Testing the Requirements of Stages of Physical Activity Among Adults: The Comparative Effectiveness of Stage-Matched, Mismatched, Standard Care, and Control Interventions

Bryan Blissmer, Ph.D.
University of Rhode Island

Edward McAuley, Ph.D.
University of Illinois at Urbana-Champaign

ABSTRACT

We tested the comparative efficacy of 4 interventions to increase the physical activity behavior of college personnel randomly assigned to one condition (N = 196, 74% female, M age = 43.4 years) for 16 weeks. Stage-matched and mismatched interventions were developed based on the stages of change from the Transtheoretical Model and were contrasted with standard care (action-oriented) and control interventions to test the requirements of a true stage behavior. Repeated measures of multivariate analyses of covariance indicated that the stage-matched and standard care interventions resulted in greater levels of both total and lifestyle physical activity compared with the mismatched and control interventions. The results supported the requirements of a stage behavior as defined by Weinstein, Rothman, and Sutton (1) and the superiority of the stage-matched intervention versus the mismatched intervention. However, the standard care intervention performed as well as the matched intervention, suggesting the need for further investigation. The results are discussed with respect to the high proportion of individuals in the action-oriented stages and previous research findings in the smoking literature.

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INTRODUCTION

Contemporary physical activity recommendations advise the accumulation of 30 min or more of moderate intensity activity on most or all days of the week to reduce health risks (2). This consensus statement is based on epidemiological evidence that indicates the greatest reductions in health risks and mortality occur when an individual moves from a relatively sedentary into a light to moderately active group (e.g., 3). However, only 22% of the population engages in activity that is at least moderate in intensity for 30 min 5 or more days per week, suggesting that a considerable proportion of the population may have increased health risks caused by inadequate activity levels (2). Low levels of physical activity coupled with an inability to increase the numbers of individuals engaging in regular activity underscores the need for the development of more effective physical activity interventions (4).

Reprint Address: B. Blissmer, Ph.D., Department of Physical Education and Exercise Science, University of Rhode Island, 108 Tootell, Kingston, RI 02886. E-mail: blissmer@uri.edu

One strategy is to develop life-span physical activity interventions that do not require the individual to exercise in a structured, group setting at a specified intensity (5). Such approaches encourage participants to exercise on their own at home and have shown that home-based activity can result in significant health and psychological benefits (6,7). These so-called lifestyle interventions typically permit participants to choose the mode and intensity of activity, as well as the environment in which to exercise, and have been shown to be equally effective in improving cardiovascular health status as structured programs with required class participation (5,8). The interventions are often based on a transtheoretical stage model that allows matching of intervention materials to the individual's readiness to change (5).

The Transtheoretical Model is predicated on the findings that the self-modification of behavior involves movement through a series of distinct stages of change (9). The model classifies individuals into five stages, varying from precontemplation (i.e., no intention to be active in the next 6 months), to contemplation (i.e., intending to be active in the next 6 months), to preparation (i.e., intending to be active in next 30 days), to action (i.e., regularly active for less than 6 months), and finally to maintenance (i.e., regularly active for more than 6 months) (10). Individuals in each stage use various unique combinations of strategies or processes to aid them in changing their behavior and thus, to move to the next stage of motivational readiness. The processes used during each stage of change have been labeled the processes of change (9).

REQUIREMENTS OF STAGES OF PHYSICAL ACTIVITY

Several critics suggest that exercise is not a true stage behavior and that matching interventions to an individual's stage of motivational readiness is unnecessary. Bandura (11) argued that the stages of change for exercise merely reflect an arbitrary distinction developed to mirror the stages of self- change found among smokers. What determines whether exercise and physical activity, which is often represented as a continuous behavior, can be considered from a true stage perspective is whether there are substantive differences between the stages of change. Weinstein, Rothman, and Sutton (1) argued that one can experimentally test whether the distinction between stages is arbitrary and useful merely for description (i.e., "pseudostages") or whether true stages of exercise behavior do indeed exist.

According to Weinstein et al. (1), four criteria must be met to establish a true stage theory of health behavior. First, a classi-

fication system must be established to define the stages. Thus, an individual may be classified into only one stage at a time. Second, there must be an ordered sequence through which an individual proceeds through the stages. Third, there must be common barriers facing individuals in the same stage. Thus, individuals must undertake common processes within each stage to efficiently make the transition into the next stage. Finally, people in different stages must face different barriers. Thus, the strategies and processes used to make the transitions from one stage to another need to be different from the processes used to progress through different stages. One implication of this requirement is that different intervention strategies that focus on different processes will be effective at different stages.

The research on the Transtheoretical Model and physical activity has supported the first two criteria of Weinstein et al.'s (1) properties of a stage theory of health behavior. It has been previously documented that current exercise behavior change algorithms can classify individuals ranging from adolescents to older adults into discrete stages and that these stages reflect a progression of intention and behavior (e.g., 12–14). However, each of the first two requirements of a stage theory may be mimicked by pseudostages that create arbitrary classification schemes out of any behavioral continuum (1).

More stringent tests of a true stage theory are found when there is support for the third and fourth requirements. Evidence from the exercise and physical activity literature has supported the third requirement. A number of cross-sectional and longitudinal studies have documented that individuals within the same stage of exercise behavior change hold similar beliefs about exercise and use similar strategies to advance to the next stage (e.g., 15,16). Typically, the early stages are defined by a lack of motivation in the guise of low perceived benefits of exercise. Thus, the processes of change required to move to the action stages require increasing motivation through knowledge as well as reevaluation of the environment and the person themselves. Movement through the later stages, however, appears to rely more heavily on behavioral maintenance strategies to enhance self- efficacy and the ability to overcome barriers to activity. These strategies or processes focus on behavioral modification and cognitive restructuring techniques to promote behavior change and maintenance.

Current research and interventions in physical activity have not addressed the final requirement that is essential in separating pseudostages from a true stage model and theory. Weinstein, et al. (1) argued that to test whether a true stage exists requires experimental designs that test stage-matched versus mismatched interventions. Within a true stage model, the sequencing of the intervention materials according to the appropriate stage should result in maximal behavioral change. If the stages of physical activity are in reality pseudostages, a mismatched intervention should still result in behavior change because individuals in each stage are facing the same barriers to change. Initial research has found that interventions based on the stages of change outperform typical, action-oriented interventions that are arguably stage-mismatched for individuals in the preaction stages (e.g., 17). However, those results cannot determine if it is the stage appropriate materials and messages or simply the personalization of the interventions that are the cause of the success. Individuals may be changing their behavior simply because they feel a greater sense of personal investment in the intervention because they *think* the material was developed for them, not necessarily because the messages are more effective. To answer this question, studies are required that explicitly test personalized stage-matched as well as stage-mismatched interventions.

Only one study to date has explicitly attempted to contrast the effects of personalized stage-matched and stage-mismatched interventions using the Transtheoretical Model. In the context of smoking behavior, Quinlan and McCaul (18) contrasted the effectiveness of precontemplation materials and action-oriented materials in 92 college smokers who expressed no interest in quitting in the upcoming months. Their results indicated that contrary to expectations, the individuals who received the action-oriented materials reported more subsequent quit attempts. Thus, matching the intervention materials to the stage of change was determined to be ineffective. However, there are several limitations to the study. First, individuals in the stage-matched condition were not subsequently given action-oriented materials. One would only expect more quit attempts if the smokers in the stage-matched condition had eventually been given information designed for the contemplation and preparation stages as well. A more accurate test of the effects of their manipulation would have been a test of transition from precontemplation to contemplation. Additionally, the study only examined a single stage of change, precontemplation. There was no examination of how effective materials developed for earlier, information-oriented stages are for individuals in later, action-oriented stages.

Thus, research designs are required to explicitly test the stage nature of physical activity and exercise behavior. Current interventions that test the stage-matched materials against standard care manuals that are typically action oriented (e.g., 17,19,20) are a step in the correct direction; however, examination of the effectiveness of personalized, yet stage- mismatched materials are required to truly test the existence of stages of exercise and physical activity. Our study examined the effectiveness of a stage-matched intervention versus stage- mismatched, standard care, and control interventions for changing physical activity levels in a group of adults over a period of 16 weeks. Inclusion of four intervention conditions permitted a thorough investigation of the stage nature of physical activity and the relative merits of intervention formats.

METHOD

Participants

Faculty and staff at a large midwestern university were contacted via e-mail and a faculty and staff newspaper to determine their willingness to participate in a 16-week study of their exercise behavior. Current exercisers, nonexercisers, and those not even interested in exercising were encouraged to participate. Participants were informed that they would be eligible for a $100 drawing for each monthly questionnaire packet they re-

turned. Eligibility for the study was limited to those individuals who successfully completed the informed consent and had no contraindications for exercise on the revised Physical Activity Readiness Questionnaire (21).

Measures

Exercise stage. A long-form lifestyle activity algorithm was used to stage individuals relative to accumulating moderate intensity activity most days of the week (9). Participants read the following prompt and indicated their current exercise stage.

> Physical activity or exercise means walking briskly, vacuuming, jogging, digging in the garden, climbing stairs, or any other physical activity where exertion is similar to these. Regular physical activity or exercise means accumulating 30 minutes or more in the above activities most days of the week. For example, you could take one 30-minute walk, jog, bike, or swim or three 10-minute walks or 15 minutes of vacuuming, 10 minutes of digging, and 5 minutes of climbing stairs. DO YOU ENGAGE IN PHYSICAL ACTIVITY ACCORDING TO THE ABOVE DEFINITION?

Individuals selected one of the following responses, "Yes, I have been for more than 6 months," "Yes, I have been for less than 6 months," "No, but I am planning to start in the next 30 days," "No, but I am planning to start in the next 6 months," and "No, I don't plan to start in the next 6 months."

Richards Reed, Velicer, Prochaska, Rossi, and Marcus (10) suggested that the use of the long definitions of activity provides the most accurate stage classifications. Similar stage classification algorithms have been used extensively in the exercise domain (e.g., 22) and have demonstrated criterion validity in their variation with the processes of change (e.g., 16). Research has also documented predicted variations in body mass index and estimated VO_2max by exercise stage (23).

Physical activity behavior. The Aerobic Center Longitudinal Study Physical Activity Questionnaire (24) was employed to assess physical activity behavior. Individuals reported their engagement in a number of activities (e.g., running, swimming, walking, housework) and the frequency, duration, and intensity of those activities for a typical week during the previous month. Metabolic equivalent (MET) values for each activity and intensity were then used to calculate a total MET-hour per week value. MET values for activities that could conceivably be completed alone, with a minimal of equipment and over the course of the life span—including walking, jogging, swimming, aerobics, treadmill use, and bicycling—were summed to create an index of MET hours expended per week in life-span activities. Housework can arguably be carried out at a moderate intensity; however, it was not specifically included in the recommendations expressed in the intervention materials, so it was desirable to conduct analyses that included just those activities targeted for intervention. This scale has been used in past exercise research and has been shown to be a valid measure (24,25).

Study Conditions

Study participants were randomized into one of four intervention conditions. As randomization occurred within groups based on initial stage stratification, there was an approximately equal stage representation among study conditions. The intervention materials sent to each condition were all black and white and consisted of textual information as well as numerous graphics and illustrations.

Stage-matched. Participants in this condition received stage-matched materials delivered via campus mail on a monthly basis. The materials were based on the study participant's current stage classification and were sent with a short, personalized, stage-appropriate cover letter. The personalized letter referred to the participants by name, referenced their previous activity levels, and indicated that the enclosed pamphlet was developed to help people like them become more active or maintain their current activity levels. The materials were manuals designed to assist their movement to the next motivational stage using stage-appropriate processes of change. Each manual was of approximately the same length and was developed based on similar materials used in prior research (26,27).

The focus in each manual was determined by the unique circumstances of the particular exercise stage. In the precontemplation manual, the focus was on enhancing the perceived benefits of activity and gathering more information about activity. In the contemplation manual, the focus was on minimizing the negative consequences (i.e., cons) of activity, increasing emotional awareness, gathering more information, and creating a new self-image as an active person. In the preparation manual, the focus was on further defining the active self-image, gathering social support for activity, and making a commitment to activity. The action manual was concerned with learning how to substitute good habits for bad, avoid situations that lead to inactivity, and develop some simple rewards for your activity. Finally, the maintenance manual covered dealing effectively with setbacks, continuing substitution methods, and avoiding activity limiting situations and habits.

Stage-mismatched. The same stage-specific manuals, as well as personalized letters, were sent to individuals in this condition on a monthly basis; however, participants only received manuals for stages that differed from their own current stage of motivational readiness. Allocation of mismatched manuals to individuals was determined randomly; however, individuals could not receive the manual appropriate for their current stage.

Standard care. One of four manuals developed by the American Heart Association concerning physical activity was randomly chosen to be sent on a monthly basis to the exercise participants. The four manuals chosen include "Walking for a Healthy Heart," "Exercise Diary," "Just Move!," and "Exercise and Your Heart: A Guide to Physical Activity." These manuals have been well developed and certainly do not provide an unsophisticated intervention; however, these manuals are basically oriented toward the preparation, action, and maintenance stages

in which individuals already are active or are seriously considering become more active in the near future. This strategy allowed us to examine a standard, well-developed set of intervention materials versus the stage-matched materials as a strong test of the efficacy of the stage-matched materials.

Control. Individuals in the control condition were sent a new general health pamphlet on a monthly basis. The information in these pamphlets was of a purely educational nature and included no information on behavior change strategies. This group served as an attentional control group because none of the intervention materials were specific to exercise or physical activity.

Procedures

Study participants were originally contacted via a campus faculty and staff newspaper and e-mail newsletter. The recruitment material explained that participation was limited to the completion surveys, the receipt of intervention materials, and the opportunity to win prize money for each survey completed and returned. Interested individuals were then sent the initial questionnaire packet.

The initial questionnaire packet contained the measure of stage of change and physical activity level. Also included in the initial packet were measures of the processes of change, quality of life, and theory of planned behavior variables, which were not analyzed in this article. Eligible participants were stratified according to their initial exercise stage and then randomly assigned to one of the four study conditions within their exercise stage group by the first author. This randomization procedure ensured an approximately equal representation of each stage across the study conditions. Study participants were blinded to their study condition, although the nature of their intervention materials differed.

At the end of 4 weeks, study participants were sent a questionnaire to assess their stage of change. In an effort to reduce participant attrition, study participants were contacted via e-mail to alert them that another questionnaire had been sent and to reaffirm the opportunity to be entered in the prize drawing. Those study participants failing to send back a completed questionnaire within 10 days were contacted again via e-mail and prompted to complete and return their questionnaire. After receipt of this questionnaire, participants were again sent the appropriate materials based on their study condition and current stage. The same procedures were followed at the end of 8 and 12 weeks. At the completion of the trial, participants completed questionnaires identical to their initial study package.

RESULTS

Participant Characteristics

Initially, 423 individuals expressed interest in the study by sending e-mail to the first author. Those individuals were then sent the informed consent and baseline materials to complete if they wished to enroll in the study. Of those 423 individuals, 288 returned the baseline questionnaires and completed informed consent for an enrollment rate of 68%. As can be seen in Table 1, 213 women and 75 men enrolled in the study. On average, participants were middle aged (*M* age = 43.36 years, SD = 10.9), however the age of participants ranged from 20 to 73 years, representing a cross-section of the working population on campus. The majority of the participants were slightly overweight (as identified by body mass indexes), married, well educated, White, and of a high socioeconomic standing.

TABLE 1
Study Participant Characteristics

	Men[a]	*Women*[b]	*Total*[c]
Age[d] (*M*/*SD*)	46.05/11.7	42.41/10.5	43.36/10.9
BMI (*M*/*SD*)	26.51/5.1	27.07/6.4	26.94/6.1
Education level[d]			
College graduate or higher	85.3%	66.6%	71.5%
Income[d]			
Higher than $40,000	78.7%	58.8%	64.0%
Race			
African American	5.3%	3.3%	3.8%
Latino/a	4.0%	1.4%	2.1%
White	85.3%	92.0%	90.0%
Native American	1.3%	0.0%	0.3%
Asian	4.0%	2.8%	3.1%
Married	65.3%	76.0%	68.1%
Number of children (*M*/*SD*)	1.45/1.4	1.45/1.4	1.45/1.4
Smokers	5.3%	8.0%	7.3%

Note. BMI = body mass index.
[a]$n = 75$. [b]$n = 213$. [c]$N = 288$. [d]Indicates a significant difference between men and women at $p < .05$.

Subsequent questionnaires were sent every 4 weeks, and return rates were 88.5% ($n = 255$) for Week 4, 81.6% ($n = 235$) for Week 8, 75.7% ($n = 218$) for Week 12, and 68.4% ($n = 197$) for Week 16. The attrition rate of 32% over the course of 16 weeks, although not encouraging, does parallel dropout rates in other studies of this length (e.g., 17). Although the individuals were not required to attend meetings and the like, the completion of all of the study questionnaires was burdensome given the large number of measures included and the lack of compensation. Figure 1 depicts the flow of study participants throughout the study from recruitment to data analysis. A multivariate analysis of variance indicated no significant differences on baseline questionnaires among those individuals who completed the entire study and those that dropped out of the study.

Baseline Physical Activity Levels

Despite attempts to recruit participants who represented a broad range of activity intentions and levels, the sample consisted largely of individuals who were active on a relatively frequent basis. This can be seen by examining the reported stage of change of individuals, the number of days per week they reported exercising enough to work up a sweat, and their MET-hours of activity (see Table 2). The majority of participants were in the action and maintenance stages (combined 57%) and had an average total energy expenditure of approximately 62 MET-hours per week, with 28 of those MET-hours

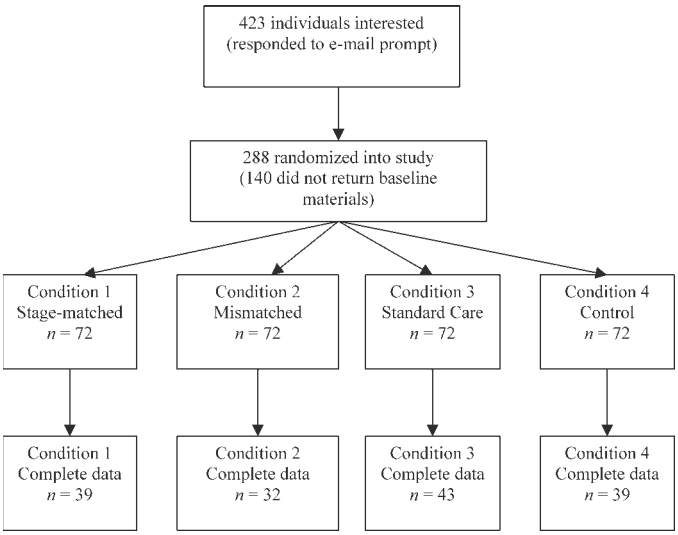

FIGURE 1 Flow diagram of study participation.

being expended in life-span activities (i.e., walking, using the treadmill, jogging, bicycling, swimming, and aerobic activity). Interestingly, men reported engaging in significantly more MET-hours of life-span activities per week than women, and these differences were covaried out in later analyses.

These mean values, however, should be cautiously interpreted because of the large variation in reported activity. As can be seen in Table 2, the standard deviations are large compared with the mean values. Therefore, it may be informative to also examine the frequency with which individuals report engaging in various activities to determine an overall average pattern of activity. Nearly all of the respondents (93.4%) reported engaging in housework on a consistent basis, and this activity contributed the largest proportion toward their total MET-hours of activity per week. The most commonly reported life-span activities included walking (64.1%), bicycling (27.1%), and aerobics (21.5%). Fewer individuals reported engaging in the more vigorous activities such as jogging, swimming, and moderate and vigorous sports. Thus, although this sample was relatively active, a large proportion of their MET-hours were obtained from the light-to-moderate intensity activities that consisted of lifestyle activities.

Stages of Change by Study Condition

Table 3 indicates the stage distribution of study participants by study condition at both baseline and after the 16-week intervention. The proportion of individuals in each stage is relatively similar regardless of study condition. Small sample sizes in each cell precluded any meaningful analysis of changes in stage distributions. However, there was some support for the utility of the stage-matched material because 40% of the individuals in the matched condition progressed one stage or more, whereas only 21–32% of individuals in the other conditions progressed in stage (see Table 3).

However, it should be noted that a 16-week intervention is not necessarily expected to result in changes in stages based on 6-month time frames, especially considering that 6 months is necessary to move into maintenance. The use of the stages of change simply allows for a structure for facilitating the development of stage-matched interventions. The outcome of real interest in any physical activity intervention is the amount of physical activity that participants engage in on a regular basis. Our national health objectives reflect amount of activity, not stages of change.

Changes in Physical Activity Levels by Condition

Although our sample was relatively active at baseline, we were still interested in examining the participants' activity levels over time. An intervention that is effective at helping both active individuals maintain their current activity levels and sedentary individuals increase their activity levels will provide the greatest health benefits to our society. To examine differences in the changes in physical activity levels by study condition, both total MET-hours of activity and MET-hours of life-span activity were entered in a mixed model repeated measures multivariate analysis of covariance (MANCOVA) (N = 186) with time as the within-subjects factor, study condition as the between-subjects factor, and gender as the covariate to control for the effect of baseline differences in the levels of self-reported activity. Life-span physical activities included those activities discussed in the intervention materials, including walking, jogging, treadmill use, swimming, bicycling, and aerobics. Table 4 reports the

TABLE 2
Baseline Physical Activity Rates

	Men[a]	*Women*[b]	*Total*[c]
Total activity (MET-hr/week) (*M*/*SD*)	63.76/54.1	61.65/37.6	62.20/42.4
Life-span activity[d] (MET-hr/week) (*M*/*SD*)	34.06/27.6	25.83/22.2	27.99/24.0
Stage of change			
Precontemplation	5.5%	20.8%	16.7%
Contemplation	8.2%	11.6%	10.7%
Preparation	9.6%	17.9%	15.7%
Action	13.7%	8.7%	10.0%
Maintenance	63.0%	41.1%	47.0%
Numbers of sweat days per week (*M*/*SD*)	3.33/2.3	2.70/2.5	2.87/2.4

Note. MET = metabolic equivalent.
[a]n = 75. [b]n = 213. [c]N = 288. [d]Indicates a significant difference between men and women at $p < .05$.

TABLE 3
Stage Distribution Preintervention and Postintervention by Study Condition

Stage Distribution	*Matched*	*Mismatched*	*Standard Care*	*Control*
Preintervention				
Precontemplation	11 (15%)	12 (17%)	11 (16%)	13 (19%)
Contemplation	9 (12%)	9 (13%)	7 (10%)	5 (7%)
Preparation	14 (19%)	10 (15%)	10 (14%)	10 (15%)
Action	8 (11%)	7 (10%)	6 (9%)	7 (10%)
Maintenance	33 (44%)	31 (45%)	36 (51%)	32 (45%)
Postintervention				
Precontemplation	5 (10%)	7 (16%)	4 (8%)	6 (13%)
Contemplation	2 (4%)	1 (2%)	2 (4%)	4 (8%)
Preparation	8 (15%)	2 (5%)	3 (6%)	2 (4%)
Action	10 (19%)	9 (21%)	13 (26%)	9 (19%)
Maintenance	27 (52%)	25 (57%)	28 (56%)	27 (56%)
Stage movement				
Regressed stage	5 (9.6%)	6 (13.6%)	6 (12.8%)	5 (11.1%)
Stable stage	26 (50.0%)	24 (54.5%)	31 (66.0%)	30 (66.7%)
Progressed stage	21 (40.4%)	14 (31.8%)	10 (21.3%)	10 (22.2%)

TABLE 4
Total Activity and Life-span Activity Means and Standard Deviations Preintervention and Postintervention by Condition

	Matched[a]		*Mismatched*[b]		*Standard Care*[c]		*Control*[d]	
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
Total activity								
M	64.35	65.61	73.19	60.54	60.15	62.69	69.57	57.95
SD	30.98	34.44	49.85	34.44	36.89	34.78	37.23	28.67
Life-span activity								
M	28.64	36.06	32.63	32.37	27.25	35.76	32.79	32.06
SD	19.32	23.80	36.44	29.95	15.55	26.92	24.84	20.99

Note. All values are reported in metabolic equivalent hours per week.
[a]$n = 39$. [b]$n = 32$. [c]$n = 43$. [d]$n = 39$.

means and standard deviations by study condition for the physical activity measures preintervention and postintervention.

The model indicated a significant multivariate effect for time, $F(2, 147) = 5.10$, $p < .01$, with nonsignificant effects for study condition and the Time × Study Condition interaction. Univariate analyses indicated that neither total activity nor life-style activity significantly differed across time individually, suggesting a true multivariate effect. However, examination of the means in Table 4 would suggest that overall, total activity declined over the intervention ($p = .10$) whereas life-style activity increased slightly on average over the trial ($p = .08$).

Because of the large standard deviation in the activity measures, a useful indication of the effects of the interventions is the examination of the effect sizes of the change in activity within each study condition. Figure 2 shows the effect sizes for changes in total activity and lifestyle activity over the intervention by study condition. For total activity, there was little to no change in the matched and standard care conditions, whereas there were small effect size declines in total activity levels in the mismatched and control conditions. Examining life-span activity, there were small to moderate effect size increases in life-span activity in both the standard care and stage-matched conditions, whereas the mismatched and standard care conditions experienced no change.

DISCUSSION

This study examined the effects of personalized stage-matched, mismatched, standard care (action-oriented), and control interventions on the physical activity behavior of college personnel over a period of 16 weeks. After controlling for initial baseline differences in activity levels by gender, a repeated measures MANCOVA found a significant main effect for time. Although neither total activity nor lifestyle activity group experienced significant univariate changes over the trial, the trends were for decreases in reported total activity and slight increases in lifestyle activity, with both changes approaching significance. The implication is that there were decreases in the

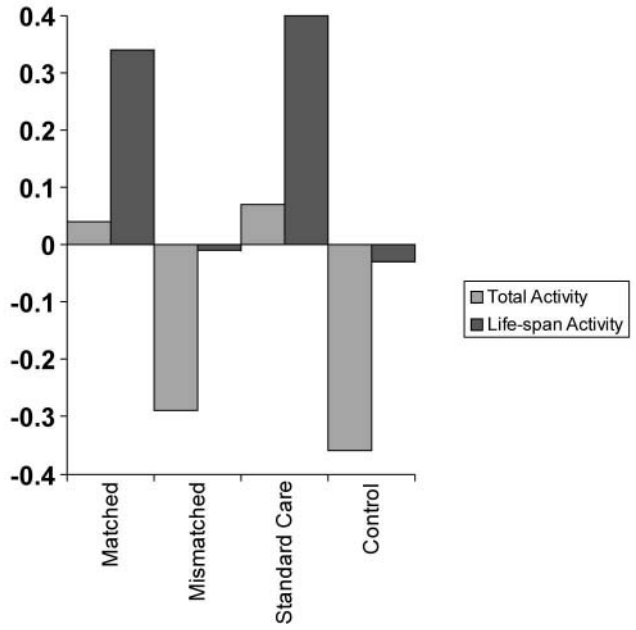

FIGURE 2 Effect sizes for changes in total and life-span activity over the intervention by study condition.

nonlifestyle activity components of the total activity measure (e.g., sports) that may be caused by the timing of the intervention. Baseline measures were reported on activity primarily for the month of November, whereas the final data point was for activity for March. Climatological records for those two months indicate that there were only 6 days with precipitation compared with 12 in March (28). Thus, declines in more vigorous sporting activities may have been caused by the increase in inclement weather; however, without daily records it is difficult to identify an association between weather patterns and activity records.

The expectation that the stage-matched condition would experience significantly greater improvements in physical activity levels than the stage-mismatched, standard care, and control conditions received mixed support. The patterns of change suggest that the stage-matched and standard care interventions were both effective at increasing the targeted life-span activity behaviors. Both the stage-mismatched and control conditions actually reported declines in total activity, although there was no change in their levels of life-span activity.

This study cannot definitively state that stage matching is a necessary requirement for a successful intervention, but in contrast to findings in the smoking literature (18), it clearly outperformed the mismatched condition. Previous research that has tested matched and mismatched interventions in the smoking literature has suggested that action-oriented interventions are as effective as stage-matched interventions for individuals in the preaction stages, thus failing to find support for the need to stage-match materials. However, this study was made up mainly of individuals in the action-oriented stages whose mismatched materials would have necessarily consisted of materials designed for the preaction stages, and it was found that the stage-mismatched materials were outperformed by the stage-matched and standard care (action oriented) interventions. Further research is required to understand the complexities of the deleterious effects of stage-mismatched interventions.

However, the finding that the standard care performed as well as the stage-matched condition, although both outperformed the stage-mismatched condition, calls into question the true stage nature of physical activity. One possible explanation for the similar effect of the stage-matched and standard care manuals is that the participants in this study were, to a large extent, in the preparation, action, and maintenance stages, for which the standard care materials have typically been written. Thus, for the majority of the individuals in the intervention, those materials may have represented stage appropriate materials. Initial research has suggested that nontailored materials may be as effective as specifically tailored materials when those nontailored materials are determined to cover topics relevant to the individual (29). These findings support the notion that it is not the personalization of the intervention materials but rather the use of appropriate materials that fuels the success of the tailored, stage-matched interventions. However, future investigations with a more diverse sample may begin to answer whether the stage-matched materials will outperform the standard care materials.

Critics of the stage approach may well interpret these results as suggesting that the stage-matched condition performed *as well as* the standard care condition, thus arguing against the need to stage-match interventions. However, previous studies examining stage-matched and standard care interventions of physical activity have found the stage-matched condition to outperform the standard care condition (e.g., 17,20). Although those studies did include active individuals in their sample, the study participants were less skewed toward the action and maintenance stages than the current sample. Therefore, as previously discussed, the efficacy of the standard care intervention in this study may largely be a function of the stage distribution of the sample. Standard care materials may be appropriate for individuals ready to change their behavior, but other intervention strategies are likely necessary for individuals in the preaction stages.

As previously stated, Weinstein et al. (1) identified four requirements for a true stage behavior. Previous research of physical activity behavior using cross-sectional approaches has supported the classification scheme of the stages of change (e.g., 14,30). Longitudinal research has documented the sequence of stages and has examined predictors of stage transitions (e.g., 16,31). These findings fulfill the first three requirements of stage behaviors according to Weinstein et al. (1). The final requirement to verify a true stage behavior is that individuals at different stages face different barriers. Weinstein et al. (1) argued that to empirically test this requirement, research must examine the efficacy of a stage-matched versus mismatched intervention. The findings in this study did offer some support for the superiority of stage-matched interventions over stage-mismatched interventions at both enhancing exercise behavior and facilitating stage progressions. Examined in conjunction with previous research findings, the present results argue for the utility of the stages of exercise behavior construct.

Although this contributes to the existing literature, the study sample limits the generalizability of the results and the analyses that could be conducted on the data. The sample was primarily White, well educated, and of a high socioeconomic status. Also, despite recruitment efforts to the contrary, the study sample was relatively active, and it clearly overrepresented the action-oriented stages of exercise behavior change. This limited the ability of this study to test the stage-matched intervention against a standard care intervention across the full range of the stages of change. There were simply too few individuals in the early stages of exercise behavior change to conduct reasonable analyses, a result that has plagued many studies of transtheoretically based interventions (e.g., 16). The attrition rate of 32% is also problematic; however, the study participants did have to complete a large number of questionnaires for only the chance of some compensation. Fortunately, those individuals that completed the intervention did not differ from those that dropped out in any of the initial baseline measures. In another similar worksite intervention, Marcus et al. (17) had only 58% of their original sample complete a 3-month intervention using printed intervention materials. More research is required to determine how to encourage greater participation and completion rates as we attempt to move from efficacy to feasibility studies.

A number of findings in this study raise further questions that will require empirical evaluation. Although this study does begin to offer some support for the view that exercise stages are viable entities, further study is necessary to definitively answer the question of whether exercise stages exist. Particularly, studies that include greater numbers of individuals at the precontemplation, contemplation, and preparation stages are required. Recruitment of those individuals is unfortunately the most difficult; therefore, specific strategies need to be developed and used to facilitate their recruitment. This may require using random-digit dialing techniques with a set recruitment goal for individuals in the preaction stages.

Overall, this study does demonstrate the utility of the Transtheoretical Model in the development of personalized, stage-targeted interventions. Future investigations may wish to examine interventions that are tailored to the full set of Transtheoretical Model measures including processes of change, decisional balance, and confidence versus this simpler, stage-targeted intervention to help determine the optimal level of tailoring.

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