HHS Public Access

Author manuscript

J Nutr Educ Behav. Author manuscript; available in PMC 2017 March 01.

Published in final edited form as:

J Nutr Educ Behav. 2016 March ; 48(3): 160–169.e1. doi:10.1016/j.jneb.2015.12.002.

Impact of a Worksite Diabetes Prevention Intervention on Diet Quality and Social Cognitive Influences of Health Behavior: A Randomized Controlled Trial

Carla K. Miller, PhD, RD[a],
Professor, Department of Human Sciences, Human Nutrition, miller.4453@osu.edu, 614-292-1391

Kellie R. Weinhold, MS, RD[a], and
Graduate Research Assistant, Department of Human Sciences, Human Nutrition, weinhold.8@osu.edu

Haikady N. Nagaraja, PhD[a]
Professor, College of Public Health, Division of Biostatistics, nagaraja.1@osu.edu

Abstract

Objective—To evaluate the impact of a worksite diabetes prevention intervention on secondary outcomes regarding the change in diet quality and components of the Health Action Process Approach (HAPA) theoretical framework

Design—Pretest-posttest control group design with 3-month follow-up

Setting—University worksite

Participants—Employees 18–65 years old with prediabetes (n=68)

Intervention—16-week group-based intervention adapted from the Diabetes Prevention Program

Main Outcome Measures—Diet quality was assessed using the Alternative Healthy Eating Index (AHEI) 2010; HAPA components were assessed via written questionnaire

Analysis—Repeated measures analysis of variance compared the between- and within-group change in outcomes across time.

Results—Significant difference occurred between-groups for the change in consumption of nuts/legumes and red/processed meats post-intervention and for fruits at 3-month follow-up (all P<.05); a significant increase in total AHEI score occurred post-intervention in the experimental group (P=.002). The changes in action planning, action self-efficacy, and coping self-efficacy from

Correspondence to: Carla K. Miller.

[a]Ohio State University, 1787 Neil Ave., 325 Campbell Hall, Columbus, OH, 43210

CONFLICT OF INTEREST

The authors do not have any conflict of interest.

HAPA were significantly different between groups following the intervention; the change in outcome expectancies was significantly different between groups at 3-month follow-up (all P<. 05).

Conclusions and Implications—The worksite intervention facilitated improvement in diet quality and in planning and efficacious beliefs regarding diabetes prevention. Further research is needed to evaluate the long-term impact of the intervention.

Keywords

type 2 diabetes mellitus; worksite; diabetes prevention; diet quality; self-efficacy; Health Action Process Approach

INTRODUCTION

Lifestyle interventions can effectively decrease the incidence of type 2 diabetes mellitus (T2DM) in high-risk patients.[1] Diet and physical activity (PA) are the cornerstones of lifestyle modification.[2] Increased PA has been shown to reduce T2DM risk,[3] and moderate to vigorous activities performed during daily life in bouts of 10 minutes or more are beneficial.[4] Likewise, a recent meta-analysis found that healthy dietary patterns that focused on nutrient dense foods were associated with a 20% reduced risk for T2DM.[5]

The Alternative Healthy Eating Index (AHEI) 2010 was created as a measure of diet quality and targets nutrient dense foods associated with reduced disease risk.[6] The AHEI score represents how well diets conform to recommendations for consumption of foods from food groups (e.g., vegetables, whole grains) as well as guidelines on fat, sugar, and sodium, and the score can be used to assess the relation between adherence to the Dietary Guidelines for Americans and the occurrence of health outcomes.[7] High AHEI scores were associated with significant risk reduction for all-cause mortality and T2DM.[8]

Adopting a nutrient dense diet and changing PA-related behaviors requires concerted effort and perseverance. Self-efficacy determines the amount of effort and perseverance one will invest in a behavior;[9] higher levels of self-efficacy have been related to greater behavioral change. For example, higher baseline levels of self-efficacy for PA were associated with higher levels of leisure PA at study end in the Diabetes Prevention Program (DPP).[10] Similarly for each unit improvement in self-efficacy for eating a low fat diet in the DPP, there was almost a threefold greater likelihood of achieving 7% weight loss at study end.[11]

The Health Action Process Approach (HAPA) model addresses the social cognitive influences of health behavior, such as self-efficacy, inherent in goal-based nutrition and PA interventions. The development of an intention or goal is a motivational process that differs from the subsequent preparation, performance, and evaluation of the target behavior.[9] Greater insight into the social cognitive factors that contribute to lifestyle change will inform health behavior theory and guide the development of more effective lifestyle interventions. The purpose of this research was to evaluate the impact of a worksite diabetes prevention intervention on HAPA-related outcomes, nutrient density and diet quality as measured by the AHEI, and 10-minute bouts of PA among employees with prediabetes.

THEORETICAL FRAMEWORK

HAPA differentiates between a motivational phase of behavior change leading to an intention to change and an action, or volitional, phase of behavior change leading to implementation of the behavior.[9,12–13] Within both phases, different patterns of social-cognitive factors play a role. In the motivational phase, an intention to act is based on risk perceptions, outcome expectancies, and perceived self-efficacy (SE). Risk perception assesses the perceived vulnerability for poor health outcomes (e.g., prediabetes). Outcome expectancies contribute to forming an intention for the target behavior. SE represents belief in one's capability to perform the behavior and perceived SE operates in concert with positive outcome expectancies to form an intention to act. Planning bridges the gap between an intention to act and acting on the behavior. However, successful behavior change requires not only getting started but also persisting until the goal is attained. SE remains influential after an intention has been formed until the new behavior becomes habitual. HAPA provides a framework to examine how individuals resist temptation and recover from setbacks and HAPA postulates that there are different phases of SE beliefs. Action SE refers to developing a motivation to act. Coping SE describes optimistic beliefs about one's capability to sustain a behavior regardless of barriers encountered and includes the perceived capability to enact better strategies, extend greater effort, or persist longer. Similarly, recovery SE describes individuals' conviction to get back on track after being derailed. Individuals with a high degree of recovery SE trust their ability to regain control following a setback or failure. Different SE beliefs may be held simultaneously with the assumption that they operate in a different manner. For example, recovery SE is most useful when resuming an interrupted chain of action, whereas action SE is most useful when facing a formidable barrier to act. However, the relation between different SE beliefs and the change in lifestyle behaviors has received little empirical attention.

METHODS

Study Design

A pretest/posttest control group design was employed at a university worksite, and participants were randomly assigned to treatment group. Following randomization, the experimental group proceeded through the 16-week DPP intervention. The control group received an information booklet regarding lifestyle changes for diabetes prevention;[14] they received no further contact from intervention staff. All participants completed a second assessment at 4 months and a third assessment occurred 7 months from baseline.

Participants and Recruitment

To be eligible, participants had to be employees of the University ages 18–65 years with prediabetes. A risk questionnaire and point-of-care glucose testing to assess prediabetes (i.e., impaired fasting glucose) were employed. Individuals completed the 7-item American Diabetes Association (ADA) diabetes risk assessment questionnaire,[15] height and weight measurement, and collection of a fingerstick blood sample to assess fasting capillary blood glucose or A1c for people with a BMI 25 – 50 kg/m^2 and an ADA risk score ≥ 5. Individuals

with a fasting glucose of 100 – 125 mg/dL or an A1c value of 5.7 – 6.4% were identified as having prediabetes.[16]

Potentially eligible people completed the Physical Activity Readiness Questionnaire and those who answered positively to ≥ 1 question(s) were excluded.[17] Individuals diagnosed with diabetes, chronically using corticosteroids, participating in a structured weight loss program, preparing for bariatric surgery in the next 12 months, planning to leave university employment or move from the community were ineligible. Women who were pregnant or lactating or planning to become pregnant also were ineligible.

Participants were recruited through electronic advertisements on the university newswire, campus flyers, a news story in the employee newspaper, and through direct mailings to employees with health insurance who completed the university health risk assessment and had a random glucose value of 110 – 199 mg/dL. Contact details were provided on recruitment material for individuals to contact to receive more information. All procedures were followed in accordance with the ethical standards of the Institutional Review Board at the sponsoring university, and participants provided written, informed consent.

Worksite Diabetes Prevention Intervention

The experimental group received the 16-week Group Lifestyle Balance intervention.[18] Weekly 60-minute group sessions were held and facilitated by a lifestyle coach using the program manual. Two coaches were involved in the study and each completed the 2-day training program prior to study initiation. Participants received a written manual with session material, food and PA trackers for self-monitoring, a graph for tracking weekly weights, and a booklet with the nutrient content of commonly consumed foods for self-monitoring. [19] Participants were encouraged to record calories and fat grams consumed and minutes spent in PA daily during the intervention. Monitoring records were reviewed by the lifestyle coach weekly and individualized feedback was provided via returned records.

The lifestyle intervention was goal-based with a goal of losing 7% of initial body weight, progressively increasing PA to 150 minutes/week of at least moderate intensity PA, and consuming 25% of energy from fat to reduce energy intake. Brisk walking for at least 10 minutes was encouraged to meet the activity goal but any activity of similar intensity could be performed. Incremental goals were established to facilitate improvement in SE for the target behaviors. The first 8 sessions presented the intervention goals, taught fundamental information about modifying energy and fat intake and increasing energy expenditure, and helped participants self-monitor. The latter 8 sessions focused on problem solving to achieving lifestyle goals, relapse prevention, and motivational factors for sustaining behavioral change. Action plans were introduced in session 9 and continued in successive sessions, in which participants were asked to identify a problem behavior. The action plan included choosing a positive behavior to try and when the behavior would be undertaken, barriers that might occur, and coping strategies. The following week, participants were asked to review the success of their action plan and how it could be modified, if unsuccessful. Following completion of the weekly intervention, participants did not receive contact from intervention staff during the 3-month follow-up period.

Instruments and Measures

All study measures were collected at baseline, post-intervention, and at 3-month follow-up. Body weight was measured using a calibrated digital scale (Health-O-Meter Professional, McCook, Illinois). Height was collected at baseline using a standing stadiometer (Perspective Enterprises, Portage, MI). For both height and weight, participants were measured wearing light clothing and no shoes.

The valid 110-item Block 2005 Food Frequency Questionnaire was self-administered to assess usual dietary intake in the previous year.[20–21] Participants received a food-portion visual to estimate portions; nine response options regarding frequency were included. Nutrient and food group intakes were calculated by multiplying the frequency of intake for each food by its nutrient content or food group membership and summing across all food items. The scoring method for the AHEI 2010 total and component scores followed methodology published previously.[6] Scores for each of the 11 components (0–10 points each) of the AHEI 2010 were summed and total scores ranged from 0 to 110. Red and processed meat, sugar-sweetened beverages, trans fats, and sodium were reverse scored so that lower intakes provided higher component scores.

PA was assessed using the Lifecorder Plus Accelerometer (Suzuken-Kenz, Inc., Nagoya, Japan) to obtain minutes spent in moderate-to-vigorous physical activity (MVPA). Participants were instructed to wear the accelerometer on their hip at the waistline for all waking hours on seven consecutive days during each assessment period. Bouts of MVPA that were at least 10 minutes in duration, consistent with PA public health recommendations,[3] were counted and summed.

A written questionnaire addressed components of the HAPA theoretical framework with weight loss through diet and PA modification as foci, consistent with the intervention. Questions were developed patterned after prior studies.[12,22–23] Risk was assessed via one item which asked participants to compare their risk of getting diabetes to an average person of their sex and age (response options: 1 = “much below average” to 7 = “much above average”). Outcome expectancies were assessed via 5 items regarding possible outcomes of losing weight. The stem, “If I lose weight…” was followed by potential outcomes (e.g., “…I will have more energy”). Two items assessed behavioral intention; 1 item assessed intention for a healthy food plan and 1 item assessed intention for performing regular exercise. Action planning was assessed via 7 items regarding diet and PA plans (e.g., “I have made plans regarding… which foods to eat”). Three items assessed action SE (e.g., “I am sure that… I can lose weight within the next week”). Five items assessed coping SE (e.g., “I can stick to healthy foods… even if I need a long time to develop the necessary routines”). Recovery SE was assessed via 3 items and introduced with, “In spite of good intentions, lapses or relapses may occur. Imagine you have regained some weight. How confident are you about losing weight again?” The stem included, “I am certain that I could lose weight again…” and was followed by “…even after I have regained a few pounds,” for example. Response options for each of the subscales ranged from 1 = “not at all true” to 4 = “exactly true.”

In addition to the HAPA questionnaire, participants also completed a questionnaire at baseline to assess demographic characteristics and prior attempts and confidence in losing weight.

Data Analyses

The Fisher exact test, Pearson chi-square test, or two-sample *t* test compared between-group differences in participant demographic and weight-related characteristics at baseline. Mixed linear models were developed and validated where participants nested within treatment groups were used as random effects, and treatment group, time and their interaction were used as fixed effects for participants who completed data collection. Outcome variables were assessed in the framework of these models using Student's t-tests within a repeated measures analysis of variance framework for between-group comparisons of mean values at baseline, and between-and within-group change from baseline to post-intervention and from baseline to 3-month follow-up. The Wilcoxon signed-rank test was used to compare groups at baseline for AHEI 2010 component scores, outcome expectancies, and recovery SE due to non-normality and for the change in scores both between- and within-groups. P-value < 0.025 was used to indicate statistical significance for the change within groups to account for multiple comparisons. Since there was significant improvement in the AHEI 2010 total score and weight, the relationship among these outcomes and components of HAPA were examined for the experimental group using Spearman correlations. Also, Cronbach's alpha coefficient for each HAPA subscale was determined at baseline for all participants combined, and Spearman correlation coefficients were calculated between baseline and post-intervention scores for control group participants to assess test-retest reliability of the HAPA subscales.

Power analysis for the primary outcome percent weight change (power=0.90, 2-tailed α= 0.05) based on a previous DPP translational study[24] indicated that 25 in each treatment group were needed to detect a 4.04% difference between groups. All analyses were completed using the SAS statistical software package JMP version 10 (SAS Institute, Inc., Cary, NC).

RESULTS

The flow of participants from screening to analyses is reported elsewhere.[25] Forty participants were randomized to the experimental group, and 35 completed the final study visit. Thirty eight participants were randomized to the control group, and 33 completed the final study visit. There were no significant differences in attrition rates between treatment groups nor in baseline characteristics between those who did and did not complete the study (all P > .05). Also, there were no significant differences in baseline demographic characteristics between treatment groups except for occupation (Table 1) and no significant differences between groups in prior weight loss attempts (Table 2).

Change in Outcomes between Treatment Groups

The experimental group lost a greater percentage of their body weight than the control group (−5.5% vs. −0.35%, respectively; P < .0001) (Table 3). The change in weight, the primary

study outcome, is reported in greater detail elsewhere.[25] The experimental group reported significantly lower intake of nuts/legumes and red/processed meats (reverse scored) post-intervention than the control group and significantly greater intake of fruits at 3-month follow-up (all $P < .05$). No significant difference occurred between groups for the change in the number of 10-minute bouts of MVPA. For HAPA-related outcomes, the experimental group reported significantly greater frequency of action planning and greater action and coping SE post-intervention (all $P< .05$) than the control group and significantly greater outcome expectancies at 3-month follow-up ($P = .002$) (Table 4).

Change in Outcomes within Treatment Groups

There was a significant increase in total AHEI score and in consumption of fruits and a significant decrease in consumption of red/processed meats, trans fats, and sodium (all $P < .01$) post-intervention for the experimental group (Table 3). The change in consumption of whole grains was lower at 3-month follow-up for the experimental group ($P = .01$), and the change in consumption of sodium and red/processed meats was lower for both groups at 3-month follow-up (all $P < .025$). There was no significant change in the number of 10-minute bouts of MVPA for either group. For the experimental group, action SE increased post-intervention; perceived risk for T2DM decreased and action planning increased post-intervention and at 3-month follow-up, and outcome expectancies regarding weight loss increased at 3-month follow-up (all $P < .025$) (Table 4). The control group reported lower action SE for losing weight at 3-month follow-up than at baseline ($P = .02$).

Relationships among Study Outcome Changes in the Experimental Group

Following the intervention, the change in outcome expectancies and recovery SE was positively related to the change in AHEI total score (Table 5); the change in behavioral intention, action planning, and action and coping SE was negatively related to weight change (all $P < .05$). At 3-month follow-up, the change in behavioral intentions was positively related to the change in AHEI total score; the change in intentions, action planning, and action, coping and recovery SE was negatively related to weight change (all $P < .05$).

DISCUSSION

Study findings demonstrate that a lifestyle intervention can promote weight reduction and improvements in diet quality among adults with prediabetes following implementation of the worksite intervention. Overall diet quality improved, as measured by the AHEI 2010, in the experimental group by almost 5 points following the intervention even though there was no significant difference between groups in the change in total score. Prior research found improvement in the AHEI score was associated with lower risk for T2DM in women independent of body mass index, suggesting that changes in diet composition played a role in diabetes etiology.[26] Intakes of red and processed meats and trans fats decreased in the current study, consistent with intervention messages, while fruit intake significantly increased in the experimental group. Similarly, dietary patterns characterized as prudent (e.g., high intake of fruits, vegetables, and whole grains and low intake of red meats,

sodium, and trans fats) were inversely associated with T2DM risk in a prior observational study of men.[27]

Expectancies and planning regarding the change process can play a vital role in promoting behavioral change. The experimental group in the current study reported lower perceived risk for T2DM following the intervention, consistent with the reduced risk associated with weight loss and improved diet quality.[28] Similarly, the experimental group reported a significant increase in planning which foods to eat, when to exercise, and how to minimize food temptations; furthermore, action planning was significantly negatively related to weight loss (Table 5). If individuals encounter a high-risk situation in which they are tempted to eat (or omit PA) and lack an effective coping response, the danger of relapse is high.[29] Effective strategies to overcome tempting situations are unlikely to be developed in the moment in such situations. Planning allows individuals to form an active mental representation of the target situation, allowing situational cues to be more easily accessible and risky situations more easily detectable.[30] With planning, ineffective, spontaneous reactions based on habit or emotion can be replaced with pre-planned, action and coping responses.[29] Thus, planned responses developed through action planning can be performed when the target situation is encountered.

Prior research found that participants who created plans regarding when, where, and how to exercise and how to overcome anticipated barriers to exercise engaged in significantly more exercise two months following discharge from a cardiac rehabilitation program than those who did not make plans or those who only made plans regarding when, where, and how to exercise.[31] Similarly, women enrolled in Weight Watchers who made detailed plans regarding what, when, where, and how much food to eat and what, when, where, and how long to exercise in the next week and included plans for how they would cope with tempting situations lost significantly more weight than women who only made plans regarding when and where they would eat and when, where, and how they would exercise.[32] Additional research found that individuals with poor planning skills benefitted from an intervention in which participants generated a high quality plan to limit snacking on sweets and desserts.[33] These study results suggest that planning is beneficial and can be coached and asking people to make detailed plans regarding the target behavior can help poor planners achieve their goals. Thus, findings from the current and prior studies suggest that detailed planning, which includes plans for coping with barriers, can be an effective self-regulatory tool to help translate goals into behavior.

Self-regulatory skills and beliefs may not only be effective in helping people initiate behavior, they may also be effective in helping people continue the behavior until the new behavior becomes habitual. According to HAPA, coping SE describes optimistic beliefs about one's ability to sustain a behavior regardless of barriers specific to the maintenance period.[34] Recovery SE pertains to individuals' beliefs about their ability to resume action after a lapse in behavior. Individuals with a high level of recovery SE trust their ability to regain control after a setback or failure. For individuals who decrease their performance of the behavior (i.e., relapse), recovery SE helps them to gradually return to acting on their intentions. In the current study, there was a significant difference between groups in the change in coping SE post-intervention; furthermore at study end, coping and recovery SE

were significantly negatively related to weight loss following the 3-month no contact maintenance period in the experimental group (Table 5). Prior research found that coping SE predicted exercise among participants who maintained an active lifestyle 8 months after leaving cardiac rehabilitation, while recovery SE predicted exercise among participants who had relapsed from the recommended level of exercise but still engaged in some exercise.[34] Thus, some individuals may have high confidence in their ability to set goals and to take initiative but little confidence in their ability to maintain the recommended behavior and may benefit from ongoing training and support. A larger sample is needed to segment participants into "maintainers" and "relapsers" to determine whether and how efficacious beliefs affect diet and PA behaviors long-term.

While the current findings regarding HAPA are promising, some limitations should be noted. The sample was not powered to detect a significant change in secondary study outcomes. Also, there was no significant change in intermittent PA. The intervention could place greater emphasis each week on increasing PA levels and include more time during intervention sessions for making detailed PA plans and coping responses for activity barriers. The sample included primarily white females and the impact of the intervention on a more diverse sample requires further research. Furthermore, the female participants who enrolled had many previous weight loss attempts, which likely influenced their outcome expectancy and efficacy beliefs for weight loss. Whether the intervention impact would be similar for individuals with fewer prior weight loss attempts is not known. The coping and recovery SE subscales had low stability based on test-retest correlation coefficients. These subscales included only 3–5 items, which likely influenced the weak correlations;[35] future research may strengthen the assessment of these efficacy beliefs by including a greater number of items. The impact of the intervention beyond 3-month follow-up was not evaluated and the long-term impact of the intervention warrants further investigation. Whether an intervention that prompts participants to make detailed plans regarding diet and PA behaviors, perhaps via mobile technology, following the weekly contact phase of an intervention during the maintenance phase would better promote weight loss maintenance through enhanced planning and coping and recovery SE requires further investigation.

IMPLICATIONS FOR RESEARCH AND PRACTICE

In summary, worksite behavioral interventions for diabetes prevention can facilitate planning activities and heighten SE for weight loss across the behavior change continuum. People can benefit from action planning to maintain and increase their previous behavior. Planning activities can go beyond goal setting by including detailed action plans regarding which behavior to perform, and when, where, how, how often, and how much or how long to engage in the behavior. In addition, asking participants to think ahead and anticipate barriers they are likely to encounter and develop detailed strategies for overcoming those barriers can be beneficial and may be necessary to avoid falling prey to tempting situations. When people do succumb to temptation, beliefs about recovering from a lapse may better explain behavior than beliefs about one's ability to engage in the behavior initially, according to HAPA. Further research is needed, however, to determine whether recovery SE helps individuals recover from a relapse and adhere to diet quality and PA recommendations longitudinally and the long-term impact of those behavioral changes on weight control.

Acknowledgments

Research reported in this publication was supported by the National Institute of Diabetes and Digestive and Kidney Diseases of the National Institutes of Health under award number R34DK093907. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

REFERENCES

1. Schellenberg ES, Dryden DM, Vandermeer B, Ha C, Korownyk C. Lifestyle interventions for patients with and at risk for type 2 diabetes: a systematic review and meta-analysis. Ann Intern Med. 2013; 159:543–551. [PubMed: 24126648]
2. Yamaoka K, Tango T. Efficacy of lifestyle education to prevent type 2 diabetes: a meta-analysis of randomized controlled trials. Diabetes Care. 2005; 28:2780–2786. [PubMed: 16249558]
3. Colberg SR, Sigal RJ, Fernhall B, et al. Exercise and type 2 diabetes: the American College of Sports Medicine and the American Diabetes Association: joint position statement. Diabetes Care. 2010; 33:e147–e167. [PubMed: 21115758]
4. Haskell WL, Lee IM, Pate RR, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Circulation. 2007; 116:1081–1093. [PubMed: 17671237]
5. Esposito K, Chiodini P, Maiorino MI, Bellastella G, Panagiotakos D, Giugliano D. Which diet for prevention of type 2 diabetes: a meta-analysis of prospective studies. Endocrine. 2014; 47:107–116. [PubMed: 24744219]
6. Chiuve SE, Fung TT, Rimm EB, et al. Alternative dietary indices both strongly predict risk of chronic disease. J Nutr. 2012; 142:1009–1018. [PubMed: 22513989]
7. Willett WC, McCullough ML. Dietary pattern analysis for the evaluation of dietary guidelines. Asia Pac J Clin Nutr. 2008; 17(S1):75–78. [PubMed: 18296306]
8. Schwingshackl L, Hoffmann G. Diet quality as assessed by the Healthy Eating Index, the Alternative Healthy Eating Index, the Dietary Approaches to Stop Hypertension score, and health outcomes: a systematic review and meta-analysis of cohort studies. J Acad Nutr Diet. 2015; 115 in press.
9. Schwarzer R. Self-regulatory processes in the adoption and maintenance of health behaviors: the role of optimism, goals, and threats. J Health Psychol. 1999; 4:115–127. [PubMed: 22021474]
10. Delahanty LM, Conroy MB, Nathan DM. the Diabetes Prevention Program Research Group. Psychological predictors of physical activity in the Diabetes Prevention Program. J Am Diet Assoc. 2006; 106:698–705. [PubMed: 16647327]
11. Delahanty LM, Peyrot M, Shrader PJ, Williamson DA, Meigs JB, Nathan DM. for the DPP Research Group. Pretreatment, psychological, and behavioral predictors of weight outcomes among lifestyle intervention participants in the Diabetes Prevention Program (DPP). Diabetes Care. 2013; 36:34–40. [PubMed: 23129133]
12. Schwarzer R, Renner B. Social-cognitive predictors of health behavior: action self-efficacy and coping self-efficacy. Health Psychol. 2000; 19:487–495. [PubMed: 11007157]
13. Schwarzer R. Modeling health behavior change: how to predict and modify the adoption and maintenance of health behaviors. Appl Psychol. 2008; 57:1–29.
14. U.S. Department of Health Human Services National Diabetes Education Program. Small Steps, Big Rewards: Your Game Plan to Prevent Type 2 Diabetes. Washington, DC: 2006. NIH Publication No. 06–5334
15. American Diabetes Association. [Accessed July 10, 2014] Are you at risk for type 2 diabetes? Diabetes risk test. Available at: http://www.diabetes.org/assets/pdfs/at-risk/risk-test-paper-version.pdf
16. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2015; 38(Suppl 1):S8–S16.
17. Scott T, Reading J, Shephard RJ. Revision of the Physical Activity Readiness Questionnaire (PAR-Q). Can J Sport Sci. 1992; 17:338–345. [PubMed: 1330274]

18. Diabetes Prevention Program (DPP) Research Group. The Diabetes Prevention Program (DPP): description of lifestyle intervention. Diabetes Care. 2002; 25:2165–2171. [PubMed: 12453955]
19. Stephenson, J.; Bader, D. Healthcheques carbohydrate, fat and calorie guide. Mankato, MN: Appletree Press, Inc.; 2010.
20. Mares-Perlman JA, Klein BEK, Klein R, Ritter LL, Fisher MR, Freudenheim JL. A diet history questionnaire ranks nutrient intakes in middle-aged and older men and women similarly to multiple food records. J Nutr. 1993; 123:489–501. [PubMed: 8463852]
21. Block G, Woods M, Potosky A, Clifford C. Validation of a self-administered diet history questionnaire using multiple diet records. J Clin Epidemiol. 1990; 43:1327–1335. [PubMed: 2254769]
22. Schwarzer R, Schuz B, Ziegelmann JP, Lippke S, Luszczynska A, Scholz U. Adoption and maintenance of four health behaviors: theory-guided longitudinal studies on dental flossing, seat belt use, dietary behavior, and physical activity. Ann Behav Med. 2007; 33:156–166. [PubMed: 17447868]
23. Scholz U, Schuz B, Ziegelmann JP, Lippke S, Schwarzer R. Beyond behavioral intentions: planning mediates between intentions and physical activity. Br J Health Psychol. 2008; 13:479–494. [PubMed: 17553212]
24. Ackermann RT, Finch EA, Brizendine E, Zhou H, Marrero DG. Translating the Diabetes Prevention Program into the community: the DEPLOY pilot study. Am J Prev Med. 2008; 35:357–363. [PubMed: 18779029]
25. Weinhold KR, Miller CK, Marrero DG, Nagaraja HN, Focht BC, Gascon GM. A randomized controlled trial translating the Diabetes Prevention Program to a university worksite, Ohio, 2012–2014. Prev Chronic Dis. 2015; 12:150301. doi: http://dx.doi.org/10.5888/pcd12.150301.
26. Fung TT, McCullough M, van Dam RM, Hu FB. A prospective study of overall diet quality and risk of type 2 diabetes in women. Diabetes Care. 2007; 30:1753–1757. [PubMed: 17429059]
27. Koning LD, Chiuve SE, Fung TT, Willett WC, Rimm EB, Hu FB. Diet-quality scores and the risk of type 2 diabetes in men. Diabetes Care. 2011; 34:1150–1156. [PubMed: 21464460]
28. Jensen MD, Ryan DH, Apovian CM, et al. 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults: a report of the American College of Cardiology/American Heart Association task force on practice guidelines and the Obesity Society. Circulation. 2014; 129(25 suppl 2):S102–S140. [PubMed: 24222017]
29. Sniehotta FF, Schwarzer R, Scholz U, Schuz B. Action planning and coping planning for long-term lifestyle change: theory and assessment. Euro J Soc Psychol. 2005; 35:565–576.
30. Gollwitzer PM. Implementation intentions: strong effects of simple plans. Am Psychol. 1999; 54:493–503.
31. Sniehotta FF, Scholze U, Schwarzer R. Action plans and coping plans for physical exercise: a longitudinal intervention study in cardiac rehabilitation. Br J Health Psychol. 2006; 11:23–37. [PubMed: 16480553]
32. Luszczynska A, Sobczyk A, Abraham C. Planning to lose weight: randomized controlled trial of an implementation intention prompt to enhance weight reduction among overweight and obese women. Health Psychol. 2007; 26:507–512. [PubMed: 17605571]
33. Allan JL, Sniehotta FF, Johnston M. The best laid plans: planning skill determines the effectiveness of action plans and implementation intentions. Ann Behav Med. 2013; 46:114–120. [PubMed: 23456214]
34. Luszczynska A, Sutton S. Physical activity after cardiac rehabilitation: evidence that different types of self-efficacy are important in maintainers and relapsers. Rehab Psychol. 2006; 51:314–321.
35. Kerlinger, FN. Foundations of Behavioral Research. 3rd. Fort Worth, TX: Harcourt Brace College Publishers; 1986.

Table 1

Demographic Characteristics at Baseline of the Sample Enrolled in a Worksite Diabetes Prevention Trial by Treatment Group

Characteristic	Exper. Group (n=35)	Control Group (n=33)	
	Mean (±SD)		P-value
Age (years)	51.6 (±9.5)	50.8 (±8.1)	0.73 [a]
	n (%)	n (%)	
White race	27 (77)	29 (88)	0.25 [b]
Black or Asian race	8 (23)	4 (12)	
Male	7 (20)	7 (21)	0.90 [b]
Female	28 (80)	26 (79)	
Less than bachelor's degree	15 (43)	9 (27)	0.34 [c]
Bachelor's degree	11 (31)	11 (33)	
Post-graduate degree	9 (26)	13 (39)	
Full-time employment	32 (91)	32 (97)	0.33 [b]
Part-time employment	3 (9)	1 (3)	
Married	24 (67)	25 (76)	0.51 [b]
Not married	11 (31)	8 (24)	
Professional occupation [d]	12 (35)	18 (55)	0.01 [c]
Clerical occupation	10 (29)	13 (39)	
Other occupation	12 (35)	2 (6)	
Years at current job			
1–5 years	13 (37)	11 (33)	0.20 [c]
6–10 years	13 (37)	6 (18)	
11–15 years	3 (9)	6 (18)	
≥ 16 years	6 (17)	10 (30)	
Annual household income [d]			
$20,000–39,999	8 (24)	3 (9)	0.27 [c]
$40,000–59,999	4 (12)	4 (12)	
$60,000–79,999	6 (18)	6 (18)	
$80,000–99,999	9 (27)	6 (18)	
≥ $100,000	7 (21)	14 (42)	

[a] One-way ANOVA of between-group difference of mean

[b] Fisher's Exact Test of between group differences

[c] Pearson Chi-Square test of between-group differences

[d] One participant in experimental group did not provide this information.

Table 2

Weight-related Characteristics of the Sample at Baseline by Sex and Treatment Group

Weight-related Characteristic		Exper. Group (n=35)	Control Group (n=33)	
	Sex[a]	n (%)	n (%)	P-value[b]
Attempted weight loss previously	M	6 (86)	6 (86)	1.00
	F	26 (93)	26 (100)	0.16
Weighs self on scale at home	M	4 (57)	7 (100)	0.05
	F	23 (82)	23 (89)	0.51
		Mean (±SD)	Mean (±SD)	P-value[c]
Personal overall health rating in past 5 years [d]	M	2.1 (±0.67)	2.6 (±1.1)	0.41
	F	3.0 (±0.7)	2.9 (±0.9)	0.62
Frequency of weighing self at home [e]	M	3.6 (±0.5)	3.4 (±1.0)	0.74
	F	3.3 (±0.9)	3.6 (±0.5)	0.35
Previous weight loss attempts (number) [f]	M	3.0 (±2.3)	7.8 (±11.3)	0.35
	F	15.1 (±23.6)	19.8 (±23.0)	0.47
Most weight lost during one attempt (pounds) [g]	M	20.2 (±12.0)	18.7 (±14.7)	0.84
	F	30.1 (±18.0)	38.2 (±22.0)	0.16
Frequency of preoccupation with losing weight [h]	M	1.9 (±0.3)	1.9 (±0.7)	1.00
	F	2.7 (±0.9)	2.6 (±0.8)	0.54
Frequency of preoccupation with food [h]	M	1.9 (±0.7)	2.1 (±1.1)	0.57
	F	2.4 (±0.7)	2.5 (±0.8)	0.62
Perceived importance of losing weight [i]	M	7.0 (±2.2)	7.6 (±2.7)	0.67
	F	8.8 (±1.3)	9.0 (±1.2)	0.68
Perceived confidence in ability to lose weight [i]	M	6.6 (±1.0)	7.6 (±2.5)	0.36
	F	6.8 (±1.7)	6.6 (±2.2)	0.92

[a] Abbreviations: M = male; F = female

[b] Fisher's Exact Test of between group differences

[c] Two-sample t test of between-group difference of mean

[d] Response options ranged from 1 = "excellent" to 5 = "poor."

[e] Response options ranged from 1 = "more than once per day" to 5 = "once per year or less."

[f] Two females and one male in experimental group and one male in control group did not provide this information.

[g] One female in experimental group did not provide this information.

[h] Response options ranged from 1 = “never” to 4 = “always.”

[i] Response options ranged from 0 = “not at all important/confident” to 10 = “extremely important/confident.”

Table 3

Total and Subcomponent Scores for the Alternative Healthy Eating Index 2010[a], 10-minute Bouts of Physical Activity, and Weight at Baseline, and Change in Outcomes by Treatment Group and Timepoint

Outcome	Baseline Group Mean (±SE)			Post-Intervention Change from Baseline Group Mean (±SE)			3-Month Follow-up Change from Baseline Group Mean (±SE)		
	Exper. (n=35)	Control (n=33)	P-value[b]	Exper. (n=33)	Control (n=32)	P-value[b]	Exper. (n=35)	Control (n=33)	P-value[b]
Weight change (%)	-	-	-	−5.50 (±0.63)***[c]	−0.35 (±0.49)	<0.0001	−5.20 (±0.96)***[c]	−0.21 (±0.71)	<0.0001
10-min bouts MVPA/day (number)	0.53 ± 0.10	0.26 ± 0.10	0.05	0.10 ± 0.10	0.07 ± 0.10	0.86	−0.04 ± 0.10	0.21 ± 0.10	0.08
Total AHEI Score [d]	58.74 ± 1.91	59.96 ± 1.97	0.66	4.63 ± 1.38**[c]	2.57 ± 1.41	0.30	1.91 ± 1.35	1.08 ± 1.39	0.67
Outcome[d]	**Baseline Group Median (range)**			**Post-Intervention Change from Baseline Group Median (range)**			**3-Month Follow-up Change from Baseline Group Median (range)**		
	Exper. (n=35)	Control (n=33)	P-value[e]	Exper. (n=33)	Control (n=32)	P-value[e]	Exper. (n=35)	Control (n=33)	P-value[e]
AHEI Vegetables score	6.32 (1.45, 10.0)	6.04 (1.94, 10.0)	0.93	0.0 (−5.86, 6.62)	0.0 (−4.48, 4.62)	0.76	0.0 (−5.66, 4.00)	0.0 (−4.96, 4.62)	0.97
AHEI Fruits score	3.35 (0.11, 10.0)	4.95 (0.95, 10.0)	0.13	0.80**[f] (−4.20, 7.47)	0.0 (−4.55, 6.34)	0.06	0.95 (−8.32, 5.0)	−0.05 (−6.18, 4.50)	0.03
AHEI Whole grains score	2.0 (0.19, 9.72)	2.2 (0.14, 8.10)	0.95	0.80 (−4.20, 7.47)	0.0 (−4.55, 6.34)	0.91	−0.40*[f] (−7.32, 1.10)	−0.35 (−6.68, 3.13)	0.80
AHEI Nuts & legumes score	5.61 (1.12, 10.0)	5.66 (1.09, 10.0)	0.82	−0.70 (−7.51, 5.78)	0.04 (−5.99, 5.84)	0.04	−0.41 (−6.92, 5.78)	0.0 (−7.11, 4.70)	0.67
AHEI Red/processed meats score	6.66 (0.0, 9.92)	6.20 (0.0, 9.30)	0.83	0.84***[f] (−3.24, 6.58)	0.22 (−3.70, 6.98)	0.03	0.93***[f] (−1.30, 6.09)	0.34*[f] (−5.04, 7.56)	0.47
AHEI Trans fats score	8.16 (5.98, 9.92)	7.87 (5.34, 9.65)	0.41	0.50**[f] (−1.33, 2.68)	0.05 (−1.53, 1.96)	0.10	0.17 (−1.81, 2.31)	0.14 (−2.38, 2.48)	0.58
AHEI n-3 fats score	2.12 (0.56, 10.0)	1.78 (0.65, 10.0)	0.29	−0.01 (−5.60, 3.42)	0.13 (−6.81, 4.94)	0.69	−0.27 (−4.0, 3.68)	−0.08 (−9.81, 2.82)	0.75
AHEI Polyunsaturated fats & oils score	7.27 (1.93, 10.0)	7.65 (4.10, 10.0)	0.98	0.0 (−4.01, 2.73)	0.19 (−3.85, 4.04)	0.55	−0.15 (−3.62, 4.08)	0.53 (−3.63, 3.05)	0.56
AHEI Sodium score	6.64 (0.0, 10.0)	5.77 (0.0, 10.0)	0.48	1.27**[f] (−3.67, 9.75)	0.25 (−3.32, 5.12)	0.08	0.71**[f] (−6.96, 8.93)	1.03*[f] (−7.91, 7.79)	0.99

Outcome	Baseline Group Mean (±SE)			Post-Intervention Change from Baseline Group Mean (±SE)			3-Month Follow-up Change from Baseline Group Mean (±SE)		
	Exper. (n=35)	Control (n=33)	P-value[b]	Exper. (n=33)	Control (n=32)	P-value[b]	Exper. (n=35)	Control (n=33)	P-value[b]
AHEI Sugar-sweet beverages score	4.62 (0.0, 9.91)	6.59 (0.0, 10.0)	0.97	0.0 (−9.46, 9.55)	0.0 (−9.0, 9.91)	0.99	0.0 (−9.58, 9.48)	−0.04 (−9.55, 10.0)	0.19
AHEI Alcohol score	5.0 (0.0, 10.0)	5.0 (0.0, 10.0)	0.19	0.0 (−5.0, 5.0)	0.0 (−5.0, 10.0)	0.08	0.0 (−7.50, 2.50)	0.0 (−5.0, 7.50)	0.10

Abbreviations: AHEI Alternative Healthy Eating Index; MVPA moderate-to-vigorous physical activity

[a] The scoring methodology for the total and subcomponent scores for the AHEI 2010 reported previously[6] were used for the present analyses.

[b] P < 0.05 used for statistical significance; student t-test within a repeated measures ANOVA model for between-group comparison

[c] P < 0.025 used for statistical significance to account for multiple comparisons; **P < 0.01, ***P < 0.001; Student's t-test within a repeated measures ANOVA model to compare the within-group change from baseline to post-intervention and from baseline to 3-month follow-up

[d] Total scores range from 0 to 110 and component scores range from 0 to 10 with a higher score indicative of a dietary pattern that better meets the U.S. Dietary Guidelines for Americans 2010

[e] P < 0.05 used for statistical significance; due to non-normality, P-values for between-group comparisons were based on the Wilcoxon test

[f] P < 0.025 used for statistical significance to account for multiple comparisons; *P < 0.025; **P < 0.01; ***P < 0.001; due to non-normality, P-values to compare the within-group change from baseline to post-intervention and from baseline to 3-month follow-up were based on the Wilcoxon test

Table 4

Outcomes Related to the Health Action Process Approach Theoretical Framework and Change in Outcomes by Treatment Group and Timepoint

Outcome[a]	Cronbach's alpha	Test-Retest	Baseline Group Mean (±SE)			Post-Intervention Change from Baseline Group Mean (±SE)			3-mo.Follow-up Change from Baseline Group Mean (±SE)		
			Exper. (n=35)	Control (n=33)	P-value [b]	Exper. (n=34) [c]	Control (n=33)	P-value[b]	Exper. (n=35)	Control (n=33)	P-value[b]
Risk for T2DM [d]	--	0.65	5.57 (±0.18)	5.60 (±0.19)	0.89	−0.60 (±0.19)** [e]	−0.18 (±0.20)	0.13	−0.57 (±0.19)** [e]	−0.41 (±0.20)	0.56
Behavioral Intention	0.74	0.62	3.30 (±0.09)	3.12 (±0.10)	0.19	0.23 (±0.11)	−0.02 (±0.11)	0.12	−0.04 (±0.11)	−0.23 (±0.11)	0.23
Action Planning	0.82	0.79	2.62 (±0.10)	2.38 (±0.10)	0.09	0.42 (±0.09)***	0.12 (±0.09)	0.02	0.22 (±0.09)*	0.11 (±0.09)	0.39
Action Self-efficacy	0.52	0,61	2.80 (±0.09)	2.89 (±0.10)	0.51	0.26 (±0.11)*	−0.21 (±0.11)	0.00	−0.01 (±0.10)	−0.25 (±0.11)*	0.11
Coping Self-efficacy	0.89	0.44	3.15 (±0.10)	3.05 (±0.10)	0.49	0.16 (±0.10)	−0.16 (±0.11)	0.04	0.04 (±0.10)	−0.16 (±0.11)	0.17
Outcome	**Cronbach's alpha**	**Test-Retest**	**Baseline Group Median (range)**			**Post-Intervention Change from Baseline Group Median (range)**			**3-mo. Follow-up Change from Baseline Group Median (range)**		
			Exper. (n=35)	**Control (n=33)**	**P-value[f]**	**Exper. (n=35)**	**Control (n=33)**	**P-value[f]**	**Exper. (n=35)**	**Control (n=33)**	**P-value[f]**
Outcome Expectancies	0.74	0.79	3.60 (2.80, 4.0)	3.60 (2.60, 4.0)	0.67	0.0 (−1.0, 0.60)	0.0 (−0.60, 0.60)	0.50	0.2** [g] (−1.0, 1.0)	−0.2 (−0.80, 1.0)	0.00
Recovery Self-efficacy	0.94	0.46	3.0 (2.0, 4.0)	3.0 (2.0, 4.0)	0.95	0 (−1.33, 1.67)	0 (−1.33, 1.0)	0.20	0 (−1.33, 1.33)	0 (−1.33, 1.0)	0.06

Abbreviations: T2DM type 2 diabetes mellitus

[a] Response options ranged from 1 = "not at all true" to 4 = "exactly true" except for the risk for type 2 diabetes question.

[b] P <0.05 used for statistical significance; Student's t-test within a repeated measures ANOVA model for between-group comparison

[c] One person in the experimental group did not complete the assessment post-intervention.

[d] Responses options ranged from 1 = "much below average" to 7 = "much above average" for 1-item regarding risk for developing type 2 diabetes.

[e] P < 0.025 used for statistical significance to account for multiple comparisons; *P < 0.025; **P < 0.01, ***P < 0.001; Student's t-test within a repeated measures ANOVA model to compare the within-group change from baseline to post-intervention and from baseline to 3-month follow-up

[f] P < 0.05 used for statistical significance; due to non-normality, P-values for between-group comparisons were based on the Wilcoxon test

[g] $P < 0.025$ used for statistical significance to account for multiple comparisons; $^{**}P < 0.01$; due to non-normality, P-values to compare the within-group change from baseline to 3-month follow-up were based on the Wilcoxon test

Table 5

Spearman Correlations between the Change in Components of the Health Action Process Approach and the Change in the Alternative Healthy Eating Index 2010 and Body Weight for the Experimental Group (n=35)

	Post-Intervention Change from Baseline (Behavior Initiation Phase)	
Component of HAPA	**AHEI 2010 (total score)**	**Weight (% change)**
Risk for type 2 diabetes	0.28	−0.23
Outcome expectancies	0.36*	0.07
Behavioral intention	0.30	−0.38*
Action planning	0.33	−0.44**
Action self-efficacy	0.21	−0.38*
Coping self-efficacy	0.20	−0.42*
Recovery self-efficacy	0.40*	−0.33
	3-month Follow-up Change from Baseline (Behavior Initiation and Maintenance Phases)	
Component of HAPA	AHEI 2010 (total score)	Weight (% change)
Behavioral intention	0.40*	−0.48**
Action planning	0.13	−0.42*
Action self-efficacy	0.29	−0.42*
Coping self-efficacy	0.11	−0.53***
Recovery self-efficacy	0.17	−0.38*

Abbreviations: HAPA Health Action Process Approach; AHEI Alternative Healthy Eating Index

* P<0.05;

** P<0.01;

*** P<0.001