Published in final edited form as:
J Acad Nutr Diet. 2012 September ; 112(9): 1428–1435. doi:10.1016/j.jand.2012.05.014.

Self-Monitoring and Eating-Related Behaviors Associated with 12-Month Weight Loss in Postmenopausal Overweight-to-Obese Women

Angela Kong, PhD, RD [Post-Doctoral Research Associate],
Cancer Education and Career Development Program Institute for Health Research and Policy University of Illinois at Chicago 1747 W. Roosevelt Rd Chicago, IL 60608 Phone: (312) 355-0557 Fax: (312) 996-0065 akong@uic.edu

Shirley A.A. Beresford, PhD [Professor],
Department of Epidemiology School of Public Health and Community Medicine University of Washington Box 357236 Seattle, Washington 98195-7236 Phone: (206) 543-9512 Fax: (206) 685-9651 beresfrd@u.washington.edu

Catherine M. Alfano, PhD [Program Director],
Office of Cancer Survivorship Division of Cancer Control and Population Sciences National Cancer Institute, NIH 6116 Executive Boulevard, Suite 404 Bethesda, MD 20892 Phone: (301) 402-1450 Fax: (301) 594-5070 alfanoc@mail.nih.gov

Karen E. Foster-Schubert, MD [Assistant Professor of Medicine],
University of Washington V.A. PSHCS (S 111) Endo 1660 S. Columbian Way Seattle, WA 98108 Phone: (206) 277-6230 Fax: (206) 764-2689 kfoster@u.washington.edu

Marian L. Neuhouser, PhD, RD [Member],
Cancer Prevention Program Fred Hutchinson Cancer Research Center 1100 Fairview Avenue North, M4-B402 PO Box 19024 Seattle, WA 98109-1024 Phone: (206) 667-4797 Fax: (206) 667-7850 mneuhous@fhcrc.org

Donna B. Johnson, PhD, RD [Associate Professor, Nutritional Sciences Associate Director],
Center for Public Health Nutrition University of Washington Box 353410 Seattle, WA 98195 Phone: (206) 685-1068 Fax: (206) 685-1696 djohn@u.washington.edu

Catherine Duggan, PhD [Senior Staff Scientist],
Epidemiology Program, Division of Public Health Sciences Fred Hutchinson Cancer Research Center 1100 Fairview Avenue North, MD-B306 PO Box 19024 Seattle, WA 98109-1024 Phone: (206) 667-2323 Fax: (206) 667-6721 cduggan@fhcrc.org

Ching-Yun Wang, PhD [Member],
Biostatistics and Biomathematics Program Division of Public Health Sciences Fred Hutchinson Cancer Research Center 1100 Fairview Avenue North, M2-B500 PO Box 19024 Seattle, WA 98109-1024 Phone: (206) 667-6949 cywang@fhcrc.org

Liren Xiao, MS [Statistical Research Associate],

Corresponding Author: Anne McTiernan, MD, PhD Phone: 206-667-7979 Fax: 206-667-4787 amctiern@fhcrc.org.

Fred Hutchinson Cancer Research Center 1100 Fairview Avenue North, MD-B306 PO Box 19024 Seattle, WA 98109-1024 Phone: (206) 667-7551 lxiao@fhcrc.org

Robert W. Jeffery [Professor],
Division of Epidemiology and Community Health 1300 South Second Street, Suite 300 Minneapolis, MN 55454 Phone (Work): 626-8580 jefferyrw@gmail.com

Carolyn E. Bain, MPH [Project Coordinator II], and
Fred Hutchinson Cancer Research 1100 Fairview Ave. N., MD-B306 PO Box 19024 Seattle, WA 98109-1024 (206) 667-7858 cebain@fhcrc.org

Anne McTiernan, MD, PhD [Director, Prevention Center Member]
Epidemiology Program Division of Public Health Sciences Fred Hutchinson Cancer Research Center 1100 Fairview Ave. N., M4-B874 PO Box 19024 Seattle, WA. 98109-1024

Abstract

Lifestyle-based interventions, which typically promote various behavioral modification strategies, can serve as a setting for evaluating specific behaviors and strategies thought to promote or hinder weight loss. The aim of this study was to test the associations of self-monitoring (self-weighing, food journal completion) and eating-related (dietary intake, diet-related weight-control strategies, and meal patterns) behaviors with weight loss in a sample of postmenopausal overweight-to-obese women enrolled in a 12-month dietary weight loss intervention. Changes in body weight and adoption of self-monitoring and eating-related behaviors were assessed in 123 participants. Generalized linear models tested associations of these behaviors with 12-month weight change after adjusting for potential confounders. Mean percent weight loss was 10.7%. In the final model, completing more food journals was associated with a greater % weight loss (interquartile range, 3.7% greater weight loss; $p<0.0001$) while skipping meals (4.3% lower weight loss; $p<0.05$) and eating out for lunch (at least once a week, 2.5% lower weight loss; $p<0.01$) were associated with a lower amount of weight loss. These findings suggest that a greater focus on dietary self-monitoring, home-prepared meals, and consuming meals at regular intervals may improve 12-month weight loss among postmenopausal women enrolled in a dietary weight loss intervention.

Keywords

Women; behavioral strategies; eating behaviors; weight loss

INTRODUCTION

Evidence from randomized controlled trials show that diets can vary in macronutrient composition and lead to successful weight loss, as long as total calories are reduced (1, 2). Consequently, identifying strategies and eating patterns that can feasibly and healthfully support the global goal of calorie restriction are still needed.

Identifying correlates and predictors related to weight loss has been a key focus of obesity related research in the last decade (3-11). A variety of eating habits may play significant roles in modifying weight management both positively and negatively. Cross-sectional studies suggest that individuals who usually eat breakfast weigh less than those who typically skip this meal (12, 13). Prospective studies have demonstrated higher rates of weight gain with fast food intake (14-16). Recent systematic reviews suggest that approaches that involve self-monitoring such as self-weighing or food journal use may lead to improved weight loss outcomes for participants in intervention trials (17, 18).

Lifestyle-based interventions, which typically promote various behavioral modification strategies, can serve as a setting for evaluating specific behaviors and strategies thought to promote or hinder weight loss. Identifying diet-related strategies that predict weight change can improve our understanding of the type of behavior change needed in order to improve weight loss outcomes. These evidence-based strategies can then be translated into specific recommendations and disseminated to appropriate audiences. Therefore, the objective of the present study was to identify which self-monitoring behaviors, diet/eating-related weight loss strategies, and meal patterns were associated with weight change at the end of a year-long dietary weight loss intervention among overweight-to-obese postmenopausal women, a group at high risk for chronic diseases due to their weight status (19).

METHODS

This was an ancillary study to the Nutrition and Exercise for Women (NEW) study, a four-arm randomized controlled trial that tested the individual and combined effects of dietary weight-loss and exercise-based interventions on circulating hormones and other outcomes (20-23) in overweight-to-obese postmenopausal women. Eligible women were randomized into 1 of 4 study arms: 1) diet-induced weight loss (Diet); 2) aerobic exercise; 3) both interventions combined (Diet + Exercise); or 4) control (no intervention). Full details of the trial methods have been published(23). The purpose of this ancillary study was to examine diet-related strategies related to weight loss; therefore, women enrolled in either the Diet or Diet + Exercise arms from June 2007 to August 2008 formed the cohort (n=143) for this ancillary study. However, only women who completed 12-month measures were included in this analytic sample (n=123, Diet n=59, Diet+ Exercise n=64). The Fred Hutchinson Cancer Research Center Institutional Review Board reviewed and approved all study procedures and all study participants provided written informed consent.

Lifestyle-Based Interventions

The dietary weight-loss intervention was based on the Look AHEAD (Action for Health in Diabetes)(24)and Diabetes Prevention Program (DPP) clinical trial diet interventions(25), with the following goals: total intake of 1200-2000 kcals/day based on baseline weight,< 30% calories from fat, and 10% reduction in weight by 6-months with maintenance to 12-months. Registered dietitians (RD) with training in behavior modification delivered identical curriculum to both Diet and Diet + Exercise intervention arms; however, instruction groups were held separately. Participants met individually with an RD at least twice, followed by weekly group meetings (5-10 women) for 6-months. Thereafter, participants attended group meetings monthly with additional phone or e-mail contact. Those struggling with initial weight loss or maintenance received additional RD assistance. Participants were asked to record all foods eaten daily on paper diaries (7 days of entries per booklet) and submitted one booklet per week to the study dietitian for the first 6-months or until they reached the 10% weight loss goal. Women also received instructions on how to read labels and were given a booklet that contained calorie amounts of common foods so that they could count their calories; however, no formal recommendations were given regarding calorie counting. Participants were also encouraged to self-weigh at home at least weekly for 12-months.

The goal of the exercise intervention was 45-minutes of moderate-to-vigorous intensity aerobic exercise, 5 days per week for 12-months. Participants attended 3 sessions per week at the study facility, supervised by an exercise physiologist, and 2 sessions per week at home.

Demographic and Anthropometric characteristics

Self-reported information on age, race/ethnicity, marital status, and education level were collected as baseline measures. Anthropometric measurements were performed at baseline and at 12-months with the participant in a hospital gown. Trained technicians obtained height and weight using a balance beam scale(DETECTO, Web City, MO)and stadiometer (Perspective Enterprises, Portage, MI),rounding up to the nearest 0.1 cm and 0.5 kg, respectively.

Diet-related measures

Participants completed a series of self-administered questionnaires to assess dietary intake, eating-related weight control strategies, self-monitoring behaviors, and meal patterns at 12-months. A list of weight control behaviors (23-items) originally developed for the Pound of Prevention study (26) was modified to examine diet-related weight loss strategies. Strategies related to physical activity, smoking, and use of commercial weight loss programs were omitted and items specific to dietary intake and unhealthful weight-control behaviors were retained. Seven items (reduce calories, decrease fat intake, eat less high carbohydrate foods, increase fruit and vegetables, eat less meat, cut out sweets, drink fewer alcoholic beverages) were used to assess common diet-related strategies and 7 items (skip meals, fast or go without food, vomit after you eat, take diet pills, take appetite suppressants, and take laxatives) were used to assess unhealthful weight-control behaviors. Prevalence of use was assessed by a yes or no response to each strategy. To estimate the magnitude of dietary change, the 120-item Women's Health Initiative food frequency questionnaire(FFQ)(27) was used to assess change from baseline to 12-months. Among a sample of postmenopausal women (n=113), the Women's Health Initiative FFQ demonstrated high test-retest reliability and produced mean nutrient estimates within 10% of 24-hour recalls (4 days) and food records (4 days) for most nutrients (27). Additional eating-related strategies were assessed using questions from the Health Styles survey reported by Kruger et al (planning meals, thinking about foods on the plate, measuring foods)(28).

Meal frequency was assessed by asking "On average, how many times per week do you eat home-prepared meals" and " …how many times per week do you eat out", respectively, for breakfast, lunch, and dinner. These questions were originally developed for the Women's Health Initiative Dietary Modification trial(29) and response categories ranged from "none" to "5 or more". Fast food intake was also assessed by asking: "Thinking about how often you eat out, how many times in a week or month do you eat breakfast, lunch, or dinner in a fast food restaurant such as McDonald's, Burger King, Wendy's, Arby's, Pizza Hut, or Kentucky Fried Chicken", which was originally used in the in the CARDIA (Coronary Artery Risk Development in Young Adults) study (16). Response categories for this question was slightly modified by adding "less than once a month" or "never" as categorical response categories in addition to continuous response categories (i.e. number of times per week or number of times per month).

Self-monitoring behaviors assessed included self-weighing, submission of completed food journals, and calorie counting. For self-weighing frequency, participants were asked: "How frequently do you weigh yourself? (on your own, not weighed by another person)" and response categories included: less than monthly, once a month, a specific number of times per week (up to 6 times/week), daily, and more than daily. To assess the regular use of calorie counting, a question reported by Kruger et al. from the Health Styles questionnaire was asked: "Which of the following, if any, do you do most days of the week? Count how many calories you eat?" with "yes" and "no" as response categories (28). The question was posed in a manner to determine a respondent's weekly practice of calorie counting. Lastly, food journal use was based on the mean number of booklets a participant submitted weekly

to the study dietitian through the first 6-months of the intervention. This time frame was selected because all participants were given the same instructions regarding frequency of food journal use during the first 6-months of the intervention.

Statistical Analyses

Descriptive data were presented as means (SD) or proportions, as appropriate. The main outcome variable was the percent of weight change observed from baseline to 12-months. Generalized linear models were used to examine each weight loss strategy with percent weight change individually and adjusted means were reported. However, in the case of "diet related" strategies (e.g. decrease fat intake, increase fruits and vegetables), change in dietary intake as assessed by the FFQ (12-month minus baseline) was used in place of these variables in the model as more accurate estimates of dietary pattern. Means were adjusted for study arm (Diet and Diet + Exercise), baseline BMI, and demographic variables (e.g. age, race, education, marital status). All behaviors significantly related to weight change at $p < 0.05$ were potential candidates for the multivariate model. The purpose of the multivariate model was to identify all behaviors that were still significantly associated with 12-month weight change after adjusting for potential confounders and all other behaviors thought to be significantly associated with 12-month weight change. All statistical tests were two-sided with an alpha of <0.05 and all analyses were performed using STATA, version 11.1, 2010 (College Station (TX): Stata Corp).

RESULTS

Demographic characteristics and 12-month weight outcomes of this subsample have been previously published(30). Briefly, study participants were on average 58 years old, primarily Non-Hispanic White (84%), and with a mean baseline BMI of 31.3 kg/m^2. There were no significant differences in baseline characteristics between the Diet and Diet + Exercise arms. At 12-months, participants lost an average of 10.7% (SD: 7.1) of their initial body weight. Percent weight loss was higher in the Diet + Exercise (11.6% SD: 6.5) compared to Diet arm (9.6% SD: 7.7); however, this difference was not statistically significant.

The most common strategies reported were: increase fruit and vegetable intake (90.2%), decrease fat intake (88.6%) and reduce number of calories (86.9%) (Table 1). Dietary intake change as assessed by the FFQ (12-month minus baseline) revealed significant decreases in total calories (kcals/d), % calories from fat, % calories from saturated fat, and added sugar intake (g/d), and significant increases in % calories from carbohydrates, fruits and vegetables (svgs/d), and dietary fiber (g/d) (Table 1). After adjusting for confounders, only change in % calories from fat and carbohydrates, respectively, were significantly associated with weight change (%) at 12-months (Table 1).

Women who were at the median number (ie. 17 booklets) of food journal booklets submitted at 6-months lost significantly more weight (mean: 12.8%, 95% CI: 11.3, 14.2) than those below the median (mean: 8.2%, 95% CI: 6.6, 9.8, $p<0.0001$). Most participants (88%) reported weighing themselves at least weekly; therefore, response options were collapsed into two categories: 1) daily or more (n=45) and 2) less than daily (n=78). No significant difference in adjusted mean weight change (%) was observed in the "daily or more" vs. the "less than daily" group (Table 2). Women who reported "yes" to counting calories most days of the week experienced greater weight loss (mean: 11.7%, 95% CI: 10.2, 13.1) than those who reported "no" (mean: 9.0%, 95% CI: 7.2, 10.8, $p=0.03$).

Eating-related weight loss strategies associated with weight change included measuring foods and skipping meals. Women who measured their foods lost significantly more weight than those who did not use this strategy (Table 2). Women who skipped meals lost less

weight (mean: 7.1%, 95% CI 4.4, 9.8) than women who did not skip meals (mean: 11.4%, 95% CI 10.2, 12.6, p=0.005). Less weight loss was also observed among women who reported eating out more frequently (at least weekly) at all meal times compared to women who ate out less often (Table 2). Specifically, mean differences between the two groups were statistically significant for breakfast (mean diff: −3.4% p=0.04), lunch (mean diff: −3.5% p=0.003), and dinner (mean diff: −2.8% p=0.03). A similar trend was observed with fast food intake (> monthly vs. <monthly); however, the difference was not statistically significant (mean diff: −2.2 p=0.084) after adjusting for confounders.

Table 3 presents the final model of self-monitoring and eating-related behaviors associated with weight loss (%) over the last 12-months. Nine behaviors were significantly associated with % weight change at 12-months and were included in the model: change in % calories from fat, % change in % calories from carbohydrates, measuring foods, food journal use (continuous), counting calories, skipping meals, and eating out for breakfast, lunch, and dinner, respectively. Food journal use, skipping meals, and eating out for lunch were still significantly associated with weight change (%) at 12-months after controlling for all other weight loss behaviors and potential confounders. Specifically, women at the 75th percentile of number of food journals submitted had a 3.7% greater weight loss (p<0.0001) than those at the 25th percentile. Women who reported skipping meals lost 4.3% less weight (p<0.01) compared to women who did not report skipping meals and women who reported eating out for lunch at least weekly vs. none lost 2.5% less weight (p<.0.05). The adjusted R^2 for the multivariate model overall was 0.45.

DISCUSSION

Lifestyle-based interventions can be useful in evaluating the effectiveness of specific weight loss strategies. Findings from these studies can inform the development of practical, yet evidence-based weight loss recommendations. In this study, more frequent food journal use predicted greater weight loss at 12-months; while skipping meals and eating out for lunch at least weekly were associated with less weight loss.

Similar to other trials, initial adherence to dietary self-monitoring was a good predictor of weight loss outcomes. Participants in the DPP trial who more successfully adopted dietary self-monitoring during the first 6-months of the intervention were more likely to meet the 7% weight loss goal at 6-months (OR = 1.08 per one record increase, p <0.0005) and at 24-months OR = 1.02, p = 0.0005)(31). Among younger (≈ mean age of 45 years) non-Hispanic White obese adults, Wadden et al. found a positive correlation between weight loss at 12-months with the number of diet records submitted(r=0.31, P<0.001) during the first 18-weeks (32). The Weight Loss Maintenance trial also reported that better adherence to food records was associated with greater initial weight loss (6-months); however, this association was stronger in non-Hispanic Whites compared to African-Americans (33). While this behavior can significantly improve weight outcomes, adherence to this activity is particularly challenging (34) and should be acknowledged. In our study, only a small percentage (<5%) of women were able to submit 7-days worth of food journals to the study dietitian each week (without missing a week) for the first 6-months. Nevertheless, even women at or above the 50th percentile of food records submitted experienced improved weight outcomes compared to those below the median. This finding suggests that even modest adherence to this type of behavior may improve weight outcomes; however, efforts to improve adherence to this behavior are still needed. Recent studies have proposed methods to alleviate some of the burdens of dietary self-monitoring through the use of technology (35-37). In the SMART (Self-Monitoring And Recording using Technology) trial, a randomized controlled trial comparing three modes of dietary self-monitoring, Burke and colleagues found adherence to be significantly greater at 6-months in two groups using

the personal digital assistant (80-90%) compared to paper records (55%)(38). Improved efforts to increase adherence to this behavior might make it easier for participants to adopt it, but further evaluation will be required.

More frequent consumption of foods prepared away from home (e.g. restaurants) negatively impacted body weight change in this study, which is consistent with findings in younger cohorts (14, 16, 39, 40). No previous studies, to our knowledge or according to a recent systematic review, have examined this relationship in postmenopausal women specifically (11). Eating out may be a barrier for making healthful dietary changes since it usually means less individual control over ingredients and cooking methods, as well as larger portion sizes. In this study, eating out at lunch was associated with less weight loss after controlling for eating out at breakfast and dinner. The lunch meal might more accurately reflect the habitual eating patterns of this population; however, more research is needed to confirm this. While a significant relationship was observed between eating out and weight change; the relationship was not as strong for fast food intake ($p=0.08$) specifically. One reason for the lack of significant findings may be due to the small percentage of women in our study that reported consuming fast food on a weekly basis (9.7%). While this rate is low relative to the general adult population in the United States(41), previous studies (based on nationally representative samples and other large cohorts) have consistently found lower rates of fast food intake in women and particularly in older adults(41-46). The lower response rates may also be attributed to the way the fast food question was framed. For instance, the question only provided examples of large national fast food chains (e.g. McDonalds, Burger King, etc); however, local chains and individual restaurants also make up a significant portion of restaurants that can be considered “fast food” establishments in the Seattle area (47). Therefore, inclusion of only large national chains in the question posed to the women in this study might have attenuated the response rate; however, further research will be needed to confirm this.

In this study, skipping meals as a weight control strategy was more common among women who lost less weight. It has been suggested that meal skipping negatively impacts energy metabolism and may be associated with greater energy intake (48, 49). The mechanism for this is not entirely clear. Using functional magnetic resonance imaging scanning, a randomized crossover study demonstrated greater activity in the reward pathway of the brain in response to pictures of high calorie foods after a fast vs. a fed state and higher subjective ratings for these foods (50). Also, skipping meals might cluster together with other behaviors. For instance, the lack of time and effort spent on planning and preparing meals may lead to eating out more and/or skipping meals. A better understanding of barriers to meal planning and preparation could help to inform future weight loss interventions in this population.

There are some limitations to our study. While study staff measured weight and collected food journals from participants, the weight loss-related behaviors were assessed by self-report. There is the potential that bias such as social desirability could affect a participant’s response (51) such that behaviors promoted in the intervention might be over-reported, while the inverse would occur for behaviors that were discouraged by the intervention staff or presumed to be negative (e.g. fast food intake). Since social desirability can vary by weight status and participant characteristics (52-54), we attempted to minimize the effects of social desirability bias by controlling for baseline BMI and demographic variables. Finally, this study population was primarily Non-Hispanic White and therefore the present findings may only be generalizable to a select group of postmenopausal overweight-to-obese women.

CONCLUSIONS

Greater food journal use predicted better weight loss outcomes while skipping meals and eating out more frequently were associated with less weight loss. This study identified specific behaviors linked to weight outcomes that can inform the development of practical, evidence-based weight loss recommendations for overweight/obese postmenopausal women. From a clinical point of view, these findings are promising and suggest fundamentals such as eating out less, eating at regular intervals, and use of food journals are weight loss strategies that may be effective for postmenopausal women. However, future studies are needed to determine if these behaviors extend to postmenopausal women of color and other populations, and to longer-term weight loss maintenance.

REFERENCES

1. Sacks FM, Bray GA, Carey VJ, et al. Comparison of weight-loss diets with different compositions of fat, protein, and carbohydrates. N Engl J Med. 2009; 360(9):859–873. [PubMed: 19246357]
2. Foster GD, Wyatt HR, Hill JO, et al. Weight and Metabolic Outcomes After 2 Years on a Low-Carbohydrate Versus Low-Fat Diet. Ann Intern Med. 2010; 153(3):147–155. [PubMed: 20679559]
3. Bish CL, Blanck HM, Serdula MK, et al. Diet and Physical Activity Behaviors among Americans Trying to Lose Weight: 2000 Behavioral Risk Factor Surveillance System. Obesity. 2005; 13(3): 596–607.
4. Tsai AG, Wadden TA. Systematic review: an evaluation of major commercial weight loss programs in the United States. Ann Intern Med. 2005; 142(1):56–66. [PubMed: 15630109]
5. Delahanty LM, Conroy MB, Nathan DM. Psychological predictors of physical activity in the diabetes prevention program. J Am Diet Assoc. 2006; 106(5):698–705. [PubMed: 16647327]
6. Delahanty LM, Meigs JB, Hayden D, Williamson DA, Nathan DM. Psychological and behavioral correlates of baseline BMI in the diabetes prevention program (DPP). Diabetes Care. 2002; 25(11): 1992–1998. [PubMed: 12401745]
7. Teixeira PJ, Going SB, Houtkooper LB, et al. Pretreatment predictors of attrition and successful weight management in women. Int J Obes Relat Metab Disord. 2004; 28(9):1124–1133. [PubMed: 15263921]
8. Teixeira PJ, Going SB, Houtkooper LB, et al. Exercise motivation, eating, and body image variables as predictors of weight control. Med Sci Sports Exerc. 2006; 38(1):179–188. [PubMed: 16394972]
9. Teixeira PJ, Palmeira AL, Branco TL, et al. Who will lose weight? A reexamination of predictors of weight loss in women. Int J Behav Nutr Phys Act. 2004; 1(1):12. [PubMed: 15287984]
10. Kruger J, Galuska DA, Serdula MK, Jones DA. Attempting to lose weight: specific practices among U.S. adults. Am J Prev Med. 2004; 26(5):402–406. [PubMed: 15165656]
11. Mesas AE, Muñoz-Pareja M, López-García E, Rodríguez-Artalejo F. Selected eating behaviours and excess body weight: a systematic review. Obesity Reviews. 2012; 13(2):106–135. [PubMed: 21955734]
12. Wyatt HR, Grunwald GK, Mosca CL, et al. Long-term weight loss and breakfast in subjects in the National Weight Control Registry. Obes Res. 2002; 10(2):78–82. [PubMed: 11836452]
13. Song WO, Chun OK, Obayashi S, Cho S, Chung CE. Is consumption of breakfast associated with body mass index in US adults? J Am Diet Assoc. 2005; 105(9):1373–1382. [PubMed: 16129078]
14. French SA, Harnack L, Jeffery RW. Fast food restaurant use among women in the Pound of Prevention study: dietary, behavioral and demographic correlates. Int J Obes Relat Metab Disord. 2000; 24(10):1353–1359. [PubMed: 11093299]
15. Liebman M, Pelican S, Moore SA, et al. Dietary intake, eating behavior, and physical activity-related determinants of high body mass index in rural communities in Wyoming, Montana, and Idaho. Int J Obes Relat Metab Disord. 2003; 27(6):684–692. [PubMed: 12833112]
16. Pereira MA, Kartashov AI, Ebbeling CB, et al. Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. Lancet. 2005; 365(9453):36–42. [PubMed: 15639678]

17. Vanwormer JJ, French SA, Pereira MA, Welsh EM. The Impact of Regular Self-weighing on Weight Management: A Systematic Literature Review. Int J Behav Nutr Phys Act. 2008; 5:54. [PubMed: 18983667]

18. Burke LE, Wang J, Sevick MA. Self-Monitoring in Weight Loss: A Systematic Review of the Literature. J Am Diet Assoc. 2011; 111(1):92–102. [PubMed: 21185970]

19. Dennis KE. Postmenopausal Women and the Health Consequences of Obesity. J Obstet Gynecol Neonatal Nurs. 2007; 36(5):511–519.

20. Mason C, Xiao L, Imayama I, et al. Effects of weight loss on serum vitamin D in postmenopausal women. Am J Clin Nutr. 2011; 94(1):95–103. [PubMed: 21613554]

21. Imayama I, Alfano CM, Kong A, et al. Dietary weight loss and exercise interventions effects on quality of life in overweight/obese postmenopausal women: a randomized controlled trial. Int J Behav Nutr Phys Act. 2011; 8:118. [PubMed: 22026966]

22. Mason C, Foster-Schubert KE, Imayama I, et al. Dietary Weight Loss and Exercise Effects on Insulin Resistance in Postmenopausal Women. Am J Prev Med. 2011; 41(4):366–375. [PubMed: 21961463]

23. Foster-Schubert KE, Alfano CM, Duggan CR, et al. Effect of Diet and Exercise, Alone or Combined, on Weight and Body Composition in Overweight-to-Obese Postmenopausal Women. Obesity. Apr 14.2011 [Epub ahead of print].

24. Look Ahead Research Group. Look AHEAD (Action for Health in Diabetes): design and methods for a clinical trial of weight loss for the prevention of cardiovascular disease in type 2 diabetes. Controlled Clinical Trials. 2003; 24(5):610–628. [PubMed: 14500058]

25. Diabetes Prevention Program Research Group. The Diabetes Prevention Program (DPP): description of lifestyle intervention. Diabetes Care. 2002; 25(12):2165–2171. [PubMed: 12453955]

26. Jeffery RW, French SA. Preventing weight gain in adults: design, methods and one year results from the Pound of Prevention study. Int J Obes Relat Metab Disord. 1997; 21(6):457–464. [PubMed: 9192229]

27. Patterson RE, Kristal AR, Tinker LF, et al. Measurement characteristics of the Women's Health Initiative food frequency questionnaire. Ann Epidemiol. 1999; 9(3):178–187. [PubMed: 10192650]

28. Kruger J, Blanck HM, Gillespie C. Dietary and physical activity behaviors among adults successful at weight loss maintenance. Int J Behav Nutr Phys Act. 2006; 3:17. [PubMed: 16854220]

29. Design of the Women's Health Initiative Clinical Trial and Observational Study. Controlled Clinical Trials. 1998; 19(1):61–109. [PubMed: 9492970]

30. Kong A, Beresford SAA, Alfano CM, et al. Associations between Snacking and Weight Loss and Nutrient Intake among Postmenopausal Overweight to Obese Women in a Dietary Weight-Loss Intervention. J Am Diet Assoc. 2011; 111(12):1898–1903. [PubMed: 22117666]

31. Wing RR, Hamman RF, Bray GA, et al. Achieving weight and activity goals among diabetes prevention program lifestyle participants. Obes Res. 2004; 12(9):1426–1434. [PubMed: 15483207]

32. Wadden TA, Berkowitz RI, Womble LG, et al. Randomized Trial of Lifestyle Modification and Pharmacotherapy for Obesity. N Engl J Med. 2005; 353(20):2111–2120. [PubMed: 16291981]

33. Hollis JF, Gullion CM, Stevens VJ, et al. Weight Loss During the Intensive Intervention Phase of the Weight-Loss Maintenance Trial. Am J Prev Med. 2008; 35(2):118–126. [PubMed: 18617080]

34. Burke LE, Sereika SM, Music E, et al. Using instrumented paper diaries to document self-monitoring patterns in weight loss. Contemp Clin Trials. 2008; 29(2):182–193. [PubMed: 17702667]

35. Burke LE, Styn MA, Glanz K, et al. SMART trial: A randomized clinical trial of self-monitoring in behavioral weight management-design and baseline findings. Contemp Clin Trials. 2009; 30(6): 540–551. [PubMed: 19665588]

36. Atienza AA, King AC, Oliveira BM, Ahn DK, Gardner CD. Using hand-held computer technologies to improve dietary intake. Am J Prev Med. 2008; 34(6):514–518. [PubMed: 18471588]

37. Glanz K, Murphy S, Moylan J, Evensen D, Curb JD. Improving dietary self-monitoring and adherence with hand-held computers: a pilot study. Am J Health Promot. 2006; 20(3):165–170. [PubMed: 16422134]
38. Burke LE, Conroy MB, Sereika SM, et al. The Effect of Electronic Self-Monitoring on Weight Loss and Dietary Intake: A Randomized Behavioral Weight Loss Trial. Obesity. 2011; 19(2):338–344. [PubMed: 20847736]
39. Bes-Rastrollo M, Basterra-Gortari FJ, Sanchez-Villegas A, et al. A prospective study of eating away-from-home meals and weight gain in a Mediterranean population: the SUN (Seguimiento Universidad de Navarra) cohort. Public Health Nutr. 2010; 13(9):1356–1363. [PubMed: 19954575]
40. Bes-Rastrollo M, Sanchez-Villegas A, Gomez-Gracia E, et al. Predictors of weight gain in a Mediterranean cohort: the Seguimiento Universidad de Navarra Study. Am J Clin Nutr. 2006; 83(2):362–370. [PubMed: 16469996]
41. Bowman SA, Vinyard BT. Fast food consumption of U.S. adults: impact on energy and nutrient intakes and overweight status. J Am Coll Nutr. 2004; 23(2):163–168. [PubMed: 15047683]
42. Paeratakul S, Ferdinand DP, Champagne CM, Ryan DH, Bray GA. Fast-food consumption among US adults and children: dietary and nutrient intake profile. J Am Diet Assoc. 2003; 103(10):1332–1338. [PubMed: 14520253]
43. Dave JM, An LC, Jeffery RW, Ahluwalia JS. Relationship of Attitudes Toward Fast Food and Frequency of Fast-food Intake in Adults. Obesity. 2009; 17(6):1164–1170. [PubMed: 19247277]
44. Satia JA, Galanko JA, Siega-Riz AM. Eating at fast-food restaurants is associated with dietary intake, demographic, psychosocial and behavioural factors among African Americans in North Carolina. Public Health Nutr. 2004; 7(8):1089–1096. [PubMed: 15548348]
45. van der Horst K, Brunner TA, Siegrist M. Fast food and take-away food consumption are associated with different lifestyle characteristics. J Hum Nutr Diet. 2011; 24(6):596–602. [PubMed: 21883532]
46. Kant AK, Graubard BI. Eating out in America, 1987–2000: trends and nutritional correlates. Prev Med. 2004; 38(2):243–249. [PubMed: 14715218]
47. Hurvitz PM, Moudon AV, Rehm CD, Streichert LC, Drewnowski A. Arterial roads and area socioeconomic status are predictors of fast food restaurant density in King County, WA. Int J Behav Nutr Phys Act. 2009; 6:46. [PubMed: 19630979]
48. Ma Y, Bertone ER, Stanek EJ, et al. Association between eating patterns and obesity in a free-living US adult population. Am J Epidemiol. 2003; 158(1):85–92. [PubMed: 12835290]
49. Carels RA, Young KM, Coit C, et al. Skipping meals and alcohol consumption: The regulation of energy intake and expenditure among weight loss participants. Appetite. 2008; 51(3):538–545. [PubMed: 18511146]
50. Goldstone AP, Prechtl de Hernandez CG, Beaver JD, et al. Fasting biases brain reward systems towards high-calorie foods. Eur J Neurosci. 2009; 30(8):1625–1635. [PubMed: 19811532]
51. Hebert JR, Hurley TG, Peterson KE, et al. Social desirability trait influences on self-reported dietary measures among diverse participants in a multicenter multiple risk factor trial. J Nutr. 2008; 138(1):226S–234S. [PubMed: 18156429]
52. Hebert JR, Peterson KE, Hurley TG, et al. The effect of social desirability trait on self-reported dietary measures among multi-ethnic female health center employees. Ann Epidemiol. 2001; 11(6):417–427. [PubMed: 11454501]
53. Novotny JA, Rumpler WV, Riddick H, et al. Personality characteristics as predictors of underreporting of energy intake on 24-hour dietary recall interviews. J Am Diet Assoc. 2003; 103(9):1146–1151. [PubMed: 12963942]
54. Horner NK, Patterson RE, Neuhouser ML, et al. Participant characteristics associated with errors in self-reported energy intake from the Women's Health Initiative food-frequency questionnaire. Am J Clin Nutr. 2002; 76(4):766–773. [PubMed: 12324289]

Table 1

Prevalence of diet-related strategies and associations of 12-month weight change with change in dietary intake from baseline to 12- among postmenopausal women in a dietary weight loss intervention

			Association with weight change at 12-months (%)[c]			
Diet-Related Strategy	**Using Strategy[a]**	**Dietary intake variable[b]**	**mean diff[c]**	**ß [d]**	**95% CI**	**p value**
Reduce number of calories	86.9%	Calories/d (kcals/d) *	−339.5	−0.0008	(−0.002,0.007)	0.30
Decrease fat intake	88.6%	% calories from fat *	−7.2	−0.12	(−0.23,−0.01)	0.038
		% calories from protein *	1.7	−0.24	(−0.54, 0.05)	0.10
Eat less high carbohydrate foods	75.6%	% calories from CHO *	6.7	0.14	(0.045,0.23)	0.004
		Dietary Fiber (g/d) *	2.8	0.12	(−0.018, 0.26)	0.09
Increase fruits and vegetables	90.2%	Fruits and Vegetables (svgs/d) *	1.7	0.063	(−0.29, 0.41)	0.73
Eat less meat	63.4%	% calories from animal protein	−0.73	0.04	(−0.21, 0.13)	0.64
		% calories from saturated fat *	−4.6	−0.12	(−0.27, 0.03)	0.12
Cut out Sweets	60.2%	Added sugars (g/d) *	−14.8	−0.0005	(−0.04,0.04)	0.98
Drink fewer alcoholic beverages	37.4%	Alcohol (g/d)	−1.5	−0.04	(−0.14, 0.06)	0.45

*mean difference significant at p value < .05

[a]based on yes or no response

[b]based on food frequency data cmean difference= 12-month value minus baseline, de, d(Baseline Weight-Weight at 12 months)/Baseline Weight Estimated ß adjusted for intervention arm, baseline BMI, marital status, race/ethnicity, and marital status for all dietary variables.

Fiber, fruits and vegetables, added sugar, water intake also adjusted for change in caloric intake

Table 2

Adjusted Mean Weight loss(%) by Eating-related strategies, Unhealthy Weight Control Behaviors, Self-Monitoring Behaviors, and Meal Patterns among Postmenopausal women in a dietary weight loss intervention (n=123)

Eating-related strategies[a]	**%**[a-f]	**Mean (%)** ***Not Using Strategy***	**95% CI**	**Mean (%)** ***Using Strategy***	**95% CI**	**p**
Think about the amount of food you put on your plate	95.9%	9.7	(5.1,14.3)	10.7	(9.5,11.9)	0.68
Plan your meals and snacks throughout the day	63.4%	9.3	(7.4,11.2)	11.4	(9.9,12.8)	0.10
Measure the amount of food you put on your plate	43.1%	9.2	(7.7,10.7)	12.5	(10.8,14.2)	0.006
Unhealthy Weight Control Behaviors[a*]						
Fast or go without food	10.6%	10.4	(9.2,11.6)	12.4	(8.8,16.0)	0.30
Take Laxatives	7.3%	10.9	(9.7,12.1)	7.5	(3.2,11.8)	0.14
Take Diuretics (water pills)	6.5%	10.8	(9.6,12.0)	7.9	(3.1,12.7)	0.26
Vomit After You Eat	1.6%	10.7	(9.6, 11.9)	5.4	(−3.6, 14.4)	0.26
Skip meals	18.7%	11.4	(10.2,12.6)	7.1	(4.4,9.8)	0.006
Self-Monitoring Behaviors						
Counting Calories[b]	61.0%	9.0 < Median	(7.2,10.8)	11.6 *> Median*	(10.2, 13.1)	0.03
Food Journals[c]	53.7%	8.2 *< Daily*	(6.6, 9.8)	12.8 *>Daily*	(11.3,14.2)	<0.0001
Self Weighing[d]	36.6%	10.3	(8.9, 11.8)	11.1	(9.2, 13.0)	0.51
Meal Patterns						
Home-prepared meals [e]		*<5 times/wk*		*> 5 times/wk*		
Breakfast	86.2%	9.6	(6.3,12.9)	10.8	(9.6,12.0)	0.51
Lunch	82.9%	8.7	(5.7,11.7)	11	(9.8,12.3)	0.30
Dinner	91.1%	10.8	(6.8,14.9)	10.6	(9.4,11.8)	0.92
Eat out at: [f]		*none*		*≥ 1 time(s) /wk*		
Breakfast	22.8%	11.4	(10.1,12.7)	8.0	(5.6,10.3)	0.04
Lunch	63.4%	12.9	(11.0,14.7)	9.4	(8.0,10.7)	0.003
Dinner	73.2%	12.7	(10.5,14.9)	9.9	(8.6,11.2)	0.03
		<monthly		*≥ 1/month*		
Eat out for fast food[g]	34.1%	11.4	(10.0,12.8)	9.2	(7.1,11.1)	0.08

[a] % based on those who reported “yes” to this strategy

[b] % is based on those who reported “yes” to this strategy over the past week

[c] % is based on those at or above the median number of food journals submitted; median number of food journals is 17

[d] based on % of women reported to weigh themselves daily or more

[e] % is based on a meal frqeuency of 5 times a week or more

[f] % is based on a meal freqency of at least once a week

[g] % is based on a meal frequency of at least once a month Means adjusted for intervention arm (Diet vs Diet + Exercise), baseline BMI, age, race/ethnicity, education, marital status

[*] use of diet pills and use of appetite suppressants omitted, no women reported use of these strategies

Table 3

Multivariate Regression Model between 12-month % Weight Change and Dietary intake, Eating-related and Self-Monitoring Behaviors among Postmenopausal Overweight/Obese Women in a 12-month Dietary Weight Loss Intervention

Variables	% Wt Change[d]	95% CI
Change in % calories from fat	0.04	(−0.14, 0.22)
Change in % calories from carbohydrates	0.11	(−0.04,0.27)
Measure foods on the plate[a]	1.31	(−0.87, 3.50)
Food Journals[b]	3.72	(2.10, 5.34)***
Count Calories[a]	−0.47	(−2.84,1.91)
Skip Meals[a]	−4.32	(−7.38, −1.25)**
Eat out for breakfast[c]	−0.85	(−3.45, 1.74)
Eat Out for Lunch[c]	−2.45	(−4.70,−0.21)*
Eat out for dinner[c]	−2.66	(−6.32,0.99)

*** indicates p value <0.0001,

** <0.01,

* <0.05,

[a] compares no (reference group) vs yes

[b] Food journals (submitted at 6 months) entered the model as a continuous variable and value refers to the predicted weight change by interquartile range

[c] compares none(reference group) vs >=1 times/wk or more

[d] parameter estimates have been multiplied by 100

Model includes all independent variables plus the following covariates: intervention arm, race, baseline body mass index, marital status