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Efficacy of a self-management intervention for weight control in overweight and obese adults: a randomized controlled trial

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Abstract Brief self-management interventions to engender successful weight maintenance are seldom tested in obese and overweight populations without diabetes. To test the efficacy of the intervention, aimed at improving proactive coping, in obese and overweight adults at risk for diabetes. Participants ($N = 255$) were randomly assigned to two experimental groups ($N = 185$) and a control group ($N = 70$). Experimental groups received the same intervention in week 1–8 (initial phase) and booster sessions with different content ("standard" vs. "relapse prevention") during week 9–24 (continuance phase). Primary outcomes were proactive coping, diet and Body Mass Index (BMI) at four time points (1 year between first and last measurement). Experimental groups improved in proactive coping during the initial phase and BMI during the continuance phase, whereas the control group did not. No differences emerged in diet. Brief self-management interventions can play a preventive role in chronic illnesses associated with obesity.

Keywords Self-management intervention · Overweight · Weight loss maintenance · Diabetes prevention

Introduction

Obesity poses serious health threats, including higher risks of developing chronic illnesses like type 2 diabetes (Kopelman, 2007). Interventions that engender successful weight management are therefore needed to prevent the development of these illnesses. In the present study, we examine the efficacy of a self-management intervention aimed at maintaining weight loss in overweight and obese adults at risk for diabetes. This self-management intervention (Thoolen et al., 2008) is built on the theoretical framework of Proactive Coping Theory (Aspinwall & Taylor, 1997), which focuses on preparation for potential threats to goal adherence before they occur. Prior research indicates that people who develop proactive coping skills are more successful in dealing with situations that may promote lapses into unwanted behavior (Thoolen et al., 2009). As such, proactive coping skills may facilitate initiation and maintenance of successful weight management. The current intervention combines the future-oriented proactive approach with self-regulation strategies that facilitate behavior change, such as goal-setting and planning (Michie et al., 2009).

Although interventions that encourage self-management and promote the use of self-regulation strategies have been presented as a viable approach to sustained behavior change, most programs require intensive treatment (e.g., weekly sessions) for at least 6 months (Appel et al., 2011; Knowler et al., 2002; Venditti & Kramer, 2012). Although such interventions have demonstrated the effectiveness of behavioral modification treatment (Wing, 2002), brief and less intensive alternatives have rarely been implemented in overweight and obese populations. This raises the question whether weight management interventions that are relatively easy to disseminate and require fewer resources could also render success in weight-related behavior change (Glasgow et al., 2003). Prior research suggests that brief interventions with relatively low intensity can indeed yield long-lasting effects on weight management (Stahre et al., 2007). Moreover, it has been shown that the current

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intervention, albeit in a sample of type 2 diabetes patients, yielded improved diet, exercise, and weight loss up to 9 months after the program (Thoolen et al., 2009). The present study aims to replicate and extend this research in three ways.

First, the intervention is examined in a population of overweight people at risk for diabetes rather than diabetes patients. These populations are sufficiently similar to render it likely that the intervention is effective as they struggle with comparable self-regulatory challenges regarding diet and physical activity (Astrup & Finer, 2000). However, the efficacy of the intervention may also differ for the two populations. That is, obese diabetic patients may be less successful than their non-diabetic counterparts in weight management, possibly due to the weight-altering properties of antidiabetic medication (Finer et al., 2006). Conversely, diabetic patients may be more successful in weight management, as they may be more aware of the urgency of behavior change (Swift et al., 2009).

Second, we extend prior research by examining whether booster sessions have added value for weight-related outcomes, as experts argue that extending the duration of treatment is a viable way to stabilize behavior changes (Jeffery et al., 2000; Wing et al., 2006). Indeed, research demonstrated that additional sessions produce promising results in this regard (e.g., Jeffery et al., 2000; Perri & Corsica, 2002; West et al., 2011). Others, however, found that extended interventions do not necessarily lead to better outcomes (Kroese et al., 2012; Leibbrand & Fichter, 2002; Svetkey et al., 2008). The present study therefore examines whether booster sessions bolster effects obtained during the initial phase of the intervention. Also, as it is unclear whether the specific content of booster sessions contributes to improved outcomes, we compare two different types. The first type of booster sessions, referred to as "relapse prevention" boosters throughout the remainder of this paper, in which relapse prevention strategies are taught, i.e., skills to anticipate and plan for high-risk situations that facilitate relapse into unwanted behavior. These skills have been proposed to promote behavior change maintenance (Gollwitzer, 1999; Marlatt & Gordon, 1985; Perri et al., 2001). We examined whether these "relapse prevention" boosters yield additional benefits compared to "standard" booster sessions, in which the same behavioral strategies were reinforced as during the initial phase of the intervention.

Third, the present study contributes to the existing body of research by including a strict and active control group, which comprised group sessions and multiple written assignments. A common methodological shortcoming of many weight management interventions is that control groups receive usual care or otherwise minimal attention (Norris et al., 2005), such as providing education material without further contact throughout the intervention (e.g., Appel et al., 2011; Thoolen et al., 2009). This makes the comparison inherently favorably biased towards the intervention's effects, because potential intervention effects can be partly due to the amount of attention that people receive and/or the frequency with which they are reminded of their long-term goal. The present control group is strict, and deviates from those in previous studies, in the sense that we controlled for non-specific intervention effects by providing contact and reminders with the same frequency as in, and concurrently in time with, the experimental groups.

In sum, we examine the efficacy of an intervention aimed at increasing proactive coping skills and self-management behaviors (a) in an overweight population without diabetes; (b) with the addition of booster sessions; and (c) against a strict control group. We report outcome measures in psychological, behavioral, and biomedical domains. In accordance with the intervention's principal focus, the primary outcomes per domain were proactive coping skills, diet and weight, respectively.

Method

Participants

We contacted 983 people by postal mail from the control arm of the Randomized Controlled Trial for Screening for Type 2 Diabetes in Obese Subjects (De Koning, 2005). Inclusion criteria were a Body Mass Index (BMI) of >25 and <40 and being committed to improving weight self-management, as assessed by consent in response to an invitation letter explaining the target population and content of the intervention. Exclusion criteria were a diabetes diagnosis and the involvement in other treatment for overweight. Of the 486 people who responded, 58 (11.9 %) were ineligible and 173 (35.6 %) declined to participate (see Fig. 1 for the CONSORT flow diagram). Of the resulting 255 (52.5 %), 185 people were allocated to the two experimental conditions (standard vs. relapse prevention) and 70 people were allocated to the control condition. No baseline data were collected from 9.7 % ($N = 18$) of experimental and 14.3 % ($N = 10$) of control participants (14.3 %), because these participants failed to return the questionnaire.

Overall, the sample had an average age of 55.69 years (SD = 5.84) and comprised native Dutch people. Most participants' (67.8 %; $N = 97$) education level was high/vocational school; 30.1 % ($N = 43$) completed higher education, one completed primary school and two failed to indicate their education level. The majority was employed (70.6 %) and male (59.4 %).

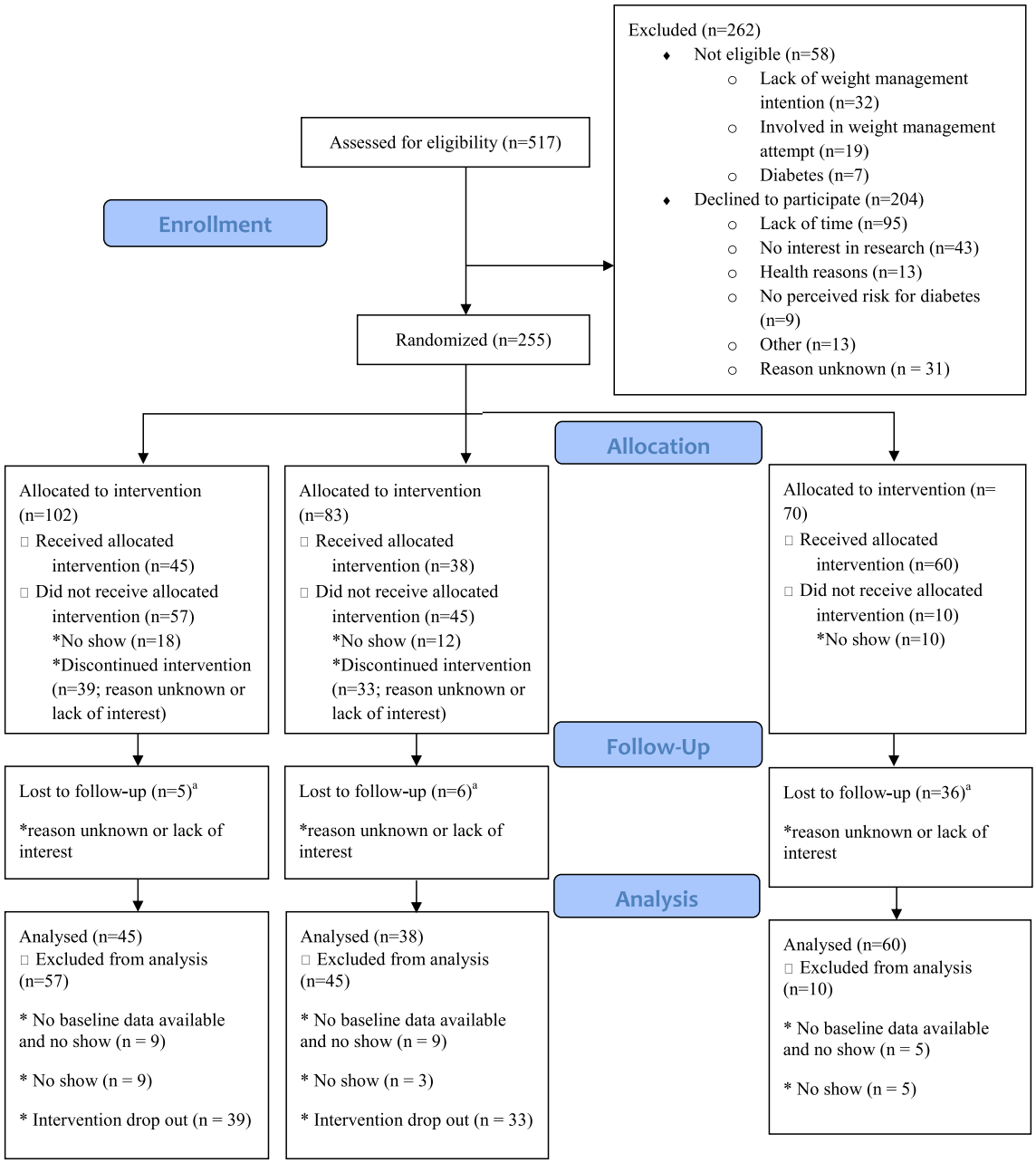

Fig. 1 CONSORT flow diagram

Design

This study was a single-blind, parallel-group randomized controlled trial, with balanced allocation using simple randomization to two experimental groups and the control group [1:1:1 ratio]. Participants were allocated to conditions using the randomization function in Excel, and assigned by the first author. The protocol was approved by the Medical Ethical Committee at Utrecht University. Written informed consent was obtained from all participants after the nature of the procedure had been fully explained to them.

Measures for all groups were employed at baseline (T0), after the initial phase (T1), 1 month after the continuance phase (T2), and at follow-up 5 months thereafter, resulting in a total duration of 1 year from first to last measurement. Weight was measured by the trainers during the individual session, after the third group session (T1) and 1–4 weeks after the T2 measurement at participants' home. Participants were recruited in June 2009. The study took place in community centers in Rotterdam, The Netherlands, from October 2009 to October 2010; data collection pertaining to 1-year follow-up measures was completed in April 2011.

Full details of the trial protocol can be found at www.trialregister.nl, trial number 2791.

Procedure

The intervention consisted of one individual and six group sessions during a period of 24 weeks; four group sessions during the initial phase (week 1–8) and two group sessions during the continuance phase (week 9–24). The initial phase included a one (1-h) individual session, in which participants' motivation, dietary knowledge and expectations towards the intervention were discussed. In addition, three (2-h) bi-weekly group sessions (6–8 participants) were given, in which participants were taught a 5-step plan targeting personally relevant dietary goals, which consisted of (a) concrete, realistic goal setting; (b) exploring conditions and barriers to goal attainment; (c) appraisal of the barriers to goal attainment; (d) making specific if–then plans for action initiation (i.e., implementation intentions; Gollwitzer, 1999) and mental simulation of plans; and (e) evaluating progress (see Thoolen et al. (2009), for a detailed description). Participants were given a workbook that provided basic background information about weight management, 5-step plans, and diaries in which they monitored their progress towards their self-set goal (homework). During each session, one step of the 5-step plan was highlighted, discussed and practiced; participants were stimulated to discuss and make use of each other's knowledge and experience with weight management.

The continuance phase, week 9–24, comprised two (2-h) booster sessions, 2 and 4 months after the initial phase had ended. In this phase, the experimental group was divided into two groups. In the standard boosters condition, the self-regulatory skills learned during the initial phase were reinforced by repeating the 5-step plan described above. The relapse prevention boosters condition entailed an adapted version of the 5-step plan, which specifically focused on identifying and making plans for situations that would promote relapse into old unwanted habits. Importantly, whereas the 5-step plan as used in the standard condition involved making action-oriented plans (e.g., "If I have my coffee break, then I will take a low-fat snack!"), thereby promoting behavior change initiation, the adapted 5-step plan in the relapse prevention condition involved making coping-oriented plans to prevent relapse, thereby promoting behavior change maintenance (Marlatt & Gordon, 1985). Another important difference was that in the standard condition, participants continued to set new goals, while in the relapse prevention condition, participants renewed goals that have been difficult to achieve so far. Specifically, the adapted 5-step plan entailed (a) renewing a goal that proved difficult to achieve in the past weeks; (b) identifying specific goal-threatening situations that hindered achievement of this goal, (c) identifying coping strategies to successfully deal with these goal-threatening situations; (d) making specific coping-oriented implementation intentions (e.g., "If I come home from work late and I am hungry, then I will eat an apple!"; Gollwitzer, 1999); and (e) evaluating the effectiveness of these coping plans.

All group sessions were led by one of seven trainers, all dieticians, who were thoroughly trained in administering the intervention. The trainers acted as coaches during sessions and did not provide dietary advice to participants. Each trainer was provided supervision after each session by mail or phone. The course of sessions followed a strict protocol as written down in a trainer manual; the supervising researcher verified adherence to the protocol by a visit to at least one of the group sessions per trainer. Although standardized notes were not taken, it was observed that all trainers strictly followed protocol. In addition, the detailed nature of the protocol (e.g., duration and content of each component per session) ensured that the likelihood of deviation from protocol was minimal. Each trainer led only one type of booster sessions (i.e., they were blinded to the existence of different versions of booster sessions) and each intervention group was generally led by the same trainer throughout the initial and continuance phases of the intervention.

Control group

The control group attended two group sessions and received four written assignments temporally concurrent with the six sessions of the experimental groups during the initial phase (one individual session and three group sessions) and continuance phase (two booster sessions). This means that the sessions and assignments were spaced at the same interval apart as the experimental group sessions. The group sessions, scheduled temporally concurrent with the experimental groups' individual and third group session during the initial phase, were led by one of three dieticians who were explicitly required to only provide nutritional knowledge as written down in the protocol. During the sessions, in addition to nutrition education, participants were asked to make a list with 10 unhealthy eating habits, and choose one habit they wanted to change in the coming 2 weeks. Two written assignments, sent temporally concurrent with the experimental groups' first and second group session during the initial phase, were sent requiring participants to reflect on their goal progress and to choose another habit they intended to change. In the continuance phase, temporally concurrent with the experimental groups' booster sessions, participants were asked to change an unhealthy habit they would be able to maintain over time, and the importance of behavior maintenance was emphasized.

Measures

Demographic measures

Demographics included sex, age, education level, and employment status (yes/no). Education level was measured on a 5-point scale; to make the Dutch school system levels comparable to others, this variable was converted into three categories: primary education, high/vocational school and higher education. Prior weight loss history was assessed by 1 item, "How often have you tried to lose weight in the past?", scored as 1 (*never*), 2 (*once*), or 3 (*multiple times*).

Psychological measures

Proactive coping Proactive coping was measured by the Utrecht Proactive Coping Competence Scale, which is validated by prior research (Bode et al., 2008). Participants were instructed to rate the extent to which they have each skill at their disposal in the context of weight-management. The 21 items, consisting of skills that together measure overall proactive coping competence (example: "Making realistic plans"), were measured on 4-point scales, ranging from 1 (*not competent*) tot 4 (*very competent*); range α T0–T3 = .80–.91. Higher scores mean that participants are better able to identify and prepare for potential threats to goal adherence, i.e., situations in which it is difficult to overcome existing unhealthy habits.

Goal commitment To measure goal commitment, we developed a scale consisting of 5 items used by prior research to capture both direct commitment (e.g., "How important is it to you to achieve a healthier weight?"; Locke et al., 1988) and affective commitment to the goal (e.g., "How disappointed would you feel if you did not succeed…"?; Oettingen et al., 2001). Scores ranged from 1 (*not at all*) tot 7 (*very much*); range α T0–T3 = .77–.83.

Self-efficacy Self-efficacy was measured by 6 items tapping participants' confidence in performing the actions necessary for successful self-management of weight and eating behavior, cf. (Kuijer & de Ridder, 2003). Each item started with "How confident are you that you are able to…" (example: "…adhere to the guidelines for a healthy diet") with scores ranging from 1 (*not at all*) to 7 (*completely*); range α T0–T3 = .77–.85).

Sense of responsibility As one core characteristic of the self-management approach is taking responsibility for one's (success in) behavior change (Funnell & Anderson, 2004), we developed 2 items capturing the extent to which participants perceived their weight management to be their own responsibility (example: "I believe it is my responsibility to bring about changes in my lifestyle to achieve a healthier weight"). These items were rated on 7-point scales, ranging from 1 (*completely disagree*) to 7 (*completely agree*); range *r* T0–T3 = .35–.58, *p*'s < .01.

Behavioral measures

Diet Diet was measured by the Kristal Food Habits Questionnaire (Kristal et al., 1990), which captures fat-related dietary habits. This questionnaire is recommended for intervention research that focuses on diet and has been shown to be as sensitive to changes in dietary habits as diet records and a food-frequency questionnaire (Glasgow et al., 1996; Kristal et al., 1994). Participants rated how often they engaged in 20 dietary habits (example: "How often do you use low-fat products while cooking?"), with scores ranging from 1 (*never*) to 4 (*always*) or "not applicable"; range α T0–T3 = .71–.79.

Exercise Exercise was measured by the Physical Activity Scale for the Elderly (PASE; Washburn et al., 1993). The PASE was deemed most appropriate for the current sample, because it includes relevant domains of activity for a sedentary population (e.g., walking, light-moderate household work) which are not detected by age-neutral measures that typically focus on more strenuous forms of exercise. The PASE has been previously employed in research on a population of middle-aged diabetes patients with a sedentary lifestyle (Thoolen et al., 2009), which mirrors the age and nature of the current sample. The scale constitutes a valid measure of energy expenditure (Schuit et al., 1997). The 15-item scale measures the number of days and time spent in the previous week on various light, moderate and high intensity physical activities and yields a composite score (range 0–800) that forms an index of energy expenditure.

Biomedical measures

Weight Participants reported their height and weight at four time points (T0–T3), and were weighed by the trainer at three time points (T0–T2; see "Design"), resulting in self-reported weight as well as measured weight [body mass index = weight in kg/(height in m^2)]. It is important to note that self-reported and measured BMI have been shown to be equally correlated with disease markers such as blood glucose (McAdams et al., 2007), and self-reported and measured BMI were highly correlated at T1 (r = .91, $p < .01$) and T2 (r = .93, $p < .01$). Self-reported BMI can therefore be regarded as a valid alternative to measured BMI.

Blood values At baseline (T0) and at follow-up (T3), participants' values of Hemoglobin A1c (Hba1c), fasting glucose, High- and Low-density Lipoprotein (HDL and

LDL) cholesterol, and triglycerides were measured (mmol/l; American Diabetes Association, 2012).

Strategy of analysis

Piecewise Linear Growth Curve Modeling (Piecewise-LGCM) was employed for analyzing change trajectories over time. LGCM is a relatively novel statistical procedure that has several advantages above traditional statistical techniques, e.g., a more reliable reflection of change over time and no listwise deletion (Duncan & Duncan, 2004). We used Mplus 6.0 (Muthén & Muthén, 1998–2010); the intercepts of all groups were fixed as equal, which means that potential baseline group differences were adjusted for in analyses. Also, we fixed the first slope (T0–T1) of the two experimental groups as equal, because they received the same intervention in the initial phase. Sensitivity analyses demonstrated that participants who did not complete the intervention ("intervention drop outs", referring to those who withdrew from attending sessions rather than those who failed to complete measurements) influenced parameter estimates of completers due to Mplus' use of the Full Information Maximum Likelihood (FIML) procedure to handle missing data. Single-imputation methods for intention-to-treat analyses (e.g., Last Observation Carried Forward) are generally deemed unsuitable methods (White et al., 2012) especially when an outcome measure concerns weight, and sufficient information over time was not available to derive adequately missing data points for multiple imputation. We therefore deemed excluding intervention drop outs most appropriate for the purpose of the present study. It is important to note, however, that no listwise deletion was employed: FIML, equivalent to multiple imputation, uses information from the available observed data to estimate the parameters of the incomplete variables (Graham, 2009). This means that the data from participants lost to follow-up (see Fig. 1) are included in the analyses. As LGCM does not yield reliable or meaningful results for less than 3 slopes, blood value measures were analyzed by repeated measures ANOVAs.

Bayesian inference was used instead of traditional *p* value significance testing, which provides a more precise and stringent method to examine effects (Kruschke, 2011). In Bayesian estimation, significance levels are determined based on whether zero is included in 90 % central credibility intervals (C.C.I.).

Results

Drop out

Figure 1 shows the rate of drop out in the experimental groups, defined as (non-)attendance during group sessions (<2 sessions during the initial phase and no sessions during the continuance phase). During the initial phase (week 1–8), 23.8 % of randomized participants dropped out. During the continuance phase (week 9–24), an additional 21.1 % did not attend any of the booster sessions. Results of analyses pertaining to characteristics of drop outs have been extensively reported elsewhere (Vinkers et al., 2012). These show that drop outs and completers, regardless of timing of drop out, did not differ on any baseline measures, and that drop outs did not improve in self-efficacy during the initial phase, while completers did (Table 1).

Psychological measures

Proactive coping

For proactive coping, only the slopes for the experimental groups were positive and significant, $\beta_{Standard}$ and $\beta_{relapse\ prevention}$ (β_S and β_{RP}) = .25 (see Table 2 and Fig. 2), whereas the control group remained stable. Results thus indicate that the experimental groups both showed improvements in proactive coping during the initial phase, while the control group did not. No slopes were significant during the continuance and follow-up phase, indicating that none of the participants, regardless of condition, showed improvement or deterioration.

Self-efficacy

For self-efficacy, the slopes during the initial phase were positive and significant for the experimental groups, $\beta_{SandRP} = .41$, but negative during the continuance phase, $\beta_S = -.37$ and $\beta_{RP} = -.61$, and non-significant during the follow-up phase. Thus, although the experimental groups experienced an initial increase in self-efficacy, this increase was nullified during the continuance phase and remained stable after this. The control condition remained stable throughout all phases.

Goal commitment

Goal commitment remained stable for all conditions during the initial phase. Whereas the standard condition (S-condition) remained stable throughout the subsequent phases, both the relapse prevention (RP-condition) and control condition showed a decrease in goal commitment during the continuance phase, albeit stronger in the control condition, $\beta_{Control} = -.74$, than in the RP-condition, $\beta_{RP} = -.48$. The control condition remained stable during the

Table 1 Baseline measures of intervention and control groups

	Experimental standard M (SD)	Experimental relapse prevention M (SD)	Control group M (SD)
N	45	38	60
Demographic measures			
Sex—no. (% male)	26 (57.8)	21 (55.3)	38 (63.3)
Age	55.84 (5.45)	55.26 (5.80)	55.85 (6.23)
Education level (%)[a]	0 (1); 75.6 (2); 24.4 (3)	2.6 (1); 50 (2); 47.4 (3)	0 (1); 73.3 (2); 23.3 (3)
Employed—no. (%)	34 (75.6)	25 (65.8)	42 (70.0)
Prior weight loss attempts (%)	55.6 (0); 26.7 (1); 17.8 (>1)	71.1 (0); 10.5 (1); 18.4 (>1)	84.7 (0); 6.8 (1); 8.5 (>1)
Psychological measures			
Self-efficacy	4.57 (.88)	4.68 (.93)	4.71 (.92)
Goal commitment	5.34 (.78)	5.33 (.95)	5.28 (.77)
Proactive coping	2.83 (.44)	2.78 (.36)	2.84 (.41)
Sense of responsibility	6.49 (.58)	6.49 (.55)	6.30 (.67)
Behavioral measures			
Diet	2.48 (.36)	2.46 (.34)	2.46 (.38)
Exercise	140.67 (69.88)	119.77 (64.23)	141.26 (68.33)
Biomedical measures			
BMI self-reported	29.10 (1.35)	28.28 (2.10)	29.19 (2.13)
BMI measured	29.45 (1.46)	29.11 (2.25)	30.01 (2.42)
Hba1c[b]	38.75 (2.82)	38.95 (2.62)	38.65 (3.04)
Glucose	5.47 (.45)	5.52 (.89)	5.43 (.38)
HDL cholesterol	1.41 (.37)	1.37 (.36)	1.50 (.86)
LDL cholesterol	3.67 (.77)	3.84 (.93)	4.05 (.95)
Tryglicerides	1.76 (1.40)	1.95 (1.90)	1.63 (.73)

Reported means are restricted to participants who completed the intervention, except for the control condition which followed a different format that prohibited the assessment of drop out

[a] 1 = primary education; 2 = high/vocational school; 3 = higher education

[b] All blood values are measured in mmol/l

follow-up phase, but the slope of the RP-condition was negative, demonstrating even further deterioration in goal commitment, $\beta_{RP} = -.70$.

Sense of responsibility

During the initial phase, the S and RP-conditions remained stable, whereas the control condition decreased over time, $\beta_{Control} = -.38$. Throughout the rest of the phases, all conditions remained stable.

Behavioral measures

Diet and exercise

A positive slope during the initial phase was obtained for all three groups in diet, $\beta_{SandRP} = 1.04$ and $\beta_{Control} = .82$, as well as for exercise, $\beta_{SandRP} = .38$ and $\beta_{Control} = .49$. Regardless of condition, participants did not show further changes during the continuance and follow-up phase, indicating stability.

Biomedical measures

BMI

The experimental groups and the control group decreased in self-reported BMI during the initial phase, $\beta_{SandRP} = -.80$ and $\beta_{Control} = -.72$. These results were even stronger for measured BMI, $\beta_{SandRP} = -1.16$ and $\beta_{Control} = -1.23$. During the continuance phase, only the S-condition decreased even further in self-reported BMI, $\beta_S = -.46$, whereas the other groups remained stable. In contrast, for measured BMI, both experimental groups decreased, $\beta_S = -.42$ and $\beta_{RP} = -.51$, whereas the control group remained stable. During the follow-up phase, the RP-condition self-reported a significant increase in BMI, $\beta_{RP} = .78$, whereas S-condition and the control group remained stable (BMI was not measured at T3).

Table 2 Standardized parameter estimates of growth curves of all outcome variables

Variable	Experimental standard		Experimental relapse prevention		Control group	
	Parameter estimate	90 % credibility interval	Parameter estimate	90 % credibility interval	Parameter estimate	90 % credibility interval
Proactive coping						
Intercept	7.63**	6.50 to 9.67	7.63**	6.50 to 9.67	7.63**	6.50 to 9.67
Slope initial	.25*	.01 to .05	.25*	.01 to .05	−.26	−.63 to .04
Slope continuance	−.26	−.73 to .08	−.23	−.74 to .15	.05	−.39 to .61
Slope follow-up	−.06	−.51 to .37	.03	−.46 to .46	.10	−.45 to .69
Self-efficacy						
Intercept	5.96**	4.86 to 8.05	5.96**	4.86 to 8.05	5.96**	4.86 to 8.05
Slope initial	.41**	.16 to .76	.41**	.16 to .76	−.10	−.48 to .20
Slope continuance	−.37*	−.71 to −.03	−.61**	−1.06 to −.25	−.26	−.73 to .19
Slope follow-up	.09	−.39 to .44	−.12	−.51 to .22	−.37	−.99 to .12
Goal commitment						
Intercept	7.19**	6.03 to 9.31	7.19**	6.03 to 9.31	7.19**	6.03 to 9.31
Slope initial	.08	−.17 to .33	.08	−.17 to .33	−.06	−.42 to .29
Slope continuance	−.30	−.71 to .04	−.48*	−.96 to −.11	−.74**	−1.38 to −.30
Slope follow-up	−.26	−.84 to .19	−.70**	−1.55 to −.23	−.06	−.70 to .55
Sense of responsibility						
Intercept	11.66**	9.69 to 15.80	11.66**	9.69 to 15.80	11.66**	9.69 to 15.80
Slope initial	.08	−.17 to .33	.08	−.17 to .33	−.38*	−.78 to −.07
Slope continuance	−.03	−.34 to .26	−.04	−.36 to .29	.34	−.01 to .72
Slope follow-up	−.21	−.61 to .14	−.07	−.45 to .39	−.07	−.56 to .32
Diet						
Intercept	7.30**	6.37 to 8.57	7.30**	6.37 to 8.57	7.30**	6.37 to 8.57
Slope initial	1.04**	.67 to 1.68	1.04**	.67 to 1.68	.82**	.47 to 1.35
Slope continuance	−.03	−.38 to .43	.19	−.20 to .81	−.12	−.56 to .34
Slope follow-up	.30	−.08 to .67	−.04	−.43 to .36	−.21	−.74 to .19
Exercise						
Intercept	2.21**	1.84 to 2.78	2.21**	1.84 to 2.78	2.21**	1.84 to 2.78
Slope initial	.38**	.10 to .85	.38**	.10 to .85	.49**	.11 to 1.11
Slope continuance	−.09	−.45 to .24	−.21	−.61 to .18	−.37	−.92 to .05
Slope follow-up	−.02	−.44 to .37	.22	−.21 to .70	.18	−.32 to .72
BMI self-reported						
Intercept	15.31**	13.56 to 17.20	15.31**	13.56 to 17.20	15.31**	13.56 to 17.20
Slope initial	−.80**	−1.24 to −.52	−.80**	−1.24 to −.52	−.72**	−1.22 to −.36
Slope continuance	−.46**	−.82 to −.14	−.31	−.67 to .05	.02	−.35 to .41
Slope follow-up	.37	−.12 to .94	.78**	.26 to 1.63	−.08	−.74 to .52
BMI measured						
Intercept	13.75**	12.32 to 15.22	13.75**	12.32 to 15.22	13.75**	12.32 to 15.22
Slope initial	−1.16**	−2.21 to −.74	−1.16**	−2.21 to −.74	−1.23**	−2.48 to −.72
Slope continuance	−.42*	−.90 to −.05	−.51*	−.95 to −.01	−.34	−.83 to .06

* $p \leq .01$; ** $p \leq .05$

Blood values

A repeated measures ANOVA revealed a significant main effect of time, $F(1, 80) = 4.60$, $p = .04$; indicating that overall Hba1c values worsened over time. This main effect was qualified by a significant time*condition interaction effect, $F(2, 80) = 6.89$, $p = .002$. Simple main effects analyses demonstrated that the S ($M_{ST0} = 38.67$, SD = 2.94; $M_{ST3} = 39.26$, SD = 3.98;$p = .17$) and RP-condition ($M_{RPT0} = 38.76$, SD = 2.74; $M_{RPT3} = 39.07$,

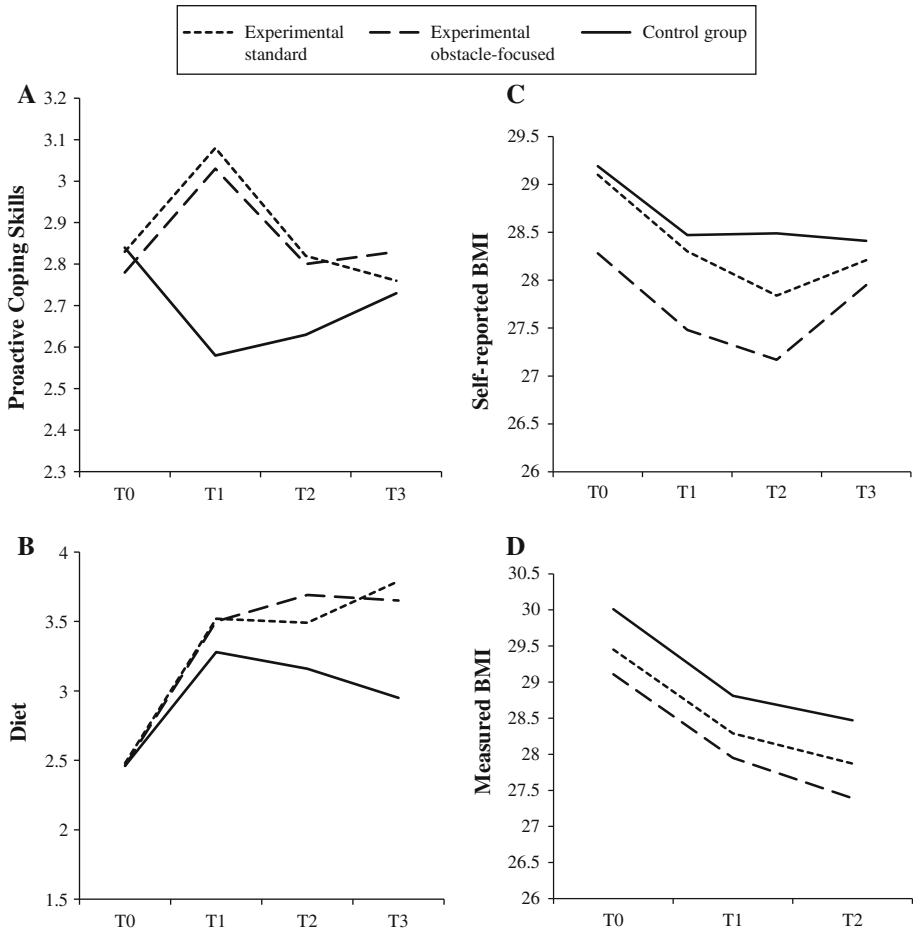

Fig. 2 Growth Curves for the main dependent variables: Proactive Coping (possible range 1–4; **a**), Diet (possible range 1–4; **b**), Self-reported BMI (**c**) and Measured BMI (**d**)

SD = 3.54; $p = .07$) remained stable. In contrast, in the control condition Hba1c significantly increased over time, $M_{\text{controlT0}} = 38.25$ (SD = 2.69), $M_{\text{controlT3}} = 39.95$ (SD = 3.72), $p = .002$. For fasting glucose, tryglicerides, and HDL and LDL cholesterol, there were no significant main effects of time, all p's $> .10$, nor interaction-effects, all p's $> .16$.

Discussion

The present study examined the efficacy of a self-management intervention in overweight and obese people at risk for type 2 diabetes. Results demonstrate that for those who completed the intervention, outcomes in behavioral, psychological and anthropometric domains improved in the short term and stabilized over a period of a year. The experimental groups demonstrated greater improvements than the control group on two primary outcomes: proactive coping and measured BMI. Furthermore, it was shown that booster sessions had little added value above the initial phase of intervention, and no straightforward differential effects were found for the two types of booster sessions.

The finding that the experimental groups showed an increase in proactive coping skills during the initial phase, and the control group did not, demonstrates that the intervention succeeded in its primary objective: the development of future-oriented self-regulatory skills. Not only did the experimental groups manage to maintain these proactive coping skills over time, they also continued to lose weight during the continuance phase, whereas the control group did not. The beneficial intervention effects on BMI were also reflected in Hba1c-levels: in the control group Hba1c increased, but it remained stable in the experimental groups. This indicates that the current intervention may help prevent weight gain and stabilize risk for chronic illnesses, which without lifestyle change most often increase over time.

It is important to note that the above results only hold for those who completed the intervention. The fact that more than 20 % of participants did not attend the booster sessions may indicate that people are less willing to adhere to intervention requirements after several months (see also Appel et al., 2011), which mirrors the notion that maintenance of successful weight management, rather than its initiation, is the most pressing challenge that research on

obesity treatment faces today (Jeffery et al., 2000). Nonetheless, the rate of drop out in the current intervention is much higher than in other weight management interventions (e.g., Knowler et al., 2002). One reason for this high drop out may be that we did not implement a run-in period before randomization in which availability and attendance confirmation is assessed (Appel et al., 2011; Ulmer et al., 2008). Also, the skills-based nature of the intervention may have played a role, as this approach yields benefits through systematic but small changes in eating behavior, which may be incompatible with the often desired fast and large weight loss among overweight and obese populations. Overall, the low attendance rates suggest that future research should attempt to identify strategies that increase session attendance, especially during later phases of the intervention. It should be noted that at follow-up, the control group lost the most participants, which may indicate that without regular face-to-face contact over an extended period of time, people are more likely to withdraw from intervention. This suggestion should be addressed in future research.

Although the experimental groups improved more than the control groups in two primary outcomes, proactive coping and BMI, for the third primary outcome, eating behavior, a similar pattern emerged for the control group as for the experimental groups. Also, few differences emerged between the control and intervention groups during the initial phase of the intervention. These findings stand in contrast to earlier work (Thoolen et al., 2009) which demonstrated the intervention's short-term advantage over a control group in diabetes patients. One explanation for the lack of differences in diet is that our measure only captured fat intake, which excluded other aspects of achieving a healthy diet that may have yielded a difference between conditions. Also, results may be partly due to the strict control group we employed. Specifically, the assignments that the control group received may have spurred on knowledge about and active use of self-regulatory principles, e.g., goal-setting and self-monitoring. Alternatively, the findings suggest that, at least for non-diabetes patients, nutrition education, written assignments, and attention might be sufficient to trigger some beneficial effects with regard to behavior change. Further research is warranted into the mechanisms that have driven the positive outcomes of the control group.

In addition to examining the intervention's efficacy, we also investigated the added value of booster sessions. Although participants did seem to benefit from attending booster sessions in some respects (e.g., decreased BMI), in general, the booster sessions had little added value beyond the initial phase, and more strikingly, beyond boosters in the form of written assignments (i.e., the control group). This suggests that the initial phase of the intervention may be sufficient to establish both successful initiation and maintenance, especially as Thoolen et al. (2009) showed that the intervention without booster sessions yielded similar maintenance effects. Notably, a large proportion of the participants failed to attend booster sessions in the first place; the lack of differences between the "standard" and "relapse prevention" booster sessions should therefore be interpreted with caution. Nonetheless, the low attendance rates during booster sessions corroborates earlier research indicating that extending interventions by means of face-to-face group sessions may not necessarily yield additional benefits (Kroese et al., 2012).

Several limitations should be noted. First, we analyzed completers only, which may have positively biased the results: it is possible that only those who were able to initiate and maintain improvements over time returned the questionnaires. However, as intention-to-treat analyses with single or multiple imputation methods were unsuitable or impossible, completers-only analyses were deemed the most appropriate for the present research question, i.e., to test the efficacy of the intervention for those who actually attended the intervention. On a related note, relatively small groups were analyzed, which could have resulted in an increased Type I error. However, LGCM counteracted this problem to some extent, as it does not employ listwise deletion when one datapoint for a participant is missing (Duncan & Duncan, 2004). Second, the fact that our population was middle-aged and ethnically homogeneous limits the generalizability of our results. Nonetheless, as middle age is the typical period when diabetes risk becomes manifest our sample was representative in this regard (Villareal et al. 2005). Third, the reliance on self-reported rather than measured BMI for the final measurement and the lack of a long-term follow-up beyond 1 year after intervention initiation are important issues that should be addressed in future research.

Notwithstanding these limitations, the present study has several important implications. First, the results indicate that self-management interventions can play an important preventive role in health practice as the intervention improved BMI and proactive coping skills among a sample of overweight, but otherwise healthy adults. Second, the study builds upon cumulative evidence calling the added value of extended interventions for behavior change maintenance into question (e.g., Kroese et al., 2012). Third, the finding that our active control condition and the experimental conditions yielded similar effects in eating behavior and exercise indicates that the efficacy of interventions can be partly explained by effects other than the specific content of the intervention itself (e.g., attention). Overall, this study provides promising results for the efficacy of brief, and thus relatively low-burden, self-management interventions in an overweight/obese population, at least for those who complete it.

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