit their daily routine and should not be too difficult to maintain.

Value:

This is one of the first studies to describe acceptance of WGP among an important target group: overweight adults. In interventions to promote WGP among overweight adults, it may be important to focus on acceptance of WGP first, by improving knowledge, awareness and skills with respect to the strategies required for WGP.

INTRODUCTION

Weight gain prevention (WGP) among overweight people (including weight maintenance and modest weight loss), is considered a promising approach in obesity prevention (Hill, Wyatt et al. 2003; Lombard, Deeks et al. 2009). Prevention is necessary, since long-term effects of obesity treatment are disappointing (Jeffery, Drewnowski et al. 2000; Aronne, Wadden et al. 2009).

Weight gain is the result of a long term energy imbalance, where energy intake exceeds energy expenditure. It has been calculated that small changes of about 100 kcal in dietary intake and/or physical activity would be sufficient to restore energy balance and to prevent an annual weight gain of 1 kg (Hill, Wyatt et al. 2003). Examples of such changes are cycling for 20 minutes extra every day or replace one can of (sweetened) soda with water. Because such small changes should be relatively easy to implement in everyday life, WGP may result in better long-term outcomes than weight loss interventions. WGP may be beneficial in Western countries where about 50% of the population is considered overweight or obese. In the Netherlands, 30% of adult females and 41% of adult men were overweight (BMI 25-30 kg/m2) in 2009 (Bakel and Zantinge 2010).

For WGP interventions to be effective, the intended target group needs to accept and adopt the concept of WGP. Currently, information on the acceptability of WGP among overweight adults is scarce. One of the few studies addressing the issue of WGP among overweight women found that weight management is not considered easy (Welch, Hunter et al. 2009). A study among 979 Dutch non-obese adults showed that 85% of the respondents intended to prevent weight gain, indicating high acceptability among the general population (Wammes, Kremers et al. 2005). This study furthermore showed that intention for WGP was positively correlated with BMI. However, the weight loss literature suggests that obese people often strive for unrealistically high weight loss goals (Blackburn 1995), such as losing 30% or more of their body weight and attempting to be slim (Parham 1999; Linde, Jeffery et al. 2004).

Thus, findings on this topic are mixed and there is a lack of knowledge about acceptance of WGP among adults being overweight, indicating a need to gain more insight into reasons for acceptance and non-acceptance of WGP. This study used focus group interviews to examine WGP acceptance among overweight women, and to explore the reasons for acceptance and non-acceptance. Focus group interviews promote interaction between participants and are a suitable method to generate ideas and opinions on new or unexplored topics, and are therefore a useful method to study acceptance of a new health goal.

METHODS

Four focus group interviews (FGI) were conducted. The Medical Ethics Committee of the Erasmus Medical Centre in Rotterdam provided a declaration of no objection for the study protocol.

Participants

The target group were overweight women (BMI 25-30 kg/m^2, although a small lower/higher margin was accepted), aged 25-65 years living in Rotterdam, the Netherlands. The aim was to include a mixed group of women in terms of age and level of education. Participants were recruited via advertisements in local news papers and via the newsletter of the Erasmus Medical Center, through which we could potentially reach a large population. Exclusion criteria were insufficient command of the Dutch language and a self-reported history of eating disorders. After agreement to participate, an invitation letter and a date for the focus group interview was sent. Of the 27 women who initially agreed to participate 19 women actually participated. Reasons were for non participation were time constraints and illness. The women who participated were aged 28-62 (mean 48, SD 11.4) years, had a self-reported BMI of 24.5-30.9 (mean 27.4, SD 1.77) and had a Western ethnic background. All women had attempted to loose weight at least once in the past five years, and fourteen had attempted to loose weight in the past six months. Four women had completed higher secondary education, eight completed lower vocational training and seven completed higher vocational education or university. Five of the women were not employed; others were employed as for example secretary, nurse, etc. The interview groups consisted of 2-6 participants.

Procedure

The focus group interviews were organized following the guidelines described by Morgan (Morgan 1996): e.g. using an open interview guide consisting of introductory and key questions and probes beforehand. During each interview two researchers, a moderator (LVG) and an assistant were present. After explaining the study goal and procedure, and assuring confidentiality of the information in the interviews, the respondents were asked to sign a consent form and fill-out a short pre-interview questionnaire in which information about level of education, height, weight and diet history were assessed. The interview was then conducted according to the interview guide. First, the moderator introduced WGP as 'the goal of preventing weight gain or small weight loss, by making small changes in your behaviour'. Than, the main topics were discussed: i) what participants thought about weight maintenance or about losing only a small amount of weight, and ii) what actions they thought are needed to achieve weight maintenance. The key questions were paired with question probes to encourage clarification, and to facilitate deeper and more detailed

discussion of the topic. The focus group interviews addressed more topics than WGP only, but these are not reported here. Each interview lasted about 90 (range 70-100) minutes. On completion of the interview, all participants received a €20 gift voucher.

Data analysis

Interview transcripts were systematically analysed for content, using the Nvivo software (QSR-International 2007). After content analysis, data were assigned codes, and code-specific reports were generated to detect common themes and key points. These themes were organised around the main questions (e.g. acceptance of WGP yes/no, reasons related to health, proposed changes in DI, disliked changes in PA), but any additional information emerging was also coded. Content analysis was performed independently by 1 researcher (LVG), and then checked by another researcher (AO).

RESULTS

There was no overall agreement between the participants on the acceptance of WGP. About half of the women supported the idea of WGP as a goal, the other half did not accept it. The opinions and arguments of the acceptors and non-acceptors are described below.

Acceptors of WGP

Nine of the participants (48%, in four different groups) expressed a positive attitude towards WGP. Many had tried a variety of dietary strategies (e.g. WeightWatchers) and had a history of losing and regaining weight (weight cycling). Although some still preferred having a lower weight, they realized that they now wanted to avoid the risk of weight gain. For example this woman (61 years), who had a long history of dieting.

'First of all, I think it's very important that it can help me to stop the weight cycling.' (Group B, age 61 years)

Acceptors also agreed that it is better to prevent weight gain than having to lose it after weight gain. They valued the idea of long-term prevention of weight gain because they have gained weight for several years. Like, the 49-year old woman who had recently experienced weight gain.

'Yes, keeping this weight is the most important, so that it doesn't change for several years' (Group C, age 49 years)

Although acceptors were willing to prevent weight gain, they had insufficient knowledge about suitable strategies for WGP, i.e. they had unrealistic and/or extreme ideas about what would be required for prevention of weight gain. They often said things such as: 'not eating any sugar or carbohydrates', 'drinking 2 liters of water every day' and 'using the home trainer daily for at least one hour'.

Current weight-gain-preventers

Two of the acceptors were already active in preventing weight gain. They were aware of their overweight, had similar experiences with dieting as the others, but have been able to maintain a constant body weight for some time and had learned to be satisfied with their weight, even if it was higher than they would want it to be. Like this woman:

'I know I weigh too much, but it's stable. I've had this weight for years (…..) I have to accept it, or make a big change. But I feel OK like this. My weight is good'. (Group D, age 35 years)

They were able to prevent weight gain by using strategies such as monitoring their weight and taking extra action when weight gain was observed. For example this woman, who is very aware of the risk of weight gain over time:

'When my weight is higher, I start paying attention. Also, I think that even though I've had the same weight for 15 years, you have to put more effort into keeping your weight when you get older. That I have to… exercise more or eat less.' (Group C, age 60 years)

Other strategies included adopting a physically active lifestyle (e.g. cycling daily) and being aware of opportunities to do small bits of physical activity throughout the day. The preventers had a dietary pattern that is easy to combine with the pattern of their family, e.g. eating low-fat cheese, skipping dessert, and decreasing intake of sugar, sweetened drinks and snacks. They stressed the importance of selecting lifestyle changes that can be maintained and do not feel like 'punishment'. This is illustrated by the following:

'And if I'm dieting I don't deny myself any crazy things (food) because then I can't maintain it (the change).' (Group D, age 35 years)

'Yes and you should be aware that it doesn't feel like punishment' (Group D, age 50 years)

Non-acceptors

Ten of the 19 women did not accept the idea of WGP. Eight of the non-acceptors rejected WGP because they were not satisfied with their current weight. Their main goal was to lose a significant amount of weight on the short term. Some had a realistic weight goal, but

others had an unrealistic ideal weight, and would like to lose for example up to 20 kg of body weight.

'I should weigh 65 kg' (current weight: 84 kg) (Group C, age 49 years)

Various reasons for the desired weight loss included: a desire to return to 'what they have always weighed', having the weight that 'fits their length', or improving their health or fitness. Non-acceptors only wanted to prevent weight gain after they have lost a considerable amount of weight. Although they have experienced weight regain, quick weight loss remains their primary goal; for example:

'But what I want, and I think most people want, is that first of all I want to return to a healthy weight. (…) First - I really have to lose that weight (at least 8 kg)*, and preferably as quickly as possible'.* (Group B, age 28 years)

Furthermore they felt that, at this moment, it is too late for them to prevent weight gain. Some said they would have liked prevention of weight gain in the past, when they weighed less.

A second reason for women not to accept WGP as a strategy was their belief that it is not possible to achieve this. This was due to their belief that weight cannot be controlled, and their lack of knowledge of appropriate strategies to prevent weight gain.

Eight women strongly believed that weight increases 'automatically' with age or factors related to age (such as the menopause), and that one cannot control or prevent this. Therefore, their belief in the ability to control their weight was low. These women express their experiences with aging as following:

'… and when you get another year older, you'll also gain a kilogram (of bodyweight).' (Group A, age 55 years)

'(…) *your hormone cycle changes and that's why 9 out of 10 women gain weight during or after their menopause*.' (Group B, age 53 years)

These women were also unaware of strategies to prevent weight gain and mentioned unrealistic and extreme strategies, similar to the acceptors. Some believe that restrained eating is always necessary to prevent weight gain.

'*And then I thought: I don't want to get heavier and heavier every year, so I decided to keep dieting for the rest of my life*, (…). (Group D, age 50 years)

DISCUSSION AND CONCLUSION

WGP has become a goal in an increasing number of obesity-related studies (Winett, Tate et al. 2005; Levine, Klem et al. 2007; ter Bogt, Bemelmans et al. 2009). The aim of this study was to get insight in acceptance of WGP by overweight women. The study shows that the opinion of the target group regarding WGP is diverse. About half of our sample accepted WGP because they were tired of weight cycling and would like to have a stable weight. A few were already engaged in WGP and had incorporated daily lifestyle changes that can be maintained for a long time, i.e. changes that fit their social environment and do not feel as punishment. The women who rejected WGP wanted to lose weight first, and (like many obese people) often aimed at an unrealistic amount of weight loss (Linde, Jeffery et al. 2004). Furthermore, their perceived control regarding weight gain prevention was low, since they often attributed weight gain to uncontrollable and external factors. Most women (except those who had successfully adopted WGP) were unaware of the actions needed to maintain their weight. They often had unrealistic ideas of the magnitude of changes needed to prevent weight gain.

Although focus group interviews do not produce quantitative results, they allow for group interaction and greater insight into why certain opinions are held. In turn, it is an appropriate method to gain insight into new topics (Morgan 1996). However, there are also some limitations. The groups' conversation and interaction can easily be influenced by a group member with strong beliefs or the style of the moderator. We aimed to minimise such influences by e.g. the presence of an assistant and paying attention to quiet group members, but it cannot be totally prevented. In the present study, due to illness the group sizes were smaller than expected. Nevertheless, there was a large variability in opinions, age and weight history among the 19 participants. Furthermore, the small groups ensured that all participants were able to speak and be heard. This study is among the first to address acceptance of WGP among overweight adults, and future quantitative studies should provide more evidence for our conclusions and enable stronger recommendations to be made.

The present study indicates that in interventions that are aimed at WGP, it is important to first motivate participants for achieving weight maintenance as opposed to weight loss.

To ensure people accepting and adopting WGP, all information needs to be tailored to the different perceptions that acceptors and non-acceptors have of WGP (Lustria, Cortese et al. 2009). Strategies for the non-acceptors could be directed at shifting focus away from losing a lot of weight (Garner and Wooley 1991; Polivy and Herman 1992) and making them aware of what causes them to gain weight and the ability to control such causes. Strategies that are used in weight loss programs for obese people, such as cognitive behavioural therapy (Werrij, Jansen et al. 2009), may be useful in WGP interventions, since the non-accepters

have opinions about their weight that are similar to those held by obese people (Schwartz and Brownell 2004). Furthermore, for both acceptors and non-acceptors, it is important to improve knowledge and awareness about the actions needed to effectively maintain weight.

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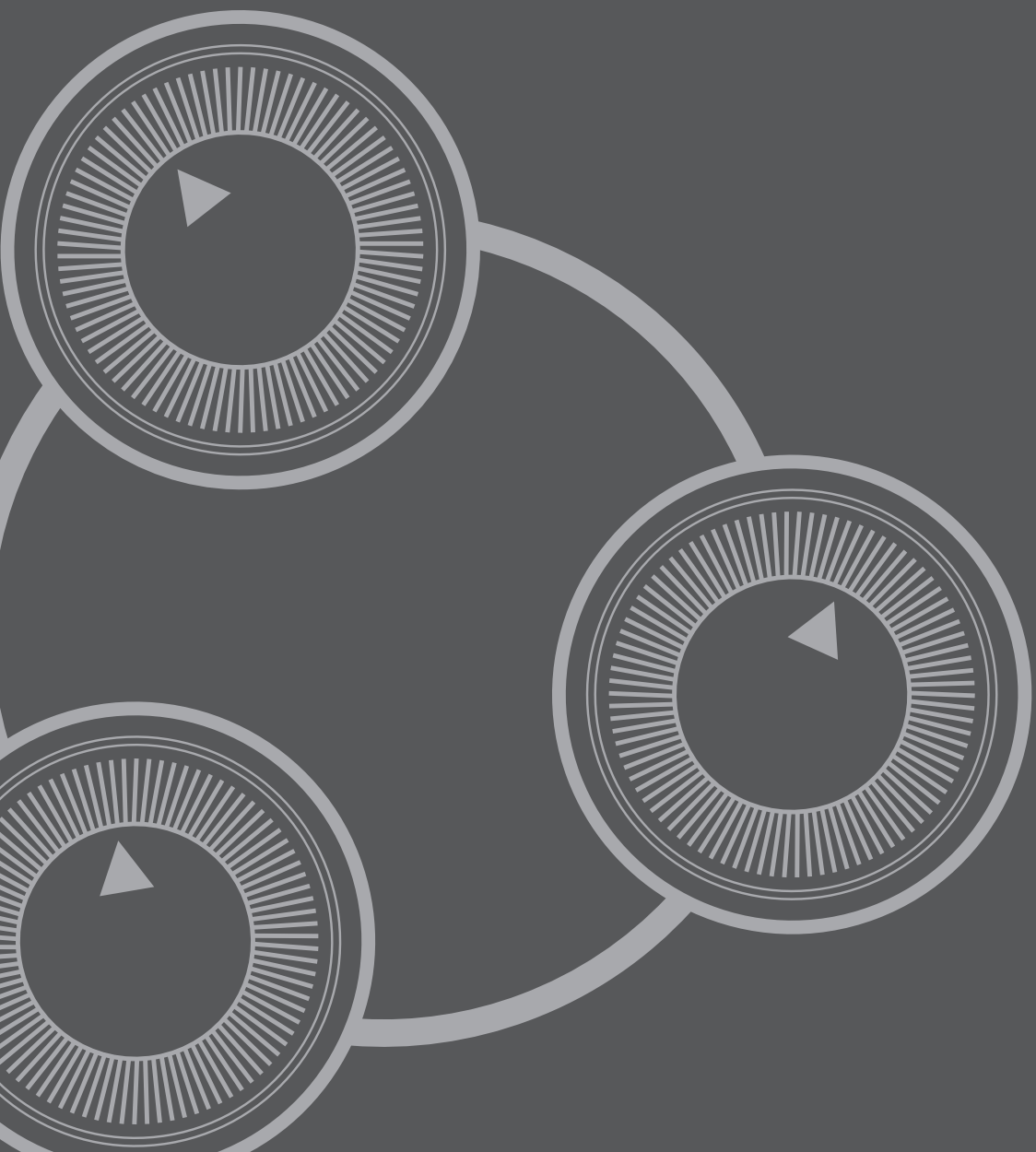
Chapter 3



From weight management goals to action planning: identification of a logical sequence from goals to actions and underlying determinants

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Submitted

ABSTRACT

Background:

Weight gain prevention (WGP) among adults being overweight is an important target in the prevention of obesity. However, little is known about the process from WGP as a goal to successful weight-management. The aims of this study were to 1) gain more insight in this process, 2) identify cognitive predictors of intention for WGP and 3) examine WGP as a potential predictor for the intention to change weight-related behaviours (dietary intake (DI) and physical activity (PA)) and specific action planning.

Materials and methods:

In this cross-sectional study, overweight adults (n=510; BMI 25-30; mean age 48 years (SD=9.5); 30.8% male) completed an online questionnaire, assessing goal intention for WGP, behavioural intention for DI and PA, planning for change in DI and PA and socio-cognitive correlates. Ordinal regression analyses were used to analyse the data.

Results

In 89% of the sample, (parts of) the proposed sequence from goal intention (for WGP), behavioural intention (for DI/PA) and planning (for DI/PA) was observed. Attitude, social norm and perceived control towards WGP, and perceived weight status and risk perception were associated with intention for WGP. Behaviour-specific perceived control and preferences were more strongly associated with intention to change DI or PA and planning for change than intention for WGP was.

Conclusion

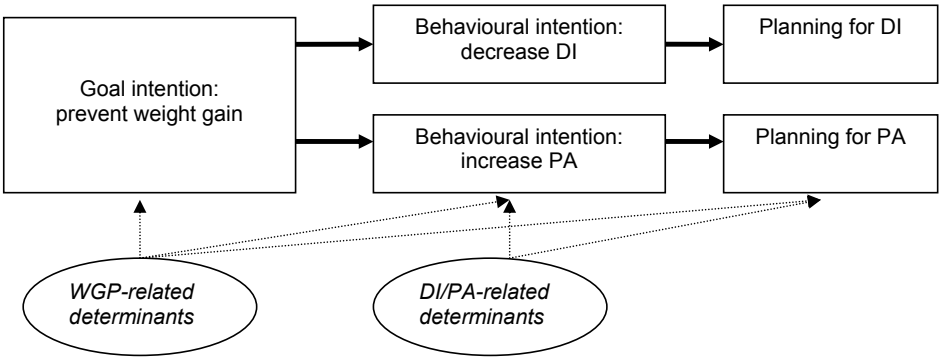
Intention for WGP is important in the process toward weight-management, as for most people intention for WGP precedes behavioural intention, which precedes planning. Intention for WGP is associated with behavioural intention but behaviour-specific factors are the strongest correlates of behavioural intention and planning.

INTRODUCTION

Obesity is a major public health concern because of its high and increasing prevalence (Visscher and Seidell 2001; Haslam and James 2005)and its association with several negative health outcomes (Roberts, Deleger et al. 2003; Stunkard, Faith et al. 2003; Formiguera and Canton 2004). Obesity is the result of a long-term imbalance between energy intake (through diet) and energy expenditure (through physical activity), where energy intake exceeds energy expenditure. One approach to curb the obesity epidemic, that is also acknowledged by the WHO (WHO 2004), is prevention of weight gain, by restoring the balance between energy intake and expenditure. Weight gain prevention (WGP) can be achieved by small daily changes in dietary intake (DI), and/or physical activity (PA) (Hill, Wyatt et al. 2003). Overweight persons are an important target group for obesity prevention, since they are most at risk for becoming obese. In addition, there are many overweight adults in Western countries. In the US for example, 34% of the population is overweight (and 32% obese) (Ogden, Carroll et al. 2006). About 37% of the UK and Dutch population are overweight (Van der Wilk 2008). To develop effective interventions aimed at motivating and guiding overweight adults toward successful WGP, an in-depth understanding of the process toward adoption of successful WGP actions and the relevant determinants in each phase of this process is needed.

Social cognition models, such as the Theory of Planned Behaviour (Ajzen 1991), suggest that goal intentions are the most proximate factor explaining behaviour. Previous studies have shown that even though a weight related goal (e.g. lose weight, maintain one's current weight) is an important first step for proceeding to action, goal intentions alone do not suffice in explaining behaviour (Conner and Norman 1996; Bagozzi, Bergami et al. 2003). For example, Conner and Norman, suggest that it is essential to examine behavioural intentions towards specific weight-related behaviours, in addition to the general goal of weight management (Conner and Norman 1996). Bagozzi and colleagues suggest that successful weight control is only likely when people have a goal intention (i.e. the intention to achieve a certain goal), select specific behaviours to achieve the goal, and engage in detailed planning (Bagozzi and Edwards 1998; Bagozzi, Bergami et al. 2003; Bagozzi, Dholakia et al. 2003). Specifically, they suggest that a sequence of goal enactment processes plays a role in order to achieve the desired end-goal. This process starts with the motivation to engage in WGP (the goal intention, e.g., wanting to maintain one's current weight), followed by setting behavioural goals (e.g., eating less high energy food product, increase PA), and planning the implementation of those behavioural goals (making a very specific plan for how, where and when to reduce the intake of high energy food products and increase PA). Identifying these action sequences and underlying cognitions may contribute to a better understanding of complex behaviours (Armitage and Conner 2000), and the development of more efficient interventions for these complex behaviours (Bartholomew, Parcel et al. 2011).

Figure 1: Model of logical sequence from goal intention for WGP through behavioural intention to planning for weight related behaviours and possible determinants for weight gain prevention. DI= dietary intake; PA = physical activity.



Limited empirical evidence with respect to these action sequences for WGP is available. Therefore, the first aim of this study is to identify whether this sequence of goal enactment processes can be seen for WGP among overweight adults. Figure 1 presents an overview of this sequence.

Secondly, little is known about the determinants of WGP as a goal and whether the goal of WGP is an important determinant for the subsequent steps in the sequence: intention for a specific behaviour intention and planning for actions to achieve the behavioural goal. Behaviour change starts with a *goal intention*, the decision maker's self-commitment or intention to achieve a chosen goal (Abraham and Sheeran 2003). Goal intentions in turn are the results of determinants or motivational factors (Ajzen 1991). In the case of WGP, the goal intention would be to prevent weight gain. The concept of goal intention is similar to the concept of behaviour intention in the Theory of Planned Behaviour (Ajzen 1991; Abraham and Sheeran 2003), which has been applied before to describe weight goals and weight related behaviours (e.g. (Armitage and Conner 2001; Bogers, Brug et al. 2004; Wammes, Kremers et al. 2005). The Theory of Planned Behaviour postulates that an intention is the result of a favourable attitude (a weighing of pros and cons of the behaviour, i.e. liking), subjective norm (what you think others would want or expect you to do) and perceived behavioural control (how easy or difficult you think it would be for you to perform the behaviour/achieve the goal). We expect that these factors can contribute to the explanation of the goal intention for WGP. In addition, the perception or awareness of the current weight status (perceived weight status) (Weinstein and Sandman 1992; Brug, Wammes et al. 2006) and the perceived risk for further weight gain (risk perception) (Janz and Becker 1984; Gorin, Phelan et al. 2004; Wammes, Kremers et al. 2005) may play a role in predicting intention for WGP, as has been demonstrated in previous WGP studies among normal weight adults.

When the goal intention is formed, one must decide which behavioural actions to choose to achieve this goal: the formation of a *behavioural intention* (i.e. which behaviour is needed/

can be helpful in achieving the goal). In the case of WGP, people may intend to make changes in DI and/or PA. People may select their behavioural intention based on what they think is best achievable (perceived behavioural control), and what they believe is desirable and helps them to achieve their goal (preferences) (Bagozzi 1992). In addition, when there is a sequence from a goal intention to a behavioural intention, we expect that the intention for WGP is related to the intention for the subsequent behaviours.

When the means (behavioural intentions) are chosen, one has to consider and finalize details regarding when, where, how and how long to perform specific actions, i.e. *planning* of the change (Gollwitzer and Sheeran 2006), in order to successfully translate the intention to perform a behaviour into actual performance of that behaviour. Planning serves many motivational purposes in goal striving, such as creating a perceptual readiness for action enactment (Brandstatter, Lengfelder et al. 2001; Bagozzi, Dholakia et al. 2003). In other words, a logical sequence is expected, for which a goal intention is required. But for goal attainment, goal intentions should result in behavioural intention and action planning to carry out the intended behaviors.

To enable the development of interventions for WGP it is necessary to establish the determinants of WGP and how the intention for WGP relates to the formation of behavioral intentions and planning of specific behavioural actions. If intention for WGP is an important determinant for change in the underlying behaviours and planning, interventions can be optimised because they can then target the determinants of WGP intention, rather than at the determinants of specific WGP behaviours. The importance of studying action sequences and determinants is also acknowledged by other researchers who stress the importance of identifying action-specific cognitions, at both the general goal level and at the specific behavioural goal level (e.g. (Conner and Norman 1996; Schwarzer and Luszczynska 2008; van Empelen and Kok 2008)).

The present study aims to contribute to the understanding of the process and determinants of WGP as a goal to the choice for changes in DI and PA and planning for the specific behaviours. The specific aims are to examine:

1. The presence of a logical sequence from goal intention for WGP through behaviour intention to planning for small changes in DI and PA.
2. Which cognitive factors contribute to the explanation of intention for WGP.
3. The importance of intention for WGP and related cognitions as potential predictors of behavioural intention and planning for PA and DI.

MATERIALS AND METHODS

Participants, procedures and design

The present cross-sectional study draws on baseline data from a larger study evaluating the efficacy of an online intervention aimed at WGP among overweight adults. Participants were included in the study between March and October 2009. Inclusion criteria were: aged 18-65 years, being overweight (BMI 25-30), being able to read/write in Dutch and having regular Internet access. Exclusion criteria were being pregnant, following a diet prescribed by a physician/dietician and having a history of depression or eating disorder(s).

Invitations to participate in the study were sent to employees of three large companies and advertisements were published in local newspapers. Those interested in participation could enrol by completing an online subscription form, in which compliance with the inclusion criteria was checked. A total of 627 people met the inclusion criteria and they enrolled the study. They signed an informed consent form and were asked to fill out the questionnaire (a necessity to be included in the evaluation study), which was done by 510 participants (81.3%). The study received a 'Declaration of no objection' from the Medical Ethics Committee of the Erasmus MC.

Measures

Data on goal intention, behavioural intention, planning and the underlying cognitions were collected through online self-report questionnaires. All factors were measured on a 5-point scale ranging from 'certainly not' (1) to 'certainly yes' (5), unless explained otherwise. The questions were based on previously used questionnaires and the questionnaire was pre-tested among a small sample of the target group.

Intentions and planning

All measures of constructs from the Theory of Planned Behaviour are based on previously used questionnaires and expert recommendations (Francis, Eccles et al. 2004).

Goal intention towards WGP was assessed with the item 'Do you intend to prevent weight gain in the next six months?'. *Behavioural intentions* for decreasing DI and increasing PA were assessed with the following items 'Do you intend to reduce your intake of energy-dense products in the next three months?' and 'Do you intend to increase your PA level by 20 minutes a day in the next three months?'. An increase of 20 minutes of PA was chosen because, in most people, such a change should be sufficient to prevent weight gain (Hill, Wyatt et al. 2003).

Planning for PA was assessed with four items: 'Do you have a clear plan for: 1) when, 2) where, 3) how, and 4) with whom you will exercise 20 minutes extra every day?'. These questions were derived from a validated questionnaire on action and coping planning (Sniehotta, Schwarzer et al. 2005), suitable for dietary and physical activity behaviours.

Planning for DI was assessed in a similar manner, with three items: 1) 'Do you have a clear plan for what (i.e., which product) to change, 2) how much you will change and 3) when you will make the change'. The four answer categories ranged from 'I don't have a plan' (1) to 'I have a very clear plan' (4). Cronbach's αwas 0.92 for planning PA and 0.94 for planning DI. Therefore, the items were combined in one variable for planning by calculating means for the 4 PA questions and the 3 DI questions.

Cognitions related to goal intention and intention for change in DI and PA

Attitude towards WGP was assessed by asking whether participants considered WGP as bad (1) to good (5) and useless (1) to useful (5). Cronbach's αfor the combination of these variables was 0.74 and the mean score of these items was calculated.

Subjective norm for WGP was assessed with the statement 'Do people who are important to you think that you should prevent weight gain?'.

Perceived behavioural control for WGP was measured with the item 'Would you be able to prevent gaining weight in the next six months, if you really wanted to?'.

Perceived weight status was assessed by asking participants to indicate how they perceived their weight (too low (1) - too high (5)). The item 'How likely is it that your weight will increase in the next 6 months, if you do not change your dietary intake or physical activity?' (very unlikely (1) - very likely (5)) was used to assess *risk perception*.

Preferences for a change in DI and PA were used as an indicator of attitude. The items were 'Eating less energy-dense products every day is a good way for me to prevent weight gain' and 'Being physically active for at least 20 minutes extra every day is a good way for me to prevent weight gain.' *Perceived behavioural control* towards a change in DI and PA was measured with the items 'Could you succeed in eating less energy dense products in the next 3 months, if you really wanted to?' and 'Could you succeed in being physically active for 20 minutes extra each day for the next 3 months, if you really wanted to?'.

Demographic variables

Sex (male/female), date of birth and educational level were assessed in the questionnaire. *Age* was determined using the date of birth and date of completion of the questionnaire. *Education* was assessed by asking participants to indicate what their highest completed level of education was (8 answering options). A three-category variable was subsequently made, indicating a low (completed no education, primary school, secondary school, lowest level of high school or lower vocational training), medium (intermediate or high level high school) or high (completed higher vocational training or university) level of education.

Analyses

Descriptive analyses

Descriptive statistics were used to describe the study population. Bivariate non-parametric correlations (Spearmans rho) were produced to describe correlations between the variables in analysis.

Descriptive analyses were used to describe how many people could be categorized in logical sequence categories and where continuation in the sequence toward planning failed. First, dichotomous scores for the goal intention, behavioural intention and planning were made, distinguishing the most positive score (2) from all lower scores (1). Combining these three dichotomous variables would result in 2^3=8 possible sequences. Of these 8 combinations, there were 4 logical combinations: people with a positive goal intention, behavioural intention and planning (1), those with a positive goal intention and behavioural intention (2), those with only a positive goal intention (3) and those with no positive intention at all (4). The fifth category includes those with inconsistent combinations.

Regression analyses

Ordinal multivariable regression analyses were conducted to study the cognitive correlates of goal intention for WGP, behaviour intentions for DI and PA and planning for DI and PA.

Intention for WGP was regressed on attitude, perceived behavioural control, subjective norm, perceived weight status and risk perception. In the analyses on behavioural intention for DI and PA, goal intention for WGP was entered in the first step, followed by preference and perceived behavioural control for the specific change (DI or PA) in the second step, and cognitions related to WGP in the third step.

In the analyses on planning for change, behavioural intention to change DI/PA was entered in the first step, goal intention for WGP in the second step, followed by the cognitions relevant for the behaviour (perceived behavioural control and preference for the specific change (DI or PA)), and in the fourth step the cognitions related to WGP.

All regression analyses were adjusted for age, sex and education. The analyses were conducted using SPSS 17. Tests were two-tailed and the significance level was set at p=0.05.

RESULTS

Participants

Complete data were obtained for 510 persons, of which 353 (69%) were women (Table 1). Mean age of the participants was 47.8 (SD 1.9) years. Of all participants, 39% had a higher, 51% a medium, and 10% a lower level of education. The average BMI of the study population was 28.0 (SD 1.9). Most participants (72%) had a positive intention towards WGP,

Table 1. Participant characteristics

Characteristic		Total	Men	Women
n (%)		510	157 (30.8)	353 (69.2)
Age	Mean (SD)	48.01 (9.5)		
Education %	Low	10.4	16.4	7.7
	Middle	51	44.7	53.8
	High	38.,6	38.9	38.5
BMI	Mean (SD)	28.05 (1.9)	28.2 (1.8)	27.9 (1.9)
% highest score in:				
Goal intention WGP		72.2	62.4	77.3
Behavioural intention DI		36.9	31.8	39.1
Behavioural intention PA		26.9	24.8	27.8
Planning DI		16.5	11.5	18.7
Planning PA		13.7	17.2	12.2

considerably less people had a positive intention for a change in DI (37%) or PA (27%), and few had concrete plans for changes in DI (17%) or PA (14%).

Correlations

Table 2 shows the bivariate non-parametric correlations (Spearman rho) and median scores of all dependent (intention for WGP, intention to change DI and PA and planning for change in DI and PA) and independent variables (attitude, subjective norm and perceived behavioural control toward WGP, perceived weight status, risk perception, preference and perceived behavioural control towards DI and PA, and age, sex and level of education). As expected the strongest correlations were seen between the variables related to one topic/behaviour. Correlations between the proposed determinants and WGP intention were small to medium in size (with attitude correlation r=0.26 (p=0.00), subjective norm r=0.13 (p=0.002), perceived behavioural control r=0.25 (p=0.00), perceived weight status r=0.15 (p=0.00) being the most strongly correlated) (Cohen 1992). Correlations between WGP intention and intention for DI (r=0.35 p=0.00) or PA (r=0.22 p=0.00) and planning (r=DI 0.18 p=0.00, PA r=0.18 p=0.00) were also small to medium in size. The associations between intention to change DI and PA and the behaviour-specific cognitions (preference (DI r=0.30 p=0.00, PA r=0.40 p=0.00) and perceived behavioural control (DI r=0.54 p=0.00, PA r=0.67 p=0.00)) were moderate to strong.

Sequence from goal intention to planning

In 89% of the sample a logical sequence in the combination of goal intention, behavioural intention and planning was observed (Table 3). About 17.5% of the participants had a positive goal intention for WGP, an intention to change behaviour, and was undertaking the necessary planning (group 1); whereas 25.3% had the intention to prevent weight gain and

Table 2. Median (M), interquartile range (IR) and inter-correlations (Spearman r) for Theory of Planned Behaviour variables for weight gain prevention (WGP), increasing physical activity (PA), decreasing dietary intake (DI) and planning to increase PA and decrease DI.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	M	IR
Intention WGP	**1**																	5	1
Attitude WGP	**2**	.26**																4	1
Social norm WGP	**3**	.13**	.18**															4	2
Perceived behavioural control WGP	**4**	.25**	.07	.10*														4	1
Risk Perception	**5**	-.02	.17**	.05	-.06													3	1
Perceived weight status	**6**	.15**	.23**	.15**	-.07	.24**												4	0
Intention PA	**7**	.22**	.10*	.13*	.20**	.11*	.17**											4	2
Perceived behavioural control PA	**8**	.13**	.10*	.10*	.26**	.08	.07	.67**										4	1
Preference for PA	**9**	.10*	.11*	.18**	.25**	.11**	.07	.40**	.32**									4	1
Planning PA	**10**	.18**	.08	.13**	.15**	.01	.05	.52**	.46**	.24**								2	2
Intention DI	**11**	.35**	.17**	.10*	.19**	.12*	.15**	.23**	.19**	.11**	.13**							4	1
Perceived behavioural control DI	**12**	.20**	.04	.07	.35**	.02	-.04	.10*	.18**	.11*	-.00	.54**						4	2
Preference for DI	**13**	.18**	.08	.18**	.28**	.16**	.015	.13**	.15**	.34**	.07	.30**	.22**					4	2
Planning for DI	**14**	.18**	.06	.08	.18**	.08	.07	.12**	.13**	.06	.29**	.41**	.28**	.30**				2	2
Age	**15**	-.05	-.13**	-.04	-.16**	-.14**	-.15**	-.02	-.02	-.05	-.04	-.01	-.01	-.02	-.05			48.0	9.47
Sex	**16**	.16**	.10*	-.21**	-.01	.16**	.09*	.03	-.01	-.05	-.03	.11*	.04	.04	.16**	-.12**		-	-
Education	**17**	.06	.13**	.08	.07	.03	.09*	-.10*	-.02	-.01	-.02	.01	-.07	-.03	.06	-.11*	.05	-	-

*n=510. * =p <.05, **=p<.01. The numbers on the horizontal axis refer to the names and number of the vertical axis (e.g. 3 is social norm). Column one displays the correlations with 'Intention for WGP' and all other variables included. E.g. in column 1, line 6, shows that the correlation with 'perceived weight status' is 0.16**, etc.*

Table 3. Grouping of participants in categories of logical sequence from goal intention to planning. Frequency and combinations of intentions and planning.

Group	Positive goal intention for WGP	Positive behavioural intention for DI/PA (or both)	Planning to change PA/DI (or both)	N	%	Cumulative %
1	Yes	Yes	Yes	89	17.5	17.5
2	Yes	Yes	No	129	25.3	42.2
3	Yes	No	No	136	26.7	68.9
4	No	No	No	102	20.0	88.9
0	no clear order/ other combination of intentions & desires			54	10.6	100.0

n=510; DI = dietary intake, PA = physical activity; WGP = weight gain prevention.

change their behaviour, but had not made any plans to do so (group 2). Group 3 was the largest group (26.7%), including those who only had a positive intention to prevent weight gain. The inconsistent category (group 0, 10.6%) was mainly composed of people who had a positive behavioural intention (18/54) without a goal intention or planning, or had a goal intention for WGP and planning for a change but were lacking a behavioural intention (16/54). Seven people had a behavioural intention and were planning for change, but lacked an intention for WGP.

Associations between cognitions and intention for WGP

Table 4a, 4b and 4c present the results of the ordinal regression analyses. Results of the most comprehensive model (the last step) are described below.

Table 4a. Odds ratios and 95%CI of ordinal regression analysis of intentions to prevent weight gain.

Independent variables	***Dependent variable***
	Goal intention WGP
Attitude WGP	**1.78** 1.36- 2.33
Social norm WGP	**1.24** 1.03-1.49
Perceived behavioural control WGP	**2.03** 1.56-2.68
Perceived weight status	**2.09** 1.26- 3.48
Risk perception	**0.75** 0.56- 0.98
R^2	**0.21**

*n=510; significant associations are printed in **bold**. WGP = weight gain prevention.*

Interpretation: a person who scores 1 point higher on the attitude scale is 1.78 times as likely to have a more positive goal intention.

Attitude (OR=1.78), subjective norm (OR=1.24) and perceived behavioural control (OR=2.03) towards WGP and perceived weight status (OR=2.09) were positively associated with goal intention for WGP, while risk perception was negatively associated (OR=0.75) (Table 4a). Total explained variance was 21%.

Associations of behavioural intention and planning for DI

Goal intention for WGP (OR=2.52) was positively associated with *behavioural intention for DI*, as were preference for DI (OR=1.61) and perceived behavioural control towards DI (OR=4.81) (Table 4b). Perceived weight status (OR=2.03) was also positively associated with behaviour intention for DI. The explained variance of the full model was 44%.

Table 4b. Odds ratios and 95%CI of stepwise ordinal regression analysis of intention for change in dietary intake (DI) (left panel) and planning for DI (right panel).

Independent variables	***Dependent variable***						
	Behavioural intention for DI			***Planning for DI***			
Step	**1**	**2**	**3**	**1**	**2**	**3**	**4**
Intention DI				**2.78**	**2.75**	**2.25**	**2.33**
				2.24-3.43	2.20-3.45	1.75-2.90	1.80-3.01
Intention WGP	**3.23**	**3.23**	**2.52**		1.03	0.97	0.91
	2.39-4.36	2.39-4.37	1.80-3.53		0.77-1.38	0.73-1.30	0.67-1.24
Preference DI		**1.63**	**1.61**			**1.53**	**1.47**
		1.34-1.99	1.31-1.99			1.27-1.84	1.21-1.78
Perceived behavioural control DI		**5.86**	**4.81**			1.25	1.19
		3.37-5.71	3.66-6.34			0.99-1.59	0.93-1.52
Attitude WGP			0.97				0.96
			0.75-1.26				0.77-1.20
Subjective norm WGP			1.01				1.19
			0.86-1.19				0.95-1.27
Perceived behavioural control WGP			0.87				1.10
			0.68-1.12				0.95-1.47
Perceived weight status			**2.03**				1.013
			1.31-3.16				0.69-1.49
Risk perception			1.19				0.96
			0.96-1.49				0.79-1.16
Step R^2	**0.14**	**0.42**	**0.44**	**0.20**	0.20	**0.24**	0.24

*N= 510; signification associations are printed in **bold**. WGP = weight gain prevention.*

The two panels of the table should be read separately. The left panel displays the stepwise regression analysis for behavioural intention, with blocks of variables entered in the various steps. The right panel displays this for planning for DI.

Interpretation: E.g. Behavioural intention for DI Step 1: when a person scores one point higher on the intention for WGP scale, this person is 3.23 times as likely to have a positive intention for DI.

Behavioural intention for DI (OR=2.33) and preference for DI (OR=1.47) were positively associated with *planning for DI*, while goal intention for WGP, perceived behavioural control towards DI and WGP related variables were not. The explained variance was 24%.

Associations of behavioural intention and planning for PA

Goal intention for WGP (OR=1.77) was positively associated with *behavioural intention for PA*, as were preference for PA (OR=1.90) and perceived behavioural control for PA (OR=5.97) (Table 4c). Furthermore, perceived weight status (OR=1.83) also showed a significant association with intention for PA. The explained variance of the full model was 58%.

Table 4c. Odds ratios and 95%CI of stepwise ordinal regression analysis of intention to increase physical activity (PA) (left panel) and planning for PA (right panel).

Independent variables	***Dependent variable***						
	Behavioural intention: PA			***Planning for PA***			
Step	**1**	**2**	**3**	**1**	**2**	**3**	**4**
Intention PA				**3.20**	**3.09**	**2.291**	**2.33**
				2.66-3.99	2.56-3.72	1.81-2.90	1.83-2.97
Intention WGP	**2.00**	**1.77**	**1.77**		**1.44**	**1.45**	**1.44**
	1.51-2.64	1.32-2.39	1.29-2.45		1.06-1.94	1.07-1.95	1.05-1.97
Preference PA		**1.91**	**1.90**			1.04	1.04
		1.59-2.29	1.57-2.29			0.87-1.24	0.87-1.25
Perceived behavioural control PA		**5.87**	**5.97**			**1.63**	**1.65**
		4.63-7.44	4.69-7.60			1.31-2.05	1.31-2.07
Attitude WGP			0.86				0.98
			0.67-1.11				0.78-1.23
Subjective norm WGP			1.02				1.101
			0.87-1.20				0.95-1.28
Perceived behaviour control WGP			0.95				0.969
			0.75-1.21				0.78-1.21
Perceived weight status			**1.83**				0.815
			1.19-2.81				0.74-1.21
Risk perception			1.12				0.89
			0.90-1.38				0.74-1.08
Step R^2	**0.07**	**0.57**	0.58	**0.29**	**0.30**	**0.33**	0.33

*N= 510; signification associations are printed in **bold**. WGP = weight gain prevention.*

The two panels of the table should be read separately. The left panel displays the stepwise regression analysis for behavioural intention, with blocks of variables entered in the various steps. The right panel displays this for planning for PA.

Interpretation: E.g. Behavioural intention for PA Step 1: when a person scores one point higher on the intention for WGP scale, this person is 2.00 times as likely to have a positive intention for PA..

Behavioural intention for PA (OR=2.33) was positively associated with *planning for PA*, as were goal intention for WGP (OR=1.44) and perceived behavioural control towards PA (OR=1.65). None of the WGP intention related factors were associated with planning for PA. The explained variance was 33%.

DISCUSSION

The first aim of this study was to identify whether a logical sequence of goal attainment processes could be observed from goal intention, through behavioural intentions to action planning. The findings of this study confirm that such a sequence does exist. In other words, action planning is unlikely if people are not certain about their intentions towards WGP, PA and/or DI. The results, however, also showed that only a small number of people actually followed through the whole sequence. That is, one quarter of participants did have a positive intention towards WGP but did not report a behavioural intention or any specific planning to achieve this goal.

Second, the study shows that attitude, subjective norm and perceived behavioural control towards WGP as well as risk perception and perceived weight status were significantly associated with the intention for WGP. Third, the results show that intention for WGP was more strongly related to intention for change in DI than PA, as well as to planning for PA, but was not related to planning for DI. Preference and perceived behavioural control explained most of the variance for the intention for DI and PA.

In overweight adults we found evidence for the proposed logical sequence, indicating that having the WGP as a goal is an important first step in the sequence toward successful WGP. This emphasizes that it is important to motivate people for WGP in interventions aimed at preventing weight gain. It is also possible to make changes in DI or PA for other reasons, which would mean that a logical sequence could also be followed through starting from a positive intention for DI or PA. However, this was probably not the case in our sample of overweight adults, since most participants could be categorized in the logical sequence, and within the inconsistency category only seven people had a positive behavioural intention and were planning for action without having the intention for WGP. However, the present study also shows that the majority of overweight respondents in our sample intended to prevent weight gain, but only half of them intended to make a change to their DI or PA behaviour. Apparently, having a positive intention for WGP is not sufficient to become motivated for behaviour change; these findings are in line with the results of other studies (Weinstein and Sandman 1992). Possible reasons for this gap between a goal and intention for performance of the behaviours through which that goal can be achieved, may be that WGP is an abstract goal which may have been interpreted as a desired state. People may

have difficulty in matching such a goal with specific actions that need to be taken in order to reach the goal. Furthermore, people may have misperceptions about what is necessary to achieve WGP and may feel that the small changes in DI or PA that were the focus in this study would not be sufficient to maintain a stable weight. In a previous qualitative study we found that overweight people tend to think in terms of 'huge' changes and 'extreme' dieting as strategies needed to work on their weight (results from focus group interviews (van Genugten, van Empelen et al.)). The present results indicate that it is important to motivate overweight people who have an intention for WGP to think of and choose for specific actions that they need to perform in order to achieve the goal.

A considerable part of the group dropped out of the sequence between behavioural intention and specific action planning. This is not surprising since people make few specific action plans without being exposed to an intervention (Gollwitzer, Heckhausen et al. 1990; Brickell, Chatzisarantis et al. 2006). In addition, this target group may be even less likely to successfully initiate self-regulation of DI and PA since they were all overweight. Because action planning is an important means to bridge the gap between intention and actual behaviour (Gollwitzer and Sheeran 2006; Achtziger, Gollwitzer et al. 2008) and our findings suggest that people with intentions do not automatically form action plans, it is important to help people in forming specific action plans in interventions (e.g. (Verplanken and Faes 1999; Luszczynska 2006; Luszczynska, Sobczyk et al. 2007)).

Although intention for WGP is not the ultimate determinant of weight maintenance processes, it does seem to play a role in the process to successful weight maintenance, and thus, it is important to understand the underlying determinants. Perceived behavioural control and perceived weight status appeared to be the strongest correlates of intention for WGP. These factors differ from an earlier study showing that attitude and risk perception were more important (Wammes, Kremers et al. 2005). However, the latter study also included individuals with a healthy weight, which may have influenced the results. The fact that variables from the Theory of Planned Behaviour do only explain only 21% of the intention may be because WGP is not a behaviour in itself, but rather a desired state. Other factors may be more important in explaining intention for WGP. For example, factors such as anticipated positive and negative emotions (e.g. regret, fear and joy) and expected effort investment for the behaviour change to influence the goal decision process have been suggested (Bagozzi, Dholakia et al. 2003). Future studies should include and explore other types of variables to explain the goal intention for WGP.

Another finding which illustrates that intention for WGP is important in the sequence from goal intention to enactment, is that intention for WGP adds to the explanation of intention for the subsequent behaviours and even to planning for a change in PA. This may indicate that strengthening the intention for WGP, up to a certain threshold, in interventions aimed at WGP is also likely to contribute to a positive intention for change in the underlying

behaviours. Perceived weight status is an important correlate for WGP and behaviour intentions, but not for planning. This may indicate that awareness of weight is important to motivate people for WGP but that it is not sufficient for action initiation. Preference turned out to be a more important correlate for the intention for DI, and perceived behavioural control for the intention for PA. Perceived behavioural control may be more important for PA because it requires people to invest their time and do something extra (which may be perceived as being more difficult than *not* doing something in DI). This may also illustrate that people see changes in DI in general as the most suitable means for managing their weight, as reported by others (Serdula, Mokdad et al. 1999; Kottke, Clark et al. 2002; andWammes, French et al. 2007).

This study has some limitations. First, because of the cross-sectional design with intentions and desires as outcomes (rather than actual goal achievement), it is not possible to predict actual behaviour or change. Second, the study population was relatively highly educated and predominantly of Western ethnic background, which limits the generalisability of the findings to populations with other characteristics. Third, the participants in this study had enrolled in an intervention study aimed at the prevention of weight gain, a prerequisite for which was that they were motivated for preventing weight gain. Lack of variability in the intention for WGP may have resulted in an underestimation of the importance of the intention for WGP as a correlate of subsequent behaviour.

From this study we can conclude that intention for WGP is important in the process toward successful weight management, as for most people intention for WGP precedes behavioural intention, which in turn precedes planning. Intention for WGP is associated with behavioural intention but rather behaviour-specific perceived behavioural control and preferences are the strongest correlates of behavioural intention and planning.

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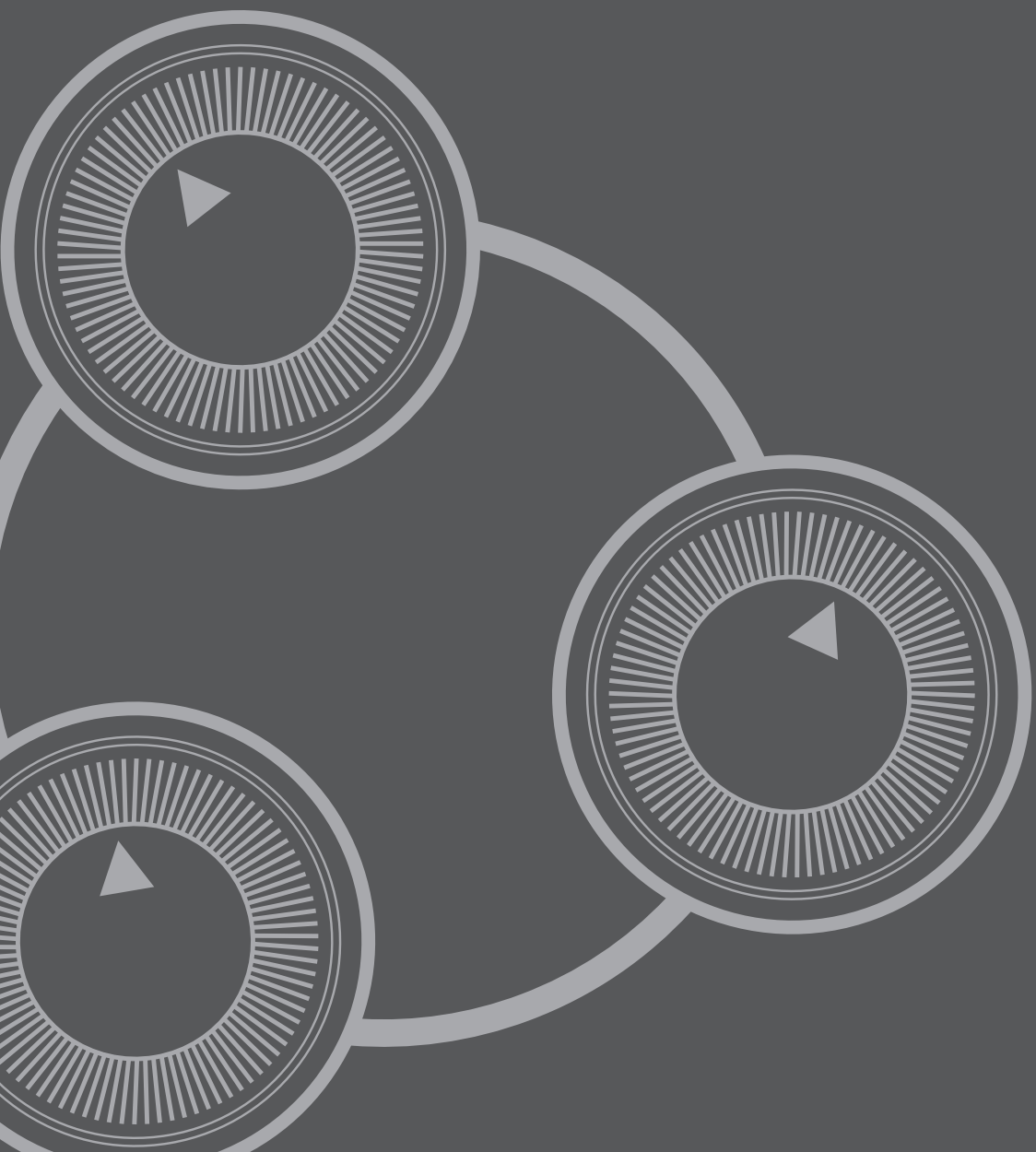
Chapter 4



Systematic development of a self-regulation weight-management intervention for overweight adults

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ABSTRACT

Background:

This paper describes the systematic development of an intervention for the prevention of obesity among overweight adults. Its development was guided by the six steps of Intervention Mapping (IM), in which the establishment of program needs, objectives and methods is followed by development of the intervention and an implementation and evaluation plan.

Methods:

Weight gain prevention can be achieved by making small changes in dietary intake (DI) or physical activity (PA). The intervention objectives, derived from self-regulation theory, were to establish goal-oriented behaviour. They were translated into a computer-tailored Internet-delivered intervention consisting of four modules. The intervention includes strategies to target the main determinants of self-regulation, such as feedback and action planning.

The first module is intended to ensure adults' commitment to preventing weight gain, choosing behaviour change and action initiation. The second and third modules are intended to evaluate behaviour change, and to adapt action and coping plans. The fourth module is intended to maintain self-regulation of body weight without use of the program.

The intervention is being evaluated for its efficacy in an RCT, the protocol for the evaluation study is described in this paper. Primary outcomes are weight, waist circumference and skin-fold thickness. Other outcomes are DI, PA, cognitive mediators and self-regulation skills.

Discussion:

The IM protocol helped us integrating insights from various theories. The performance objectives and methods were guided by self-regulation theory but empirical evidence with regard to the effectiveness of theoretical methods was limited. Sometimes, feasibility issues made it necessary to deviate from the original, theory-based plans. With this paper, we provide transparency with regard to intervention development and evaluation.

Trial registration: NTR1862

BACKGROUND

Because of its association with several negative health outcomes (Roberts, Deleger et al. 2003; Stunkard, Faith et al. 2003; Formiguera and Canton 2004) and increased health care costs (Polder, Takkern et al. 2002), the high and increasing prevalence of obesity is a major public health concern. In 2005 there were about 1.1 billion obese adults worldwide (Haslam and James 2005). Recent Dutch data (2005-2008) showed that 11% of adult males and 12% of adult females were obese (Bakel and Zantinge 2010). Although behavioural treatment of obesity has improved greatly over the past 20 years, reductions in weight are rarely maintained among obese people (Jeffery, Drewnowski et al. 2000). Given these poor results, the prevention of obesity has been postulated as a promising strategy for fighting the obesity epidemic (Bakel and Zantinge 2010). This includes weight maintenance or modest weight loss, from here on referred to as weight-management (Stevens, Truesdale et al. 2006), which can be achieved by restoring the balance between energy intake and energy expenditure.

Overweight adults (BMI 25-30 kg/m^2) are an especially important group to target with obesity prevention interventions: not only are they most at risk of becoming obese, they also comprise a large group. In the Netherlands, more than 28% of women and 41% of men were overweight in 2005-2006 (Visscher and Schoemaker 2007).

There is a lack of well designed, theory and evidence-based interventions that focus on weight-management among adults being overweight. Such an intervention should be able to reach a large group of overweight adults and has to take the large differences between people in their behaviours, preferences and capabilities into account. Therefore, individualized intervention approaches are needed to successfully modify weight-related behaviours (Kreuter, Oswald et al. 2000). We initiated a project to develop and evaluate such an intervention.

In this paper we describe the results of the planned development of the intervention and the evaluation protocol. The development was guided by the Intervention Mapping (IM) protocol to ensure that the intervention was grounded in theory and evidence and to maximise the likelihood of effectiveness (Bartholomew, Parcel et al. 2006). The IM protocol distinguishes six steps in the (iterative) process of developing an intervention, implementation and evaluation plan. The first step is the needs assessment, which results in a description of the health problem addressed, its behavioural causes and the intervention goal. The second step is aimed at stating specific change objectives, the most detailed and proximal goals that will be addressed in the intervention. In the third step, theoretical methods and practical strategies that are suitable to reach the change objectives are identified. In step four the actual program is developed and pre-tested. Step five and six involve the development of an implementation and evaluation plan. In the present paper we will specifically focus on

the results of steps two to four. By detailing these steps specifically we comply to recent calls for specific descriptions of interventions that will increase transparency of intervention content and improve the options for replication (Hardeman, Griffin et al. 2000; Abraham and Michie 2008).

METHODS AND DESIGN

The results of each step of the development process are described below.

Step 1 Needs assessment

As determined by the needs assessment, which is briefly summarised in the introduction section, the overall goal of the intervention was to prevent weight gain in overweight adults. Weight gain prevention (WGP) does not require dieting, but can be achieved by making small, but sustained changes of about 100 kcal a day in energy intake and/or energy expenditure. Dietary intake (DI) can be reduced by making changes in food categories that contribute most to excess energy intake and obesity, namely alcoholic drinks, sugar sweetened drinks and juices, and energy-dense foods (high in fat and/or sugar) (Swinburn, Caterson et al. 2004). Physical activity (PA) can be increased by activities in the various PA sub-domains, namely active transport and activities at work, during leisure time (walking or cycling), and sports (Swinburn, Caterson et al. 2004). An increase in PA of about 20 minutes a day is equivalent to a 100kcal increase in energy expenditure. Preferably, the activities should be of moderate to vigorous intensity. Thus, the overall goal of the intervention can be achieved by making small (at least 100 kcal per day) and sustained changes in DI and/or PA.

Step 2 Matrices of change objectives

The overall intervention goals cannot be achieved directly, but only through targeting specific behavioural actions that are needed to achieve them (e.g. reduce intake of high-energy snacks). The definition of these most specific program goals occurs in two steps. In the first step we defined performance objectives (POs), in the second step we defined change objectives (COs). POs specify the behavioural actions that the target audience has to perform in order to successfully change behaviour (e.g. reduce the intake of sugar sweetened drinks by 1 glass per day).

Performance objectives

Because weight gain prevention requires long-term self-management skills to regulate and adapt behaviour to changing circumstances, self-regulation models were used to guide the definition of the POs. Self-regulation models (e.g (Austin and Vancouver 1996; Maes and Karoly 2005)) describe sub-behaviours that are necessary to establish and maintain changes

in complex behaviours. Five different POs were defined and involved establishing, setting, planning, striving, revising and maintaining a goal:

(1) People decide to prevent weight gain (goal establishment).
(2) People choose at least one small change in DI or PA (goal setting).
(3) People prepare strategies to establish how they will make their chosen behaviour change (planning).
(4) People change their DI or PA (goal striving).
(5) People evaluate the success of the behaviour change and its effect on body weight (goal monitoring, attainment, revision and persistence decisions).
    (a) if successful, they may maintain or adapt their goal,
    (b) If unsuccessful, they go back to previous stages and revise their strategies for them (#5)
    (c) if unsuccessful, they may also choose a new behavioural goal (#2)

These objectives provide a sequence of actions but are also circular in nature, meaning that recycling to previous steps in the self-regulation process is possible.

Selecting determinants

Translating the POs into more specific change objectives requires a thorough analysis and selection of the most important and changeable determinants of each PO (and thus phase in self-regulation). Our analysis of determinants was based on a review of empirical determinant studies and relevant motivational and volitional theories such as self-regulation theory (Austin and Vancouver 1996; Maes and Karoly 2005), the Theory of Planned Behaviour (Ajzen 1991), the Precaution Adoption Process Model (Weinstein and Sandman 1992), implementation intentions and goal setting (Gollwitzer and Sheeran 2006), and Relapse Prevention Theory (Marlatt and Gordon 1985). It was also based on the results of focus group interviews (FGI) held with the target group.

The study of determinants showed that awareness and risk perception, knowledge (Weinstein and Sandman 2002; Schwarzer 2008), attitude and perceived behavioural control (Ajzen 1991) are important determinants. Table 1 provides a selection of the most important determinants for each PO.

Writing change objectives

In the last phase of step 2 we defined the change objectives (COs). This is an important step, since these define what the target audience has to learn or change in order to be able to perform the specific behaviours and are therefore the most direct targets of the intervention. A matrix of change objectives was developed by crossing the behavioural determinants and

Table 1; Performance objectives for preventing weight gain, with a selection of determinants per performance objective.

Performance Objective	Theory	Determinants
1. People decide to prevent weight gain.	PAPM (Weinstein and Sandman 2002)	- Awareness. - Knowledge - Risk-perception (Bosch, Daansen et al. 2004)
	TPB (Ajzen 1991)	- Attitude - Perceived Behavioural Control
2. People choose at least one small change in DI or PA (goal setting).	PAPM	- Awareness
	TPB	- Attitude /preferences (Mela 2001) - Subjective norm (FGI), (Wammes, Kremers et al. 2005; Hagger and Chatzisarantis 2009) - Goal-efficacy (FGI)
	SDT (Ryan and Deci 2000)	- Goal commitment.
3. People prepare strategies to establish how they will make their chosen behaviour change	HAPA (Schwarzer and Luszczynska 2008)	- Action self-efficacy (Luszczynska and Schwarzer 2003; Sniehotta, Schwarzer et al. 2005; Luszczynska and Sutton 2006) - Awareness of cues to action
	TPB	- Social influence (Verheijden, Bakx et al. 2005)
4. People change their DI or PA (goal striving).	HAPA	- Action self-efficacy (Luszczynska, Tryburcy et al. 2007) - Coping self-efficacy (FGI)
	RPT (Marlatt and Gordon 1985)	- Awareness of barriers/ high risk situations - Coping self-efficacy (Marlatt and Gordon 1985)
	SRT (Maes and Karoly 2005)	- Awareness of standards (their self-chosen change) - Monitoring (self-regulation effort)
5. People evaluate their behaviour change and its effect on body weight.	SRT (also for 5a, 5b and 5c)	- Awareness of personal weight standards - Skills
a. if successful, they may maintain or adapt their goal (towards a higher goal).	HAPA	- Task self-efficacy
	SDT	- Commitment
b. If unsuccessful, they go back to previous stages (#5) and revise their strategies for them	RPT	- Recovery self-efficacy (Baumeister 2003)
	SDT	- Commitment
c. if unsuccessful, they may also choose a new behavioural goal (#2)	TPB	- Attitude (Marlatt and Gordon 1985; Baumeister and Heatherton 1996; Rasmussen, Wrosch et al. 2006). - Awareness

***FGI** = information derived from Focus Group Interviews, **GST** = Goal Setting Theory, **HAPA**= Health Action Process Approach, **PAPM** = Precaution Adoption Process Model, **RPT** = Relapse Prevention Theory, **TPB** = Theory of Planned Behaviour, **SDT** = Self determination Theory, **SRT** – Self- Regulation Theory.*

POs. In total, almost 200 COs were defined to design the program, a selection of which is presented in the first column of table 2.

Table 2. Selected change objectives, theoretical methods and practical strategies

Change objectives The participant: (determinant)	**Theoretical Methods** (all tailored)	**Parameters for use**	**Practical strategy**
PO 1. People decide to prevent weight gain.			
1.1 Acknowledges personal weight changes in past (awareness) Acknowledges risk of possible future weight gain and its health consequences (risk perception)	Provide feedback using images. Personalised scenario based risk information (Bosch, Daansen et al. 2004).	Familiar physical or verbal images as analogies to a less familiar process. Plausible scenario with a cause and outcome; imagery. Presented as individual and undeniable.	Weight development over past 5 years is shown in a graph after answering questions about weight history. Trend for weight development is predicted (e.g. weight gain when no action is undertaken) and compared to the intervention goal: lifelong weight-gain prevention.
1.2 Can explain what the energy balance is, its relation to body weight and small changes in DI and PA (knowledge).	Provide information about behaviour-health link. (Bartholomew, Parcel et al. 2006).	Message is relevant and not too discrepant from target's group experience.	Short pieces of factual information about the energy balance, bodyweight, and small changes. Illustrations are added to clarify the text.
1.3 Has stronger positive feelings towards WGP than negative (attitude).	Prompt review of current behavioural goals /perspective (Prochaska, Velicer et al. 1994) Anticipated regret (Abraham and Sheeran 2003).	Initiation from the perspective of the learner. Neutrality of original attitude.	Users fill out advantages and disadvantages of WGP, which results in a decisional balance. They are asked to (re)consider their advantages and disadvantages and relative importance and decide whether they are willing to prevent weight gain. Those who do not yet decide for WGP are asked to consider the long-term consequences of weight-gain prevention and 'no action', and can then re-consider their choice.
1.4 Says to be able to prevent weight gain. (self-efficacy)	Provide general encouragement by modelling	Attention, remembrance, skills, reinforcement; credible source, method and channel.	People are asked if they think they can prevent weight gain. If not, some peers tell their positive experiences with WGP (testimonials).

Table 2 (continued)

Change objectives The participant: (determinant)	**Theoretical Methods** (all tailored)	**Parameters for use**	**Practical strategy**
PO 2. People choose at least one small change in DI or PA.			
2.1 Is able to describe personal DI and PA (awareness)	Personal feedback on behaviour (Weinstein 1988; Brug, Oenema et al. 2005; Oenema, Tan et al. 2005; Kroeze, Werkman et al. 2006; Oenema, Brug et al. 2008)	Feedback that is individual, follows the desired behaviour closely in time.	They fill out detailed questions on DI and PA. Individual feedback on DI and PA is given, and areas for improvement are indicated. (Oenema, Tan et al. 2005; Oenema, Brug et al. 2008)
2.2 Chooses a change that they feel positive and self-efficacious about (goal commitment + action efficacy).	Prompt intention formation by belief selection (Bartholomew, Parcel et al. 2006)	Requires investigation of the current beliefs of the individual before choosing the belief on which to intervene.	The program allows users to choose one change from a personal list. People are asked to pick a change that they think they *can* change and would *enjoy*.
2.3 States a clear goal	Guided goal setting (Locke and Latham 2002).	Commitment to the goal; goals that are difficult but available within the individuals practice of coping response.	People set a clear goal, guided by questions in a graphic organiser, such as the size of the change the would like to make./ Their answers are presented as their personal goal.
PO 3. People prepare strategies to establish how they will make their chosen behaviour change			
3.1 Is able to perform the change (action-efficacy)	Guided action planning (Sniehotta, Scholz et al. 2005).	Subskill demonstration, instruction, and enactment with feedback	People answer questions (from a graphic organiser, figure 2) on how they will make the change and which preparation is necessary (such as shopping). This is presented as their action plan.
3.2 Makes the change at the chosen moment (cues to action)	Learn to use cues by implementation intentions (II) (Gollwitzer and Sheeran 2006).	Existing positive intentions and clear cues for action	Guided setting of implementation intentions for initiation of action. They state where when and how the change will be made.
3.3 Receives support from others when necessary (social support)	Mobilise social support	Combines caring, trust, openness, and acceptance with support for behavioural change.	People are motivated for and guided in asking significant others to support their behaviour change. They can talk with other participants on the forum of the intervention website.
PO 4. People change their DI or PA			
4.1 Is able to monitor behavioural change and compare it with goal (awareness)	Personal feedback and prompt self-monitoring	Feedback that is individual, follows the desired behaviour closely in time.	People answer questions about their behaviour change over the past week. Next, tailored feedback about performance is given.

Table 2 (continued)

Change objectives The participant: (determinant)	**Theoretical Methods** (all tailored)	**Parameters for use**	**Practical strategy**
4.2 Feels able to pick up change after lapse (maintenance-efficacy)	Reattribution training to prevent relapse (Marlatt and Gordon 1985; Hospers, Kok et al. 1990).	Requires counselling of unstable and external attributions for failure.	People are asked to describe the situation that caused failure. Feedback: concentrate on the success. Learns that a lapse is normal, and that one can learn from it. It is explained to them that the situation caused the failure, but that failure can be prevented by preparing for this situation.
4.3 Identifies high-risk situations (awareness) Has possible coping strategies available. (self-efficacy?)	Relapse prevention Planning coping responses Implementation intentions (Marlatt and Gordon 1985; Sniehotta, Schwarzer et al. 2005))	Identification of high-risk situations and practice of coping response.	After describing the failure situation, people receive tailored advice on how to act in this specific situation (cognitive and behavioural). The coping response is formulated as an implementation intention: 'If difficult situation X arises, I'll do Y'
PO 5. People evaluate the success of the behaviour change and its effect on body weight.			
5.1 Is able to monitor (changes in) body weight (awareness) Is aware of normal weight range (awareness of standards)	Monitoring Guided practice (Bandura 1991) Visualisation of personal feedback.	Subskill demonstration, instruction, and enactment with feedback Familiar physical or verbal images as analogies to a less familiar process.	It is briefly explained why weight monitoring is done and how it should be done. At the same time, guided practice is applied to learn the steps of evaluating body weight in practice. People fill out their bodyweight every week. After four weeks, the program provides them with information about the 'normal range' of their bodyweight, and what it means if they cross this range. Visuals are used to make this visible.
5.2 Attributes weight changes correctly Shows confidence in WGP (maintenance self-efficacy)	Guided pratice Reattribution training	Requires counselling of unstable and external attributions for failure.	People passively learn how to recognise and attribute weight gain, and the actions to be taken when weight gain is observed (Marlatt and Gordon 1985).
5.3 Shows commitment to WGP (attitude/ commitment)	Behavioural contract (Kirschenbaum and Flanery 1984)	Should include goal, timeline and rewards, respondent has to agree.	People are asked to sign a personalised 'certificate', which includes tailored information from previous parts of the intervention.
Other components of the website:			
Receives support from others when necessary (social support)	Plan social support	Combines caring, trust, openness, and acceptance with support for behavioural change.	The GRIPP website also includes a forum, to stimulate interaction with other participants.

Table 2 (continued)

Change objectives The participant: (determinant)	**Theoretical Methods** (all tailored)	**Parameters for use**	**Practical strategy**
Knows and can cook healthy dishes	Active learning	Time, information and skills	The website includes a database with healthy recipes from all food groups.
Knows where to find other information about healthy food and exercising	Prompt cues	Existing positive intentions and clear cues for action	A selection of useful websites is presented. This includes website on prevention of PA injuries, healthy recipes, etc.

Step 3 Theory-Based Methods and Practical strategies

In step 3 we identified and selected theoretical methods for modifying the important determinants and thus achieving the COs. These are to be translated into practical strategies. For each determinant we retrieved potentially applicable methods, strategies and their parameters for use (i.e. consideration to ensure effectiveness) from the theoretical and empirical literature. We then selected methods for inclusion in the intervention on the basis of technical options, feasibility, parameters for use and strategies identified in the FGIs, so that we could include one or two methods per change objective. The most important methods and strategies are shown in table 2.

We will now provide some more detailed examples of methods and strategies that were chosen and applied in the program.

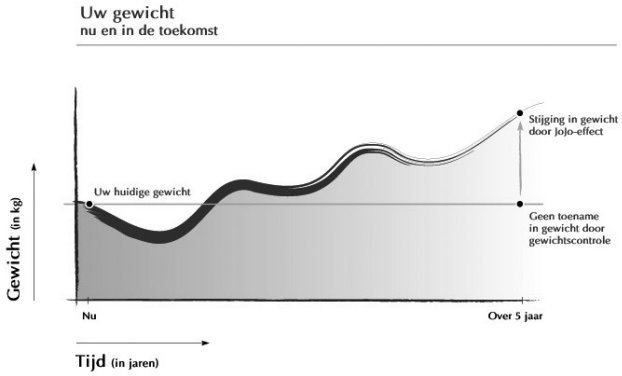
Personalised risk information

Personalised (visual) risk information (Bosch, Daansen et al. 2004) was, for example, selected as a suitable method for increasing the perceived risk of weight gain (PO 1). With regard to the parameters for feasibility and use (individualisation, and the plausibility of the scenario), tailored graphs were shown depicting the development of expected body weight over the next five years, based on a person's weight history in the past five years (figure 1) and their future weight goal. People who had indicated WGP, substantial weight loss, or doing nothing as their future weight goal were provided with respectively a graph depicting a flat line (representing weight maintenance), a cycling curve that gradually goes up (representing weigh cycling), or a straight line that gradually goes up (representing increase in weight). All graphs were accompanied by a text explaining how it should be interpreted.

Decisional balance

To establish a positive attitude towards WGP (PO 1) the users were asked to review their beliefs about WGP. Their perspectives were taken into account by asking him/her what the perceived advantages and disadvantages of WGP are. The answers were presented in a decisional balance format. Each user was asked to consider both advantages and disadvantages,

Figure 1. Example: visualisation of past weight gain.



Title of the graph: 'Your weight: now and in the future. On the y-axis: 'bodyweight in kg', on the x-axis: 'time in years' (from present until 5 years in the future). The black dot on the left represents: 'your weight at present', and the upper black dot on the right represents: 'your weight in 5 years, increased because of weight cycling'. The lower black dot represents 'your possible weight when weight gain is prevented'.

then to determine which are more important and last, to decide whether he/she was willing to prevent weight gain.

Behavioural feedback

Behavioural feedback on DI and PA was identified as a suitable method for increasing awareness of the current DI and PA (PO 2) (Weinstein and Sandman 1992; Oenema 2004) and to identify areas of change. By taking account of the parameters for use (individualized and specific feedback that follows the behaviour closely in time), this intervention component assesses behaviour over the past month, provides feedback on the behaviour and indicates in which specific DI or PA sub-behaviours changes of 100 kcal a day would be feasible.

On the basis of their own preference and feasibility of making small changes in DI or PA, users can choose the change that they want to proceed with. Users that prefer to make a change in DI, can start with completing the 112-item DI-questionnaire (DI-q), which assesses frequency, quantity and type (high energy – low energy) of dairy products, bread spreads, carbohydrates, meat, gravy and sauces, sugar-sweetened drinks, snacks and alcohol usually consumed during a day. After completing the questionnaire, users receive feedback on personal energy intake for each food category, illustrated by green, orange or red scores. Participants can click on each food category, to receive more detailed feedback on why they had a certain score (red or orange indicating that it would be possible to make a small change in that food category) and suggestions for what they can change in order to reduce energy intake with 100 kcal a day (see additional file S1 for an example). For PA, a thirty-five item questionnaire is used to analyse total daily PA and PA in four specific sub-domains (PA in leisure time, at work, for transportation and sports and household activities). Orange

and red scores indicate the sub-behaviours in which improvements can be made. From the feedback provided, people can choose what they would like to change.

Goal setting

Goal setting and formation of implementation intentions were identified as appropriate strategies for preparing a behavioural change (PO 3). Important parameters for goal setting are that a user shows commitment to the goal and that goals are challenging but achievable within the individuals' possibilities. To ensure their commitment, users choose a goal that best matches their preferences and abilities. The program guides participants in defining a goal, by asking them in which DI or PA sub-domain, as indicated in the feedback (e.g., snacks), they want to make a change, to specify more exactly what they would want to change in that category (e.g., cut down on eating peanuts), how much they would like to change and whether they want to completely omit the product, or replace it by a low energy alternative (e.g., a rice cracker). Finally, users are asked to indicate when they would like to change, starting the sentence with 'If:..' (e.g. If I watch television in the evening). All choices could be written down in text boxes within the program. To support correct answers, example answers were given for every question. The answers to these four steps are summarised in an 'if… then…' statement (e.g., 'If I'm watching television in the evening, then I will eat a rice cracker instead of 2 handfuls of peanuts'). Users are advised to read the plan thoroughly and print it. A graphical representation of this process is shown in figure 2.

Figure 2; Graphic organiser indicating the steps that need to be taken to plan for action.

Text in figure: Deciding for action (title). Step 1: Decide what you would like to change. Step 2: Decide how much you would like to change. Step 3: Decide how you would like to make the change. Step 4: Decide when you would like to make the change.

Coping planning

To facilitate the phase of goal-striving behaviour (PO 4), coping planning was identified as a suitable method to prepare people for high-risk situations. Prerequisites for this method are the identification of high-risk situations and practice of coping response, which requires instruction and demonstration. Users are instructed and guided in the action-planning process. This is applied in the second and third visit, after users have initial experience with the execution of their plans. They are asked to think of a situation that took place

during the past week in which they were unable to meet their goal and choose this situation from a list (or describe the situation when it was not listed). Then, suggestions are given for strategies to cope with the chosen situation. Subsequently, users are asked to write down in pre-determined boxes what they will do the next time the difficult situation arises. Next, they are asked to think about this situation and imagine themselves performing the coping plan as a practice for the actual situation.

Contracting

Weight-management requires long-term commitment (PO 5). Contracting may help to remind people of their commitment and may be useful for long-term change because it increases the likelihood of self-modification by inducing self-monitoring. Important parts of a behavioural contract (Kirschenbaum and Flanery 1984) are the statement of a clear goal, as well as a timeline and a reward plan.

The information on self-regulation of body-weight and behaviour from previous modules is summarised in a 'certificate of enrolment'. The certificate is personalised, states that person X has finished the program, and provides a personalised overview of the behavioural goals set during the program, outlining the steps of self-regulation of behaviour and bodyweight. Participants are asked to sign the certificate and print it.

Combining strategies

The above specified methods and strategies represent a selection of the methods and strategies used in the intervention program. The other methods were similarly translated into practical strategies that were subsequently developed into intervention components. Columns 2–4 of table 2 show the methods, parameters for use and strategies for a selection of the change objectives.

Computer-tailoring is a technique that enables the provision of individualized and personally relevant feedback and information to large numbers of people. Therefore, it was decided that the intervention would be developed as a computer-tailored program and be provided over the Internet. Computer-tailoring has proven to be a suitable method for initiating and maintaining changes in DI (Noar, Benac et al. 2007; Neville, O'Hara et al. 2009) and PA behaviours (Kroeze, Werkman et al. 2006; Neville, O'Hara et al. 2009) and is also thought to be useful for interventions to promote weight-management (Hardeman, Griffin et al. 2000; Winett, Tate et al. 2005; Lombard, Deeks et al. 2009). The chosen theoretical methods and strategies were embedded within the tailored program.

Step 4 Creating a coherent program

In this step, the strategies were combined within one program plan that led to the development of the actual program. Below, we outline the scope and sequence of the final program.

Scope, delivery

The main theme of the program is 'controlling your body weight'. The program was developed around the main steps of self-regulation: monitoring body weight and behaviour ('Watch'), establishing and setting goals ('Decide'), and planning and actively pursuing them ('Act'). Throughout the program these steps were symbolized by icons (see figure 3). The final program was called GRIPP, a name that was derived from getting a grip on your bodyweight, and thus to being able to control your weight.

Figure 3. Icons for Watch, Decide and Act

Sequence

The final program consists of four parts and users are asked to visit each of the program parts during four consecutive weeks in order to work through the whole program. The first part is the most elaborate, and can take up to 45 minutes. The follow-up sessions are shorter, but the length of each visit depends on the answers of the user. In total, it takes about 90 minutes to finish the program.

The main goals of the first visit are to motivate people for weight gain prevention (PO 1), have them choose one behaviour change (PO 2) and plan action initiation (PO 3). The main goals of the second and third visit are to evaluate behaviour change in the past week, and to adapt action and coping plans (PO 4). The main goal of the fourth visit is to learn how to maintain self-regulation of body weight in the future, without use of the program (PO 5). The sequence is shown in figure 4.

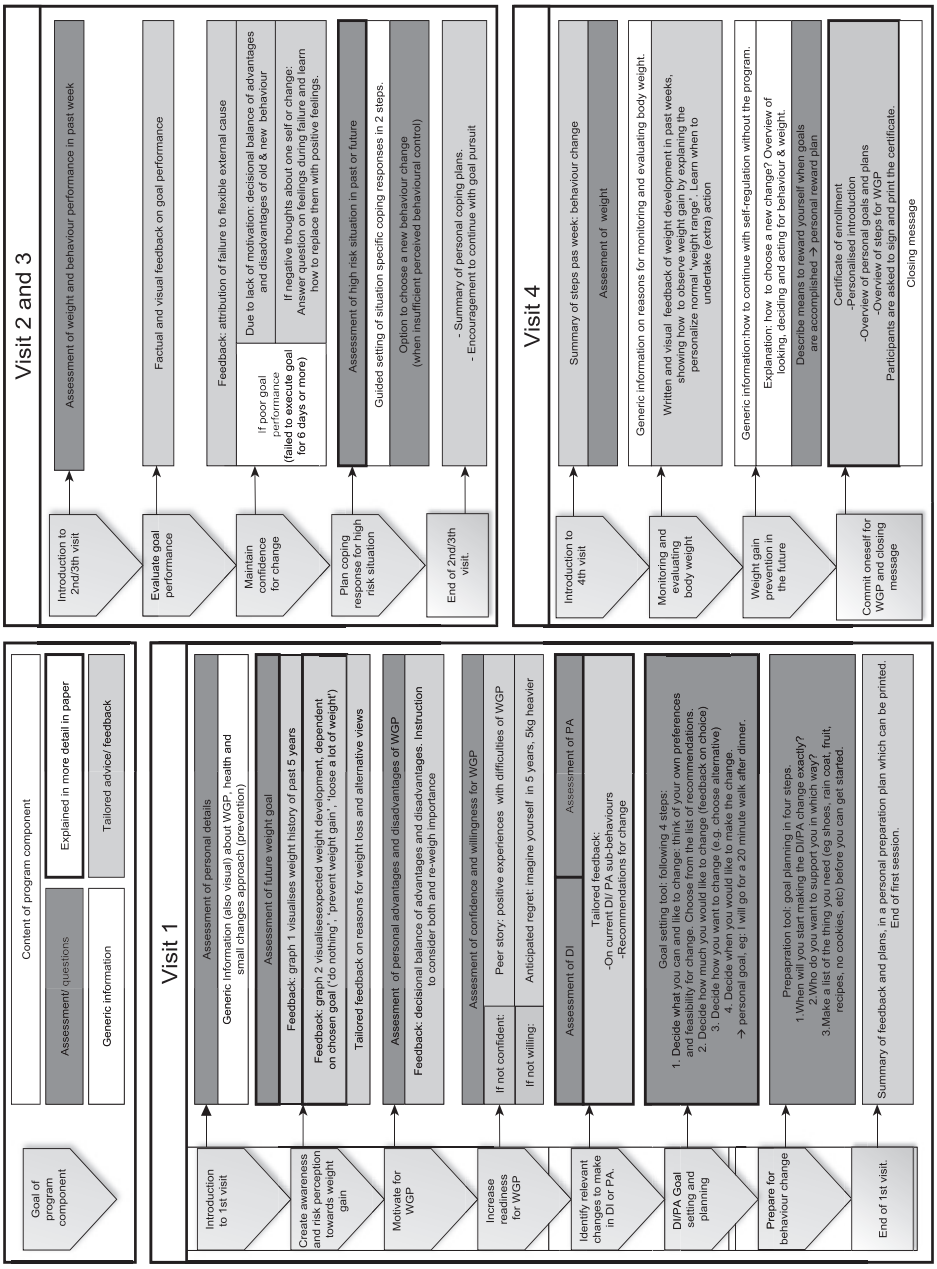
Development

The tailored program was developed using Tailorbuilder © software, which supports the creation of an entire internet-based computer-tailored program without a programmer. The tailored program was delivered as part of a project website that also included a forum (to generate support and share experiences with other participants), a recipe database and links to useful websites.

Pre-test of the intervention

A prototype of the program was pre-tested in order to identify aspects of the program that could be improved. Forty-eight adults aged 25–64 years with a BMI between 25–30 kg/m^2 (i.e. representatives of the target group) participated in the pre-test.

Figure 4. Overview of the program.



The most important findings of the pre-test were that the participants liked and appreciated the program, particularly the interactive elements. All information was understood well. The program was also considered to be long, not always clear in structure and navigation, and the follow-up sessions were perceived as being less tailored than the first session. On the basis of these findings, the program was considerably reduced in length by reducing the amount of text per page and the number of pages. Changes were made to improve ease of navigation and attractiveness. The content of follow-up sessions was also made more tailored and personalised.

Step 5 Anticipation of Adoption and Implementation

The purpose of step 5 of the IM protocol was to anticipate the adoption and implementation of the intervention. To do so, representatives from potential implementing organizations and of the target group were involved in the intervention-development process.

Representatives of potential implementing organizations participated in expert groups, which also included other researchers and intervention developers. These expert groups supported development, evaluation and implementation of the intervention. To facilitate its future implementation as an Erasmus MC program, it was designed according to the style guide of the University Medical Centre.

Representatives of the target group participated in focus-group interviews, which facilitated the identification of important determinants, important goals and potentially useable and well appreciated intervention components. By participating in the pre-tests, representatives of the target group helped to modify and improve the program.

Step 6 Evaluation Plan

The final step of the IM process was the development of an evaluation plan, of which a brief overview is described below. The Medical Ethics Committee of Erasmus Medical Center issued a declaration of no objection for the study. The trial was registered in the Dutch Trial registry (nr 1862).

Design and procedure

A two-group randomized controlled trial design will be used to study the effects of the intervention by comparing the intervention with a control group that will receive generic information about weight-management. The graphic designs of the intervention and control website are identical.

Measurements will be at baseline and one-month and six-months post-intervention. Stratified block randomisation to either the intervention or control group will take place after completion of the baseline measures. Participants will have access to their assigned study website for 2 months. To prompt website use bi-weekly e-mail reminders will be sent.

Participants

A total of 600 adults will be recruited for participation in the study. The required number of participants is based on a power calculation, in which 400 participants would be sufficient to detect an intervention effect of 0.4 BMI points with a power of 0.80 and a significance level of $p < .05$. To account for drop-out between the measurements we will recruit 600 participants for the study.

The main inclusion criteria for participation are being overweight (BMI = 25-30 kg/m^2) and aged between 25 and 65 years. In addition, sufficient command of the Dutch language and access to the Internet is required. Exclusion criteria are a diet prescribed by a doctor or dietician, pregnancy, being physically unable to increase PA and unwillingness to participate in all parts of the study.

Participants will be recruited from the general population through advertisements in local newspapers, flyers will be delivered door-to-door and in waiting rooms of GP's, and among the employees of four large companies, with the aim to reach a diverse population with respect to socioeconomic status.

Program outcomes and measurements

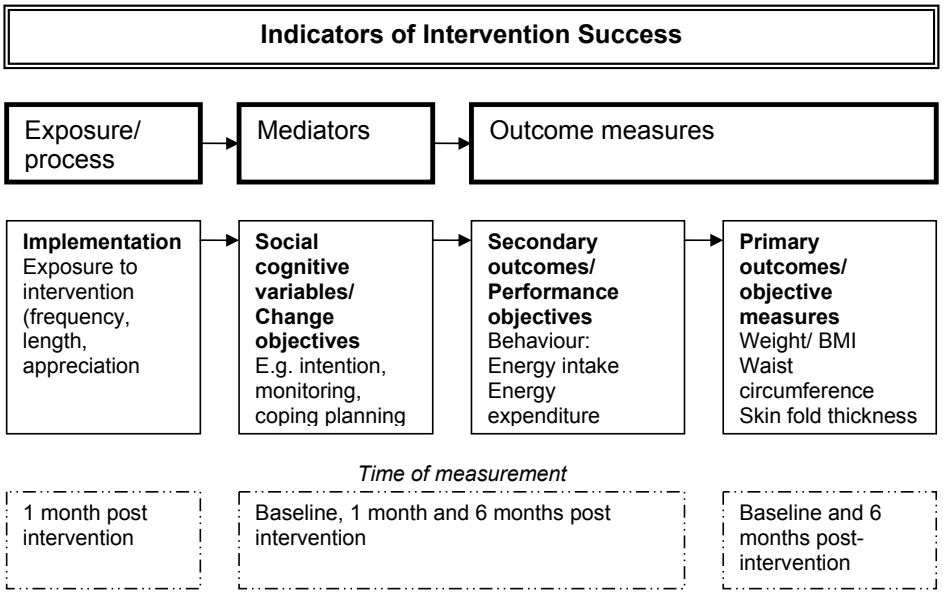
The various levels of program outcomes that will be evaluated are determined by the goals established in the IM procedure. Because the primary objective of this study is to prevent weight gain, body weight, waist circumference and skin-fold thickness (Durnin and Womersley 1974) will be evaluated at six months post- intervention. The measurements will be performed by trained research-assistants. Written informed consent will be obtained at baseline measurements.

Weight gain can be prevented by small changes in energy intake and energy expenditure and these behaviours are therefore secondary outcomes of this study. They are measured by self-reported, online questionnaires at baseline, one-month and six-month post-intervention. We hypothesised that self-regulation skills and other determinants of behaviour (such as attitude and self-efficacy) are mediators of DI and PA, as such they are also assessed in these questionnaires.

Other outcomes are measures of development and implementation, also referred to as the process evaluation (Bartholomew, Parcel et al. 2006). Participants will fill out a process evaluation questionnaire at one-month follow-up, which includes questions on perceived personal relevance, appreciation, readability, difficulty and usability. The tailoring software allows for the collection of objective data about the use of the program.

An overview of the outcomes is shown in figure 5.

Figure 5. Indicators of success and time of measurements.



DISCUSSION

This paper describes the systematic development of an online computer-tailored intervention intended to prevent weight gain in overweight adults. The intervention follows users over a period of three weeks and provides them with feedback at several points in time in order to promote self-regulation of behaviour and weight. It has an interactive, individualised approach and can be used by a large group of people.

The IM protocol helped us integrating insights from various theories. The performance objectives and methods were guided by self-regulation theory but empirical evidence with regard to the effectiveness of theoretical methods is limited (Abraham and Michie 2008). Sometimes, feasibility issues made it necessary to deviate from the original, theory-based plans. Although IM was helpful in specifying sub-goals from general goals, it does not take into account the complexity of (sub-)goals that may need to be targeted simultaneously (e.g. DI *and* PA). These simultaneous goals generally lead to multiple mini-interventions. The tailored approach allowed us to realise that and ensured that the intervention was personalised in content as well as strategies.

The aim of this paper was to provide transparency with regard to intervention development, as suggested by Abraham and Michie (Abraham and Michie 2008). We aimed to increase insight into the effectiveness of interventions and the techniques that enhance effectiveness.

The design and measures of the evaluation study are based on previous steps of IM and therefore allow us to study the contribution of specific components to the efficacy. If the intervention is efficacious it may help to prevent weight gain at the population level, at relatively low costs.

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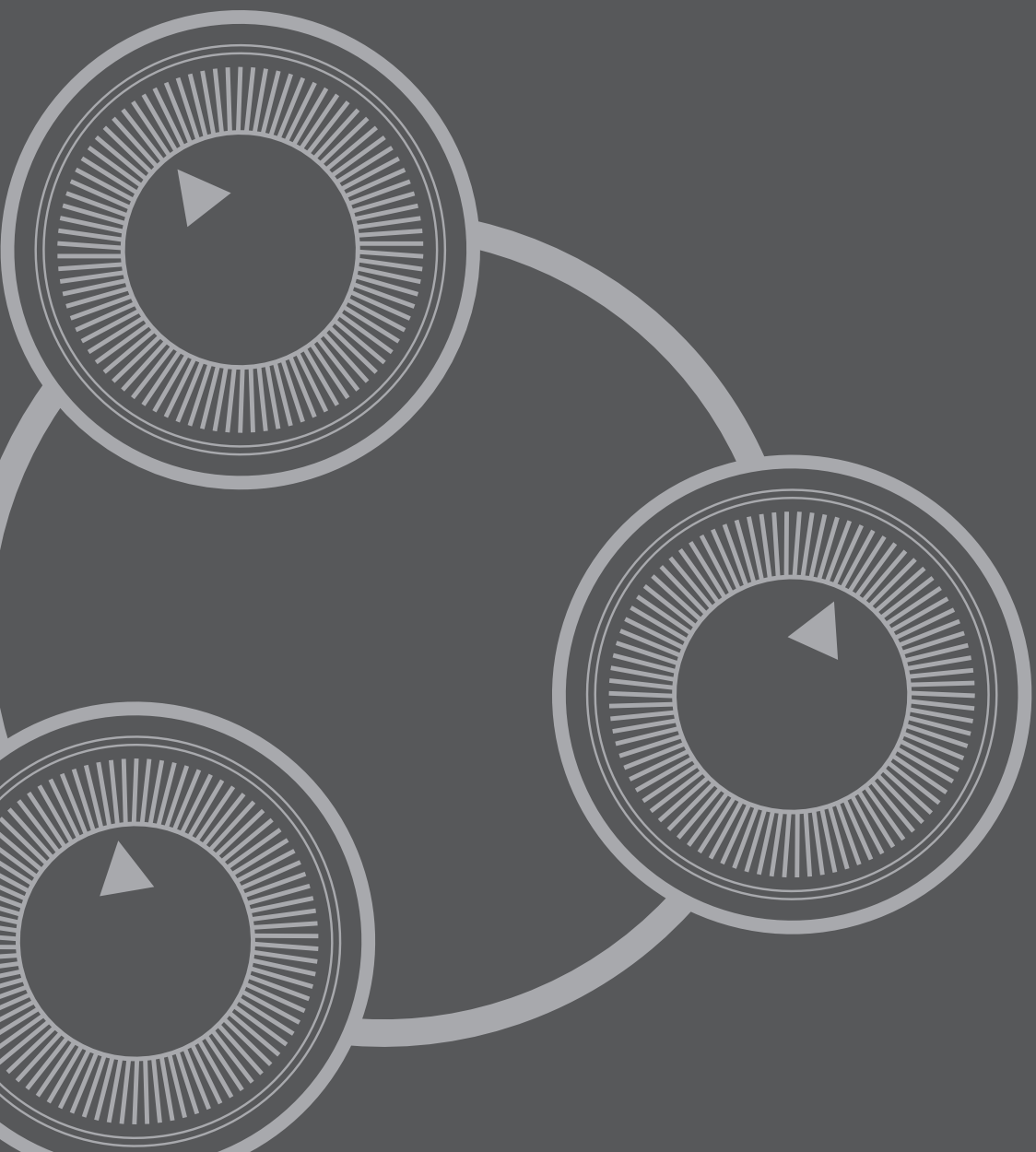
Chapter 5



Evaluating the effects of an online computer-tailored weight management intervention for overweight adults on anthropometric and behavioural outcome measures: results of a randomised controlled trial

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ABSTRACT

Background

Prevention of weight gain has been suggested as an important strategy in the prevention of obesity and people with overweight are a specifically important group to target. Currently there is a lack of weight gain prevention interventions that can reach large numbers of people. Therefore, we developed an Internet delivered computer-tailored weight management intervention for overweight adults. The focus of the intervention was on making small (100 kcal per day) but sustained changes in dietary intake (DI) or physical activity (PA) behaviours in order to maintain current weight or achieve modest weight loss. Self-regulation theory was used as the basis of the intervention.

Objective

This study aims to evaluate the efficacy of the computer-tailored intervention in weight related anthropometric measures (BMI, skin folds and waist circumference) and energy balance related behaviours (physical activity, intake of fat, snacks and sweetened drinks) in a randomised controlled trial.

Methods

The tailored intervention (TI) was compared to a generic information website (GI). Participants were 539 overweight adults (mean age 47.8 years, mean BMI 28.04, 30.9% male, 10.7% low educated) who where recruited among the general population and among employees from large companies by means of advertisements and flyers. Anthropometric measurements were measured by trained research assistants at baseline and 6-months post-intervention. DI and PA behaviours were assessed at baseline, 1-month and 6-month post-intervention, using self-reported questionnaires.

Results

Repeated measurement analyses showed that BMI remained stable over time and that there were no statistically significant differences between the study groups (BMI: TI 28.09, GI 27.61, P=0.09). Similar results were found for waist circumference and skin fold thickness. Amount of physical activity increased and intake of fat, snacks and sweetened drinks decreased during the course of the study, but there were no differences between the study groups (e.g. fat intake: TI=15.4 GI=15.9, P=.74). The first module of the tailored intervention was visited by almost all participants, but only 15% completed all four modules of the tailored intervention, while 46% completed the three modules of the general information intervention. The tailored intervention was considered more personally relevant (TI 3.20 vs GI 2.83, P=.001), containing more new information (TI 3.11 vs GI 2.73, P=.003) and having longer texts (TI 3.20 vs GI 3.07, P=.01), while there were no group differences on

other process measures such as attractiveness and comprehensibility of the information (e.g. attractive design: TI 3.22 vs GI 3.16 *P*=.58).

Conclusions

The online computer-tailored weight management intervention resulted in changes in the desired direction, such as stabilisation of weight and improvements in dietary intake, but the intervention was not more effective in preventing weight gain or modifying dietary and physical activity behaviours than generic information. A possible reason for the absence of intervention effects is sub-optimal use of the intervention and the self-regulation components. Further research is therefore needed to gain more insight in how the intervention and exposure to its contents can be improved.

Trial registration: NTR1862

INTRODUCTION

Obesity (BMI > 30 kg/m^2) is a major public health concern, because of its high prevalence and association with several negative health outcomes (Roberts, Deleger et al. 2003; Stunkard, Faith et al. 2003; Formiguera and Canton 2004), a lower quality of life (Han, Tijhuis et al. 1998; Burns, Tijhuis et al. 2001) and increased health care costs (Polder, Takkern et al. 2002). Given the poor long-term results of weight loss among obese people (Jeffery, Drewnowski et al. 2000), prevention of weight gain has been postulated as an important strategy for fighting the obesity epidemic (WHO 2007). Prevention of weight gain is particularly important among people being overweight (BMI 25-30 kg/m^2), since they are most at risk of becoming obese. Weight gain prevention (WGP) or modest weight loss does not require drastic dieting but can be achieved by making small, sustained changes in dietary intake or physical activity. In the Netherlands, the average annual weight gain was up to 0.5 kg (Visscher, Kromhout et al. 2002). The global average 1 kg of annual weight gain that is seen in many populations is caused by excess energy intake of about 7000 kcal a year. In reverse, it is hypothesised that 1 kg of annual weight gain can be prevented in about 90% of the population by a daily decrease in dietary intake (DI) or increase in physical activity (PA) of about 100 kcal (Hill, Wyatt et al. 2003). Currently, there are only few effective interventions that focus on the prevention of obesity in overweight adults (Lombard, Deeks et al. 2009) that take the small changes approach and that can reach large numbers of people. Therefore, we developed a computer-tailored intervention aiming to prevent weight gain among adults being overweight (van Genugten, van Empelen et al. 2010) and evaluated it for effects.

Behaviour change and online interventions

Evidence on the effectiveness of current obesity prevention interventions indicates that such interventions can be successful, but that findings are mixed. In the "Pound of Prevention Study", favourable (but statistically insignificant) effects of a monthly newsletter and other activities such as weight control sessions were found on behaviour and weight (Jeffery and French 1999). Two Dutch worksite interventions were successful in changing behaviour and/or preventing weight gain, using ten modules of usual care and e-mail counselling (van Wier, Arieëns et al. 2009) or individual and environmental intervention strategies (Kwak, Kremers et al. 2010). In a review by Lemmens et al(Lemmens, Oenema et al. 2008), four of eleven studies reported a positive effect on weight, of which three were aimed at modifying DI and PA. More intensive and longer, sustained interventions, including monitoring of behaviour, were more effective (Lemmens, Oenema et al. 2008). Kremers et al (Kremers, Reubsaet et al. 2009) reported a small, but statistically significant average effect size (d=0.06) of weight management interventions in their meta-analysis on prevention of overweight and obesity,

with studies aiming at weight management being more successful. However, most of these studies were not aimed at overweight adults (Kremers, Reubsaet et al. 2009).

One key factor in successful WGP is that changes in DI and PA need to be maintained for a long time, which requires self-regulation skills. Self-regulation (Austin and Vancouver 1996; Maes and Karoly 2005) motivates and enables people to achieve self-set goals. The first step of self-regulation consists of setting a goal, in this case WGP. Second, one has to choose the means to achieve this goal. In the case of WGP this means deciding to make small changes in DI and/or PA. Third, a person needs to make a detailed plan for how to make the desired change and how to avoid difficulties that may occur when making the desired change. The step of planning is followed by actual goal pursuit, monitoring and evaluation of progress toward goal achievement. Providing a platform for goal setting, planning, monitoring and providing feedback on targeted behaviour has been identified as pre-requisite for interventions that aim for change in dietary intake and physical activity (Anderson-Bill 2011). Another prerequisite for WGP interventions is that large numbers of people need to be reached, with relative low costs per person, since about 35% of the adults in the Netherlands is being overweight (Bakel and Zantinge 2010).

To be able to meet the criteria of an individualised approach and large reach, we have chosen to develop an online, computer-tailored intervention. Several reviews have shown that (online) computer tailored interventions may have a positive effect on energy-balance related behaviours (Kroeze, Werkman et al. 2006; Neville, O'Hara et al. 2009; Neville, O'Hara et al. 2009; Krebs, Prochaska et al. 2010), compared to general information or no information. One review included 76 studies on eating a healthy diet and/or physical activity and found a statistically significant overall small effect size (g=0.17) for computer-tailored interventions (Krebs, Prochaska et al. 2010). Kroeze et al concluded in a review that there is consistent evidence that tailored interventions have a positive effect on dietary intake, especially on fat reduction, and probably on physical activity (Kroeze, Werkman et al. 2006). Five of the ten studies that were included in the review of Neville (Neville, O'Hara et al. 2009) and that were aimed at reduction of dietary fat intake found a positive effect of 'second generation' (delivered through interactive technology or desktop applications such as websites, email and CD-rom) tailored interventions. A review on physical activity showed that ten of 16 studies found statistically significant positive effects on physical activity and weight reduction measures (Neville, O'Hara et al. 2009). These reviews show that positive effects on weight, dietary and physical activity behaviours can be achieved with computer tailored interventions, but there is currently no evidence for the efficacy of a tailored intervention on prevention of weight gain among overweight adults.

Aims of the study

The aim of this study was to establish the efficacy of an online, computer-tailored weight management intervention (GRIPP) on anthropometric outcome measures at 6-months

post-intervention and on energy balance related behaviours (intake of sugar sweetened drinks, snacks and fat, and physical activity) at 1- and 6-months post-intervention compared to a generic information control group. The hypotheses were that:

1. Anthropometric outcomes (BMI, waist circumference and skin fold thickness) will be more favourable at 6-months post-intervention for the intervention group, because the average annual weight gain will occur in the control group and not in the intervention group.
2. The intervention group will have lowered intake of sugar sweet(ened) drinks, snacks and high fat products, and engage in more PA at 1 and 6-months post-intervention, as compared to the control group.

In addition we performed a process evaluation in order to contribute to a better understanding of the (non) effects of the intervention and identification of areas for improvement for the intervention (Bartholomew, Parcel et al. 2011). Therefore, measures of use and appreciation are included in the process evaluation.

METHODS

Study design

A two-group randomised controlled trial was conducted, in which the computer-tailored intervention (TI, n=270) was compared with a generic information intervention (GI, n=270) control group. Body height, weight, waist circumference and skin fold thickness were measured at baseline and 6-month post-intervention and measurements of energy balance related behaviour were taken at baseline, 1-month post-intervention and 6-month post-intervention. After baseline assessment, participants were allocated to one of the two study groups (1:1), by means of sex-stratified computer block randomisation (block size: 10). The study received a declaration of no objection from the Erasmus MC medical ethics committee. The trial registration number is NTR1862 (http://apps.who.int/trialsearch/trial.aspx?trialid=NTR1862).

Participants

The participants were adults (18–65 years) being overweight (self-reported BMI 25-30 m2). Exclusion criteria were not having a sufficient command of the Dutch language, not having Internet access, being pregnant, following a diet prescribed by a physician or dietician and having a history of depression or eating disorders.

A power calculation showed that a number of 200 participants in each study group would be sufficient to detect 0.4 difference in BMI points between the intervention and control group (caused by weight gain of 0.3 kg in the control group and weight maintenance

or slight weight reduction in the intervention group) with a power of 0.80 and a significance level of $p<.05$. To account for drop-out between the measurements 600 participants needed to be recruited for the study.

Participants were recruited (between March and October 2009) from the general population in the Rotterdam (the second largest city in the Netherlands, with approximately 600.000 inhabitants) region through advertisements in local newspapers, flyers that were delivered door-to-door and in waiting rooms of GP's, and among the employees of four large companies, with the aim to reach a diverse population with respect to socioeconomic status. The recruitment materials contained information about the goal, process and incentives for the study. More detailed information was available on the study website. People who were interested in participating in the study were asked to fill out an online subscription form available on the study website that was used to assess whether they were eligible for participation in the study. Participants were included in the study if their body mass index (BMI, calculated as weight/heigt^2), based on self-reported height and weight, was between 24 and 31 (the range was broader than the objective inclusion criteria of a BMI of 25-30, in order to prevent exclusion based on biased self-reported measures). If people did not meet the inclusion or exclusion criteria, they could not subscribe for the study.

Procedures

After subscription, participants received a confirmation letter and information leaflet about the study. In addition, they received an email in which they were asked to fill out the baseline questionnaire online. Weight, height, waist circumference and skin folds were measured at the hospital site. Participants signed the informed consent form when they had their anthropometric measurements taken. When participants did not come to have their anthropometrics measured, the informed consent form was sent to their home address, with a return-envelope. Participants preferably completed both measurements (anthropometrics and questionnaire) but were also randomised when they had completed only one measurement.

All randomised participants received a login name and a password by e-mail, which gave them access to the allocated intervention program. Participants were asked to visit the websites at least three/four times during a two month period. They received e-mail reminders to (re-) visit the intervention every two weeks. One month and six months after the intervention period participants were asked by e-mail to fill out the online questionnaire again. Furthermore, after six months they were again invited to the hospital site for measurement of weight, waist circumference and skin fold thickness. Participants who did not respond to the e-mail invitations for the anthropometric measurements or to complete the questionnaire received a phone call to motivate them to complete the questionnaire or have their anthropometric measures taken. Gift vouchers were handed out as a compensation for travel expenses and invested time. Participants who filled out the questionnaire 1-month

post-intervention received a gift voucher of €10. Participants who filled out the questionnaire and had their anthropometrics measured at 6-months post-intervention, received (another) gift voucher of €10. Furthermore, because drop-out at 1-month post-intervention was higher than the expected 10%, 10 extra gift vouchers of €20,- were raffled among the participants who completed all measures at 6-months post-intervention.

Outcomes/measures

Anthropometric measures

The body measurements were performed by trained research-assistants, following a measurement protocol. *Body height* was measured twice using a Seca mobile height rod with an accuracy of 0.1 cm. The mean of both measures was used for height. A calibrated electronic digital floor scale (Seca 888 clas III) was used to measure *body weight*, with an accuracy of 0.2 kg. The measures of height and weight were used to calculate *BMI* (weight (kg) / (length (m))^2). *Waist circumference* was measured twice with a flexible band (Seca 201) with a precision of 0.1 cm. When the difference between two measurements was larger than 1.0 cm, the waist circumference was measured twice again. Mean waist circumference was calculated, based on the last two measurements. *Skin fold thickness* was measured at four sites (biceps, triceps, subscapular and supra-iliac) with the Harpenden Skinfold Caliper to assess body fat percentage (Durnin and Womersley 1974; Kwak, Kremers et al. 2010). Each site was measured three times and the mean was calculated for each site. A variable for total skin fold thickness in cm was composed by summing the means for the four sites in one measure.

The same measures, except for height, were taken at baseline and 6-months post intervention.

Energy balance related behaviours

In this study, we examined the effects on 1) fat intake, 2) snack intake, 3) intake of sweetened drinks (mean number of sweet and sweetened drinks per day) and 4) physical activity. *Fat intake*, expressed as 'fat score', was assessed using a food frequency questionnaire assessing the frequency and quantity of a variety of high density foods eaten in the past week. It was based on a validated questionnaire (Van Assema, Brug et al. 2001), and allows for calculating fat intake and intake from specific food groups. The questionnaire consisted of 74 questions and was organized according to meal pattern. Participants recorded their frequency of consumption and portion size for a selection of food items eaten during meals or between meals. Fat points were based on frequency and amount of intake of high fat products, with higher scores indicating higher fat intake. There were 23 products, in the following categories: dairy products (5), butter (1), gravy (1), sandwich fillings (3), meat and cheese for main dinner (2) and snacks (sweet, salty, hot and cold, 11 in total)). There were a

maximum number of points (2 to 5) for each product. In total, a maximum of 83 fat points could be obtained.

Furthermore, people were asked to answer questions about the mean number and amount of sweet and salty, hot and cold snacks per week, from 11 categories (e.g. fried products, candy bars, etc). *High energy snack intake* was calculated as the mean number of high energy snacks per day by multiplying the frequency per week with the amount per frequency, divided by 7 (days a week). To assess intake of sweetened drinks, questions on frequency and amount for fruit juices, soft drinks and sweetened tea and coffee were asked. *Intake of sweetened drinks* was calculated in a similar way as intake of snacks.

Physical activity was assessed using a questionnaire based on 'The Short Questionnaire to Assess Health - Enhancing Physical Activity' (SQUASH), developed to assess habitual activity level (Wendel-Vos, Schuit et al. 2003). In this 16-item questionnaire, participants were asked to indicate on how many days of the week they participated in specified activities and how much time they engaged in the activity per occasion. For active transport, respondents were asked how often they cycled and walked for home-work transportation, and the duration. Similar questions were asked for walking and cycling during leisure time. Furthermore, participants were asked how many different sports they did on a weekly basis (with a maximum of four). For each different sport, they were asked to choose the type of sport (e.g. swimming, yoga, running) from a list, choose the weekly frequency and the average duration per activity. For each category, the average number of minutes per week was calculated by multiplying the frequency with the duration. Than, this number was divided by 7 to calculate the mean number of minutes per day. Next, the number of minutes engaged in physical activity per day was calculated as the sum of all activities (active transportation, leisure time activities and sports).

The same questionnaires were used at baseline, 1-month and 6-month post-intervention to assess energy balance related behaviours.

Demographic factors

Sex (male/female), date of birth and educational level were assessed in the baseline questionnaire. To determine *age* we asked for date of birth. *Education* was assessed by asking the participants to indicate what their highest completed education was (8 answering options). A three-category variable was subsequently made, indicating a low (completed no education, primary school, secondary school or lowest level of high school or lower vocational training), medium (intermediate or high level high school) or high (completed higher vocational training, college or university) level of *education*.

Process measures

An *objective measure of exposure* to the intervention was obtained from the log-in data from the intervention registration, which keeps information from participants' use of the (tailored) information. One scale was made for use/exposure, indicating the number of modules actually used (0-4 for TI, 0-3 for GI).

Self-reported measures of use and appreciation were included in the one-month post-intervention questionnaire. If not stated otherwise, answer categories ranged from 'totally disagree' (1) to 'totally agree' (5).

Amount of information read was assessed by the question 'To what extent did you read the information in the program?". Answering categories ranged from 'none of it' (0) to 'all of it' (5). *Perceived length of the texts* was assessed by the question 'What do you think of the lengths of the texts in the program?' (Much too short (1) – Much too long (5)). Perceived *personalisation* was assessed with the statement 'The information in the program was relevant for me personally'. *Novelty* of the information was assessed by: 'The information in the program was new for me'. *Usefulness* of the information was assessed with: 'The information in the program was useful'. *Attractiveness* was assessed by the question 'The design of the program is attractive'. Usefulness of the intervention was assessed with the question 'the program is a good instrument to control my weight'. Furthermore, participants were asked whether they would *recommend the intervention to others* (No (1) – Maybe (2) – Yes (3)). Participants were also asked to give an *overall grade* to the intervention on a scale from 1 to 10 (1 being very low, 10 being very high). These questions were included in the questionnaire for the intervention and the control group and are only reported for those who have actually used the interventions.

The intervention

The objective of the computer-tailored intervention was to prevent weight gain in adults being overweight by inducing small changes (100 kcal/day) in energy balance related behaviours (DI and PA). It aimed at making a change in (one or more) behaviours that add most to the energy balance and that are associated with weight gain (frequency and duration of various physical activities and intake of fat (from several categories such as dairy, meat, cheese, sauce), snacks and sweetened drinks) (Swinburn, Caterson et al. 2004). The intervention was carefully developed based on theory and evidence using the Intervention Mapping approach (Bartholomew, Parcel et al. 2011). The intervention goals, methods and strategies were based on self-regulation theory (Maes and Karoly 2005), and other theories, such as the Theory of Planned Behaviour (Ajzen 1991), Precaution Adoption Process Model (Weinstein and Sandman 1992) and implementation intentions (Gollwitzer 1996). The strategies were combined into a computer-tailored Internet-delivered intervention. Detailed information about the intervention development and content is described elsewhere (van Genugten, van Empelen et al. 2010).

The intervention consisted of four modules each to be visited one week after the previous one and followed the steps of self-regulation. Completion of the entire program took about 90 minutes in total. The first module aimed at commitment to prevent weight gain by weighing pros and cons of WGP, identifying and setting a goal for one relevant change in DI or PA and making a plan for change. Participants were made aware of current levels of DI and PA and possibilities for change by providing them with individualised feedback on their behaviour. Then, people could make a choice for what to change (guided goal setting) and make a plan for where, when and how to make that change (implementation plan). The second and third module were focussed around evaluation of progress toward behaviour change, and provided feedback on past week performance. If necessary, it supported adaptation of action and coping plans (when attempts to change behaviour were unsuccessful). The fourth module was aimed at promoting sustained self-regulation of body weight without use of the program. A tool to monitor and evaluate (changes in) body weight was provided, as well as a short guideline with sequences of actions for long term WGP, reflecting on the self-regulatory skills that had been practiced in the previous three modules, and provision of positive reinforcement to maintain behaviour. At the end, the participants signed a personalised contract, which included their personal behaviour goals, actions plans, weight status, etc.

The tailored modules were embedded in a website that also contained recipes, a peer-to-peer forum and links to useful websites, and was accessible through the internet.

The generic information for the control group was embedded in a website with similar content, and similar reminders were sent to the participants. The main components of this website were three modules with general information on weight gain prevention, which had a similar lay-out as the TI. The first module aimed at increasing the motivation for WGP. The second module aimed at choosing for behaviour change by providing information about possible changes. The third module provided general information about a healthy diet and safe physical activity.

Statistical analyses

Descriptive statistics were used to characterize both study groups at baseline. Logistic regression analyses were conducted to evaluate whether participant characteristics (BMI, sex, education and age) and allocated intervention group were related to drop-out (drop-out no=0, yes=1) during the study. Repeated measures analyses were performed, using a general linear mixed model with a random intercept, to study changes during the study period ('time') and differences in changes between the intervention groups ('group', GI=0 vs TI=1) for the main outcome measures. These measures are objectively measured BMI, skin fold thickness and waist circumference and self-reported PA and DI (intake of fat, snacks and sweetened drinks) ('group*time' interaction). This procedure allows for inclusion of cases

with missing data, without replacement of missing values, and therefore includes all randomized participants. The 'Type III Wald test' was used to test overall statistical significance of the effects. The significance level (*P*) was set at .05 and tests were two-sided. All analyses were performed using SPSS 17.

RESULTS

Participant characteristics

In total, 630 people completed the online registration, and 539 enrolled in the study by completing the baseline questionnaire and/or anthropometric measures (Figure 1). The mean age of the participants was 47.8 years (SD 9.4), 31% were male and 11% had a low level of education. The mean BMI was 28.04 (SD 1.94). No baseline differences in

Figure 1. Participant flow for the GRIPP study.

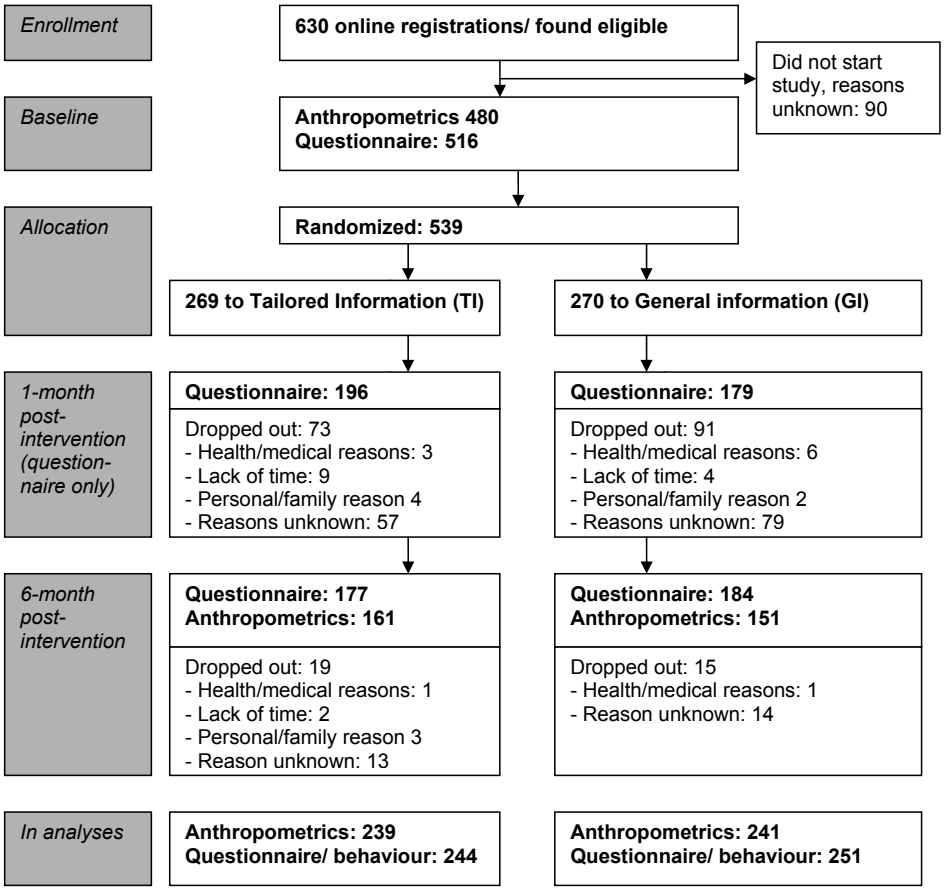

Table 1 Participant characteristics at baseline.

Group characteristics			Baseline		
			Total	**TI assigned group**	**GI assigned group**
		N	**539**	**269**	**270**
Age	Mean (sd)		47.8 (9.4)	47.7 (9.2)	47.9 (9.7)
Sex	% male (n)		30.9 (164)	31.3 (84)	30.5 (80)
Education	% low (n)		10.7 (49)	10.3 (24)	11.0 (25)
	% medium (n)		50.2 (231)	48.7 (113)	52.0 (118)
	% high (n)		39.1 (179)	40.9 (95)	37 (84)
			480	**239**	**241**
BMI	Mean kg/m^2 (sd)		28.04 (1.94)	28.17 (2.02)	27.91 (1.85)
	% Normal weight (<25) (n)		4.2 (20)	4.2 (10)	4.1 (10)
	% Overweight (25-30) (n)		78.5 (377)	75.3 (180)	81.7 (197)
	% Obese (>30) (n)		17.3 (83)	20.5 (49)	14.1 (34)
Waist circumference	Centimetres (sd)		95.78 (8.79)	95.89 (9.05)	95.66 (8.55)
Skinfold thickness	Centimetres (sd)		8.82 (1.97)	8.87 (1.92)	8.77 (2.0)
			457	**231**	**226**
Physical activity	Minutes/day		67.12 (54.3)	63.1 (50.4)	69.6 (42.4)
Fat intake	Points/week		17.14 (6.1)	17.0 (6.0)	17.3 (6.2)
Sweetened drinks	Servings/day		0.95 (1.2)	0.96 (1.2)	0.93 (1.2)
Snacks	Number/ day		2.28 (1.9)	2.2 (2.0)	2.3 (1.9)

TI = tailored intervention, GI = General information.

No significant differences at baseline (P< .05) were observed.

socio-demographic characteristics, behaviour and anthropometrics were observed between the intervention groups (Table 1).

Loss to follow-up

At baseline, 480 participants had their anthropometrics measured and 313 people at 6-month post-intervention (drop-out 34.8%). Younger people were more likely to drop-out between the two moments of anthropometric measures (OR age= 0.97, 95% CI 0.95-0.99).

A total of 375 participants filled out the 1-month post-intervention (drop-out 31%) and 361 people the 6-month post-intervention questionnaire (drop-out 33%). Drop-out between baseline and 1-month post-intervention questionnaires was more likely among men (OR sex =0.56, 95%CI 0.35-0.89). Drop-out between baseline and 6-month post-intervention was more likely among younger participants; (OR age=0.97, 95%CI 0.95-0.99). No other differences were observed among those who completed the study and those who were lost after the first or second measurement.

Intervention effects

Repeated measures analyses showed that BMI did not change statistically significantly over time (*P*=.09) (Table 2 and 3) and that there was no difference between the two groups (interaction effect group*time *P*=.09). Skin fold thickness increased statistically significantly over time (*P*<.001) but there were no differences in change over time between the TI and GI group (interaction effect group*time *P*=.95). There was a statistically significant decrease in waist circumference over time (*P*<.001), but the change in time was not different between the study groups (interaction effect group*time *P*=.12).

Table 2. Crude means and difference of objectively measured anthropometric outcomes at baseline and 6-month post-intervention. (N=480)

Outcome (sd)	*Group*	Baseline		6-month post-intervention		Difference
		N	Mean values	N	Mean values	T0-T2
BMI	**TI**	239	28.17 (2.02)	151	28.09 (2.36)	TI: -0.08
Kg/m^2 (sd)	**GI**	241	27.91 (1.85)	161	27.61 (2.03)	GI: -0.30
WC	**TI**	239	95.89 (9.05)	151	94.41 (10.23)	TI: -1.48
Cm (sd)	**GI**	241	95.66 (8.55)	161	93.20 (8.61)	GI: -2.46
SFT	**TI**	239	8.87 (1.92)	151	9.67 (2.14)	TI +0.80
Cm (sd)	**GI**	241	8.77 (2.0)	161	9.47 (2.14)	GI: +0.70

BMI = body mass index, WC = waist circumference, SFT = skin fold thickness, TI = tailored intervention, GI = general information.

Table 3. Results of general linear mixed model analyses for objectively measured anthropometric outcome measures: Estimated marginal means and p-values of time and group*time effects. (N=480)

Outcome	Group	Baseline estimated means	6-month post-intervention: estimated means	Type III tests (p)	
				Time	Group*time
BMI	**TI**	28.19	29.19	.09	.09
Kg/m^2 (sd)	**GI**	27.89	27.65		
WC	**TI**	95.87	94.62	.000	.12
Cm (sd)	**GI**	95.66	93.48		
SFT	**TI**	8.87	9.55	.00	.95
Cm (sd)	**GI**	8.77	9.66		

BMI = body mass index, WC = waist circumference, SFT = skin fold thickness, TI = tailored intervention, GI = general information.

The time spent on physical activity decreased statistically significantly in the total population (*P*=.002), but the change was not statistically significantly different among the TI and GI (interaction effect group*time *P*=.44) (table 4 and 5). Mean fat intake decreased statistically significantly between baseline measurement and post-intervention measurements (*P*<.001), but the decrease was similar in the two conditions (interaction effect group*time *P*=.74).

Table 4. Crude means and difference of specific self-reported behaviour (DI and PA) at baseline, and 1 and 6-month post-intervention. (N=495)

Outcome (sd)	Group	Baseline T0		1-month post-intervention		6-month post-intervention		Mean difference
		N	Mean values	N	Mean values	N	Mean values	T0-T1, T0-T2
Minutes PA/ day	**TI**	231	63.1 (50.4)	196	61.9 (56.5)	177	63.3 (53.6)	-1.2, +0.2
	GI	226	69.6 (42.4)	179	68.9 (51.8)	184	78.7 (60.7)	-0.7, +15.6
Fat intake/ week	**TI**	231	17.0 (6.0)	196	15.3 (6.3)	177	15.4 (6.0)	-1.7, -1.6
	GI	226	17.3 (6.2)	179	15.7 (6.2)	184	15.9 (6.4)	-1.6, -1.4
Servings sweetened drinks/day	**TI**	231	0.96 (1.2)	196	0.8 (1.3)	177	0.8 (1.1)	-0.16, -0.16
	GI	226	0.93 (1.2)	179	0.7 (1.2)	184	0.7 (1.0)	-0.23, -0.23
Snacks/ day	**TI**	231	2.2 (2.0)	196	1.7 (1.6)	177	1.8 (1.4)	-0.5, -0.4
	GI	226	2.3 (1.9)	179	1.8 (1.6)	184	1.9 (1.5)	-0.5, -0.4

TI = tailored intervention, GI = general information.

Table 5. Results of general linear mixed model analyses for specific self-reported behaviour (DI and PA) at baseline, and 1 and 6-month post-intervention: Estimated marginal means and p-values of time and group*time effects. (N=495)

Outcome	Group	Baseline estimated means	1-month post-intervention: estimated means	6-month post-intervention: estimated means	Type III tests (p)	
					Time	Group* time
Minutes PA/day	**TI**	63.06	61.94	63.25	.00	.44
	GI	69.58	68.90	78.71		
Fat intake/ week	**TI**	17.94	15.47	15.23	.00	.74
	GI	16.94	15.89	15.99		
Servings sweetened drinks/day	**TI**	0.96	0.82	0.81	.00	.55
	GI	0.94	0.74	0.67		
Snacks/ day	**TI**	2.21	1.73	1.80	.00	.78
	GI	2.29	1.91	1.90		

TI = tailored intervention, GI = general information.

Intake of sweetened drinks and snacks showed a similar pattern: intake decreased over time (sweetened drinks $P<.001$, snacks $P<.001$), but changes were not different between the intervention groups (interaction effect group*time: sweetened drinks $P=.55$, and snack intake $P=.78$).

Some of the behavioural outcomes measures (physical activity and intake of sweetened drinks and snacks) had a very skewed distribution. Log-transformation of these outcomes did not improve the fitted model and was not of influence on the time and intervention effects.

Process evaluation

The log-in data showed that more than 80% (n=272) of the respondents used the first module of their allocated intervention (Figure 2). About 15% (n=41) completed four modules of the TI intervention and 46% (n=124) completed the three modules of the GI intervention.

Figure 2. Attrition diagram: server registration of use of general information intervention and tailored information intervention.

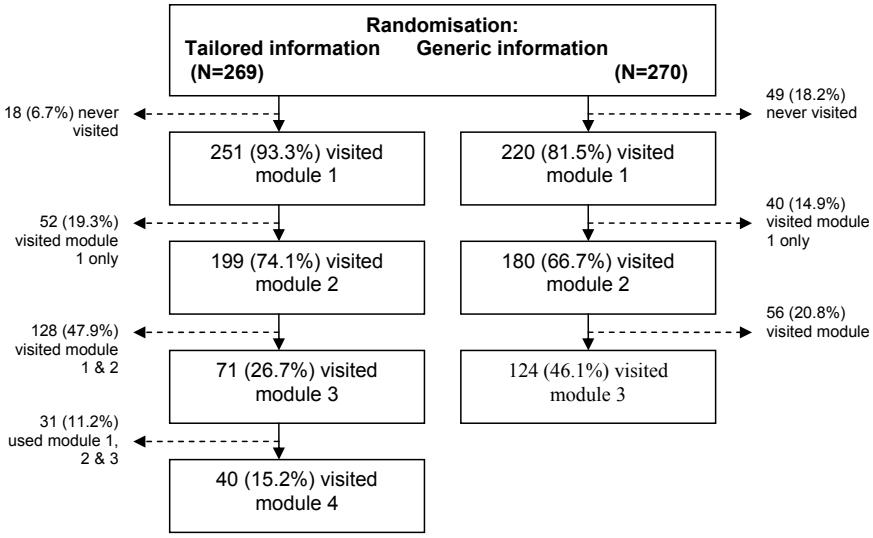

Table 6. Process measures; means (sd) of appreciation of general information intervention and tailored information intervention, self-reported at 1-month post intervention, and t-test for differences between these groups.

Process measure	Scale	TI	GI	*P*
Self-reported measures[b]	**N**	162	154	-
Amount of information read	Nothing (1) – All (5)	4.07 (1.0)	4.5 (0.8)	.00
Length of the texts	Much too short (1)- Much too long (5)	3.20 (0.5)	3.07 (0.4)	.01
Information meant for me personally	Not at all (1) – Very much (5)	3.20 (1.0)	2.83 (1.0)	.001
New information	Totally disagree (1) - Totally agree (5)	3.11 (1.1)	2.73 (1.1)	.003
Useful information		3.48 (0.9)	3.44 (0.9)	.68
Attractive design		3.22 (0.9)	3.16 (0.9)	.58
Good tool for WGP		2.90 (1.1)	2.75 (1.0)	.20
Recommend to others	No (1) – Maybe (2) - Yes (3)	2.14 (0.7)	2.14 (0.8)	.93
Overall grade	Very low (0) – Very high (10)	6.6 (1.4)	6.6 (1.3)	.69

TI = tailored intervention, GI = general information

[a] Objective use of intervention, information obtained from tailoring software.

[b] Self-reported at 1-month post-intervention questionnaire, must have used at least the first module

T-tests (table 6) showed that participants in the TI group reported to have read statistically significantly less of the presented information (TI: 4.07 vs GI 4.5, *P*=.00) and were slightly less positive about the lengths of the texts (TI 3.20 vs GI 3.07, *P*=.01), compared to the TI group. The information in the TI group was experienced as more 'new' (TI 3.11 vs GI 2.73, *P*=.003) and individualised (TI 3.20 vs GI 2.83, *P*=0.001), compared to the GI. No differences were found for the usefulness (TI 3.48 vs GI 3.44) and attractiveness (TI 3.22 vs GI 3.16) of the information, the usefulness of the program as a tool for WGP (TI 2.90 vs GI 2.75), recommending it to others (TI 2.14 vs GI 2.14) and the overall grade (TI 6. 6 vs GI 6.6).

DISCUSSION

In the present study we evaluated the effects of a carefully developed multi-session computer-tailored weight management intervention for overweight adults that was based on self-regulation theory and contained a number of self-regulation strategies. The results of the study showed that weight remained stable over time and that waist circumference and dietary behaviours slightly improved over six months, but that these improvements were not different from those in the generic information control group. Thus, even though some of the effects of the intervention were in the desired direction, in the present study we could not demonstrate that the elaborate intervention was more effective in inducing weight gain prevention than more basic generic information about weight management.

Interpretation of the results: theory and previous evidence

Our intervention was solidly based on theory and evidence relevant for inducing weight maintenance and long-term changes in dietary intake and physical activity and used the promising method of computer tailoring as an educational technique. It therefore had, in theory, good prospects for effects. The technique of computer tailoring has successfully been applied in interventions aimed at dietary intake, physical activity and weight loss (Noar, Benac et al. 2007; Enwald and Huotari 2010; Krebs, Prochaska et al. 2010) but no meta-analytic results are known for prevention of weight gain.

Our tailored intervention had a number of characteristics that have been indentified as having a positive influence on intervention efficacy (Noar, Benac et al. 2007; Krebs, Prochaska et al. 2010), such as including four modules ('contact moments'), and at least six behaviour change strategies. Thus, the intervention had, in theory, good prospects to be effective.

Furthermore, based on the limited evidence with respect to effectiveness of interventions aimed at the prevention of weight gain (Kremers, Reubsaet et al. 2009), the results of our study fit in the pattern of mixed effects that have been found. One study found positive

effects of an online weight management intervention (Hunter, Peterson et al. 2008), but this intervention aimed at a restriction of calorie intake to 1200-1500 calories/day, while our study aimed at a reduction of 100 kcal/day. It may be argued that a change of 100 kcal/day is too small to prevent weight gain or induce modest weight loss, but there is compelling evidence that this approach can in fact result in weight maintenance and modest weight loss, also for people who are overweight (Rodearmel, Wyatt et al. 2007; Hill 2009; Hall, Sacks et al. 2011). Our results are furthermore, comparable to a number of other studies where the intervention group showed small or no effects on weight, compared to their control group (Jeffery and French 1999; Levine, Klem et al. 2007; Booth, Nowson et al. 2008).

The results of our study compare unfavourably to the results from two previous intervention studies conducted in the Netherlands (van Wier, Arieëns et al. 2009; Kwak, Kremers et al. 2010). These studies found effects on waist circumference and skin fold thickness (Kwak, Kremers et al. 2010) or waist circumference and weight (van Wier, Arieëns et al. 2009), but had employees of companies as their target population and were more extensive in that it included e-mail counselling (van Wier, Arieëns et al. 2009) and changes in the environment (Kwak, Kremers et al. 2010). Despite the planned, theory and evidence-based development, the number of contacts and the dynamic tailoring, our tailored intervention did not appear to be more effective than general information. Possible explanations may be the integration of self-regulation theory in an online intervention, methodological issues and exposure to the intervention.

Theoretical basis

We used self-regulation theory as the main theoretical basis for the intervention. This theory is particularly suitable for management of chronic diseases and behaviours and outcomes that need life long regulation, which is also the case for weight management. Self-regulation theory has been applied successfully in interventions aimed at weight-loss among young adults, asthma management and diabetes (e.g. (Shegog, Bartholomew et al. 2001; Gokee-LaRose, Gorin et al. 2009; Thoolen, de Ridder et al. 2009)). Many successful interventions that were based on self-regulation have been intensive counsellor led interventions, in which participants are guided through all the important steps of self-regulation (monitoring, goal setting, action planning, evaluation, adaptation). However, in the present study we had to apply the self-regulation principles and strategies in a computerised program that had to guide the participants through all the steps of self-regulation. Even though feasible, incorporating principles from self-regulation theory and self-regulation strategies in an online self-management intervention may not translate into the same results as when implemented in a face-to-face counselling session. That is, there are fewer possibilities for instructions for use, a smaller variety of options, and use of the intervention components may be less optimal, both in quality and frequency of use. There is indeed evidence that for example implementation intentions have been of better quality when developed in the presence of

a researcher who reviewed the plans, as without a counsellor present (Luszczynska 2006) and lack of quality of goals and plans in unguided interventions have been reported (de Vet, Gebhardt et al. 2011; de Vet, Oenema et al.).

Exposure to the intervention

Even though multiple visits are associated with more efficacy of (computer-tailored) interventions (Norman, Zabinski et al. 2007) it has also been well documented that attrition is high in online interventions with multiple sessions (Verheijden, Jans et al. 2007; Brouwer, Oenema et al. 2010; Robroek, Brouwer et al. 2010). To improve the likelihood that participants would revisit the intervention, we incorporated some of the elements that had been indicated as potentially associated with more revisits in previous research (Brouwer, Oenema et al. 2008) in the intervention. In follow-up visits participants could monitor progress, could access new elements of the intervention, could review recipes and tips on the website that were refreshed every two weeks and participants received email reminders to visit the website every two weeks. Nevertheless logon rates decreased over time. As a consequence large numbers of participants in the intervention group were not exposed to parts of the intervention in which important self-regulation strategies, such as monitoring, feedback and coping planning were incorporated. Therefore, the 'dynamic' tailoring (e.g. feedback on progress) which is one of the potentially effect size increasing elements of computer tailoring (Michie, Abraham et al. 2009; Krebs, Prochaska et al. 2010), was not delivered to large numbers of participants. Similar (low) use of self-regulation components has been observed before among a study sample of overweight adults (Binks and Van Mierlo 2010).

Possible reasons for drop out were the number and length of the tailored modules and perhaps the ineffectiveness of the reminders. In order to increase use and effectiveness, we should improve these aspects, e.g. by using other media such as short message service (SMS), as reminders (Webb, Joseph et al. 2010). Direct contact, e.g. to motivate people, teach the steps of self-regulation and problem solving skills (Norman, Zabinski et al. 2007) may be useful to increase involvement. Furthermore, although the tailored intervention was appreciated a little bit better than the general information intervention, the overall appreciation was just sufficient. Improving the intervention on these aspects may have a positive influence on use and effect.

Methodological considerations

Kremers et al (Kremers, Reubsaet et al. 2009) found in their review that interventions aimed at weight management have small effect sizes (mean effect size of 0.06). This means that studies need to be powered to detect such small effect sizes. Our study was sufficiently powered to detect a difference of 0.4 BMI points, based on the assumption that weight would remain stable or be slightly reduced in the intervention group and that weight would show the usual annual increase of 0.6 kg among the control group. However, weight did not

increase in the control group in the actual study, but remained stable. Even though initially our sample size was sufficient for detecting the anticipated effect, retention of participants in the study was much lower than we had anticipated, thus reducing the actual power of the study. However, the size of the effect appears to be very small, indicating that lack of power was not the most important reason for not detecting an effect. Rather, the effect in the control group, whether it was caused by participation in the study, completion of the questionnaire or the exposure to generic information, was larger than expected. The high drop-out from the study is not unusual (Groeneveld, Proper et al. 2009), but a serious concern and at this moment we do not know the reasons for this high drop-out.

It is possible that we could have detected an effect had we compared the intervention with a no-intervention control group. There is evidence that the effect size of a computer tailored intervention depends on the comparison condition: comparing a tailored intervention to a generic message (r=0.058) results in smaller effect sizes than comparing it to a no-treatment group (r=0.11) (Noar, Benac et al. 2007). However, comparing the intervention to a no information control group can only provide insight in the effects of the intervention per se and cannot provide insight in the effectiveness of a specific technique, such as tailoring or self-regulation. In the present study we were interested in examining the effects in comparison to a control group that received 'usual care' in the form of generic information about weight management that can also be found on the website of the Dutch Nutrition Bureau. The technique of computer tailoring and the incorporation of self-regulation strategies as incorporated and implemented in the present study appeared no more effective than the already available information on Dutch websites.

Another methodological issue that is worth to be discussed is the effect of offering respondents the option to choose their own behavioural change. Our second hypothesis concerned differences in dietary and physical activity behaviours. Changes in dietary and PA behaviours may precede or mediate changes in anthropometric outcome measures and are therefore relevant to study. Even though there was a time effect for some of these behaviours, there were no differences between the intervention and control group.

Lack of effects on the behavioural outcome measures was somewhat expected since participants could choose from 10 changes in DI and PA (e.g. increase active transport with 20 minutes per day), and even more options within these subgroups (e.g. cycling or walking), based on their current dietary and PA behaviour. This results in small groups of people who chose for the same change to make, which makes it difficult to detect differences between the study groups in the dietary and PA sub-behaviours. Limited power for detection of differences in relevant underlying behaviours is one of the consequences of dynamic and personally adapted interventions.

Strengths and limitations

Strengths of the study are its randomised controlled design and the use of objective measures of BMI, waist circumference and skin fold thickness. Limitations are the self-reported measures for physical activity and dietary intake, which may have resulted in less reliable outcomes. The baseline level of PA was high among all participants in the study, which may be due to over-reporting. If the participants also over-reported their PA level in the tailored intervention, this may have resulted in less room for improvement, limiting the potential intervention effect. Another limitation is that participants in the intervention and control condition were not exposed to an equal number of program sessions. However, we do not expect that this had a large effect on the study outcomes, since the tailored intervention (with more and more elaborate content) was not more effective than the generic information. Furthermore, we had a six month assessment as the longest follow-up. We cannot rule out that differences between the study groups would become more apparent after a longer follow-up period. Although drop-out was high, it was similar in both conditions and mainly related to age, as in other studies (Verheijden, Jans et al. 2007; Brouwer, Oenema et al. 2010; Robroek, Brouwer et al. 2010). However, due to the high drop-out the results cannot be generalized to other populations than those who remained participating in the study.

Conclusion

The carefully developed online computer-tailored weight management intervention for adults being overweight resulted in stable weight and changes in dietary intake in the desired direction, but the tailored intervention was not more effective than generic information. A possible reason for the absence of intervention effects is sub-optimal use of the intervention and the self-regulation components. Further research is therefore needed to gain more insight in how the intervention and exposure to its contents can be improved.

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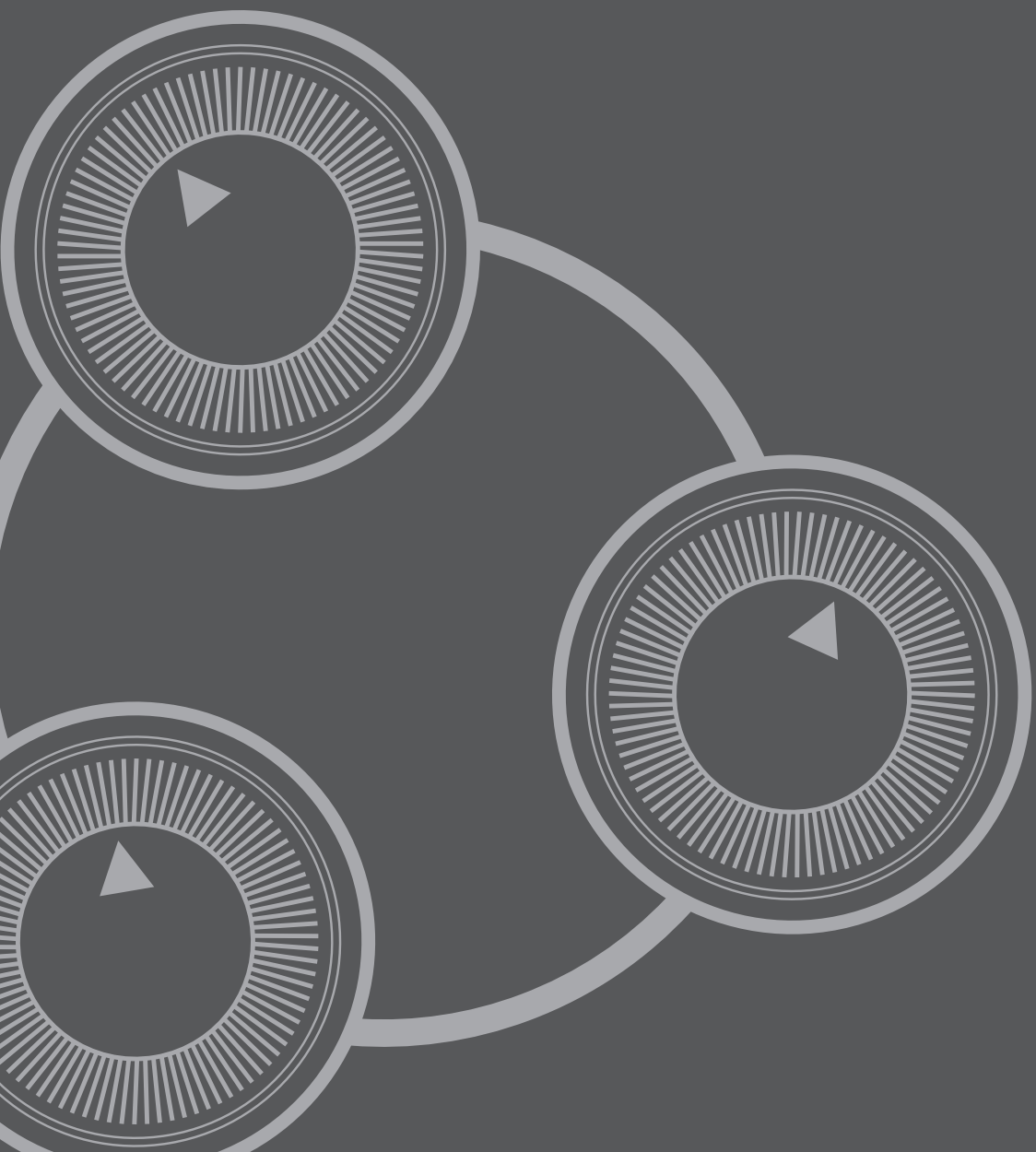
Chapter 6



Correlated characteristics of intervention use and quality of self-regulation plans in an online computer-tailored weight gain prevention program for overweight adults

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Submitted

ABSTRACT

The aims of this study were to 1) identify whether user characteristics were associated with use of an online, computer-tailored self-regulation intervention aimed at prevention of weight gain, 2) examine the quality of the goals and action plans that were generated using the online planning tools and 3) the relation between intervention use and effects on weight and weight related behaviours. Data were obtained as part of the effect evaluation trial in which the tailored intervention was compared to a website containing generic information about prevention of weight gain. Participants were 539 overweight adults (mean age 46.9 years, mean BMI 28.03, 31.2% male, 11% low education level). Use of the intervention and its components was derived from server registration data. BMI was measured and physical activity, fat intake, motivational factors and self-regulation skills self-reported at baseline and 6-month post-intervention. Use of the tailored intervention decreased sharply after the first modules. Visiting the first tailored intervention module was more likely among participants with unfavourable levels of physical activity but low fat intake. Revisiting the intervention was more likely among participants high in restrained eating. The planning components were used by 5-55% of the participants, but only 20-75% of the plans were of good quality. Higher intervention use was related to a lower fat intake, but not to other outcome measures. These results indicate that use is not of large influence on effectiveness, but that quality of implementation of the self-regulation components may be more important.

INTRODUCTION

The Internet is increasingly being used as a channel for the delivery of interactive and individualized interventions to promote healthy lifestyles of populations (Kreuter, Farrell et al. 2000; Leung 2008; Oenema, Brug et al. 2008; Tu and Cohen 2008). Even though there is evidence that such interventions can be effective in improving a variety of behaviours and outcomes (Kroeze, Werkman et al. 2006; Norman, Zabinski et al. 2007; Krebs, Prochaska et al. 2010; Webb, Joseph et al. 2010), there is also a large body of evidence to suggest that the use of such interventions is not optimal (Verheijden, Jans et al. 2007; Brouwer, Oenema et al. 2010; Robroek, Brouwer et al. 2010). A steep decline in numbers of visitors to follow-up sessions is often observed, and non-optimal use or exposure to the intervention content may result in an underestimation of the effects that can be achieved with an online intervention (Eysenbach 2005). More evidence is needed with regard to factors that may be associated with intervention use (Eysenbach 2005; Brouwer, Oenema et al. 2010; Brouwer, Kroeze et al. 2011). The aim of the present study was to identify factors that are associated with first and repeated use of an online weight gain prevention program for adults being overweight and to identify whether higher intensity of use is associated with the intervention effect.

The intervention

The intervention under study is an online, computer-tailored self-regulation program aimed at the prevention of weight gain among overweight (BMI 25-30) adults (van Genugten, van Empelen et al. 2010). The computer-tailored intervention consisted of four modules which people could visit in a four to eight week period. The effects of the computer-tailored self-regulation intervention were compared to a generic information website in a randomised controlled trial. The results of this evaluation study showed that even though weight was maintained in the intervention group, there was no significant difference between the intervention group and the control group [chapter 5]. One of the reasons for this lack of effect may have been insufficient exposure to the intervention.

Determinants of intervention use

The existing literature suggests that intervention use may be related to their age, sex, education, BMI, motivational and behavioural factors. Older adults were more likely to use online interventions (Verheijden, Jans et al. 2007; Brouwer, Oenema et al. 2010), and women (Verheijden, Jans et al. 2007; Brouwer, Oenema et al. 2010; Robroek, Brouwer et al. 2010) have found to be more likely to use online interventions, but the evidence is inconclusive with respect to level of education. Visiting and revisiting an online intervention may be related to risk factors such as higher-than-recommended intake of saturated fat (Brouwer, Oenema et al. 2010), elevated cholesterol level {Robroek, 2010 #826) and higher (Verheijden, Jans et al. 2007) or lower body weight (Brouwer, 2010 #827). Thus, there have been several

studies that have examined the use of intervention. However, their results are inconclusive and more research is needed. Therefore, it is important to identify participant factors that are associated with intervention use. Besides demographic and behavioural factors, psychological factors such as weight locus of control, restrained eating, and self-regulation skills may also influence intervention use, since such factors may determine whether people feel a need for using supportive interventions.

Quality of usage: action and coping planning

The present intervention was developed based on the principles of self-regulation theory. For that reason, goal selection and action planning (deciding about behaviour by specifying where, when and how to act) and coping planning (linking anticipated risk situations with a suitable coping responses) were important intervention components (Luszczynska, 2009 #932; Sniehotta, 2006 #267; Schwarzer, 2010 #674) Working through these planning exercises requires time, effort and independent thinking from the participants, which may influence the utilization of the component as well as the quality of the plans that are formulated. Findings concerning the use of online self-regulation components are scarce, but action plans must be of good quality to be effective (de Vet, Oenema et al. 2011). Therefore, it is important to study the use quality of the goals and plans made by the participants.

Intervention use and effects

A meta-analytic review on tailoring showed that the number of intervention contacts is positively related to intervention effects (Noar, Benac et al. 2007). Therefore, our third aim was to study the effect of revisiting the tailored intervention on BMI, behavioural outcomes and self-regulation skills.

This study aims to answer the following 3 questions:

1. Which baseline demographic, motivational and behavioural factors and self-regulation skills are associated with first time and repeated use of an online computer-tailored self-regulation intervention aimed at preventing weight gain among overweight adults?
2. Do participants use the action planning and coping planning tools and, if so, what is the quality of the generated plans?
3. Is higher intensity of use (i.e., more visits to the program) associated with effects on BMI, dietary and physical activity behaviours, and self-regulation skills?

METHODS

Design, participants and recruitment

The data for this study were generated in a randomized trial (conducted March 2009 – October 2010) that aimed to establish the effects of the intervention on anthropometric and behavioural outcomes. The study was conducted between March 2009 and October 2010. In this trial the tailored intervention website (TI) was compared to a generic information website (GI). Anthropometrics and self-reported behaviour were measured at baseline and six months after the intervention. Participants were all overweight adults (BMI 25–30; 25–65 years of age). Participants were recruited from the general population through advertisements placed in local newspapers and flyers that were distributed door-to-door, in the waiting rooms of GPs and among the employees of four large companies. Participants enrolled in the study by filling out an online submission form. Subsequently, criteria for inclusion (25-60 years of age, BMI 25-30, ability to read and write in Dutch and easy access to the Internet) and exclusion criteria (pregnancy, following a diet prescribed by dietician or physician, having a history of depression or eating disorder) were checked.

Procedures

After subscription, participants received a confirmation letter and information leaflet about the study. They also received an email in which they were asked to fill out the baseline questionnaire online. Weight, height, waist circumference and skin fold thickness were measured at the hospital site. Participants preferably completed both measurements (anthropometrics and questionnaire) but were also randomised when they had completed only one measurement.

All randomised participants received a login name and password by e-mail, to login to their assigned intervention program. Participants were asked to visit the websites at least three/four times during a two month period. They received bi-weekly e-mail reminders to (re-) visit the intervention. Six months after the intervention period participants were asked by e-mail to fill out the online questionnaire again and their anthropometrics were assessed at the hospital site. Phone calls were made to participants who did not respond by e-mail. Participants who filled out the questionnaire and had their anthropometrics measured at the six month follow-up, received a gift voucher of €10.

The intervention

The intervention was developed using the Intervention Mapping protocol (Bartholomew, Parcel et al. 2006). The intervention's main objective was to prevent weight gain in overweight adults by inducing small changes (100 kcal/day) in energy balance-related behaviours. Examples of these changes include frequency and duration of physical activity and the intake of fat from several categories such as dairy, meat, cheese, sauce and gravy, snacks

and sweetened drinks (Swinburn, Caterson et al. 2004). The intervention goals, methods and strategies were based on self-regulation theory (Maes and Karoly 2005), motivational theories (Ajzen 1991; Weinstein and Sandman 1992; Gollwitzer 1996) and goal setting and action planning theories (Gollwitzer 1996; Sniehotta 2009).

In order to deliver the self-regulation strategies in a timely fashion, the intervention consisted of four modules, each to be visited one week after the previous one, to work through all steps of self-regulation (goal setting, active goal pursuit and evaluation (Maes and Karoly 2005)). Completion of all modules would take about 90 minutes. The first module aimed at increasing participants' commitment to prevent weight gain by first weighing the pros and cons of WGP, then choosing one behaviour change and planning for change. Based on the tailored feedback on DI or PA people were guided in choosing what they wanted to change (goal selection) and where, when and how to make the change (action planning). To prevent relapse in the first week of change, people were asked whether they expected to encounter a risk situation (a situation for which they expected that making the change might be difficult, e.g. at a party). If they did, they were asked to think about this situation and to describe their (coping planning) strategy to avoid or handle the situation in text boxes (Marlatt and Gordon 1985). The second and third module intended to evaluate progress on behaviour change, by giving participants feedback on the performance during the past week, based on self-reported behaviour change. If necessary, the intervention supported adaptation of the action and coping plans (when achieving the behavioural goals had failed). The fourth module instructed participants how to maintain self-regulation of body weight without using the program and they were provided with a tool to monitor and evaluate (changes in) their body weight. To finalise the program, the participants signed a personalised contract, which included the goals and plans they had written down in the intervention, but also their weight status and information for weight regulation in the future.

The tailored modules were embedded in a website that also contained recipes, a peer-to-peer forum and links to useful websites. Reminders to (re)visit the intervention were sent to the participants every two weeks. A more detailed description of the intervention's development and content has been published elsewhere (van Genugten, van Empelen et al. 2010).

Generic information group

Those randomly assigned to the generic information (GI) condition had access to a website that provided generic information on weight management. This information could be worked through in three modules. The first module provided generic information about the goal of weight gain prevention, such as health risks associated with weight gain. The second module provided information about possible behaviour changes. The third module provided general information about a healthy diet and safe physical activity. The visual design of the website was the same as the tailored intervention and participants received the same reminders as the TI group.

Measurements

An objective measure of *exposure to the interventions* was obtained by retrieving the log-in data from the intervention server registrations, which registered how often each participant logged on to the program and which intervention modules they visited (0-3 for GI, 0-4 for TI). First, a dichotomous 'never-ever' *score* was created, with 0 indicating 'never visited' and 1 indicating 'visited at least once' (sum score ≥ 1). For those who visited at least one module (sum score ≥ 1), a dichotomous score was made for *'revisiting'* (visited first module only: 0, also visited later modules: 1).

Use of action planning and coping planning components and quality of goals and plans

Information about the use of the action planning and coping planning components and the quality of the plans developed by the participants was also obtained from the intervention server registration, where the plans that had been written were stored. Two dichotomous variables were made, indicating whether or not people chose to make *a change in dietary intake and/or physical activity*. A dichotomous variable was created for *use of the action planning component*, coded as 0: no plan, 1: a plan. Then, the *quality* of the goal was determined, by scoring the text that was written in the text boxes in the program. For this text, one point was obtained if a challenging but realistic goal was stated (e.g. increase walking by 30 minutes daily) and 1 point was obtained if the situation in which the change would be made was clearly and realistically stated (e.g. when going and returning from work). For PA, a third point could be obtained for filling out with whom one was planning to do the activity (e.g. 'with my partner' or 'alone'). Therefore, three points could be obtained for a stated PA goal, and two points could be obtained for a DI goal.

A similar approach was used for *use and quality of the coping plans*, in particular how the participant planned to avoid or cope with a difficult situation in the first week of behaviour change. A dichotomous variable was created based on the participant's use of the coping planning component (0: did not describe a coping plan, 1: described a coping plan). Next, the content of the coping plan was coded to assess its quality. A coping plan was coded as 'correct' (scoring a 2) if a response was given that a) would facilitate the desired behaviour, and b) was feasible in the risk situations that were defined (van Osch, Lechner et al. 2008). If either or both these criteria were not met, 1 point was given to indicate an 'incorrect plan'.

All goals and coping plans were coded by two researchers (LVG and HVDP) separately, and then discussed until agreement was obtained.

Correlates of intervention use: cognitive factors

Intention to prevent weight gain, perceived behaviour control, weight locus of control and restrained eating are potential determinants of intervention use and were assessed at baseline. A description of the assessments of these factors is described in appendix 1.

Weight locus of control was assessed using a translation of the Weight Locus of Control (WLOC) scale (Saltzer 1982), which has four statements (two externally and two internally worded items). The scale reliability (Cronbach's α of the four items was 0.61, which is low, but acceptable (Cortina 1993) and comparable to the original scale (Saltzer 1982). Thus, a composite measure (mean value) was created.

Restrained eating was assessed with the restrained sub-scale of the Dutch Eating behavior Questionnaire (van Strien, Frijters et al. 1986; Strien 2005). This questionnaire consists of 10 items about restrained eating. Cronbach's α of all items was 0.87 and all items were combined to one mean value.

Correlates of intervention use and study outcomes: self-regulation skills

Since monitoring weight, planning for PA, planning for DI and proactive coping skills could be related to the participant's use of the intervention, these are intervention outcomes. These variables were assessed at baseline and at the six-month follow-up. A description of the assessments of these factors is described in appendix 1.

A dichotomous variable was made for *monitoring of weight*: weighting weekly (1) and not weighting weekly (e.g. daily or never) (0).

Planning for PA was assessed with four items and *Planning for DI* was assessed with three items. Cronbach's α was 0.92 for planning for PA and 0.94 for planning for DI. Therefore, composite measures (mean scores) were calculated for PA and DI respectively.

Pro-active coping skills toward body weight were measured using the 21-item 'Proactive Competence Scale' (PCS) (Bode, de Ridder et al. 2007), which is based on the five phases of coping (Aspinwall and Taylor 1997). All items were combined in one mean score.

Correlates of intervention use and study outcomes: fat intake and physical activity

Fat intake and physical activity were assessed at baseline and six months after the intervention.

Fat intake was assessed using a food frequency questionnaire that assessed the frequency and quantity of a variety of high energy foods eaten in the past week. It was based on a validated questionnaire (Van Assema, Brug et al. 2001), and it allows the researcher to calculate fat intake in 'fat points'. The questionnaire consisted of 74 questions and was organized according to meal pattern. Participants recorded their frequency of consumption and portion size for a selection of food items eaten during meals or between meals. Higher scores indicate more frequent and/or larger amounts of fat intake. There were 23 products that fell into the following categories: dairy products (5), butter (1), gravy (1), sandwich fillings (3), meat and cheese for main dinner (2) and sweet, salty, hot and cold snacks (11 in total). In total, a maximum of 83 fat points could be obtained.

Physical activity was assessed using a questionnaire based on the 'Short QUestionnaire to ASsess Health enhancing physical activity' (SQUASH), developed to assess habitual physical

activity (Wendel-Vos, Schuit et al. 2003). In this 16-item questionnaire, participants were asked to indicate how many days of the week they participated in specific activities and how much time they engaged in the activity per occasion. For active transport, respondents were asked how often they cycled and walked from home to work, and how long that takes. The same questions were asked about walking and cycling during leisure time. Furthermore, participants were asked how many different sports they do on a weekly basis (with a maximum of four). For each different sport, they were asked to pick their sports activities (e.g. swimming, running, soccer) from a list, indicate the weekly frequency and how long on average they engaged in that sports activity per occasion. For each category, the mean number of minutes per day was calculated by multiplying the frequency with the duration and dividing this number by 7. Next, the total number of minutes engaged in physical activity per day was calculated as the sum of all activities (active transportation, leisure time activities and sports).

Study outcome: Body Mass Index

The body measurements were performed by trained research-assistants, following a measurement protocol. Body height was measured twice at baseline using a Seca mobile height rod with an accuracy of 0.1 cm. The mean of both measures was used for height. A calibrated electronic digital floor scale (Seca 888 class III) was used to measure *body weight*, with an accuracy of 0.2 kg. The measures of height and weight were used to calculate *BMI* (weight (kg) / length $(m)^2$). Body weight was measured at baseline and six months after the intervention.

Correlates of intervention use: socio-demographic factors

Sex (male/female), date of birth and educational level were assessed in the baseline questionnaire. To determine *age* we asked participants their date of birth. *Education* was assessed by asking the participants to indicate what their highest completed level of education was (8 answering options). A three-category variable was subsequently made, indicating a low (completed no education, primary school, secondary school or lowest level of high school or lower vocational training), medium (intermediate or high level high school) or high (completed higher vocational training, college or university) level of education.

Analyses

Descriptive statistics were used to describe the study population. T-test and chi-square tests were used to compare the two intervention groups on baseline demographic, behavioural and psychological factors. Logistic regression analyses were applied to study participant predictors of first intervention visit and follow-up visits. In order to identify the best predictors of usage, a backward elimination (likelihood ratio) procedure was used. Independent variables were age, education, sex, BMI, fat intake, physical activity, intention and perceived

behavioural control for WGP, weight locus of control, restrained eating, monitoring of weight, action planning for change in DI and PA and pro-active coping skills as assessed at baseline.

Descriptive statistics were used to describe the usage of the self-regulation components and the quality of the plans.

To study whether more intense usage of the intervention was associated with improved intervention effects (on BMI, fat intake, PA, coping skills, monitoring behaviour and action planning) in the tailored intervention group, multiple linear regression analyses were conducted. BMI, fat intake, PA, coping skills, monitoring behaviour and action planning were the dependent variables; usage of the tailored intervention was the independent variable. The analyses were adjusted for the baseline value of the outcome measure, age, sex and education and all factors that appeared to have a statistically significant influence on repeated intervention use in the previous step.

RESULTS

Study population

In total, 630 people completed the online registration, and 539 initially participated by completing the baseline questionnaire and/or coming in for anthropometric measurements. Subsequently, 480 people had their anthropometrics measurements recorded at baseline and 313 of the 480 returned for measurements 6 months after the intervention (drop-out rate of 39.5%). A total of 516 participants filled the baseline questionnaire and 361 participants filled out the six-month follow-up questionnaire (drop-out rate of 33%). The mean age of the participants was 46.9 years (SD 9.5), 31% were male, 11% had a low and 50.3% had a medium level of education. The mean BMI was 28.03 (SD 1.94). No group differences in socio-demographic characteristics, BMI, behaviour, motivational factors and self-regulation skills were observed at baseline (table 1).

Table 1. Baseline characteristics of total study population and intervention groups.

		All participants	TI	GI	Difference
Demographics	**N**	**539**	**269**	**270**	**p-value**
Age	Mean	47.8 (9.4)	47.7 (9.2)	47.9 (9.7)	.81
Sex	% male	30.9	31.3	30.5	.46†
Education	% low	10.7	10.3	11.0	.69†
	% medium	50.3	48.7	52.0	
	% high	39.0	40.9	37.0	
Outcome measures					
BMI	Mean	28.03 (1.94)	28.17 (2.02)	27.9 (1.85)	.14
Fat intake	Mean fat points	17.2 (6.0)	17.0 (6.0)	17.3 (6.2)	.64
Physical activity	Mean minutes	66.2 (51.5)	63.1 (50.4)	69.6 (42.4)	.17
Motivational factors					
Intention for WGP	Mean score (1-5)	4.67 (0.6)	4.7 (0.6)	4.6 (0.7)	.15
PBC towards WGP	Mean score (1-5)	4.21 (0.8)	4.3 (0.8)	4.1 (0.8)	.06
Self-regulation skills					
Monitoring weight	% that weights weekly	46.5	48.7	44.3	.32†
Action planning	Mean score DI (1-4)	2.28 (1.0)	2.30 (1.0)	2.27 (1.0)	.78
	Mean score PA (1-4)	2.06 (0.9)	2.08 (1.0)	2.04 (0.9)	.68
Pro-active coping skills	Mean score (1-4)	2.67 (0.5)	2.67 (0.5)	2.66 (0.5)	.97
Weight locus of control	Mean score (1-4)	3.75 (.61)	3.76 (.66)	3.73 (.56)	.62
Restrained eating	Mean score (1-5)	3.10 (.69)	3.11 (.63)	3.08 (.75)	.56

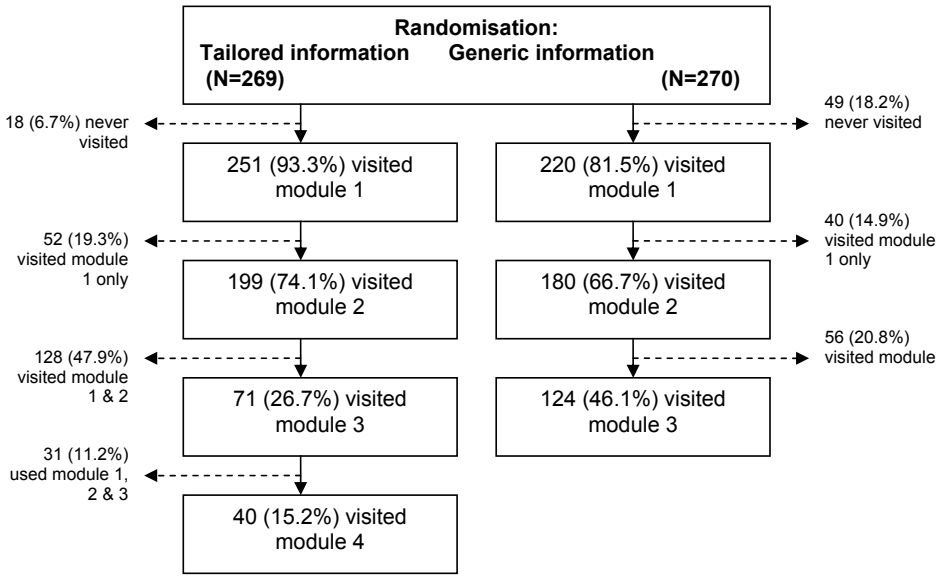
TI= tailored information, GI= general information

† = p-value obtained from chi-square test

Website visit

After randomization, the first TI module was visited by 93.3% of the participants who were allocated to the tailored intervention (figure 1), the second by 74.1%, the third 26.7%, and the fourth and last module by 15.2%. The first GI module was used by 81.8% of those allocated to the generic information group, the second by 66.9%, and the third and by 46.1%. Logistic regression analysis (table 2) showed that first time usage of the tailored intervention is more likely among participants with a lower level of physical activity (OR=0.98, 95% CI .96-.999), lower action planning for PA (OR=0.23, 95%CI .06-.9) and lower fat intake (OR=0.77, 95%CI .62-.95) at baseline. Re-visiting the tailored intervention was more likely among people with fewer pro-active coping skills (OR=0.28, 95% CI 0.10-0.76) and higher levels of restrained eating (OR=2.45, 95% CI 1.11-5.43) at baseline.

Figure 1. Use N (%) of the tailored and generic information intervention modules among all participants, who were randomly assigned to one of the intervention groups.



Usage of self-regulation components

Server registrations showed that of those assigned to the TI website (n=251), 140 (55.7%) of the participants chose to make a change in DI and 40 (15.9%) chose to make a change in PA. Further, 138 participants (54.9%) wrote down an action plan for change in DI (Table 3), of which 111 (44.2%) had a plan of good quality. Thirty-nine people (15.9%) developed an action plan for an increase in PA, of which 14 (5.6%) stated a plan of good quality. The most important reasons for lack of quality of a plan was an unclear description of the moment of change (e.g. 'in the morning').

Table 2. Results of multivariable backward logistic regression analyses with demographic, motivational and self-regulation factors and BMI as correlates of use and repeated use of the tailored intervention condition. N=269

Predicting factors		**Using the intervention at least once**	**Using the intervention at least twice**
Demographic factors		**OR (95% CI)**	**OR (95% CI)**
Age	Mean		
Sex	Male		
	Female		
Education	Low		
	Medium		
	High		
BMI & behavioural factors			
BMI	Kg/m^2		
Fat intake	Mean fat points/day	0.77 (0.62-0.95)	
Physical activity	Mean minutes/day	0.98 (.96-.999)	
Motivational factors			
Intention for weight gain prevention	Mean (1-5)		
Perceived behavioural control for weight gain prevention	Mean (1-5)		
Self-regulation factors			
Monitoring weight	Non-weekly		
	Weekly		
Action planning	Mean DI (1-4)		
	Mean PA (1-4)	0.23 (0.05-0.97)	
Pro-active coping skills for prevention of weight gain	Mean (1-4)		0.28 (0.10-0.76)
Restrained eating	Mean (1-5)		2.45 (1.12-5.43)
Weight locus of control	Mean (1-4)		

BMI = Body Mass Index, DI = dietary intake, PA = physical activity.

Table 3: Frequency of use and quality of self-regulation components of visitors (n=251) of the first module of the tailored intervention.

Target behaviour	Component	% (n) 'yes'	% of good quality (n)
Dietary intake	Chose a change in DI	55.7 (140)	-
	Set a goal for DI	54.9 (138)	80.4 (111)
	Described a coping plan for change in DI	27.9 (70)	71.4 (50)
Physical activity	Chose a change in PA	15.9 (40)	-
	Set a goal for PA	15.9 (40)	35 (14)
	Described a coping plan for a change in PA	4.7 (12)	50 (6)

DI = dietary intake, PA = physical activity

Seventy people (27.9%) indicated that they were expecting a risk situation for making a change in DI. Fifty (19.9%) stated a clear and helpful coping plan. Twelve participants (4.7%) were expecting a high-risk situation for a change in PA. Six of them (2.3%) wrote a clear and helpful coping strategy. Reasons for insufficient plans were an unclear description of the situation or a not-helpful strategy.

Effects of usage on outcome measures

Participants who used the TI website more than once had a larger decrease in fat intake than those who used the intervention only once (b=-2.82, 95% CI -4.84, -.79), but there were no differences for the other outcomes (self-regulation skills, physical activity and BMI) between one-time visitors and re-visitors (table 4).

Table 4. Baseline and 6 months post-intervention means for outcome measures specified for number of intervention visits, and results from multivariate regression analyses for the influence of repeated intervention visits on outcome measures.

Outcome measure	*Baseline*		*6 months post-intervention*		*Effect of repeated intervention use (> 1 visits) on outcome measure* [a]	
	N	**mean (SD)**	**N**	**mean (SD)**	**B**	**95% CI**
Pro-active coping skills (1-4)						
1 visit	31	2.71 (.54)	26	2.77 (.60)	0	
>1 visits	182	2.63 (.46)	135	2.74 (.52)	0.068	-0.12, .26
Weight monitoring (% that monitors weekly)						
1 visit	31	7.7%	27	22.1%	1	
>1 visits	182	7.7%	146	25.6%	3.93[b]	0.98, 15.71
Planning for change in DI (1-4)						
1 visit	31	2.26 (1.09)	26	2.40 (.95)	0	
>1 visits	182	2.29 (1.02)	146	2.40 (.96)	0.146	-.27, .56
Planning for change in PA (1-4)						
1 visit	31	2.35 (1.07)	27	2.11 (1.11)	0	
>1 visits	182	2.02 (.92)	146	2.07 (.95)	0.002	-.40, .40
Fat intake/ day (fat points)						
1 visit	31	18.03 (6.27)	27	18.56 (5.58)	0	
>1 visits	183	16.67 (5.72)	146	14.77 (5.96)	**-2.82**	**-4.84, -.79**
PA: minutes/day						
1 visit	30	65.73 (68.12)	27	67.30 (51.91)	0	
>1 visits	182	61.25 (46.08)	146	62.76 (54.29)	12.15	-9.30, 33.59
BMI: kg/m^2						
1 visit	43	28.61 (2.30)	25	28.10 (2.08)	0	
>1 visits	187	28.01 (1.92)	129	27.99 (2.37)	0.52	-.16, 1.20

Results printed in **bold** are statistically significant. DI = dietary intake, PA= physical activity

[a] Linear regression analyses, controlled for age, sex, education, planning for PA, weight locus of control, pro-active coping skills and restrained eating at baseline.

[b] Odds Ratio, derived from logistic regression analysis, value refers to the likelihood of weekly monitoring for repeated use compared to one time use.

DISCUSSION

In this study, we examined usage and predictors of usage of an online computer-tailored weight gain prevention intervention for overweight adults and the association between intensity of intervention use and intervention effects. Initial use of the the TI was high (93%), but only 27% of the participants visited three modules and 15% completed all four modules. Initial visit of the control condition was lower (82%), but completion of all three modules was higher (46%) compared to the TI condition. Use of the first tailored intervention module was more likely among participants who had a lower fat intake, lower physical activity, and lower action planning for PA at baseline. Repeated use of the tailored information condition was more likely among participants with higher levels of restrained eating and who had lower on pro-active coping skills at baseline. Of those who used the tailored intervention, 55% stated a goal for a change in DI and 15% for a change in PA. Only 28% made a coping plan for DI and 5% for PA. Participants who used the tailored intervention more than once had a lower fat intake six months post intervention than those who used it only once.

Website usage and characteristics of users

Usage of the first intervention modules was overall high (80-90%). However, in the tailored intervention we saw that only 15% finished the last (fourth) module, compared to 46% that used the last (third) generic information module. The latter modules were shorter than the tailored modules and required less effort because they were not interactive and required no personal input for completion of questionnaires and formulation of action and coping plans. The higher time and effort required for completion of the TI may be one of the reasons for the difference in use between the study groups. The sharpest decline in visits to the TI website was between the second and third visit. In the second visit participants had evaluate the success of their behaviour change. It is possible that participants experienced this module as difficult or confronting. The observed decline after the first module is comparable to what has been reported in evaluations of other online interventions (Spittaels and De Bourdeaudhuij; Verheijden, Jans et al. 2007; Brouwer, Oenema et al. 2010; Robroek, Brouwer et al. 2010), but is nevertheless worrisome. The e-mail reminders sent every two weeks to (re)visit the intervention may have helped some, but was not sufficient to prevent the decline in follow-up visits. Other actions to increase revisiting might be helpful, e.g. telephone calls, short text messages (SMS) or short initial face-to-face contact (Spittaels and De Bourdeaudhuij 2006; Webb, Joseph et al. 2010).

More restrained eaters are more likely to revisit the intervention, perhaps because some characteristics related to restrained eating, such as high conscientiousness (Elfhag and Morey 2008), may translate in more conscientiousness in completing an entire program. Baseline weight-related pro-active coping skills was negatively related to revisiting. This may indicate that those who could profit most of the intervention (through learning planning and

coping skills) were indeed more likely to use the intervention more often, whereas those already high in coping skills may have felt that they were not sufficiently supported by the program. Therefore, the program may be adapted to also fit the needs of those who have already better coping skills, but who have nevertheless not been not been successful in managing their weight.

Unlike other studies (Brouwer, Oenema et al. 2010; Robroek, Brouwer et al. 2010; Anderson-Bill 2011), use and repeated use of the intervention were not associated with motivational factors and socio-demographic characteristics. This may indicate that the program was equally appealing to people with higher and lower educational levels, higher and lower self-efficacy and higher or lower intention for WGP.

Use of website and effects/ outcome measures

Repeated intervention usage was significantly related to a lower fat intake at six months post-intervention, but not to change in physical activity, BMI or self-regulation skills. Even though we cannot interpret this as a true intervention effect, it may indicate that the intervention has some potential to cause changes in fat intake. The tailored feedback on fat intake was based on previous computer-tailored interventions that have been effective at reducing fat intake (Oenema, Brug et al. 2008), which makes it likely that the present intervention may have the potential to effect fat intake as well.

Use of self-regulation components

More participants described a goal for change in DI, compared to PA. This preference has been observed before in weight-related behaviour studies (Serdula, Mokdad et al. 1999; Kottke, Clark et al. 2002; Wammes, French et al. 2007). About 70% of the participants wrote down their behaviour action plan but the coping planning component was used by only about 30%. Such figures have been reported in other online tailored interventions, for example by Spittaels and DeBourdeadhuiij (Spittaels and De Bourdeaudhuij 2006), who found that only 3 of 6 people used the goal planning component for improving PA. The goal setting and action planning components required active involvement of the participants (e.g. self-reflection, thinking about a solution, writing it down). A lack of usage of the goal-setting component is worrisome since the behaviour change goal is the starting point for the rest of the intervention and a coping plan is beneficial for actual change. It is, therefore, of high importance to identify how use of action and coping planning tools in online interventions can be promoted.

In general, the quality of the participants' action plans was higher than the quality of the coping plans. Coping planning is a more complex process than action planning and requires the identification of critical situations (Sniehotta 2009). Exercises that promote the self-regulation of behaviour or health have been applied in many other studies (e.g. (Powell and Gibson 2003; Gokee-LaRose, Gorin et al. 2009; Thoolen, de Ridder et al. 2009)

but most of these studies employed a more intensive approach, such as 10 weekly group sessions (Gokee-LaRose, Gorin et al. 2009). Often, the coping planning was guided by a counselor. There is also evidence that action plans that are completed in the presence of a counselor are more strongly related to behavior change (Luszczynska 2006). Even though computer tailoring mimics individual counseling to some extent, this may as yet not apply to action and coping planning components. The low usage of the planning elements and quality of the goals and plans may indicate that this is a difficult task for participants or that it requires too much effort, at least in the way these planning components were incorporated in the present intervention. It is, therefore, of high importance to identify how the quality of action and coping plans in online interventions can be improved.

Strengths and limitations

One of this study's strengths is its use of objective information to assess the level of usage of the website and the goal setting and coping planning tools. Additionally, we were able to link intervention use to personal characteristics, making it possible to describe characteristics of users and non-users. A limitation of the study is the use of self-reported measures of physical activity and dietary intake. The design that was used to evaluate the association between higher intensity of intervention use and intervention effect was not strong, since the groups were self-selected and a control group was absent. Therefore, based on these results, no strong conclusions about the effectiveness can be drawn.

Conclusion

This study showed that psychological factors such as self-regulation skills and action planning were associated with repeated use of an online, computer-tailored self-regulation intervention aimed at prevention of weight gain among adults being overweight. Use of the intervention was not optimal, with only limited numbers of participants who visited all the intervention modules. The exploratory study on the association between intervention use and intervention effects provided no compelling evidence for an association between use and effect. The use of the action and coping planning components of the intervention was not optimal and the quality of the generated plans was low, especially for the coping plans. The lack of optimal use of the action and coping planning components, that are important factors in the regulation of behavior, may have contributed to limited intervention effects. It is important to identify how use of action planning and coping planning components in online interventions can be promoted and how the quality of plans generated through these tools can be improved.

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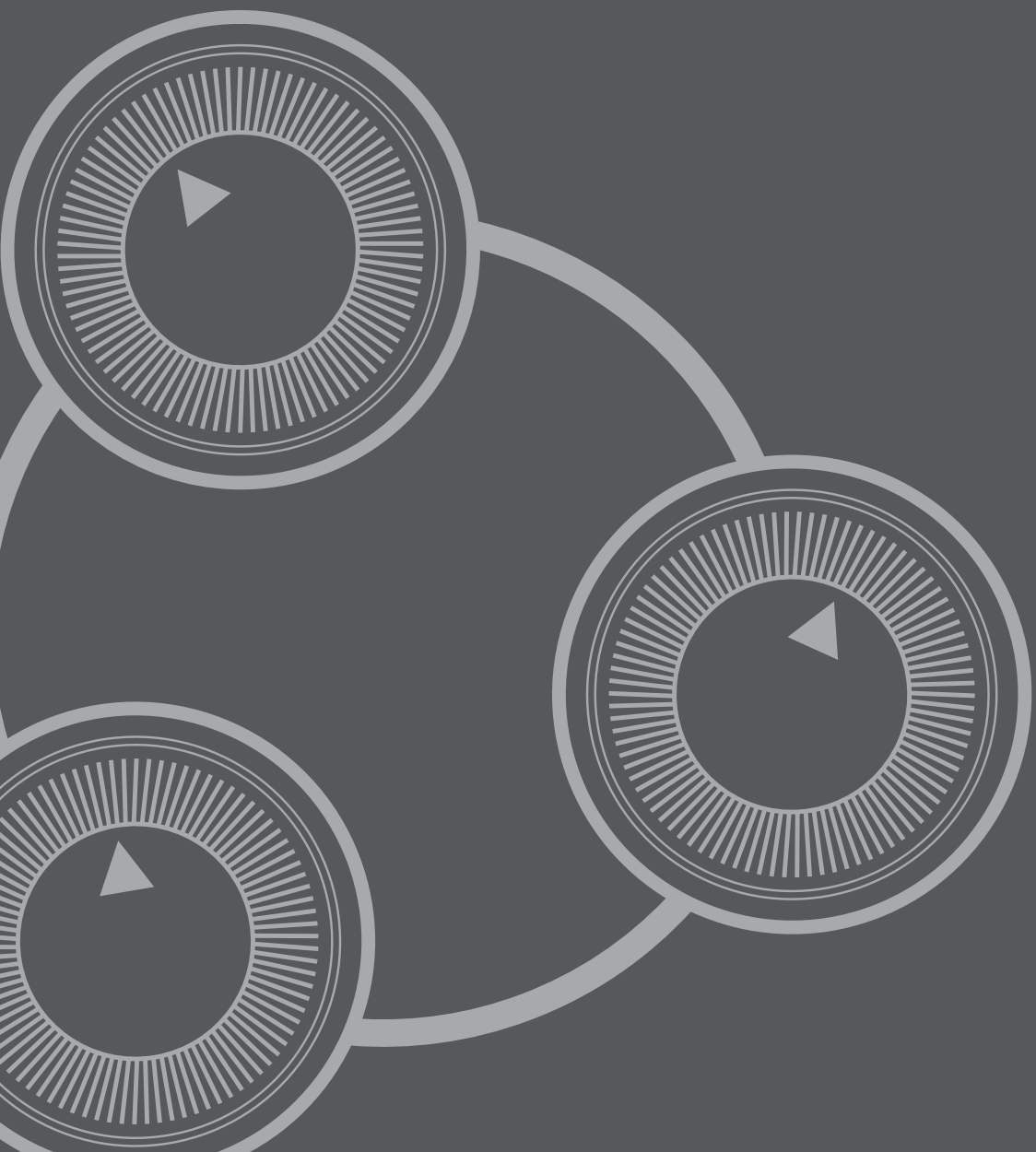
Appendix 1 Measurements of correlates of use and intervention outcomes.

Measure	Item	Scale
Intention to prevent weight gain	Do you intend to prevent weight gain in the next six months?	Definitely not (1) to 'definitely yes' (5)
Perceived behavioral control	Would you be able to prevent weight gain in the next six months, if you really wanted to?	'definitely not' (1) to 'definitely yes' (5)
Weight locus of control	Weight Locus of Control (WLOC) scale (Saltzer 1982), 4 item scale. E.g. 'Whether I gain, lose, or maintain my weight is entirely up to me'	'totally disagree' (1) to 'totally agree' (5)
Restrained eating	Restrained sub-scale of the Dutch Eating behavior Questionnaire (van Strien, Frijters et al. 1986; Strien 2005), 10 item scale. E.g. 'After you have put on weight, do you eat less than you usually do?'	'never' (1), 'seldom' (2), 'sometimes' (3), 'often' (4), and 'very often' (5).
Monitoring of weight	How often did you weigh yourself during the past month?'	'never' to 'several times a day'
Planning for PA	4 items. 'Do you have a clear plan for: 1) when, 2) where, 3) how, and 4) with whom you will exercise 20 minutes extra every day?'	'I don't have a plan' (1) to 'I have a very clear plan' (4).
Planning for DI	1) 'Do you have a clear plan for what (i.e., which product) to change, 2) how much you will change and 3) when you will make the change?'	'I don't have a plan' (1) to 'I have a very clear plan' (4).
Pro-active coping skills	21-item 'Proactive Competence Scale' (PCS) (Bode, de Ridder et al. 2007). E.g. 'I am able to find solutions'	1 (not at all able) to 4 (very able)

Chapter 7



General discussion

INTRODUCTION

In this thesis a series of studies on the prevention of weight gain among overweight adults are presented. The first aim of this thesis was to increase the understanding of the overweight adults' acceptance of weight gain prevention and the determinants of their motivation for weight gain prevention and changes in energy balance-related behaviours. A qualitative study (using focus group interviews) and a quantitative cross-sectional study (using questionnaires) were conducted to gain insight into this topic. The second aim of this thesis was to study the effectiveness of an online, computer-tailored self-regulation intervention aimed at the prevention of weight gain among overweight adults. Therefore, following a carefully planned process, an online, self-regulation intervention was developed, that aimed at self-regulation of body weight and behaviour. A randomised controlled trial was conducted to evaluate the one month and six months intervention effects on BMI, waist circumference, skin fold thickness, physical activity, dietary behaviours and process measures.

This chapter summarises the main findings of the studies reported in chapters 2-6. After this summary, the methodological issues of the studies will be discussed. Results will be integrated and interpreted in order to answer the research questions. Furthermore, recommendations for future research and practice will be provided.

MAIN FINDINGS

The results of the focus group interviews (see chapter 2) among overweight women showed that about half of the women expressed a positive attitude towards prevention of weight gain. These women wanted to stop the weight cycling that they had experienced in the past and they saw the prevention of weight gain as a good option. The other half of the women were not interested in weight gain prevention, and many of them wanted to lose a large amount of weight first. These women showed low-self-efficacy towards prevention of weight gain, which may be due to a lack of knowledge about suitable behaviour changes for weight gain prevention. These findings show that not all overweight women may view weight gain prevention positively, which is important to take into consideration when developing interventions aimed at weight gain prevention.

In chapter 3, the social-cognitive factors related to the intention to prevent weight gain and change related behaviours are described. The factors perceived behavioural control towards prevention of weight gain and perceived weight status were most strongly associated with the intention to prevent weight gain. Most participants intended to prevent weight gain, but a substantial number did not intend to make the necessary behaviour changes. The intention to prevent weight gain was related to behaviour change and, in turn, intention to

change behaviour is one of the factors related to preparatory planning for behaviour change. Behaviour-specific perceived behavioural control and preferences were also important determinants for intention to change behaviour and for planning for behaviour change. Thus, intention to prevent weight gain may be an important factor in the process towards change in weight-related behaviours, but it is not sufficient; behaviour-specific factors also influence the sequence towards behaviour change.

Following a step-by-step, planned approach, an online computer-tailored intervention consisting of four interactive modules was developed, which aimed to prevent weight gain (see chapter 4). In order to achieve life-long behaviour change, teaching self-regulation of body weight and weight management behaviours was one of the main goals of the intervention. In four modules, participants could work through all the important phases of the self-regulation process. They can learn how to monitor their body weight and dietary intake, identify and select goals they would like to achieve, plan their actions and deal with difficult situations, evaluate goal achievement, and adapt their goals and plans. This was one of the first interventions that applied self-regulation in an online, tailored intervention for the prevention of weight gain among overweight adults.

In chapter 5, the results of the randomised controlled trial to evaluate the effectiveness of the intervention are reported. For about half of the anthropometric outcomes and behavioural changes, the differences between the groups were more favourable for the tailored intervention group, but the other half of these outcomes were not. However, the differences between the groups were never statistically significant. In general, the tailored intervention was not more effective at preventing weight gain or in changing relevant dietary and PA behaviours than a general information website. The tailored intervention was experienced as newer and more personally relevant but was visited less often than the general information website. Low use and thus low exposure to the intervention content may have influenced the outcomes.

Analysis of use and exposure to the intervention (see chapter 6) showed that exposure to the intervention and the self-regulation components was mixed, with 93% of the respondents visiting the first tailored intervention module but only 15% visiting all four modules. About 60% of the participants in the intervention group used the self-regulation components, but the quality of their goals and plans was often low. Baseline fat intake and physical activity, self-regulation skills and locus of control were associated with intervention use. Higher intervention use was associated with a reduction in fat intake.

METHODOLOGICAL ISSUES

The reported studies have several strengths and limitations and the results should be interpreted in light of these limitations. In this section, several considerations regarding the studies' designs, theoretical framework, participants and procedures are discussed.

Focus group interviews

Focus group interviews are especially suitable for exploring existing opinions, providing deeper insight into underlying attitudes, and generating ideas about new topics because they allow for interaction between the participants. At the start of the study, little was known about the acceptance of weight gain prevention among overweight adults. Insight into this topic was considered important for the development of a WGP intervention. Therefore, focus group interviews were conducted in order to explore views and opinions of weight gain prevention among overweight adults.

The participants of this study were overweight women who responded to advertisements we placed in local newspapers, in the university-hospital magazine, and on the hospital intranet. By using these mass media approaches for recruitment the sampling frame was quite large, nevertheless we were only able to recruit a limited number of women (n=19) for the study. Thus, the women participating in this study form a selective sample and not a representative sample of the total population of overweight adults. For example, the majority of the participants had completed higher education (higher vocational school or university), a few had a non-Western ethnic background and very few men were interested in participation (therefore, they were not included in this study). This limits the external validity of this study and thus the results should be interpreted with caution. This study provides an exploration of the acceptance of weight gain prevention among overweight women but to confirm the findings, this study should be repeated among a more diverse sample of overweight adults. The new study should have a sample that includes groups that were not included in this study (e.g. men, people with a low socioeconomic status and people of non-Western ethnicity) and be followed by quantitative studies among a representative sample of overweight adults.

Cross-sectional study

The second study, on the determinants of intention for weight gain prevention and behaviour change, was a cross-sectional study. This design is valid for identifying associations between constructs and gives insight into factors that are potentially relevant for the motivation for weight gain prevention and change in dietary and physical activity behaviours. This study indicates that the desire to be lean, knowledge about possible changes, perceived behavioural control and intention to prevent weight gain may be potentially important determinants, which should be targeted in interventions that aim to prevent weight gain.

However, the design does not allow to study causal relations between possible determinants and intentions for change and therefore the predictors may be very different from cross-sectional correlations (de Vet, de Nooijer et al. 2008; Ezendam, Evans et al. 2010).

Another limitation of this study was that the outcomes were intentions (to prevent weight gain and change behaviour) and planning (to change dietary intake and physical activity) and not the actual behaviours. Thus it has yet to be established whether this whole set of potential determinants is related to actual behaviour and weight. Other research designs, such as a longitudinal or experimental study, should be applied to study actual predictors of intentions and behaviour change. In future studies on determinants of the intention for weight gain prevention, determinants from theories other than the Theory of Planned Behaviour, such as goal theories and theories that describe decision-making processes, could be included to broaden the knowledge of relevant determinants of intentions and behaviour change. Even though the study design had limitations, the findings are important because this is one of the first studies on the intention to prevent weight gain and make small changes in dietary intake and physical activity among overweight adults. The results should, however, be interpreted with caution.

Intervention development

The intervention was developed following a carefully planned approach in order to increase the likelihood of effectiveness. Intervention Mapping was used as the planning protocol to ensure that the intervention was goal-directed, well grounded in theory and contained evidence-based strategies for behaviour change (Webb, Joseph et al. 2010; Bartholomew, Parcel et al. 2011). However, in the development process a lot of choices had to be made that may have influenced the intervention effects, and these need to be considered when interpreting the results of the intervention evaluation study. A selection of the important issues that may be of relevance for the intervention effects are discussed below.

Small changes approach

In one of the first steps of the planned development of the intervention, the primary goal was defined as prevention of weight gain. Weight gain is caused by a long-term imbalance between energy intake and energy expenditure, therefore, it is thought that weight gain can be stopped by restoring the energy balance through changes in dietary and physical activity behaviours. It is important to know how much change in diet or physical activity is needed to achieve weight maintenance. This intervention was based on the small changes approach suggested by Hill and colleagues (Hill, Wyatt et al. 2003). Based on data from two large studies (NHANES (Flegal, Carroll et al. 2002) and CARDIA (Lewis, McCreath et al. 2001)) they calculated that the average weight gain was about 2 pounds (0.9 kg) per year and that in order to prevent this annual weight gain among 90% of the population, energy intake should be reduced (or expenditure increased) by 100 kcal/day. The advantage of this approach is

that prevention of weight gain can be achieved by making small behaviour changes ("take a few less bites of food at each meal" (Hill, Wyatt et al. 2003)), which might be relatively easy to initiate and maintain. As the observed annual weight gain in the Netherlands was lower than the 0.9 kg (Visscher, Kromhout et al. 2002),a 100 kcal change in energy intake or expenditure was also thought to be sufficient to prevent weight gain and might even induce some weight loss among the Dutch population. However, Hill and colleagues stressed that the estimations were theoretical and included many assumptions, and that empirical testing of the hypotheses was needed. In a more recent publication, Swinburn and colleagues postulate that in order to prevent weight gain at the population level, it is necessary to make larger changes (Swinburn, Sacks et al. 2009). They posit that the observed weight gain among adults in the past three decades is caused by an excessive intake of almost 400 kcal/day. This would mean that a much larger change in dietary intake or physical activity is required to prevent weight gain. If such changes are indeed necessary, it is unlikely that the small behaviour changes that are proposed in our intervention would result in the prevention of weight gain. However, there are studies that have seen positive effects from the small changes approach to behaviour change and weight maintenance (Rodearmel, Wyatt et al. 2007; Hill 2009), which demonstrates that a 100 kcal approach may be enough to prevent weight gain. Moreover, Hall and colleagues have developed an advanced mathematical model that estimates that a daily 100 kcal behaviour change may prevent 1 kg of annual weight gain (Hall, Sacks et al. 2011). Thus, the small changes approach seems to be suitable, especially because such small behaviour changes are easier to make and maintain. However, if we had aimed at larger behavioural changes, the likelihood of finding differences between the study groups would have increased.

Self-regulation theory approach

Long-term maintenance of weight requires long-term maintenance of behaviour changes and adaptation of behaviour when this appears to be necessary (e.g. when circumstances change). Many studies on weight loss maintenance have shown that failing to maintain behaviour change is one of the underlying causes of the lack of long-term success of weight loss interventions (Jeffery, Drewnowski et al. 2000; Curioni and Lourenco 2005). Self-regulation theory aims to help participants achieve maintenance of behaviour and adaptation to changing circumstances. Therefore, self-regulation theory was used as the underlying theory of the intervention (Austin and Vancouver 1996; Maes and Karoly 2005). Self-regulation theory has been successfully applied in group therapy based diabetes (Thoolen, de Ridder et al. 2009) and asthma (Bartholomew, Gold et al. 2000) management programs. These programs have been effective at inducing long-term changes in disease management behaviour. This was one of the first studies to apply self-regulation theory to an intervention to prevent weight gain, and there was little prior evidence that this application would be suitable. Thus, even though the theory would conceptually be suitable for WGP, and has shown to be

effective for the management of chronic diseases, this study cannot confirm its suitability for initiating and maintaining successful regulation of body weight. More interventions that use self-regulation theory as the basis for weight management interventions are necessary to be able to draw conclusions about the suitability of the theory for regulation of body weight.

Self-regulation and computer-tailoring

The translation of the theoretical methods derived from self-regulation theory into practical strategies may have influenced the intervention's effectiveness. Many of the previous studies that aimed at self-regulation used a face-to-face method, for example group sessions led by a trained psychologist (Thoolen, de Ridder et al. 2009). This type of intervention has shown to be effective for the initiation and maintenance of disease-management, but it is rather expensive because it requires the involvement of a professional caregiver. Computer-tailored interventions are supposed to mimic, to a certain extent, 'person-to-person' counselling (Brug, Oenema et al. 2003). Therefore, the current intervention attempted to 'guide' participants online through the self-regulation process (goal identification, goal pursuit, evaluation) as if it was a face-to-face contact.

Developing an online, tailored intervention based on the self-regulation theory was rather new and little was known about how to optimally implement important self-regulation strategies (i.e., goal setting, planning, monitoring, and evaluation) in the online program. In the program open-ended formats were used in which participants could write down their goals for change (based on a previous assessment) and subsequently write a plan for where and when they wanted to perform the action. Brief instructions for how to state a goal and a plan were provided, but it may have been too difficult for participants to state appropriate goals and plans. Closed-ended formats in which people can choose from pre-defined plans may make stating goals and plans easier, but would put restrictions on the amount of choice. Furthermore, open-ended questions allow fewer possibilities to provide feedback on the quality of the goals and plans. Feedback on the quality of these goals and plans could have improved the stated goals (Luszczynska 2006). The process evaluation showed indeed that not all exercises resulted in clear goals or good plans, (e.g. only half of their coping plans were of good quality). Poor quality plans are not likely to induce behaviour change (de Vet, Gebhardt et al. 2011). Thus, choices that were made to translate strategies into a practically deliverable format may have influenced the potential effectiveness of the intervention.

Based on the present study it is not possible to draw conclusions about the efficacy of using self-regulation strategies in online interventions, but it seems that the way in which these strategies were implemented in the present intervention was not optimal. More research is necessary to identify self-regulation strategies that can be successfully applied in online interventions.

Randomised controlled trial

Design of the study

A randomised trial was conducted to evaluate the effects of the online intervention on weight-related outcomes, dietary intake, physical activity and process measures. This is the most appropriate design to ascribe observed effects to the intervention, as it has the greatest level of certainty to ascribe effects (Campbell, Fitzpatrick et al. 2000). The aim of the study was to prevent weight gain among overweight adults, and inn this study, changes in the intervention group were compared to changes in the generic information control group. This control condition was chosen because it allows conclusions to be drawn about the added value of a new intervention, compared to 'usual care'. We hypothesised that participants using the tailored intervention would successfully change their dietary or physical activity behaviour and thus not gain weight. We also hypothesised that those using the generic information intervention would not change their behaviour and would therefore show the expected annual weight gain that is observed in the general adult population. However, even though a strong design was chosen, there are other factors that may have influenced the results of our studies.

Detection of a small weight difference

It was assumed that participants in the generic information condition would, following the trend among adults in the Netherlands, gain weight during the study. However, it appeared that the generic information group (also) did not gain weight during the study. A possible explanation is that the annual weight gain in the population is lower than the 0.6 kg that was assumed in the power calculation that was conducted prior to the study. In fact, more recent, lower estimations of annual weight gain have been made (Visscher, Kromhout et al. 2002). If the annual weight gain is indeed lower and a 100 kcal behaviour change was actually made by the tailored intervention group, a reduction in weight would have been expected in this group. Thus, if the intervention would have been effective at inducing a100kcal change in the tailored intervention group, there would still have been a difference in weight between the intervention and the control group. The fact that we did not find this difference may indicate that the intervention was not effective at inducing this change. Alternatively, participating in a weight management study, completing questionnaires and reading through generic information may also have resulted in behaviour changes in the control group. A lack of contrast between the study groups may have prevented us from detecting an intervention effect.

Participants and procedures

The intervention aimed at preventing weight gain among the general overweight adult population. Therefore, we attempted to recruit participants via advertisements in local papers,

in company websites, and in the waiting rooms of general practitioners. Special attention was paid to try to attract people with a low socio-economic status. However, compared to the Dutch population, the study sample was highly educated and mostly female. The study population was similar to users of other health-related interventions or websites (e.g. (Dutta-Bergman 2004; Brouwer, Oenema et al. 2010) and may thus represent the participants that are most likely to use health interventions. Nonetheless, the results of this study cannot be generalised to other population groups.

Even though the people who enrolled in the study were interested in weight management, there was a high drop-out rate during the course of the study. Only 65% of the participants completed the study. There was no difference in the drop-out rates of the intervention and control group, but dropping-out between the measurements was more common among younger people and men. High drop-out rates are not uncommon in weight-related studies where the drop-out rates are usually close to 50% (Douketis, Macie et al. 2005). Yet, high drop-out rates lead to missing data and thus limit the ability to get an accurate estimate of the intervention effect. For example, intention-to-treat analyses may result in a conservative estimation of intervention effects and thus fail to show an effect that does exist. On the other hand a complete case analysis may show results that are too optimistic because it is more likely that those who were more motivated or experienced more benefit of the intervention remained in the study. The reported results in this study are based on repeated measures mixed model analyses, performed with all available data for all randomised participants. Other analyses, which included 'complete cases' and 'last-observation-carried-forward' outcomes, had the same results as the current, reported results. Therefore, it is unlikely that there is an intervention effect that has not been detected because of selective drop-out.

Exposure to the intervention

In order for an intervention to be effective, participants have to be exposed to and actively engage in the intervention content. In order for participants to go through all the phases of self-regulation and learn sufficient self-regulation skills that they could also apply without the guidance of the program, participants had to visit all four modules. Although 76% of the participants visited more than one module, only 15% visited all four modules. In contrast, more participants in the control group (46%) visited all three modules. These findings with respect to revisiting the intervention are comparable to what has been found in previous studies on online intervention use (Verheijden, Jans et al. 2007; Brouwer, Oenema et al. 2010; Robroek, Brouwer et al. 2010), but it is, nevertheless, far from optimal. The length of the program (it took about 90 minutes to complete all modules), expectations about required effort to complete the modules, and technical problems may have influenced the use of the intervention.

Active engagement was particularly important in this intervention, since participants had to state their own goals and plans. The low exposure to a number of important self-regulation

exercises may particularly have compromised the intervention effects. It is unlikely that participants have learned self-regulation skills or made changes in DI and PA behaviours when they were not even exposed to the self-regulation components. Even though there was no compelling evidence for an association between higher intensity of use and improved intervention effects in secondary analyses of the data, it cannot be ruled out that insufficient use and exposure to the intervention was an important reason for not finding more pronounced intervention effects.

Measurements: anthropometric measures

One of the strengths of this study is the objective measurement of BMI (height and weight), waist circumference, and skin fold thickness at baseline and at six months after use of the intervention, by trained research assistants. The advantage of objective measurements of weight-related outcomes is that they are not prone to response bias. Even though such objective assessments have advantages and are generally considered to be superior to self-reported measures, there are drawbacks, such as a larger burden on participants. Participants had to come to the university hospital twice for the anthropometric measurements. This may have attracted a selective sample of participants who were motivated and able to spend time and effort in the study. People who were less willing to put this effort into participation were possibly less likely to make an appointment for baseline and follow-up measurements and to participate throughout the entire process. Those who remained in the study may therefore represent a more motivated group, which is not representative of the total population of overweight adults. Therefore, the results are not generalisable to groups with other characteristics than those who participated in the study.

Another drawback of objective measurements of body weight-related measures is timing of the measurements. Preferably, measurements would be taken at standardised times (e.g. at the same time of the day and day of the month). In the present study measurements may have been taken at various times of the day, week and month and may therefore have been influenced by normal fluctuations in weight. However, the fluctuations in timing of the measurements are also likely to have occurred in a similar way in the intervention and control group. Thus, the lack of differences between the study groups can probably not be explained by timing of the measurements.

Measurements: Questionnaires

In order to prevent weight gain, a balance between energy intake and expenditure is required. In order to measure exact intake and expenditure and calculate the balance, methods such as doubly-labelled water to measure energy expenditure would be needed (Schoeller 2008). Such exact methods are often expensive and/or a burden for the participant and can therefore not be used in population-based studies. In this study, questionnaires were used to assess energy balance-related behaviours that are specifically associated with

weight gain. This means that actual (caloric) changes in the energy balance could not be calculated, but only changes in energy balance-related behaviours.

Also, self-reported data are subject to a bias towards socially-desirable answers. Underreporting of dietary intake is likely to have taken place, since this is related to being overweight (Johansson, Solvoll et al. 1998), and physical activity is more likely to be over-reported (Rzewnicki, Auweele et al. 2003). However, under- and over-reporting as well as an increased awareness of behaviour due to completing questionnaires would have occurred in both the tailored intervention group and in the control group. One possibility that could have contributed to the lack of detectable effects on behaviour outcomes is that the tailored intervention group, as a result of the feedback that is provided in the program, may have become more aware of their behaviour and thus began reporting their behaviour more accurately (irrespective of the previously mentioned over and underreporting). This may have decreased the likelihood of finding the expected differences in physical activity and dietary intake between the two study groups. However, if there would have been effects in DI and PA behaviours that remained undetected due to potential reporting effects, these effects were not large enough to have an impact on BMI or other objective weight-related outcomes.

INTERPRETATIONS

In this section the studies' findings will be interpreted in light of their limitations and the research questions will be answered.

Are overweight adults motivated for weight gain prevention and is this motivation an important determinant for subsequent dietary and physical activity behaviour changes?

Our first study showed that about half of the overweight women were not very motivated to prevent weight gain, but preferred to lose weight. Other factors related to non-acceptance of prevention of weight gain may be a lack of knowledge about the changes that are required to achieve weight maintenance and a low level of perceived control over preventing weight gain. Previous experience with weight cycling may have had a positive influence on level of WGP acceptance. Even if participants intend to prevent weight gain, this does not always mean that they intend to make the necessary small changes in DI or PA behaviour. The factors perceived behavioural control towards prevention of weight gain and perceived weight status were most strongly associated with the intention to prevent weight gain. Intention to prevent weight gain was related to the intention to change behaviour, even though behaviour-specific factors such as perceived behavioural control explained more of the variance in the intentions for behaviour change. The studies presented in this thesis are among the first to describe the acceptance of prevention of weight gain among overweight adults and were

explorative in nature, which means that the results should be interpreted with caution. It is important to further study the target groups' acceptance of and motivation for prevention of weight gain in a longitudinal study, in more detail, among a more representative sample, and with behaviour and weight as outcomes of the study. Nevertheless, the findings have provided important new information, which can be considered when designing such studies and developing interventions.

It is of concern that many overweight women in the first study reported a desire to become lean again, which is similar to the unrealistic amounts of weight loss often desired by obese people (Parham 1999; Linde, Jeffery et al. 2004). Dieting may increase the risk of weight gain, and thus, reducing the desire to lose unrealistic amounts is an important step in the prevention of weight gain. Body size acceptance has been suggested as an important goal by weight-related studies (Parham 1999). For example, the 'Health At Every Size' intervention that aimed to increase body size acceptance among obese adults did not only result in higher self-esteem and lower depression and body image avoidance behaviour, but also resulted in more physical activity and a lower body weight (Bacon, Stern et al. 2005). Acceptance of current weight and size may thus be an important part of weight-related studies; in order to improve health outcomes participants can learn, for example, how to disentangle feelings of self-worth from their weight (Bacon, Stern et al. 2005). Furthermore, intentions to prevent weight gain and make a behavioural change seem to be important to the process of weight gain prevention and should therefore be taken into account in interventions for weight gain prevention. Interventions should first aim at increasing participants' intention to prevent weight gain if it is the case that the participant is not motivated. As a next step, the interventions could focus on behaviour change by influencing factors like knowledge of small behaviour changes and perceived behavioural control.

Is an online, computer-tailored self-regulation intervention effective in prevention of weight gain and promotion of weight-related behaviour change among overweight adults, compared to online generic weight maintenance information?

In the current study, the tailored intervention was not more effective in prevention of weight gain than a general information website. Some outcomes were in the expected direction (e.g. fat intake), others were not (e.g. waist circumference), and no statistically significant differences in changes in dietary intake or physical activity were observed between the two groups. Use of the tailored intervention was not optimal, which may partly explain the lack of differences between the two groups. However, implementation of the self-regulation components may also play a role.

A relationship between use and effects is likely because frequent users have had more exposure to health promoting content. Such relations have been found before in health behaviour studies (Noar, Benac et al. 2007; Wanner, Martin-Diener et al. 2009). Many tailored interventions that aim at weight gain prevention (Lemmens, Oenema et al. 2008;

Kremers, Reubsaet et al. 2009) or change in dietary intake and/or physical activity (Kroeze, Werkman et al. 2006; Noar, Benac et al. 2007; Enwald and Huotari 2010; Krebs, Prochaska et al. 2010) show small effects. Perhaps, the small effect sizes that are usually reported from such studies (Noar, Benac et al. 2007) are related to low exposure to the online interventions, which is also common (Verheijden, Jans et al. 2007; Brouwer, Oenema et al. 2010; Robroek, Brouwer et al. 2010). Analyses of the relation between use of the tailored intervention and relevant outcomes measures indicated that fat intake decreased more when the tailored intervention was used more intensively, compared to one-time use. In order to improve intervention use, studying use, and participant-related determinants of use is important (Brouwer, Oenema et al. 2010; Brouwer, Kroeze et al. 2011). For example this may increase the interventions' fit with a hard-to-target population. Previous studies identified socio-demographic and behavioural factors as correlates of intervention use (Verheijden, Jans et al. 2007; Brouwer, Oenema et al. 2010; Robroek, Brouwer et al. 2010); our study added information about psychological constructs as correlates of use. The intervention was used more often by those with low planning for PA and coping skills for weight management, and those with high restrained eating. However, it was used less often by people with a low locus of weight control. These user characteristics indicate areas for improvement in the intervention. A more thorough process evaluation along with results from other studies, for example studies about the application of specific effective theories and strategies (Noar, Benac et al. 2007; Webb, Joseph et al. 2010; Brouwer, Kroeze et al. 2011), may also provide input for possible adaptations of the tailored intervention.

Yet, the strength of relation between use and outcomes does not indicate that use of the tailored intervention can fully explain the lack of differences in relevant outcome measures between the study groups. Thus, besides exposure to the intervention, active involvement in the intervention may also be important. The overall use and quality of use of the self-regulation components was rather low, suggesting that the translations of theoretical methods derived from self-regulation theory in practical strategies was not optimal. Thus, the intervention may benefit from some adaptations to improve use and quality of the self-regulation components.

However, it is also possible that an online self-regulation intervention may not be sufficient for weight management. Interventions that have shown to be effective in preventing weight gain often use a more comprehensive approach, for example, combining individual intervention with changes in the worksite (Kwak, Kremers et al. 2010) or contact with a counsellor via e-mail (van Wier, Arieëns et al. 2009).

RECOMMENDATIONS

The studies presented in this thesis aimed to explore the motivation for weight gain prevention among overweight adults and the effectiveness of an online, self-regulation, computer-tailored intervention aimed at preventing weight gain among overweight adults. A number of implications for future research, policy and practice arise from the results of the described studies.

Recommendations for future research

- The qualitative study on motivation for weight gain prevention should be repeated among a more varied population of overweight people and the determinants of both intention for weight loss and prevention of weight gain should be studied in quantitative studies. Results from these studies can be used to improve the understanding the target groups' motivation, which is important for intervention development.
- Interventions for preventing weight gain should first aim at increasing the participants' motivation for prevention of weight gain. However, while this motivation is necessary, it is not sufficient. The first part of the thesis showed that being motivated to prevent weight gain does not mean that one is motivated to change one's weight-related behaviour. Hence, it is important to identify causal relations between intention to prevent weight gain, intention to change behaviour and actual behaviour change, and the determinants of these factors. In order to describe causal relations, a longitudinal study should be conducted in which behaviour changes, and perhaps weight changes, are the main outcomes.
- Such a study should also aim to provide more insight into the strategies that those who successfully prevent weight gain use to help them prevent weight gain. This insight would be very helpful in developing future interventions.
- Study the application and effectiveness of self-regulation theory for weight regulation in other interventions, in order to increase insight in the usability of self-regulation theory for prevention of weight gain.
- Writing good goals, action and coping plans increases the likelihood of successful; behaviour change (Gollwitzer and Sheeran 2006; de Vet, Oenema et al. 2011). Future studies should examine how self-regulation techniques, such as goal setting and action planning, can best be implemented in online interventions. For online interventions, strategies should be developed to increase use and quality of self-regulation components. Studies should attempt to answer the question: how can we guide people in developing clear goals and action plans in a computer-tailored intervention?
- Studying the added value of face-to-face contact with a health professional (ter Bogt, Bemelmans et al. 2009) may improve the quality of WGP goals and plans and thus

improve intervention outcomes. This may require greater commitment and more time from the participant and the health professional, but it may also improve the results.
– In general, in order to identify effective strategies and interventions, it is important to continue developing and evaluating interventions aimed at preventing weight gain.

Recommendations for policy and practice

– The first step in weight gain prevention should be motivating the target group. The current studies were not able to identify effective strategies for enhancing motivation for weight gain prevention. However, the studies indicate that such efforts should be aimed at decreasing the participants' desire to lose weight, improving their knowledge about possible behaviour changes, and increasing their perceived ability to control their weight and make possible changes.
– To carry out more research on weight gain prevention with more diverse participants. Being overweight is more common among men, people with low levels of education and people with a non-Western ethnicity (Schokker, Visscher et al. 2007) but the participants in the evaluation study were mainly females who were highly-educated and had a Western ethnicity. Although we used recruitment strategies that attempted to reach higher risk groups, apparently we either did not find them, or were not able to persuade them to participate. These higher risk groups are important for weight gain prevention and thus efforts should be made to reach them and support them in the prevention of weight gain.
– Finally, as the intervention cannot be implemented in its current form, more research is needed to find ways to improve the efficacy of interventions aimed at weight gain prevention. It is very important to evaluate future efforts aimed at weight gain prevention because it provides input for the improvement of WGP interventions. When making further adaptations, involvement of the target group also important.

GENERAL CONCLUSION

This thesis provides important insight into the possibilities for weight gain prevention among overweight adults. Exploratory studies suggest that overweight adults do not always accept weight gain prevention as a goal. And even if they are motivated for weight gain prevention, they are not necessarily motivated to change their dietary intake or increase their physical activity. Increasing the target groups' motivation for weight gain prevention and behaviour change is an important factor when developing interventions aimed at the prevention of weight gain.

The online, computer-tailored self-regulation weight gain prevention intervention was not more effective in preventing weight gain than generic information. The lack of

effect may be due to low exposure to the tailored intervention. It may also indicate that the tailored intervention was not an appropriate way to introduce self-regulation of body weight, perhaps due to unsuccessful implementation of self-regulation components. For online self-regulation interventions, it is important to find ways to successfully implement self-regulation components.

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ENGLISH SUMMARY

The increasing prevalence of obesity is a major public health problem because of its negative associations with health. Obesity is associated with several negative health outcomes, such as a higher risk for type 2 diabetes, cardiovascular disease and a lower quality of life. It is also a large contributor to health care costs. Long-term results of obesity treatment are generally poor. Therefore, prevention of obesity has been postulated as an important strategy in fighting the obesity epidemic. People who are already overweight are an important target group for obesity prevention, since they are most at risk for becoming obese when they gain more weight. Furthermore, there are many overweight people, which makes it important to prevent them from becoming obese. Obesity is the result of a long-term imbalance between energy intake and energy expenditure. It has been calculated that a 100 kcal reduction in daily energy intake or 100 kcal increase in daily energy expenditure should be sufficient in achieving energy balance and thus prevent weight gain for most people. Such small changes may be easier to initiate and maintain than drastic dieting. However, there was a lack of knowledge as to whether overweight adults were motivated for weight gain prevention.

An intervention aimed at prevention of weight gain should be able to reach the large group of overweight adults and deliver an individualised approach to support the complicated process of behavioural change for prevention of weight gain. At the start of the project there were no weight gain prevention programs for adults being overweight that used the small changes approach and that could reach large numbers of people for relatively low costs. Therefore, a new intervention was developed. The intervention aimed at motivating and guiding overweight adults in making a small, daily change in dietary intake or physical activity and to maintain these changes over time. In order to achieve this lifelong behaviour change, the intervention was based on self-regulation theory. Self-regulation has been effective in long-term behavioural change for disease management and may therefore also be applicable to behaviour change and maintenance for body weight regulation. A four module intervention was developed, in which participants learned the steps of self-regulation of body weight: goal setting, goal pursuit and evaluation.

The first aim of this thesis was to increase our understanding of motivation for weight gain prevention (WGP) among overweight adults, and the importance of motivation for WGP for changes in dietary and physical activity behaviour. Furthermore, since no online computer-tailored intervention aimed at prevention of weight gain existed, the second aim of this thesis was to develop an intervention program that uses a self-regulation approach to prevent weight gain and that reaches many overweight people from the general adult population.

The general introduction (**Chapter 1**) presents the background, aims and theoretical framework used in this thesis.

Chapter 2 describes a qualitative focus group study that aimed to gain insight in the acceptance of WGP among overweight women. The study consisted of four structured focus group interviews with overweight women. With respect to acceptation of WGP, two groups could be identified: acceptors and non-acceptors. The group of acceptors was the smallest group and consisted of women who were tired of weight cycling and expressed a positive attitude towards prevention of weight gain. The few women who were already active in prevention of weight gain monitor their weight and undertake action when weight gain is observed, are physically active and have chosen life style changes that can be maintained. Most women were only interested in WGP after they lost weight. They showed low-self-efficacy towards prevention of weight gain, which may be due to their lack of knowledge about suitable behavioural changes for WGP. Many people in this group had unrealistic ideas about the size of the changes that are needed to achieve weight management. From this study it was concluded that in an intervention that aims to achieve weight maintenance among overweight people, it is important to target motivation for WGP because overweight people may not readily be motivated to prevent weight gain.

In **chapter 3** the results from a study that aimed to understand the sequence from intention for WGP to planning for behaviour change in dietary intake or physical activity are described. Participants of this cross-sectional study were 510 overweight adults, who filled out a questionnaire on intention to prevent weight gain, intention to make a small change in dietary intake or physical activity, action planning for behaviour change and possible determinants of these factors. In 89% of the sample, (parts of) the proposed sequence from goal intention for WGP, through behavioural intention (for dietary intake or physical activity) to action planning (for dietary intake or physical activity) was observed.

The majority of the participants had a strong intention to prevent weight gain, but about a third of them did not intend to make a change in their dietary intake or physical activity. Attitude, social norm, perceived behavioural control towards WGP, perceived weight status and risk perception were associated with the intention for WGP. Intention for WGP was associated with the intention to change dietary intake and physical activity behaviours and with planning for change in physical activity. However, behaviour specific perceived behavioural control and preference and perceived weight status were more strongly related to intention and planning for changes in dietary intake or physical activity. These results confirm findings from the first chapter of this thesis, that motivation to prevent weight is important for motivation to change behaviour, and that this should be taken into account in interventions aiming at weight gain.

Chapter 4, describes the systematic development of the computer-tailored weight gain prevention intervention. At the start of the project it was decided that it should be an online intervention, in order to reach the large population of overweight adults in the Netherlands.

Computer-tailoring was chosen as the main intervention technique, because it delivers a 'tailor-made' message, which is more likely to result in behaviour change than a generic advice. The goal of the intervention was to prevent weight gain by making a small change in dietary intake or physical activity. In order to achieve long term prevention of weight gain the intervention was based on self-regulation theory. The steps of self-regulation may support long term change and allow for adaption to changing circumstances. In four modules, people learn to monitor their body weight and dietary intake, decide on the goals they would like to achieve, prepare behaviour change, monitor and evaluate the process of behaviour change and maintenance and adapt goals and plans if required. This was one of the first interventions that applied self-regulation strategies in an online computer-tailored intervention for prevention of weight gain among overweight adults.

In **chapter 5**, the results from the randomised controlled trial to evaluate the effectiveness of the intervention are reported. The aim of the study was to evaluate the short- (one month) and longer term (six months) effects of the intervention on weight related outcome measures (BMI, waist circumference and skin fold thickness) and dietary and physical activity behaviours. The tailored intervention was compared to a generic information website in a randomised controlled trial with 539 overweight adults (mean age 47.8 years, mean BMI 28.04, 30.9% male, 10.7% low educated). The hypothesis was that users of the tailored intervention would change their behaviour and prevent weight gain, whereas the usual annual weight gain of 1 kg per year would be seen in the participants in the control group. The results of the evaluation study showed that weight remained stable from baseline to six months follow-up, but that there were no differences between the users of the tailored intervention and general information website. Changes in dietary and physical activity behaviour were also similar between the two study groups. The tailored intervention was experienced as more new and more personally relevant, but was used less often than the general information website, which may be due to the extensiveness of the tailored intervention. The potential effects of the intervention may not have been achieved because only few participants used all intervention modules, especially in the tailored intervention group. Thus, in this evaluation study we could not demonstrate that the computer-tailored self-regulation intervention was more effective in prevention of weight gain than a general information website.

Chapter 6 describes a study in which use of the intervention, the quality of goals and plans that the users made and the relation between intensity of intervention use and intervention effects are explored in more detail. Data for this study are derived from…., the same data as chapter 5. The first aim was to assess which participant characteristics were associated with first and repeated use of the tailored intervention. Participants with low baseline physical activity, low fat intake, and low baseline goal setting for PA were more likely to visit the intervention. Participants who scored higher on restrained eating, and lower on pro-active

coping skills were more likely to revisit the intervention. The second aim was to explore use of the intervention in a more qualitative way. It turned out that about 40% of the visitors did not write a behavioural goal or action plan, and about 30% of the goals and plans were not of good quality.

Revisiting the tailored intervention was related to a larger decrease in fat intake, but not with other outcomes. The results indicate that lack of use was not likely to be of influence on the effectiveness. The lack of optimal use of the action and coping planning components, that are important factors in the regulation of behavior, may have contributed to limited intervention effects.

In the general discussion (**Chapter 7**) the findings of all studies are integrated and conclusions and recommendations for practice and future research are given. With respect to the first research question, based on the exploratory studies, it can be concluded that non-acceptance of WGP may be widespread among overweight adults. Often, they prefer to lose large amounts of weight, do not experience control about their weight and have limited knowledge about the behavioural changes that are needed to prevent weight gain. Even among those who aim to prevent weight gain, few intend to change dietary intake or increase physical activity. These variations in motivation for WGP and energy-balance related behaviours should be taken into account when developing interventions. However, it is also important to conduct longitudinal studies to identify predictors of intention for WGP and actual behavioural change.

With respect to the second research question, based on the results of the randomized trial, it can be concluded that the online, computer-tailored self-regulation intervention was not more effective in achieving prevention of weight gain than online, general information. The lack of effect may be due to low exposure to the tailored intervention. It may also indicate that the tailored intervention was not an appropriate way to introduce self-regulation of body weight, perhaps due to unsuccessful implementation of self-regulation components. For online self-regulation interventions, it is important to find ways to successfully implement self-regulation components.

NEDERLANDSE SAMENVATTING

Het aantal mensen in Nederland met obesitas neemt toe. Dat is een groot probleem omdat obesitas een negatieve invloed heeft op de gezondheid: het verhoogt het risico op aandoeningen zoals suikerziekte en cardiovasculaire aandoeningen. Het resulteert in een lagere kwaliteit van leven en leidt tevens tot hoge kosten in de gezondheidszorg. De langetermijneffecten van behandeling van obesitas zijn teleurstellend en bij een verdere toename van het aantal mensen met obesitas is er te weinig capaciteit om alle mensen met obesitas te behandelen. Preventie van obesitas is daarom erg belangrijk. Volwassenen met overgewicht zijn een belangrijke doelgroep voor preventie van verdere gewichtstoename, omdat verdere gewichtstoename bij hen al snel kan leiden tot obesitas. Obesitas is het gevolg van een jarenlange disbalans tussen energie-inname en energiegebruik. Er is berekend dat gewichtstoename kan worden voorkomen door een kleine verandering in voedings- en beweeggedrag van ongeveer 100kcal (dit zijn 1 á 2 koekjes per dag, of iedere dag 20 minuten meer bewegen) per dag te maken en dit langdurig vol te houden. Zulke kleine veranderingen zijn vermoedelijk niet zo moeilijk te realiseren, en makkelijker om vol te houden dan een dieet. Het was echter nog niet bekend of volwassenen met overgewicht open staan voor preventie van gewichtstoename.

Een interventie die zich richt op het voorkomen van gewichtstoename moet de grote groep mensen met overgewicht kunnen bereiken en een geïndividualiseerde benadering bieden om het gecompliceerde proces van gedragsverandering te ondersteunen. Aan het begin van het project was er nog geen interventie die zich richt op preventie van gewichtstoename bij volwassenen met overgewicht door het maken van een kleine verandering en die veel mensen kan bereiken tegen lage kosten. Er is daarom een dergelijke interventie ontwikkeld. De interventie was gericht op het maken een kleine, dagelijkse verandering in eten of bewegen, en het volhouden van deze verandering. Om dit te bereiken was de interventie gebaseerd op zelfregulatie theorie. Zelfregulatietheorie was eerder al met succes gebruikt voor het aanleren van gedrag dat nodig is om een chronische ziekte zoals diabetes goed te reguleren. Daarom werd verondersteld dat de theorie ook succesvol zou kunnen worden toegepast voor gedragsverandering die nodig is om gewichtstoename te voorkomen. De interventie heeft vier modules die de gebruiker helpen om de stappen van zelfregulatie uit te voeren: het stellen van een doel, het proberen te bereiken van het doel en evalueren of het doel is behaald.

Het eerste doel van dit proefschrift was om meer te weten te komen over de motivatie voor preventie van gewichtstoename bij volwassenen met overgewicht, en het belang van deze motivatie voor verandering in voedingsinname en fysieke activiteit. Het tweede doel van dit proefschrift was om een online advies-op-maat interventie te ontwikkelen en evalueren die gebaseerd is op zelfregulatietheorie en als doel heeft om gewichtstoename,te voorkomen.

In de algemene introductie (**hoofdstuk 1**) worden de achtergrond, de doelen en het theoretisch kader van de studies in dit proefschrift beschreven.

In **hoofdstuk 2** wordt een kwalitatieve studie over de acceptatie van preventie van gewichtstoename beschreven. De studie bestond uit vier gestructureerde focusgroep interviews (een soort groepsgesprekken) met vrouwen met overgewicht. Hierbij konden twee groepen onderscheiden worden. De eerste groep, een minderheid, had genoeg van de in het verleden ervaren gewichtsschommelingen en had een positieve houding ten opzichte van preventie van gewichtstoename. Een aantal van hen was al actief bezig met preventie van gewichtstoename door het monitoren van hun gewicht en extra gedragsveranderingen bij gewichtstoename. Zij waren regelmatig fysiek actief en hadden gedragsveranderingen gekozen die zij goed vol kunnen houden. De tweede groep, een kleine meerderheid van de deelnemers, accepteerden het idee van preventie van gewichtstoename niet. Zij waren vooral geïnteresseerd in groot gewichtsverlies, en eventueel daarna in preventie van gewichtstoename. Zij hadden er weinig vertrouwen in dat zij zelf kunnen voorkomen dat hun gewicht toeneemt. Tevens hadden zij onrealistische ideeën over de grootte van kleine gedragsveranderingen die nodig zijn voor preventie van gewichtstoename. Uit deze studie kan geconcludeerd worden dat in een interventie die als doel heeft om gewichtstoename te voorkomen, het belangrijk is om aandacht te besteden aan de motivatie voor preventie van gewichtstoename, omdat niet alle volwassenen met overgewicht hier vanzelfsprekend voor gemotiveerd zijn.

In **hoofdstuk 3** worden de resultaten van een studie beschreven die als doel had om na te gaan of er een logische volgorde zit in het hebben van een intentie voor preventie van gewichtstoename, via een intentie voor het maken van een verandering in voedings- of beweeggedrag naar het plannen van een verandering in voedings- of beweeggedrag. Aan dit onderzoek deden 510 volwassenen met overgewicht mee. De deelnemers vulden een vragenlijst in over hun intentie voor preventie van gewichtstoename, intentie voor gedragverandering (eetgedrag beweeggedrag), het maken van actie plannen voor deze verandering en mogelijke determinanten van deze factoren. Het bleek dat bij 89% van de deelnemers, (een deel van) de veronderstelde logische volgorde van doel intentie voor preventie van gewichtstoename, via intentie voor gedragsverandering (eten of bewegen) naar planning van verandering (eten of bewegen) te zien was.

De meerderheid van de deelnemers had een sterke intentie om gewichtstoename te voorkomen, maar slechts ongeveer een derde van hen had niet de intentie om iets te veraderen aan hun eet- of beweeggedrag. Attitude, subjectieve norm, verwachte gedragscontrole voor preventie van gewichtstoename, en ervaren gewichtsstatus waren positief gerelateerd aan deze intentie. Het verwachte risico op gewichtstoename hing negatief samen met intentie voor preventie van gewichtstoename. De intentie om gewichtstoename te voorkomen was

duidelijk gerelateerd aan de intentie voor verandering in eten of bewegen, maar voorkeur voor een verandering in eten of bewegen en verwachte gedragscontrole voor een verandering in eten of bewegen waren sterker positief gerelateerd aan de intentie voor gedragsverandering en het maken van plannen voor deze gedragsverandering. Deze resultaten laten zien dat de motivatie om gewichtstoename te voorkomen belangrijk is voor de intentie om gedrag te veranderen. Interventies die zich richten op preventie van gewichtstoename zouden hier rekening mee moeten houden.

De ontwikkeling van de geautomatiseerde advies-op-maatinterventie wordt beschreven in **hoofdstuk 4**. Van te voren was besloten dat het een online interventie zou moeten zijn om veel mensen met overgewicht te kunnen bereiken. Daarnaast was er gekozen voor een geautomatiseerd advies-op-maatinterventie omdat dit persoonlijke, unieke adviezen geeft aan alle deelnemers en daarom een grotere kans heeft om effectief te zijn dan algemene voorlichting. Het doel van de interventie was het voorkomen van gewichtstoename door het maken van een kleine verandering in eet- of beweeggedrag. Om levenslange gedragsverandering te bereiken was de interventie gebaseerd op de theorie van zelfregulatie. De stappen van zelfregulatie ondersteunen lange termijn gedragsverandering en aanpassing aan onder andere veranderende omstandigheden. In vier modules leren deelnemers hoe zij hun gewicht, eet- en beweeggedrag kunnen monitoren, hoe zij doelen kunnen stellen, hoe ze gedragsverandering kunnen voorbereiden, hoe ze het veranderingsproces kunnen controleren en de verandering behouden door evaluatie en het aanpassen van doelen. Dit is een van de eerste interventies die zelfregulatie toepast in een online, geautomatiseerde advies-op-maatinterventie om gewichtstoename te voorkomen bij mensen met overgewicht. Voorafgaand aan de studie was er daarom niet veel bewijs beschikbaar over de effectiviteit van theoretische methodieken voor dergelijke interventies.

In **hoofdstuk 5** worden de resultaten van het onderzoek waarin het effect van de interventie wordt geëvalueerd beschreven. De interventie werd geëvalueerd in een gerandomiseerde en gecontroleerde studie met 539 volwassenen met overgewicht (met een gemiddelde leeftijd van 48 jaar, een gemiddeld BMI van 28, 31% was man en 11% had aan lage opleiding). Het doel van dit onderzoek was het evalueren van de effecten van de interventie op gewichtsgerelateerde uitkomsten (BMI, middelomvang en huidplooidiktes), en voedingsinname en fysieke activiteit. De online advies-op-maat zelfregulatie interventie werd vergeleken met een website met algemene informatie over gezonde voeding en fysieke activiteit. De hypothese was dat gebruikers van de advies-op-maat interventie hun eet- of beweeggedrag zouden veranderen en dat zij zo gewichtstoename zouden voorkomen, en dat gebruikers van het algemene advies dit niet zouden doen en verder zouden aankomen. Uit de resultaten bleek dat het gewicht van de deelnemers niet toenam, maar dat er geen verschil was tussen de groep die het advies-op-maat gebruikte en de groep die een algemeen advies

kreeg. Er waren ook geen verschillen in eet- en beweeggedrag tussen de twee groepen. De advies-op-maatinterventie werd als nieuwer en meer persoonlijk ervaren, maar deze was minder vaak bezocht dan het algemene advies. Dit heeft mogelijk te maken met het feit dat de advies-op-maatinterventie langer was. Omdat maar weinig deelnemers alle interventie modules gebruik hebben, zijn mogelijk de potentiële maximale effecten van de advies-op-maatinterventie niet zichtbaar. In deze evaluatiestudie kon niet worden aangetoond dat een online advies-op-maatinterventie die gebaseerd was op zelfregulatie theorie effectiever is voor preventie van gewichtstoename bij mensen met overgewicht dan een algemeen advies.

Het doel van de studie beschreven in **hoofdstuk 6** was inzicht krijgen in het gebruik van de interventie, in de kwaliteit van de doelen en plannen die werden gemaakt in de interventie en de relatie tussen gebruik en interventie-effect. Voor dit onderzoek werden de gegevens gebruikt die verzameld waren in het onderzoek dat beschreven is in hoofdstuk 5. Het eerste doel van de studie was het beschrijven van kenmerken van deelnemers die van invloed zijn op het gebruik van de advies-op-maatinterventie. Deelnemers die bij aanvang van de studie minder bewegen, weinig vet eten, duidelijke doelen hebben voor voeding maar niet voor beweging, gebruikten relatief vaker de eerste module van de advies-op-maatinterventie. Deelnemers die meer lijngericht eten, sterke controle over hun gewicht ervaren, en minder plannen voor beweging en proactieve copingvaardigheden hadden bezochten de interventie relatief vaker. Het tweede doel van de studie was om de kwaliteit van de doelen en plannen die deelnemers geschreven hadden bij de zelfregulatie opdrachten in detail te bekijken. Het bleek dat veel deelnemers geen doel en plan geschreven hadden, en dat van de geschreven plannen circa 30% niet van goede kwaliteit was. Deelnemers die de interventie meerdere malen hadden bezocht hadden een lagere vetinname dan deelnemers die de interventie maar één keer gebruikt hadden. Herhaald gebruik had echter geen invloed op andere gedragingen. Gebaseerd op deze resultaten concluderen we dat de advies-op-maatinterventie verbeterd kan worden om bepaalde groepen (bijvoorbeeld mensen met een lage ervaren controle over het gewicht) beter te bereiken, maar dat het vooral belangrijk is om het gebruik van de zelfregulatie onderdelen en de kwaliteit van de gemaakte plannen te verbeteren.

De resultaten van de verschillende studies worden geïntegreerd in de algemene discussie in **hoofdstuk 7**. Ook worden er conclusies getrokken en aanbevelingen gedaan voor praktijk en onderzoek. Op de eerste onderzoeksvraag kan, gebaseerd op de explorerende studies, geantwoord worden dat lang niet alle volwassenen met overgewicht het voorkomen van overgewicht een acceptabel doel vinden. Zij geven er vaak de voorkeur aan om grote hoeveelheden gewicht te verliezen, ervaren weinig controle over hun eigen gewicht en hebben beperkte kennis over mogelijke kleine veranderingen die ze kunnen maken om gewichtstoename te voorkomen. Van de mensen die de intentie hebben om gewichtstoename

te voorkomen zijn er relatief weinig die daarvoor van plan zijn om de benodigde gedragsverandering (voeding of beweging) te maken. Deze variaties in motivatie voor preventie van gewichtstoename en gedragsverandering zijn belangrijk bij het ontwikkelen van interventies. Het is echter ook van belang om longitudinale studies te doen, om meer en beter inzicht te krijgen in de factoren die van invloed zijn op intentie voor gewichtstoename en gedragsverandering en daadwerkelijke gedragsverandering en gewichtsbehoud.

Met betrekking tot de tweede onderzoeksvraag laten de resultaten van de effectiviteitstudie laten zien dat de online advies-op-maatinterventie niet effectiever is in het voorkomen van gewichtstoename dan een algemeen, online advies. Dit gebrek aan effectiviteit is misschien het gevolg van het lage gebruik van de advies-op-maatinterventie. Het kan ook zijn dat de advies-op-maatinterventie niet de juiste manier is om zelfregulatie van gewicht aan te leren, mogelijk omdat de zelfregulatie oefeningen niet op de juiste manier geïmplementeerd zijn in de interventie. Om effectieve online zelfregulatie interventies te ontwikkelen is het belangrijk om manieren te vinden om zelfregulatie componenten succesvol te implementeren.

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CURRICULUM VITAE

Lenneke van Genugten was born in Eindhoven on 18th October 1983, and grew up in Waalre. In 2002 she finished her pre-university education (VWO) at Pleincollege Sint Joris in Eindhoven. In the same year, she moved to Maastricht and started studying General Health Sciences at Maastricht University. In the winter of 2005 she studied at the University of Gävle, Sweden, for one semester. In 2006 she obtained her Masters Degree in 'Health Education and Promotion' at Maastricht University. The research for her master thesis about determinants of exclusive breastfeeding was conducted in Kaleo, Ghana, where she lived for three months. In 2007 she started working as a PhD-student at the Department of Public Health, Erasmus Medical Centre, where she conducted the studies described in this thesis. Meanwhile, she completed the 'Master of Public Health' at the Netherlands Institute for Health Sciences (Nihes) in 2010. Since 2011, she works as a post-doc researcher in a co-operational project of the Department of Public Health, ErasmusMC and TNO 'Healthy Living'.

Lenneke van Genugten is geboren in Eindhoven op 18 oktober 1983, en opgegroeid in Waalre. In 2002 behaalde ze haar VWO diploma aan het Pleincollege Sint Joris in Eindhoven. In datzelfde jaar verhuisde zij naar Maastricht, om Algemene Gezondheidswetenschappen te studeren aan de Universiteit van Maastricht. Zij heeft 3 maanden aan de Universiteit van Gävle gestudeerd tijdens de winter van 2005. In 2006 studeerde zij af voor de master 'Health Education and Promotion' aan de Universiteit van Maastricht. Het onderzoek voor haar masterscriptie over determinanten van exclusieve borstvoeding voerde zij uit in Kaleo, Ghana, waar ze 3 maanden woonde. In 2007 begon zij als promovendus op de afdeling Maatschappelijke Gezondheidszorg van het ErasmusMC te Rotterdam, waar ze de studies uitvoerde die in dit proefschrift beschreven staan. Tijdens dit onderzoek rondde zij ook de 'Master of Public Health' bij de Netherlands Institute for Health Sciences (Nihes) af in 2010. Op dit moment werkt ze als postdoctoraal onderzoeker in een gezamenlijk project van de afdeling Maatschappelijke Gezondheidszorg, ErasmusMC en TNO 'Healthy Living'.

LIST OF PUBLICATIONS

Van Genugten, L., van Empelen, P. and Oenema, A. Acceptance of weight gain prevention among overweight women. *Submitted*.

Van Genugten, L., van Empelen, P. and Oenema, A.From weight management goals to action planning: identification of a logical sequence from goals to actions and underlying determinants. *Submitted*.

Van Genugten, L., van Empelen, P., Flink I., Oenema, A. Systematic development of a self-regulation weight-management intervention for overweight adults. *BMC Public Health* 2010, 10:649

Van Genugten, L., van Empelen, P., Boon, B., Visscher, T., Borsboom, G.J.J.M., and Oenema, A. Evaluating the effects of an online computer-tailored weight management intervention for overweight adults on anthropometric and behavioural outcome measures: results of a randomised controlled trial. *J Med Internet Res* (in press). DOI:10.2196/jmir.1901

Van Genugten, L., van Empelen, P. and Oenema, A. Correlated characteristics of intervention use and quality of self-regulation plans in an online computer-tailored weight gain prevention program for overweight adults. *Submitted*.

PHD PORTFOLIO

Summary of PhD training and teaching activities

Name: Lenneke van Genugten PhD Period: 2007-2011

Erasmus MC Department: Public Health Promoter: Prof.dr. J.M. Mackenbach

Supervisor: Dr. A. Oenema

	Year	*Workload (hours/ECTS)*
1. Phd Training		
General courses		
– Biomedical English Writing and Communication, Erasmus MC Rotterdam	2009	4 ECTS
– Master of Public Health, Netherlands Institute for Health Sciences, ErasmusMC.	2010	70 ECTS
Specific courses		
– Seminar 'Emotion Regulation & Health', 'Psychology and Health' Institute, Utrecht (October 25 & 26). Workshops and presentations.	2007	16 hours
– Symposium 'Kwalitatief onderzoek: een update, Netwerk kwalitatief onderzoek, AMC Amsterdam (November 2). Presentations and lectures.	2007	4 hours
– Course 'Cognitive behavioural therapy for the treatment of obesity', Cure & Care Development, Arnhem (November 29)	2007	8 hours
Presentations		
– Seminar 'Emotion Regulation & Health', 'Psychology and Health' institute, Utrecht (October 25 & 26); Oral presentation 'Self-regulation in Obesity Prevention'	2007	1 ECTS
– 10th International Congress of Behavioral Medicine, Tokyo, Japan (August 27-30); oral presentation 'A Computer-Tailored Weight Management Program for Adults at Risk of Obesity'	2008	1 ECTS
– Meeting 'Werkgroep Voedingsgewoonten', Deurne (Ocotober 9). Oral presentation: 'Ontwikkeling en inhoud van een advies-op-maat interventie ter preventie van obesitas bij een hoog-risico groep'.	2008	1 ECTS
– 8th Conference of the Internationals Society of Behavioral Nutrition and Physcal Activity, Lisbon, Portugal (June 17-20); poster presentation 'Systematic development of a self-regulation weight management intervention for adults at risk for obesity'	2009	1 ECTS
– Mini-symposium 'Computer Tailoring and Health' (March 9); oral presentations 'GRIPP: An online computer-tailored intervention aimed at weight management among overweight adults'	2010	1 ECTS
– 9th Conference of the Internationals Society of Behavioral Nutrition and Physcal Activity, Minneapolis, USA (June 9-12); oral presentation 'Identifying correlates and associations of intentions toward weight gain prevention and weight-related behaviours'.	2010	1 ECTS

– 24th European Health Psychology Conference, Cluj-Napoca, Romania (September 1-4); oral presentation 'Short-term effects of an online computer-tailored weight management intervention on dietary intake, physical activity, action planning and self-regulation skills.'	2010	1 ECTS

International conferences

– 10th International Congress of Behavioral Medicine, Tokyo, Japan (August 27-30)	2008	1 ECTS
– 8th Conference of the Internationals Society of Behavioral Nutrition and Physcal Activity, Lisbon, Portugal (June 17-20).	2009	1 ECTS
– 9th Conference of the Internationals Society of Behavioral Nutrition and Physcal Activity, Minneapolis, USA (June 9-12).	2010	1 ECTS
– 24th European Health Psychology Conference, Cluj-Napoca, Romania (September 1-4)	2010	1 ECTS

2. Teaching activities

– Curriculum Medical Students, 1st and 2nd year, Erasmus MC Rotterdam, lectures as part of themes 1.S/ 2.2: 'Disorders in nutrition, metabolism and hormonal regulation'.	2009-2011	20 hours
– Supervision of master student 'Health Sciences', VU University, Amsterdam. Thesis title: 'The formative evaluation of an intervention aimed at weight-gain prevention among overweight adults; Gripp'	2009	30 hours
– Supervision of master student 'Health Psychology', Leiden University. Thesis title: 'Process evaluation of GRIPP: a tailored web-based weight-management intervention for adults being overweight: Use, appreciation and the quality of action and coping plans'	2010	30 hours

3. Other activities

– General board member and treasurer of Promeras (Association for PhD-students at Erasmus MC) and EPAR (Association for PhD-students at Erasmus University Rotterdam).	2007-2009	