Computerized weight loss intervention optimizes staff time: The clinical and cost results of a controlled clinical trial conducted in a managed care setting

Wylie-Rosett, Judith; Swencionis, Charles; Ginsberg, Mindy; Cimino, Christopher; et al.

Abstract (summary)

In a weight-loss program, computers can facilitate selecting behavioral change goals. A study found that more frequent usage resulted in greater weight loss and that staff counseling to augment the computer intervention achieved the most weight loss.

Headnote

Objective To evaluate the costs and effects of incremental components of a weight-loss program.

Design A 3-arm, 12-month randomized controlled clinical trial to evaluate 3 incremental levels of intervention intensity.

Subjects/setting The study included 588 individuals (BMI > 25 kg/m^sup 2^) in a freestanding health maintenance organization and achieved an 81% completion rate.

Intervention Using a cognitive behavioral approach for tailoring lifestyle modification goals, the incremental levels of intervention included a) a workbook alone, b) the addition of computerized tailoring using onsite computer kiosks with touch screen monitors, and c) the addition of both computers and staff consultation.
Main outcome measures: Endpoints included weight parameters, lipid profile, plasma glucose, blood pressure, intervention costs, dietary intake, and physical activity. Statistical analysis performed Study endpoints were analyzed using analysis of variance for normally distributed variables and analysis of covariance to control for any baseline differences. Regression and correlation analysis.

**Headnote**

assessed the relationship between weight loss and other variables.

Results: For the increasing levels of intervention intensity, the mean 12-month weight losses were 2.2, 4.7, and 7.4 pounds, with the respective cost per participant being $12.33, $41.99, and $133.74. The decreases in mean BMIs for these respective intervention levels were 0.4, 0.9 and 1.2. All groups reported a decrease in energy and fat intake and an increase in blocks walked (P<.01). Intervention variables that correlated with weight loss included more computer logons, achieving computer-selected goals, more self-monitoring, increased walking, and decreased energy and fat intake, as well as higher attendance in staff consultation group sessions for that treatment condition. Weight loss correlated with decreases in fasting glucose and blood pressure.

Applications/conclusions: In a weight-loss program, computers can facilitate selecting behavioral change goals. More frequent usage resulted in greater weight loss. Staff counseling to augment the computer intervention achieved the most weight loss. JAm Diet Assoc. 2001:101:11551162.

The Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity (1) define overweight as a body mass index (BMI) from 25 to 29.9 kg/m² and obesity as a BMI > 30 kg/m². The proportion of Americans having a BMI > 25 increased to 54.9% in the National Health and Nutrition Examination Survey (NHANES) III which was conducted in 1988-1994 (2). The 1995 total cost attributable to obesity in the United States was estimated to be $99.2 billion by Wolf and Colditz (3). The direct healthcare expenditures associated with obesity account for approximately $51.6 billion (5.7% of the total healthcare expenditures) (3), and indirect costs related to lost productivity are comparable with the economic output reduction associated with cigarette smoking (3,4).

The 65 million Americans who are trying to lose weight spend an estimated $33 billion on their weight-reduction efforts each year (1,3). Little is known about the costs of providing weight-loss programs of varying intensity as integral components of healthcare. The levels of weight-loss program intensity described by the National Academy of Science include: self-help (do-it-yourself), nonclinical, and clinical (5). Survey data suggest that self-help is the most common weight control approach used in the United States, but clinical trial data indicate that intervention intensity predicts weight loss (1,5). The traditional nonclinical approach used by most commercial weight-reduction programs involves an open-group format in which support is provided by the leader and those attending the session. Efforts to optimize resources in providing nonclinical aspects of weight control services or health promotion behaviors include correspondence courses (6), videotapes (7,8), and telephone consultations (9,10). Over the past 25 years, nutrition software has evolved from focusing on menu planning and analyzing dietary food intake to focusing on techniques for behavioral change (11-16).
The goals of our study were to evaluate weight-loss outcomes and the effect on CVD risk factors, and the resources required (from the perspective of a managed care organization) of the self-help, nonclinical, and clinical approaches to weight control. Our research evaluated the metabolic effect and costs of a do-it-yourself approach, using a workbook as the minimal intervention control, an expert computer system together with the workbook to optimize use of resources, and the addition of staff consultation to the computer system and workbook as the most intensive intervention.

METHODS

Study Design

The randomized, controlled clinical trial evaluated the metabolic effects and costs of 3 levels of intervention intensity for providing cognitive behavioral weight control intervention in a managed care environment. Assumptions from previous research (7) were utilized to calculate the sample sizes for each intervention arm to detect a difference in weight loss of 8 pounds between the minimum (do-it-yourself) workbook-only control group and the maximum intervention clinical approach (workbook combined with computer and staff intervention) with a power >.99; a difference of 4.5 pounds between the minimal intervention (workbook-alone) and the intermediate nonclinical intervention (workbook plus computer alone) with a power of .82; and a difference of 3.5 pounds between the intermediate intervention and the maximum intervention with a power of .80. Thus, the randomization schedule ensured that the trial would have at least 80 subjects in the minimal treatment condition and 171 subjects in the intermediate and maximum interventions at the end of the trial to allow for 20% attrition. If additional household members wished to participate in the study, they were assigned to the same group as the first household member to avoid potential contamination between treatment groups. Data related to additional household members are not included in the analyses in this paper. The protocol and process of obtaining informed consent were reviewed by the Committee on Clinical Investigations of the Albert Einstein College of Medicine.

Setting

The study was conducted in a freestanding Health Maintenance Organization (HMO) with an enrollment of 25,000 patients. The HMO was located on the Albert Einstein College of Medicine-Long Island campus, adjacent to the Long Island Jewish Medical Center in New Hyde Park, NY. A computer network with 5 kiosks was located in the HMO's subspecialty medical waiting room.

Study Participants

Participants were recruited from the HMO's patient population and from the surrounding community. Information about the study was disseminated to patients enrolled in the HMO and in the community using a variety of techniques including newsletter articles, flyers, posters, and local media news coverage via cable television and newspapers. Interested individuals (n= 1,560) were scheduled for a group recruitment session that provided an overview of the study and the eligibility criteria. Eligibility criteria included a BMI of more than 25 (or a BMI of 24 or more plus 1 cardiovascular risk factor) and the willingness to follow the study protocol, which included a refundable $100 deposit. Exclusion criteria included: intention to move beyond commuting distance within the next 12 months, medical
conditions that would interfere with study participation, and unwillingness to follow the study protocol.

In the group orientation sessions, potential participants (n= 1,041) completed a brief survey related to study participation. Those who agreed to participate (n=919) signed an informed consent approved by the Albert Einstein College of Medicine's Institutional Review Board. They were then scheduled for an individual computer orientation session, and 722 potential participants completed computerized baseline questionnaires. Mean age of individuals who completed randomization (n=588) was older than the 1,041 individuals who completed the brief survey (51.9 vs 50.2 years, respectively, P=.04). Of the individuals who completed the computerized questionnaires, those randomized had a greater proportion of people with diabetes (10.9% vs 4.8%, P =.04) and a greater proportion of people who felt comfortable using the computer (77.7% vs 71.49%, P =.02). There were no other differences in reported demographic and clinical characteristics.

Intervention methods

The intervention for all 3 intensity levels utilized a cognitive behavioral approach (8) for tailoring goals, including both lifestyle and behavioral modifications (17-19). The intervention materials addressed motivation and behavioral goals based on an individualized needs assessment and the principles of the Transtheoretical Model of Behavioral Change (19).

Workbook The workbook developed for the study was designed for use as a standalone (do-it-yourself) program in which participants completed self-help sheets that guided them to sections of the workbook (20) most salient to their needs. The workbook also served as an integral component of the more intensive intervention modalities.

Computer Intervention The computer intervention was provided using a network system that included a file server plus 5 multimedia computers with touch screens. The expert software program was written to guide participants in using the workbook (20) and tailor behavioral goals based on their prior computer use and the answers they provided on baseline questionnaires. The 3 primary paths in the computer system addressed nutrition, fitness, and psychobehavioral content. Each computer path contained a series of topics that participants could explore and re-explore, including information and guidance regarding weight-reduction (via text, animation, graphics, interactive quizzes, and video clips).

Instruments used in the initial computerized tailoring of the intervention included: dietary knowledge, the Block et al fat screener (21), and consumption of food intake based on the Food Guide Pyramid (22), the Paffenbarger et al self-reported physical activity instrument (23), our instrument to assess barriers to lifestyle change (24), and the Sallis et al dietary and exercise self-efficacy scales (25). A median split was used to designate each participant's scores as high or low for each instrument. For each of the computerpaths, an algorithm matched topics to corresponding instruments. If the score for targeted behavior was high, the algorithm rated the topic as a lower area of need and thereby skipped to the next. Conversely, for a low behavior score, selection of corresponding topics would consider the participant's barriers and self-efficacy scores. To promote the likelihood of success, topics with lower barrier scores and higher self-efficacy scores were recommended first. The participant then had the option to accept or reject each recommended topic area, or make free choices that did not consider their scores or previous selections.
There were 289 goal options that corresponded to various topic areas in the computer program. Based on the Transtheoretical Model for Behavioral Change (19), the participant could select goals that reflected differences in their readiness to make changes. For participants at a pre-action stage of readiness, each of the paths contained 16 to 18 goal options for reading sections within the workbook (20). Goals at the action and maintenance stages of readiness addressed specific behavioral targets broken down to 105 nutrition-related options, 57 fitness-related options, and 77 psychobehavioral-related options. During the first 3 months of the program, participants were instructed to log on to the computer system weekly to help identify individual problems and select behavioral goals. The participants were instructed to log on at least once per month thereafter. Computer sessions were intended to be approximately 20 to 30 minutes in length. After 20 minutes of being logged on, participants received a reminder of the amount of time they had been online. However, they could remain online as long as they wished.

At the end of each computer session, participants were prompted to continue with or modify their goals for monitoring food intake and physical activity. They reviewed previously chosen goals related to the computer session and selected up to 5 behaviorally targeted goals to implement until their next computer session. At the beginning of the following computer session, participants were prompted to evaluate their success with their chosen goals.

Staff Consultation The staff consultation component included 6 closed-group workshop sessions and up to 18 telephone or face-to-face consultations with a registered dietitian and/or a cognitive behavioral therapist. The workshop curriculum focused on specific activities and assignments in the workbook (20), and it encouraged use of the computer to identify problems and issues (24). Thus, the consultation reinforced and amplified the content of the computer system and the workbook (20).

Assessment and Data Collection

Study participants were evaluated at baseline and at 1 year to assess potential changes in measures of body weight, diabetes and cardiovascular risk, medication usage, dietary and exercise habits, and quality of life measures. Staff evaluated the potential use of an outside weight program at 3, 6, and 9 months into the study. Medication usage was evaluated at baseline, 6 months, and 1 year. Staff recorded information regarding dosage and frequency of use of medications by instructing participants to bring in their current prescriptions to their appointments.

Body weight and height were measured on a balance beam scale with participants dressed in light clothing and without shoes. Body composition was measured by bioelectrical impedance analysis, using the formula developed by Segal et al (26). Circumferences of the waist and hip were measured at the umbilicus and the level of maximum protrusion of the buttocks, respectively, using a tape measure. The lipid measurements were analyzed in a CDC certified laboratory. Fasting cholesterol and triglycerides were measured using colorimetric enzymatic analysis, HDL cholesterol was analyzed by the heparin manganese method, and LDL cholesterol was calculated using the Friedwald algorithm (27,28,29). Trained and certified staff members, who used standardized procedures, obtained blood pressure measurements.

Exercise was assessed by self-report using an adaptation of the Paffenbarger et al physical activity questionnaire (23) to obtain information about stairs climbed and blocks walked, as
well as recreation activities during the week; the Paffenbarger et al instrument has been used extensively in diet and exercise intervention studies (1,7,8). Dietary intake was assessed using the Block Food Frequency Questionnaire (FFQ) (30). Medical and weight histories were also assessed. All instruments were self-administered on the computer except for the FFQ and a brief survey of demographic data.

Obtaining Cost Data

The perspective of the managed care organization was used to estimate the incremental cost compared with the incremental benefit of providing each intervention. The cost of the workbook (20) was based on the bulk purchase price ($11.97 each when ordering more than 10 copies). Computer costs were derived for the actual cost of the network system used in the study allocated across the participants assigned to the computer intervention groups, assuming a 5-year life for all equipment and using Modified Accelerated Cost Recovery System depreciation rates.

Labor costs were calculated based on national wage rates from the Bureau of Labor Statistics (31). Clerical tasks were calculated at $15.51 per hour (salary + fringe benefits), based on the average rates for clerks and statistical clerks; professional tasks performed in the most intensive intervention were calculated at $21.15 per hour (salary + fringe benefits), based on the average rates for dietitians and social workers (31). The intervention staff kept a log in which they recorded the amount of time spent in direct service providing the intervention and in weekly supervision and training sessions. Information recorded in their logs included: preparing for and conducting scheduled educational sessions, responding by telephone to participant questions, assisting participants with computer usage and providing participants with positive reinforcement related to achieving intervention goals. Intervention staff simultaneously recorded logs for sample cases to reduce the discrepancies in coding entries to less than 5% and established inter-rater reliability for the amount of time spent on tasks related to providing the intervention.

Statistical Analysis

Statistical analyses were performed using SAS software (Statistical Analysis System Institute: SAS/STAT Windows Software, Carey, NC). One-way analysis of variance was used to compare the 3 interventions on all normally distributed variables measured at baseline and at each of the 4 quarters. When comparisons involved 2 intervention arms, analysis was by t test adjusted using the Bonferroni method. Chi-square was calculated for statistical comparisons of the groups for categorical variables. Regression analysis was used to evaluate predictors of weight loss. Correlations were calculated to assess the relationship between intervention variables and weight loss, and between weight loss and changes in CVD risk factors. Analysis of covariance was used to control for differences in baseline values.

Cost Analysis

The total cost of providing each intervention was calculated by adding each element used in providing the interventions, including print materials (workbook), staff time, and computer costs. The mean cost per participant was calculated by dividing the total cost of providing the intervention by the number of study participants randomized to that intervention. In calculating the mean cost per pound lost, only participants who had complete data (baseline and 1 year) were included.
Evaluation of Intervention Components

All participants were given a self-administered anonymous exit survey regarding their opinions of the acceptability of intervention components. Additional evaluation information of the computer components was obtained in a telephone survey using a randomly selected subsample of the participants in the two intervention arms that involved computer usage.

RESULTS

Baseline

Table 1 lists the baseline demographic and clinical characteristics of the 588 study participants by randomization group. The intervention groups were similar with respect to baseline demographic characteristics. Compared with the 2 computer-based intervention groups, the workbook-alone group had a higher mean fat intake (P<.01) and a larger mean waist measurement (P<.001).

Of the participants randomized at baseline, 81% completed the 12-month study, with dropout rates of 16% (n=19), 22% (n=53), and 17% (n=42) for the least, intermediate, and most intensive intervention groups, respectively. Those who completed the study did not differ significantly from the dropouts with respect to baseline characteristics.

Lifestyle Changes

The lifestyle changes achieved by each randomization group are listed in Table 2. The mean energy intake and percent of energy from fat decreased from baseline in all 3 intervention groups (P<.01); there was not a statistically significant difference in the mean nutrient intake change by intervention group. All of the intervention groups reported a mean increase in walking time, as well as in the number of blocks walked each day (P<= 0.1); there was no statistically significant difference by intervention group.

Weight Changes

The 1-year changes in physiological parameters are listed in Table 2. All of the groups achieved a statistically significant weight loss. The most intensive intervention group (workbook with computer and staff added) lost significantly more weight than the least intensive (workbook-alone) group (F=5.56, P=.02). The mean weight loss in the intermediate treatment group (workbook and computer) was not significantly greater than the weight loss in the workbook-alone control group.

Using a subset of data, an efficacy analysis indicated that 80% of intermediate group participants (n=147) completed at least 5 computer sessions, which resulted in a mean weight loss of 5.9 pounds, significantly more than the loss in the workbook-alone control group (P=0.04). Intervention variables that correlated with weight loss included: more self-monitoring (r=0.25, P=.0001), higher attendance in staff consultation group meetings (r=0.22, P=.002), a greater frequency of computer sessions (r=0.24, P=.0001), feeling successful with self-monitoring (r=0.25, P=.0001), and achieving more computer dietary goals (r=0.13, P=.02). A regression analysis of all participants randomized to the computer treatment condition (computer alone or computer plus staff) showed that more frequent computer usage...
was highly predictive of weight loss ($r^2=0.06$, $F=24.9$, $P=.0001$). In a multivariate regression analysis, more frequent computer usage was the most predictive of weight loss.

Across all groups, correlates of weight loss were: a decrease in energy ($r=-0.18$, $P=.0001$), a decrease in percent of energy from fat ($r=-0.26$, $P=.0001$), and an increase in the average time spent walking ($r=0.16$, $P=.002$).

Changes in variables related to CVD risk

The most intensive intervention group (computer and staff consultation) had a significant increase in the mean HDL cholesterol level ($P<.01$) and a decrease in the mean diastolic blood pressure level ($P<.01$). There were no significant differences in mean changes in CVD risk variables among the intervention groups. For the pooled intervention groups, weight loss correlated with a decrease in blood pressure (systolic, $r=0.16$, $P=.0007$; diastolic, $r=0.19$, $P=.0001$), and a decrease in fasting blood glucose ($r=0.14$, $P=.004$).

Resources utilized/intervention costs

The mean amount of clerical time (reinforcement or help on the computer) utilized per participant in each of the randomization groups was 1.35 minutes for the least intensive (workbook-alone) group, 2.28 minutes for the intermediate intensive group, and 2.47 minutes for the most intensive group.

The mean amount of professional staff time utilized in conducting the most intensive intervention was 227.1 minutes per participant. The types of tasks performed by the professional staff included: preparing for and conducting group sessions (mean of 66.5 minutes per participant), clinical supervision and staff training (mean of 33 minutes per participant), conducting make-up sessions (mean of 1.64 minutes), reviewing diaries (mean of 5.17 minutes), and conducting private consultations (mean of 50.1 minutes per participant).

The cost of staff time per participant for each intervention group over the 12-month study period was $0.35 for the least intensive (workbook-only) group, $0.59 for the intermediate intervention (workbook+computer) group, and $92.33 for the intensive intervention (workbook+computer+staff) group. After adding the cost of the computers to the participants in the groups that used the computers (calculated to be $29.44 per participant) and the cost of the workbook ($20) to each participant in the study, the mean cost of the intervention was $12.33 per participant for the workbook-alone group, $41.99 per participant for the intermediate intensive group and $133.74 per participant for the most intensive group. For participants who completed their 1-year visit and had complete cost data ($n=434$), the mean cost per pound lost was $6.23 for the workbook-only group, $8.57 for the intermediate intensive group, and $18.78 for the most intensive group.

Evaluation of intervention components

Results of the post-intervention anonymous survey are listed in Table 3. Comparison with those in the intermediate or least intensive intervention groups, individuals in the most intensive intervention group were more likely to report that they completed the workbook activities, that they considered completing workbook components and keeping a diary helpful, and that they changed habits. In the most intensive group that received the workbook
plus the addition of computer-tailoring and the staff consultation, a higher proportion reported completing 50% or more of the workbook activities than in the workbook-alone and workbook+computer groups. The workbook (20) was considered to be helpful by a higher proportion of participants in the most intensive intervention group (workbook+computer+staff) than in the other groups (P=.001).

Among all participants, the proportion rating diary-keeping as helpful was twice as great in the most comprehensive intervention that received staff consultation in addition to computer and workbook, compared with the least intensive workbook-alone group for the physical activity diaries (P=.02) and food diaries respectively (P=.001). In the most intensive intervention group, a greater proportion reported changing habits while in the program compared with the intermediate and least intensive intervention groups (P=.001). The proportion agreeing that the computer-printout of goals was helpful was greater in the intensive intervention group than in the intermediate intensive group, which received the computer without staff (P=.03). In the telephone interview of a subsample of the participants who used the computer (n=87, data not shown), 50% indicated that finding time to go to the onsite computer was a problem, and 75% preferred Internet access, listing email and bulletin boards as desired components.

DISCUSSION

Our findings suggest that computer-tailoring of weight-control programs may facilitate implementation of weight-loss programs in HMOs. In our randomized trial, as anticipated, the most intensive intervention, which included both the computer program and access to professional staff, resulted in a significantly greater mean weight loss compared with the do-it-yourself (workbook-alone) control arm. The computer-tailoring system promoted diary keeping, which in turn was associated with a greater weight loss. The amount of weight lost by participants predicted a greater improvement in their cardiovascular risk factors, but the change in CVD risk factors did not differ based on the intensity of the intervention provided by the treatment groups.

Several studies have demonstrated that computerized menu planning systems or dietary monitoring systems are valuable as components in weight-loss interventions or in achieving lifestyle changes (12-16). In a more recent study, Kristal et al (32) were able to achieve a mean decrease in fat intake of 8% among HMO enrollees using personalized computer-generated educational materials including behavioral feedback, a self-administered food frequency questionnaire, and a motivational telephone call. Glasgow et al (33) demonstrated a modest decrease in blood cholesterol levels using a computer-generated tailored mailing of information about grocery shopping, eating out, and reducing fat intake; their research was based on a self-administered food frequency questionnaire among individuals with type 2 diabetes. However, none of these studies included a computer system that utilized self-efficacy and other behavioral questionnaire data to help tailor intervention goals. In our earlier study, which used a videotape to optimize use of staff time, we demonstrated a weight loss (comparable with that achieved in the present study) that was maintained for up to 3 years (8). The program participants in our earlier study had nonprofessional staff contact when they reported for weight check-ins, however. Thus, our present study has explored methods of utilizing computer technology to free up staff time to address more complex issues such as identification of barriers and problem solving.
Our efficacy evaluation in the intermediate intensity group (workbook+computer, with no access to additional staff) provides insights for further refinement of computer-based interventions. Almost 80% of the participants in this intermediate treatment arm logged on to the computersystem at least 5 times during the study, and the number of log-ons was directly related to a greater weight loss. Indeed, in the absence of staff intervention, participants who are able to achieve interactivity via the computerlost more weight than participants in the workbook-only control group.

Although the cost per pound lost was the lowest in the least intensive intervention group, the satisfaction with the program increased as intervention intensity increased. In the postintervention survey, our study participants clearly indicated the need for interacting with staff. The actual amount of professional staff time utilized in the intervention was modest, averaging a total 66.5 minutes per participant for all of the group sessions and 50.1 minutes per participant for all of the individual consultations. However, the amount of staff time devoted to training and clinical supervision during the study exceeded the level potentially available in most managed care settings. The weekly 60-minute clinical supervision meeting, which was attended by the 3 part-time intervention staff members, accounted for the majority of training time. (The use of full-time staff would make the staff time devoted to supervision more efficient).

The computer system was successfully used for simple problem solving and goal selecting, which thereby freed up staff consultation time for more complex consultation issues. Using an expert computer system has enabled us to further optimize staff time in developing individually tailored weightloss programs. A modified version of our computer program is being made available via the Internet and will expand the potential for interactive levels utilizing email, listserv, bulletin boards or chat rooms (34). Our post-intervention survey indicated that three fourths of the participants wanted an Internet accessible system that utilized the options for greater interactivity. Unfortunately Miles et al (35) report that an Internet search for weight loss diets yielded primarily sites that "promoted dietary supplements or other `slimming aids' often of uncertain composition and based on dubious physiological principles." Davison (36) advocates, "Because Internet resources continue to increase at incredible pace, health professionals need to take an active role in this technology ..." Fortunately, there are a growing number of consumer Web sites with registered dietitian oversight that provide reputable weight loss information. Examples include www.cyberdiet.com and the American Dietetic Association's www.eatright.org and our own Web site www.aecom.yu.edu/nutrition.

APPLICATIONS

As the US prevalence of obesity and its comorbidities increase, more effort is needed for preventive services related to controlling the adverse effects of obesity. Dietitians and other health professionals should consider using computer-based communications to maintain frequent contact, promote selfmonitoring, and tailor behavioral goals. Computer-based communication strategies can be readily combined with other approaches that are found to be predictors of weight loss. The cost per participant in each of 3 interventions was quite modest. Managed care organizations could potentially incorporate all 3 options as preventive health services. Patients could opt for an approach based on availability and personal preference for learning method and time.

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AuthorAffiliation

JUDITH WYLIE-ROSETT, EdD, RD; CHARLES SWENCIONIS, PhD; MINDY GINSBERG; CHRISTOPHER CIMINO, MD; SYLVIA WASSERTHEIL-SMOLLER, PhD; ARLENE CABAN, PhD; CJ SEGAL-ISAACSON, EdD, RD; TAMARA MARTIN, MA, CPA; JAMES LEWIS, ScD

AuthorAffiliation

J Wylie-Rosett, M. Ginsberg, S. Wassertheil-Smoller, and CJ Segal-Isaacson are with the Department of Epidemiology and Social Medicine, C. Cimino is with the Office of Education, and A. Caban is with the Department of Psychiatry, all at the Albert Einstein College of Medicine, Bronx, NY. C. Swencion is with the Department of Epidemiology and Social Medicine, Albert Einstein College of Medicine and with the Ferkauf Graduate School of Psychology, Yeshiva University. T Martin and J Lewis are with the Department of Health Management and Policy at the University of New Hampshire, Durham.

Address correspondence to Judith Wylie-Rosett, EdD, RD, Albert Einstein College of Medicine Department of Epidemiology and Social Medicine, Belfer 1308, 1300 Morris Park Ave, Bronx, NY 10461.
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