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Maintenance of Activity and Eating Change Following a Clinical Trial of Tailored Newsletters with Older Rural Women

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Abstract

Background—In the Wellness for Women Project, a randomized-by-site 1-year controlled clinical trial, the efficacy of generic newsletters and tailored newsletters on Health Promotion Model behavior-specific cognitions, eating change, and activity change were compared among 225 women aged 50 to 69 years.

Objectives—To compare the maintenance of change in healthy eating and physical activity over 12 months following the tailored versus generic mailed newsletter intervention.

Method—Outcomes at 18 and 24 months included behavioral markers and biomarkers of physical activity and eating. Data were analyzed using the multivariate approach to repeated measures analysis of variance and generalized estimating equations ($\alpha < .05$).

Results—At 18 months, the tailored group maintained levels of all eating and activity behaviors, while the generic group maintained levels of fruit and vegetable servings and moderate or greater activity, stretching exercise, lower body strength, and flexibility, but increased saturated fat intake and declined in weekly strength exercise and cardiorespiratory fitness. At 24 months, both groups

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maintained or returned to 12-month levels of all eating behaviors and moderate or greater activity, stretching exercise, and flexibility, but declined in cardiorespiratory fitness; the tailored group maintained levels of strength exercise and lower body strength, while the generic group decreased in both. A greater proportion of women who received tailored newsletters continued to achieve most Healthy People 2010 criteria for eating and activity.

Discussion—Mailed tailored print newsletters were more effective than generic newsletters in facilitating maintenance of change in eating and activity for 6 months postintervention. Both tailored and generic newsletters facilitated the maintenance of change in eating behaviors and in moderate or greater physical activity and stretching exercise, while tailored newsletters were more effective in maintaining change in strength exercise for 12 months postintervention.

Keywords

maintenance of behavior change; exercise and eating; Health Promotion Model; middle-aged and aged women; randomized controlled trial; rural population; middle-aged and aged women

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Chronic diseases and the associated disability and economic costs do not have to be an inevitable consequence of aging; they can be ameliorated by healthy lifestyle choices that include healthy eating and regular physical activity (Rowe & Kahn, 1998; United States Department of Health and Human Services [DHHS], 1988, 1996, 1997). The need to change these interrelated health behaviors by reducing dietary fat consumption and increasing intake of fruits and vegetables, and by engaging regularly in moderate intensity physical activity as well as activity to enhance muscular strength and flexibility is emphasized in the Healthy People 2010 objectives (DHHS, 2000).

The Center for the Advancement of Health (2006) recently emphasized the importance of helping older adults make healthier choices in an issue briefing detailing the benefits of improving eating habits and increasing physical activity. The four primary benefits identified were (a) longer life resulting from lower risk of chronic diseases that lead to premature death, (b) reduced rates of disability, (c) better mental health and cognitive function, and (d) lower health care costs. Despite these documented benefits, many older adults do not choose to engage in physical activity and consume a healthy diet.

Midlife and older rural women represent a population at increased risk for chronic illness, functional limitations, and disability (Murtagh & Hubert, 2004; National Center for Health Statistics, 2002) and experience lower access to health care and are less likely to receive preventive services (Jones, Parker, Ahearn, Mishra, & Variyam, 2009). The Wellness for Women Project was the first reported randomized clinical trial of a computer-tailored home-based intervention employing distance methodology to facilitate simultaneous change in physical activity and healthy eating behaviors among this hard-to-reach rural population. In the Project, 18 newsletters were delivered over 12 months to allow time for incorporation of behavior change into the women's lifestyle (Walker et al., 2009).

Computer tailoring is a relatively recent approach to theory-driven behavior change intervention. Tailoring has been defined as “any combination of information and behavior change strategies intended to reach one specific person, based on characteristics that are unique to that person, related to the outcome of interest, and derived from an individual assessment” (Kreuter, Farrell, Olevitch, & Brennan, 2000, p. 5). Tailored print messages that are designed to be personally relevant to the recipient are more likely than nontailored messages to be read and remembered and to help the individual enact behavioral change (Kreuter et al., 2000; Skinner, Campbell, Rimer, Curry, & Prochaska, 1999). While computer tailoring has been shown to be effective in the adoption of behavior change (Kroeze, Werkman, & Brug, 2006; Noar, Benac, & Harris, 2007), little research has been conducted to evaluate its effect

on the maintenance of behavior following an intervention--yet it is maintaining healthy eating and physical activity as regular components of lifestyle that is the key to prevention of chronic disease and disability and to enjoying healthy aging and longer life.

The purpose of this study was to compare the maintenance of change in healthy eating and physical activity among rural women aged 50 to 69 years during the year following a clinical trial that delivered a tailored intervention framed within the Health Promotion Model (Pender, Murdaugh, & Parsons, 2002) and a comparison generic (nontailored) intervention. Maintenance was examined for those outcomes that had changed significantly for one or both groups during the 12-month active intervention phase of the study. Primary outcomes were changes from 12 months to 18 and 24 months in: (a) eating behavioral markers (fruit and vegetable servings, percent of calories from saturated fat); (b) activity behavioral markers (minutes of moderate or greater intensity activity, stretching, and strength exercise) and activity biomarkers (estimated VO_{2max}, flexibility, and lower body strength); and (c) biomarkers influenced by eating and activity (systolic and diastolic blood pressure, and low density lipoprotein-cholesterol). Secondary outcomes were achievement at 18 and 24 months of Healthy People 2010 behavioral standards: (a) meeting daily goals of at least 2 servings of fruits and 3 servings of vegetables (Healthy People 2010 objectives 19-5 and 19-6); (b) no more than 30% of calories from fat and less than 10% of calories from saturated fat (objectives 19-9 and 19-8); and (c) engaging regularly in moderate or greater intensity physical activity for at least 30 minutes per day (objective 22-2).

Literature Review

Maintenance of health behavior change

In intervention studies, successful maintenance of behavior change is typically defined as continuing to engage in the behavior at the same level for at least 6 months after the end of the intervention. Marcus et al. (2000) emphasized that “maintenance of physical activity is critically important because ongoing participation in the behavior is necessary to sustain health benefits” (p. 32). They summarized what is known about the maintenance of physical activity behavior in adults and concluded that little is known about effective intervention strategies for long-term behavior maintenance.

A Cochrane review of 19 randomized controlled trials for promoting physical activity in community-living sedentary adults (Foster, Hillsdon, & Thorogood, 2005) concluded that, while a variety of interventions have a positive moderate-sized effect on increasing self-reported activity and cardiorespiratory fitness in the short- to mid-term, the long-term effectiveness has not been established because the majority of studies stopped after 12 months. Only six studies reported outcomes more than 6 months postintervention. Conn, Minor, Burks, Rantz, and Pomeroy (2003) reviewed the results of 17 randomized, controlled trials of nontailored interventions to increase physical activity among aging adults reported from 1960 to 2000. They noted as a limitation that the majority of studies were focused on activity adoption but did not follow participants long enough to determine maintenance 6 months or more after the intervention.

These observations are also relevant to healthy eating behaviors. Povey and Clark-Carter (2007) systematically reviewed results of 23 studies of healthy eating behavior interventions within diabetes care and concluded that future research would benefit from interventions focused on the maintenance in addition to the initiation of eating behavior change.

Maintenance of change following tailored interventions

Prochaska, DiClemente, Velicer, and Rossi (1993) first suggested that tailored interventions may be superior to nontailored interventions over a longer follow-up period. Since then, limited evidence has been accumulated concerning the long-term efficacy of computer-tailored interventions for physical activity and eating behavior change. Richards et al. (2007) reviewed the literature on tailored biobehavioral interventions published from 1996 through 2005 and emphasized that "interventions are needed that reliably produce long-term benefits … especially in health promotion areas such as … nutrition and exercise, in which change may require a longer time" (p. 280).

Kroeze, Werkman, and Brug (2006) systematically reviewed 30 randomized controlled trials of computer-tailored interventions to change physical activity or nutrition behaviors, or both, published from 1965 to 2004. None of studies targeted rural older women. In only one of six studies of physical activity, none of two studies of fat consumption, and two of two studies of fruit and vegetable consumption with follow-up measurements at 6 months or more were significant long-term effects of tailored interventions found when compared to generic interventions or to no intervention. Recent narrative systematic reviews of the evidence on computer-tailored primary prevention interventions for dietary behavior change (Neville, O'Hara, & Milat, 2009a) and activity behavior change (Neville, O'Hara, & Milat, 2009b) delivered through interactive technology or desktop computer applications rather than printed materials concluded that, while the evidence for short-term effectiveness is fairly strong, there is little evidence that effectiveness can be sustained long-term. The authors pointed to the need for more studies with long-term follow-up of 12 months postintervention.

A randomized controlled trial to compare print with generic messages offers the best test of tailoring because it isolates the effect of tailoring from that of other factors, such as message content, which might be present when tailored messages are compared to no intervention. Only three studies were found comparing print and generic messages, addressing change in both eating and activity behaviors, and including follow-up of outcomes at least 6 months postintervention. Blalock et al. (2002) delivered two mailed and one telephone communication concerning calcium intake and exercise over 1 month, with follow-up data collected 3, 6, and 12 months postintervention. Outcomes were analyzed by stage of change and intervention group status, with women in the engaged stage who received tailored materials having a significantly greater increase in calcium intake at the 6-month follow-up only than those who received nontailored materials. There were no group differences in exercise outcomes at any point. Demark-Wahnefried et al. (2003, 2007) mailed a workbook and a series of six newsletters concerning diet and exercise behaviors to cancer survivors over 10 months, with follow-up interviews at 1 and 2 years postbaseline. At the 1-year follow-up (2 months postintervention) of 519 participants, the tailored group had significantly greater improvement in exercise minutes per week, fruit and vegetable servings per day, and total and saturated fat intake. Results of the 2-year follow-up to assess sustainability of these changes have not been published. Kreuter and Strecher (1996) mailed one written communication concerning seven health-related behaviors and mortality risk for four health problems to patients from family medicine practices, with follow-up data collected 6 months later. At follow-up, those who received tailored feedback about their behaviors and risk were 18% more likely than those receiving nontailored or no feedback to change at least one behavior. Change occurred in fat consumption and exercise.

Two studies were designed to examine maintenance of eating or physical activity behaviors, or both, following a behavior change intervention with tailored print materials. In a randomized, controlled trial of maintenance of physical activity, Bock, Marcus, Pinto, and Forsyth (2001) compared results of mailed feedback reports tailored to psychological variables from social cognitive theory and the Transtheoretical Model with those of a standard print-based

intervention among 194 healthy, sedentary men and women. The intervention included mailings at baseline and 1, 3, and 6 months. A follow-up assessment of exercise maintenance was conducted 6 months postintervention. Participants in the tailored arm met or exceeded exercise goals at Month 6 and maintained that level of activity at Month 12 significantly more than participants in the nontailored arm. The Study of Exercise and Nutrition in Older Rhode Islanders (SENIOR) Project consisted of a 12-month tailored intervention, based on the Transtheoretical Model of Health Behavior Change, to increase fruit and vegetable consumption, exercise, or both behaviors among 966 community-dwelling older adults, followed by a 12-month observational period to allow assessment of maintenance of behavior change (Clark et al., 2005). Participants were assigned randomly to intervention groups who received tailored print materials and coaching calls focused on exercise and nutrition, exercise alone, nutrition alone, or to a contact-comparison group. Only the results of the exercise components of the intervention have been published (Greaney et al., 2008). When including only the 608 participants who were not in the maintenance stage for exercise throughout the entire 24-month period, a greater proportion of those who received the exercise intervention progressed in stage by 24 months. There were no significant differences in physical activity or physical function. The tailored exercise intervention was more effective than the comparison for increasing readiness for exercise, but not for enhancing the adoption or maintenance of actual exercise behavior.

Conceptual Framework

The Health Promotion Model (HPM), based on social cognitive theory (Bandura, 1986) and depicted in Pender et al. (2002), was used as the framework for the tailored intervention in this clinical trial. The intervention targeted change in physical activity and healthy eating as well as in known cognitive influences on those behaviors. Four behavior-specific cognitions (perceived benefits, barriers, self-efficacy, and interpersonal influences) from the HPM were used in designing the tailored messages for the intervention. Research supports association of these cognitions with physical activity and healthy eating (Walker, Pullen, Hertzog, Boeckner, & Hageman, 2006).

Design and Methods

The Wellness for Women Project was a community-based clinical trial using a repeated measures experimental comparison group design with randomization of two demographically similar rural geographical areas in a Midwestern state to intervention (tailored newsletters) or comparison (generic newsletters) groups. The intervention lasted for 12 months and follow-up extended an additional 12 months. Institutional Review Board approval was obtained and each participant provided written informed consent for both phases of the study (Walker et al., 2009).

Details of the intervention during year 1 of the clinical trial have been reported previously (Walker et al., 2009). The major intervention components were tailored or generic newsletters mailed to the women's homes; these were supplemented by plans of action (goal setting) in the tailored group and by physical activity instructional videotapes provided to both groups. During the year 2 follow-up, women came to the two rural research offices at 6-month intervals for assessments only. No intervention was delivered. A descriptive report that included each woman's assessment results and an indication of desirable ranges was sent to all participants in both groups within 1 month following their 12-, 18-, and 24-month assessments. No advice concerning needed behavior change was included with those mailings. It is recognized that, although not intended as such, reassessment of behavioral and biomarkers may have had an effect as intervention boosters for both groups.

Results during the intervention period have been reported (Walker et al., 2009). Mailed computer-tailored newsletters were more effective than generic newsletters in facilitating change in behavioral and biomarkers over 12 months. Both groups increased the amount of stretching and strengthening exercise, while only the tailored group increased moderate or greater intensity activity and fruit plus vegetable servings and decreased % calories from saturated fat from baseline to 12 months. Among the biomarkers measured, both groups increased cardiovascular fitness, flexibility, and lower body strength and lowered diastolic blood pressure and low-density lipoprotein (LDL) cholesterol, while only the tailored group lowered systolic blood pressure. A higher proportion of women receiving tailored newsletters met Healthy People 2010 criteria for moderate or greater intensity activity, fruit servings, vegetable servings, and percent of calories from fat at 12 months (Walker et al., 2009). Results concerning maintenance of change in these behavioral and biomarkers during the follow-up period are reported here.

Sample

Power analyses for repeated measures analysis of variance (RM-ANOVA) for the primary outcomes, random digit dialing recruitment procedures, inclusion and exclusion criteria, characteristics of the sample, and a CONSORT participant flowchart (see Figure, Supplemental Digital Content 1, which illustrates the characteristics of the sample) have been described in detail by Walker et al. (2009). Enrollment on a rolling basis occurred from 2002 to 2003; the intervention phase was conducted from 2002 to 2004 and the follow-up phase from 2003 to 2005. There were 115 women in the tailored newsletters intervention group and 110 women in the generic newsletters comparison group. Attrition during the intervention phase of the study was 9 (7.8%) and 1 (1.8%) respectively for the two groups. All 215 of the women who completed the 12-month intervention completed the 18-month and 24-month follow-up assessments with no further attrition.

Assessments and Measurement Methods

Behavioral markers and biomarkers of healthy eating and physical activity to measure primary and secondary outcomes were assessed at the end of the 12-month intervention and at 18 months (excluding serum lipids) and 24 months during follow-up. All assessments were conducted at two rural research offices and data were transmitted to investigators via the university's restricted access intranet. A research nurse at each site assessed biomarkers and supervised women individually in completing self-report questionnaires on the computer. Established valid and reliable measures were used for all assessments. Reliability and validity of the measures have been described by Walker et al. (2006, 2009).

Primary and Secondary Outcome Measures

Healthy eating—Self-reported daily servings of fruits and vegetables and daily intake of dietary fat (percent of calories from saturated fat) were measured using the web-based version of the 1998 Block Health Habits and History Questionnaire (HHHQ) to measure the usual self-selected diets of individuals over a period of time (Boeckner, Pullen, Walker, Abbott, & Block, 2002). The timeframe used for this follow-up study was the 6 months since the previous assessment. Achievement of Healthy People 2010 behavioral criterion standards for healthy eating was calculated from these data (Walker et al., 2009).

Physical activity—Time engaged daily in moderate or greater intensity activity and the associated energy expenditure were measured using the Modified 7-Day Activity Recall (Hellman, Williams, & Thalken, 1996/1997). Achievement of Healthy People 2010 behavioral criterion standards for physical activity was calculated from these data. Time engaged weekly in strengthening and stretching exercises was measured by 2 items in a format similar to that

of the 7-Day Recall. Cardiorespiratory fitness was measured using the 1-mile walk test on an indoor route to obtain an estimate of VO_{2max} (Hageman, Walker, Pullen, & Pellerito, 2001). Flexibility was measured via the modified sit-and-reach test, recommended by the American College of Sports Medicine (ACSM; 2006) as a measurement of general flexibility. Lower body muscular strength was measured through repeated timed chair stands (Hageman et al., 2001).

Biomarkers affected by activity and eating—Systolic and diastolic blood pressure were measured before physical activity testing, using a calibrated mercury sphygmomanometer and following standardized auscultatory methods (ACSM, 2006). Following a 12-hour fast, LDL cholesterol was measured using biochemical analysis (Walker et al., 2009).

Data Analysis

Intervention and comparison groups were compared on health-related characteristics at 12 months, the baseline for follow-up. Analyses of change in behavioral and biomarkers of healthy eating and physical activity were based on intention to treat. Square root and logarithmic transformations were used to normalize the positively skewed distributions of several variables by reducing the effects of a small number of outliers (Tables 1 and 2). Only three variables were missing more than 6% of observations at any one time: chair stands and sit-and-reach, with 10-12% missing across the three times, and VO_{2max} having 18-21% missing. Eighty-two percent of cases had complete data or were missing fewer than 5% of observations across the 24 months. An additional 8% of cases were missing from 5-10% of observations. The remaining cases tended to be missing all data for one or more collection times. Maximum likelihood estimates of missing data values at the 12-, 18-, and 24-month assessments for all variables except VO_{2max} were imputed via the expectation maximization (EM) algorithm (Dempster, Laird, & Rubin, 1977) as implemented in SPSS Missing Values Analysis 12.0. Missing values on VO_{2max} were not imputed because they could not be considered missing at random, as they were due to the inability of some participants to perform the task.

For each primary outcome, two analyses were done. A 2-group by 3-time RM-ANOVA was performed to compare differences over time in the tailored and generic newsletter groups. Results of the multivariate tests of the main effects for time and time by newsletter group are reported from these analyses. A second analysis utilized an approach common in the health behavior literature: planned comparisons of simple main effects of time within group. Comparisons of changes from 12 months to 18 and 24 months in each group are reported for these analyses.

For the secondary outcomes, generalized estimating equations were used to estimate the same effects described for the primary outcomes, with the proportion achieving each Healthy People 2010 physical activity and healthy eating behavioral criterion standard as the dependent variable. This method allowed appropriate modeling of the error distribution for a dichotomous outcome and took into account the dependence among repeated observations. A binomial error distribution, logit link, and unstructured working correlation matrix were specified. Alpha of .05 was used for all analyses except the planned comparisons, for which a Bonferroni-adjusted value of .017 was used to adjust for the three possible pairwise comparisons.

Analyses were performed using the SPSS statistical package. Block Dietary Data Systems (Berkeley, CA) conducted the analysis of the online HHHQ to obtain nutrient and food group values.

Results

Sample Characteristics

Initial equivalence of groups on sociodemographic and health-related characteristics at baseline has been reported (Walker et al., 2009). At 12 months, the baseline for follow-up, groups differed on use of lipid-lowering medications (29.2% in tailored group, 12.8% in generic group; $\chi^2 = 8.74, p = .003$) and on use of hormone replacement therapy (31.1% in tailored group, 47.7% in generic group; $\chi^2 = 6.18, p = .013$).

Primary Outcomes

Results of RM-ANOVA are shown in Table 1 and changes from 12 months to 18 and 24 months are shown in Table 2. For a summary of data for each group over the entire 2-year study period, see Figures in Supplemental Digital Content 2.

Healthy eating—Among the two behavioral markers of healthy eating that showed positive change during the intervention phase, only percentage of calories from saturated fat had significant main effects for time over the year-long behavioral maintenance follow-up phase. From the end of the intervention at 12 months to 18 months, the tailored newsletter group maintained levels of all behaviors, while the generic newsletter group maintained levels of fruit and vegetable servings but increased the percentage of calories from saturated fat. From 12 months to 24 months, both groups maintained levels of all healthy eating behaviors. Time by group interactions for all eating markers across the three time points were not significant.

Physical activity—Among the six behavioral and biomarkers of physical activity that showed positive change during the intervention phase, only strength exercise and cardiorespiratory fitness had significant main effects for time over the year-long behavioral maintenance follow-up phase. From the end of the intervention at 12 months to 18 months, the tailored newsletter group maintained levels of all markers, while the generic newsletter group maintained levels of moderate or greater activity, stretching exercise, lower body strength, and flexibility, and declined in weekly strength exercise and cardiorespiratory fitness. From 12 months to 24 months, both groups maintained levels of moderate or greater activity, stretching exercise, and flexibility, but declined in cardiorespiratory fitness; only the tailored newsletter group maintained levels of strength exercise and lower body strength, while the generic newsletter group showed a decrease in strength exercise and lower body strength. Time by group interactions for all activity markers across the three time points were not significant, indicating that the groups did not differ in change in these markers over the three time points.

Biomarkers of activity and eating—Among the three biomarkers influenced by both physical activity and healthy eating that showed positive change during the intervention phase, both systolic and diastolic blood pressure had significant main effects for time over the year-long behavioral maintenance follow-up phase. However, the planned pairwise comparisons showed that both groups maintained levels of all biomarkers from the end of the intervention at 12 months to 18 months and from 12 months to 24 months. Time by group interactions for all markers were not significant.

Secondary Outcomes

Results of generalized estimating equations for the change in proportion of each newsletter group achieving the physical activity and healthy eating behavioral outcome targets from 12 months to 18 and 24 months are shown in Table 3 (omnibus tests) and Table 4 (changes from 12 months to 18 and 24 months). For a summary of data for each group over the entire 2-year study period, see Figures in Supplemental Digital Content 3.

Healthy eating—At the end of the intervention at 12 months, a significantly higher proportion of the tailored newsletter group had achieved the eating behavioral outcome targets of at least 2 daily fruit servings, at least 3 daily vegetable servings, and not more than 30% of calories from fat daily. The omnibus tests for the follow-up period showed no significant time or time by group effects for these outcomes. The within-group analyses also showed that levels achieved at 12 months were generally maintained at 18 and 24 months, with two exceptions: In the tailored newsletter group, there was significant decline from 12 months to 24 months in achieving the target of at least two servings of fruit daily and in having no more than 30% of calories from fat daily. At the later follow-up times, the tailored and generic newsletter groups did not differ on the target for fruit servings ($p = .184$ at 18 months; $p = .436$ at 24 months) or on calories from fat ($p = .072$ at 18 months; $p = .239$ at 24 months).

Physical activity—At the end of the intervention at 12 months, the groups were similar in regard to achievement of the activity behavioral outcome target of at least 150 minutes of moderate or greater intensity activity weekly (30 minutes daily for 5 days each week), while a significantly higher proportion of the tailored newsletter group had achieved the target of at least 210 minutes of moderate or greater intensity activity weekly (30 minutes daily for 7 days each week). For the entire period from 12 to 24 months, neither time by group interaction was significant, but the main effect for time was significant for the outcome of at least 210 minutes of weekly moderate or greater activity. *Post hoc* tests showed that the combined groups significantly increased from 12 months to 18 months on this outcome ($p = .015$). However, considered separately, there was no significant change within either group.

Discussion

The strengths of the Wellness for Women project were that it was focused on an understudied group of rural older women, was tailored based on a conceptual framework, had a more sustained or intensive intervention as compared with many relatively minimal interventions that have been reported, included follow-up of behavior maintenance during the year following the intervention, and had an excellent participant retention rate despite the fact that women had the study-associated burden of driving to the Project office every 3 to 6 months for assessments during years 1 and 2, respectively.

Several limitations to the study design have been acknowledged, including that generalizability was limited by low enrollment of minorities, possible bias of women's behavioral self-report by social desirability of response, and the initial randomization of sites rather than participants to intervention groups (Walker et al., 2009). Because there were only two sites, it could not be assumed that equivalence between groups would be achieved. At 12 months (the baseline for this report), the groups differed on the use of lipid-lowering medications and hormone replacement therapy, which might affect some biomarker outcomes. During follow-up, lack of statistical significance was interpreted as evidence that gains made by 12 months were maintained at 18 or 24 months. This conclusion should be drawn carefully, as it is possible that the study lacked sufficient power to detect a meaningful effect and that a finding of no change simply reflected Type II error. Examination of effect sizes suggests that this was probably not the case. Effect sizes were small (partial η^2 generally less than .02) for nonsignificant effects in the repeated-measures ANOVA, and mean changes in the outcomes within each group were generally small enough to be considered of little practical importance.

For the primary outcomes, time effects were not significant for 6 of the 11 behavioral and biomarkers of activity and eating that had shown desirable changes during the intervention, indicating that those changes had been maintained. Effects of the newsletters on behavior maintenance were most apparent when examining the simple main effects tests of the tailored and generic groups' change in behavior separately at 18 and 24 months.

As reported previously, during the intervention period, the tailored group had increased their average daily servings of fruits and vegetables from 5.7 at baseline to 6.6 at 12 months, and decreased their percentage of calories from saturated fat from 11.3% to 10.5% daily. The generic group had achieved no improvement in eating behavior (Walker et al., 2009). From the end of the intervention to 18 months (6 months postintervention), the tailored group maintained these gains, and the generic group undesirably increased their percentage of calories from saturated fat from 11.8% to 12.3% daily, well above their pre-intervention baseline level of 11.6%. By 24 months (12 months postintervention), the tailored group continued to maintain these gains and the generic group showed no change, having decreased their percentage of calories from saturated fat to 11.8%, similar to their level at the end of the intervention.

From baseline to 12 months during the intervention period, only the tailored group had improved significantly on moderate or greater intensity physical activity, with women who received tailored newsletters increasing their weekly minutes of activity by 74%. Both groups had improved on stretching exercise and flexibility, strength exercise and lower body strength, and improved their cardiorespiratory fitness (VO_{2max}; Walker et al., 2009). By 18 months (6 months postintervention), the tailored group maintained all of these gains, while the generic group maintained gains in stretching exercise, flexibility, and lower body strength, but showed declines in weekly strength exercise and cardiorespiratory fitness. From the end of the intervention to 24 months (12 months postintervention), the tailored group maintained all gains except for that in cardiorespiratory fitness, which still was above their pre-intervention baseline level. In contrast, the generic group declined in cardiorespiratory fitness close to baseline level, declined in weekly strength exercise but remained well above their baseline level, and decreased in lower body strength close to baseline level.

The 12-month intervention resulted in desirable changes in three of the biomarkers affected by both eating and activity. Both systolic and diastolic blood pressures were lowered in the tailored group, while only diastolic pressure was lowered in the generic group. In both groups, LDL cholesterol was lowered to near optimal levels (Walker et al., 2009). Both newsletter groups maintained these gains at both 6 and 12 months postintervention.

For the secondary outcomes, there were significant newsletter group differences in achievement of Healthy People 2010 healthy eating and physical activity behavioral criterion standards at the end of the 12-month intervention. A higher proportion of the tailored newsletter group had achieved the daily eating targets of at least 2 servings of fruits and 3 servings of vegetables and less than 10% of calories from saturated fat, and the daily activity target of engaging regularly in moderate or greater intensity physical activity for at least 30 minutes (Walker et al., 2009). From the end of the intervention to 6 months postintervention, both groups maintained these achievement levels. By 12 months postintervention, both groups maintained their achievement of targets for vegetable servings and physical activity. However, the tailored group's achievement of targets for fruit servings and calories from fat declined so that they were no longer significantly higher than the generic group. It is of concern that, with the exception of 70% of the women in the tailored group achieving the vegetable intake target, half or more of the women in both groups did not meet the healthy eating and physical activity behavioral outcome targets set in the Healthy People 2010 objectives.

Lasting change in lifestyle behaviors such as eating and activity may require considerable time, and cannot be expected to occur as a result of brief interventions (Richards et al., 2007). This 12-month tailored newsletter intervention was more sustained than many, and results of the 12-month follow-up study indicate that tailored print newsletters, based on women's individual assessment data, had a more lasting effect than generic newsletters on the maintenance of lifestyle behavior change achieved during the intervention. The tailored newsletter group's greater success in maintaining both eating and activity behavior change during the year

following the intervention is consistent with the prediction by Prochaska, DiClemente, Velicer, and Rossi (1993) that tailored interventions may be superior to nontailored over a longer follow-up period. These findings contribute to the need identified in the literature to determine whether the greater behavior change demonstrated for tailored as compared with generic interventions over a short-term period can be sustained long-term (Neville, O'Hara & Milat, 2009a, 2009b). There remains a need for additional studies with long-term follow-up of at least 6 months and preferably 12 months or longer postintervention before it can be concluded that tailored interventions can help midlife and older rural women as well as other populations to achieve a healthy lifestyle.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

2 × 3 Repeated Measures Analysis of Variance *F* Ratios for Newsletter Group × Time (Imputed Data *n* = 225)

		Time	Time by Group	Effect Size[c] (Partial η^2)	
	df	*F* (*p*)	*F* (*p*)	Time	Time by Group
Healthy Eating Outcomes					
Fruit and Vegetable Servings [a]	2, 222	1.54 (.217)	0.24 (.785)	.01	.00
% Calories from Saturated Fat	2, 222	3.41 (.035)*	0.69 (.503)	.03	.01
Physical Activity Outcomes					
Moderate+ Activity (min/day) [a]	2, 222	2.21 (.112)	1.61 (.203)	.02	.01
VO_{2max} (ml/kg/min)	2, 156	16.51 (<.001)*	1.37 (.256)	.18	.02
Stretching Exercise (min/wk) [a]	2, 222	2.89 (.058)	0.80 (.452)	.03	.01
Sit-and-Reach (cm)	2, 222	0.85 (.431)	0.13 (.876)	.01	.00
Timed Chairstands (sec)	2, 222	0.81 (.444)	2.90 (.057)	.01	.03
Outcomes Influenced by Eating and Activity					
Systolic Blood Pressure	2, 222	4.45 (.013)*	1.44 (.240)	.04	.01
Diastolic Blood Pressure	2, 222	4.62 (.011)*	0.19 (.826)	.04	.00
Low-Density Lipoprotein Cholesterol	1, 223	1.91 (.168)	0.34 (.563)	.01	.00

Notes. F ratios are Wilk's approximation of F values;

[a] Square root transformed;

[b] Log10 transformed;

[c] Effect size: .01 = small, .06 = medium, .14 = large;

* Significant change $p < .05$

Table 2

Change in Activity and Eating Outcomes - Imputed Data (*N* = 225)

Marker	12 months Mean (SD)	18 months Mean (SD)	Change 12 Months to 18 Months		24 months Mean (SD)	Change 12 Months to 24 Months	
			Mean (95% CI[a])	p[a]		Mean (95% CI[a])	p[a]
			Healthy Eating Outcomes				
Fruit + Veg Servings [b]							
Tailored (*n* = 115)	6.59 (3.3)	6.31 (3.1)	-0.28 (-0.73 to 0.17)	.242	6.28 (3.0)	-0.31 (-0.81 to 0.19)	.207
Generic (*n* = 110)	5.34 (2.7)	5.21 (2.3)	-0.12 (-0.58 to 0.34)	.763	5.03 (2.4)	-0.30 (-0.82 to 0.21)	.226
% Calories from Saturated Fat							
Tailored (*n* = 115)	10.52 (2.5)	10.74 (2.5)	0.22 (-0.18 to 0.62)	.280	10.60 (2.2)	0.08 (-0.30 to 0.45)	.689
Generic (*n* = 110)	11.76 (2.6)	12.26 (2.9)	0.50 (0.10 to 0.91)	.015*	11.80 (2.6)	0.04 (-.343 to 0.42)	.841
			Physical Activity Outcomes				
Moderate+ Activity (min/day) [b]							
Tailored (*n* = 115)	509.88 (749.4)	471.82 (553.6)	-38.06 (-176.73 to 100.62)	.810	414.21 (672.1)	-95.67 (-233.04 to 41.70)	.041
Generic (*n* = 110)	280.09 (360.1)	436.57 (689.1)	156.48 (14.69 to 298.27)	.119	368.34 (575.4)	88.25 (-51.21 to 228.71)	.678
VO_{2max} (ml/kg/min)							
Tailored (*n* = 84)	23.67 (7.1)	23.12 (6.9)	-0.55 (-1.10 to 0.00)	.048	22.71 (7.0)	-1.04 (-1.71 to -0.37)	.002*
Generic (*n* = 85)	23.27 (6.3)	22.35 (6.1)	-0.92 (-1.45 to -0.38)	.001*	21.80 (6.9)	-1.79 (-2.45 to -1.12)	<.001*
Stretching Exercise (min/wk) [b]							
Tailored (*n* = 115)	27.00 (39.6)	24.34 (32.6)	-2.66 (-11.07 to 5.75)	.482	25.45 (39.4)	-1.55 (-10.27 to 7.17)	.481
Generic (*n* = 110)	36.36 (50.1)	28.72 (51.5)	-7.64 (-16.23 to 0.96)	.033	27.89 (39.6)	-8.46 (-17.38 to 0.45)	.023
Strength Exercise (min/wk) [b]							
Tailored (*n* = 115)	26.95 (49.6)	25.40 (46.4)	-1.55 (-10.46 to 7.35)	.542	24.02 (51.1)	-2.93 (-12.70 to 6.85)	.259
Generic (*n* = 110)	32.83 (62.8)	24.03 (53.6)	-8.80 (-17.90 to 0.31)	.010*	24.58 (57.0)	-8.25 (-18.25 to 1.74)	.010*
Sit-and-Reach (cm)							
Tailored (*n* = 115)	29.99 (6.3)	30.22 (6.4)	0.23 (-0.52 to 0.97)	.549	29.77 (6.6)	-0.22 (-1.01 to 0.58)	.589
Generic (*n* = 110)	29.82 (6.6)	30.10 (6.8)	0.28 (-0.48 to 1.04)	.470	29.88 (6.9)	0.06 (-0.75 to 0.87)	.885
Timed Chairstands (sec)							
Tailored (*n* = 115)	14.14 (4.0)	14.05 (4.3)	-0.09 (-0.70 to 0.52)	.771	13.83 (4.1)	-0.31 (-0.96 to 0.34)	.350

Marker	12 months Mean (SD)	18 months Mean (SD)	Change 12 Months to 18 Months		24 months Mean (SD)	Change 12 Months to 24 Months	
			Mean (95% CI[a])	p[a]		Mean (95% CI[a])	p[a]
Generic (*n* = 110)	15.92 (4.6)	16.52 (5.3)	0.59 (-0.03 to 1.21)	.061	16.73 (5.0)	0.81 (0.14 to 1.47)	.017*
Biomarkers Affected by Eating and Activity							
Systolic Blood Pressure							
Tailored (*n* = 115)	124.36 (10.7)	124.01 (13.1)	-0.35 (-2.34 to 1.64)	.729	122.58 (12.6)	-1.79 (-3.99 to 0.42)	.112
Generic (*n* = 110)	123.93 (14.7)	125.94 (15.6)	2.01 (-0.02 to 4.04)	. 052	122.85 (14.7)	-1.08 (-3.33 to 1.18)	.348
Diastolic Blood Pressure							
Tailored (*n* = 115)	77.19 (7.2)	77.48 (7.8)	0.28 (-1.06 to 1.63)	.679	76.18 (8.3)	-1.02 (-2.44 to 0.41)	.161
Generic (*n* = 110)	76.32 (7.1)	77.06 (9.1)	0.74 (-0.64 to 2.11)	.292	75.13 (8.4)	-1.19 (-0.01 to -3.67)	.108
Low-Density Lipoprotein Cholesterol							
Tailored (*n* = 115)	107.48 (31.5)	Not measured			111.26 (34.0)	3.78 (-1.5 to 9.1)	.162
Generic (*n* = 110)	105.74 (38.2)	Not measured			107.29 (35.9)	1.55 (-3.9 to 7.0)	.575

Notes.

[a] CIs use Bonferroni adjustment for three comparisons; p values are unadjusted and are significant if < .017 (.05/3);

[b] Raw values shown for interpretability; reported probabilities based on analyses of square root transformed values;

[c] Raw values shown for interpretability; reported probabilities based on analyses of log transformed values;

* Significant change $p < .017$

Table 3

Generalized Estimating Equations Results for Change in Achievement of Behavioral Outcome by Newsletter Group (Imputed Data *n*=225)

Outcomes	Time		Time by Group
	df	Wald χ^2 (*p*)	Wald χ^2 (*p*)
Healthy Eating			
At least 2 servings of fruit daily	2	0.94 (.626)	5.35 (.069)
At least 3 servings of vegetables daily	2	1.21 (.546)	0.54 (.765)
Not > 30% calories from fat daily	2	2.72 (.257)	1.04 (.594)
< 10% calories from saturated fat daily	2	2.25 (.325)	3.59 (.166)
Physical Activity			
At least 150 min of moderate or greater intensity activity weekly	2	5.78 (.056)	1.56 (.454)
At least 210 min of moderate or greater intensity activity weekly	2	7.34 (.026)*	2.50 (.286)

Notes.

* Significant change $p < .05$

Table 4

Change in Proportion Achieving Behavioral Outcomes - Imputed Data ($N = 225$)

Marker	12 months Proportion[a] (SE)	18 months Proportion[a] (SE)	Change 12 Months to18 Months		24 months Proportion[a] (SE)	Change 12 Months to 24 Months	
			Proportion (95% CI[b])	p^b		Proportion (95% CI[b])	p^b
Healthy Eating							
≥ 2 servings of fruit daily							
Tailored	.45 (.046)	.37 (.045)	-.08 (-.19 to .04)	.102	.34 (.044)	-.11 (-.21 to -.01)	.007*
Generic	.25 (.042)	.29 (.043)	.04 (-.07 to .15)	.431	.29 (.043)	.04 (-.08 to .15)	.449
≥ 3 servings of vegetables daily							
Tailored	.69 (.043)	.70 (.043)	.02 (-.08 to .11)	.670	.70 (.043)	.01 (-.09 to .11)	.835
Generic	.49 (.048)	.54 (.048)	.05 (-.09 to .18)	.410	.47 (.048)	-.02 (-.14 to .10)	.724
≤ 30% calories from fat daily							
Tailored	.18 (.036)	.12 (.030)	-.06 (-.14 to .02)	.067	.10 (.027)	-.09 (-.17 to .00)	.010*
Generic	.06 (.023)	.05 (.022)	-.01 (-.07 to .06)	.739	.05 (.022)	-.01 (-.07 to .06)	.739
< 10% calories from saturated fat daily							
Tailored	.38 (.045)	.40 (.046)	.02 (-.08 to .11)	.654	.42 (.046)	.03 (-.06 to .13)	.392
Generic	.27 (.042)	.18 (.037)	-.09 (-.20 to .02)	.056	.23 (.040)	-.05 (-.15 to .06)	.315
Physical Activity							
≥ 150 mins. of moderate or greater intensity activity weekly							
Tailored	.63 (.045)	.71 (.042)	.08 (-.05 to .20)	.135	.58 (.046)	-.05 (-.18 to .08)	.328
Generic	.53 (.048)	.55 (.047)	.02 (-.13 to .17)	.773	.50 (.048)	-.03 (-.16 to .10)	.621
≥ 210 mins. of moderate or greater intensity activity weekly							
Tailored	.55 (.046)	.64 (.045)	.10 (-.03 to .22)	.067	.50 (.047)	-.04 (-.17 to .08)	.410
Generic	.39 (.047)	.48 (.048)	.09 (-.04 to .23)	.110	.45 (.047)	.05 (-.07 to .18)	.301

Notes. $n = 115$ for tailored group, $n = 110$ for generic group;

[a] CIs use Bonferroni adjustment for three comparisons;

p values are unadjusted and are significant if < .017 (.05/3);

* Significant change $p < .017$.