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Examination of print and telephone channels for physical activity promotion: Rationale, design, and baseline data from Project STRIDE

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Abstract

Background—*Project STRIDE* is a 4-year randomized controlled trial comparing two computer-based expert system guided intervention delivery channels (phone vs. print) for physical activity adoption and short-term maintenance among previously sedentary adults.

Methods—Sedentary adults ($n=239$) were randomized to one of the following (1) telephone-based, individualized motivationally-tailored feedback; (2) print-based, individualized motivationally-tailored feedback; (3) contact-control delayed treatment group (received intervention after 12 months as control). This paper: (1) outlines the study design, rationale, and participant sample; and (2) describes relationships between baseline variables to better understand their influence on the efficacy of the intervention.

Results—Participants averaged 19.8 ± 25.0 min of physical activity/week that was at least of moderate intensity, with no group differences. The average estimated VO_2 at 85% of maximum heart rate was 25.6 ml/kg/min. Body fat was 34.1% for women and 23.2% for men and the BMI of the sample averaged 28.5 kg/m².

Conclusions—*Project STRIDE* examines non face-to-face approaches for promoting physical activity behavior. It has unique features including a direct comparison of an expert system guided intervention delivered via phone or print. Future analyses will examine the cost-effectiveness of the interventions and this will likely yield important information for policy-makers.

Keywords

Exercise; Intervention studies; Decision-making; Computer assisted; Expert systems; Telephone

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1. Introduction

The American College of Sports Medicine (ACSM) and the Centers for Disease Control and Prevention (CDC) recommend that healthy individuals with no known cardiovascular disease engage in at least 30 min of moderate intensity physical activity on most, preferably all, days of the week [1]. Only 25% of Americans meet the recommended levels of physical activity participation [2] despite the health benefits of a physically active lifestyle (e.g., reduced risk of cardiovascular disease and non-insulin-dependent diabetes) [3,4].

In order to reach the large number of sedentary individuals, non face-to-face interventions utilizing different delivery channels such as print and telephone need to be developed and evaluated. To improve the efficacy of these interventions, researchers recommend that such interventions be grounded in psychological theories of behavior change [5]. Both Social Cognitive Theory [6] and the Transtheoretical Model [7] are two frameworks that have been used to guide physical activity interventions in community, workplace, and primary care settings, with promising results (e.g., [8–10]). The Stages of Motivational Readiness for Change Model posits that individuals move through a series of stages when making a behavior change [7]. These stages include Precontemplation (not intending to make changes), Contemplation (considering a change), Preparation (making small changes), Action (actively engaging in the behavior) and Maintenance (sustaining the change over time). In addition, aspects of Social Cognitive Theory (e.g., self-efficacy, outcome expectations) have been shown to be important factors in predicting physical activity behaviors [11,12].

Theory-based face-to-face interventions have been found to be efficacious; however, their reach to the broad population of sedentary individuals is limited because there are numerous barriers associated with face-to-face interventions (e.g., work schedules, time, childcare, cost). Consequently, the examination of non face-to-face channels, such as print materials delivered through the mail, for intervention delivery is critical when cost containment and time constraints do not allow for frequent or lengthy in-person contacts. Non face-to-face channels, or mediated interventions, are especially important for reaching individuals who have typically not availed themselves of health promotion programs because of real or perceived barriers of access, cost, or transportation.

In a review of 127 published studies on physical activity interventions from the years 1965–1995, Dishman and Buckworth [13] found larger effect sizes for those interventions that employed non face-to-face interventions (e.g., print mailings, telecommunication) when compared with those that were strictly face-to-face. This review indicates that interventions designed to increase physical activity can be effective, particularly when they are delivered using non face-to-face approaches and emphasize home-based, lifestyle activities.

Individually-tailored, print-based interventions are one example of a low cost, less time intensive channel for facilitating behavior change. Several investigations have demonstrated that print-based interventions are effective for the adoption of physical activity [10,14]. For example, one study found that participants who received a 6-month individualized motivationally tailored print intervention (Tailored) spent more time exercising per week

(151.4 min) and were more likely to achieve CDC/ACSM recommended levels of physical activity ($p<0.01$) than participants who received standard print materials (Standard; 97.6 min, $p<0.05$) [14]. Interestingly, at 12 months, both groups reported increases in their time spent in physical activity (Tailored: 187 min vs. Standard: 133 min), although these increases were not significant [15]. At month 12, Tailored participants were significantly more likely than the Standard group to meet or exceed the CDC/ACSM criteria for physical activity participation (42% vs. 25%). These results indicate that print-based materials are effective tools for enhancing physical activity adoption, particularly when they are individualized, motivationally tailored, and emphasize key social cognitive concepts such as self-efficacy and outcome expectations.

Theory-based telephone-delivered programs have also been shown to be efficacious for physical activity promotion. For example, one study examining the efficacy of three exercise programs found that initially sedentary participants in the two telephone-delivered home-based programs reported a greater number of exercise minutes (averaging approximately 120–131 min/week) than participants in the group-based program (who averaged approximately 60 min/week) at 1 year [16]. These findings were generally maintained at 2 years [9]. Similarly, in a recently completed study evaluating telephone-based physical activity interventions delivered through either a health educator or a telephone-linked computer system, both telephone-based programs were shown to be able to significantly increase 12-month physical activity levels above the 150 min of moderate or more vigorous activity per week recommended in the 1996 Surgeon General's report [5,17].

In summary, both print- and telephone-based interventions can be effective for adults who, due to work, family, or social demands, may have difficulty attending face-to-face programs. This is an important area for public health given that print-based interventions are typically less costly and more easily disseminated than telephone-based interventions. The primary aim of this study was to determine the differential effects of intervention delivery channel (phone vs. print vs. contact-control) on physical activity adoption and short-term maintenance among previously sedentary adults. In order to control for content across the intervention delivery channels, we utilized a computer-based expert system to guide the information for both delivery arms. Based on previous research in the field, we hypothesized that individuals randomized to either the telephone or print conditions would exhibit significantly higher levels of physical activity participation at 6 and 12 months than individuals in the delayed treatment condition (contact control). Additionally, we hypothesized that participants randomized to the telephone condition would exhibit significantly higher levels of physical activity participation at 6 and 12 months than those in the print condition. We hypothesized that the telephone intervention would outperform the print intervention because of the potential for increased support and social connectedness between the telephone counselor and participant.

The purpose of this paper is to describe: (1) the study design and rationale; (2) sample of participants; and (3) relationships between baseline variables in order to better understand how these variables may influence the efficacy of the intervention. Because baseline variables may interact with one another to influence the outcome of the intervention, it is important to examine the correlations among these variables at baseline.

2. Methods

This was a randomized controlled clinical trial comparing three conditions: (1) telephone-based, individualized motivationally-tailored feedback; (2) print-based, individualized motivationally-tailored feedback; (3) contact-control delayed treatment control group (received intervention after 12 months as control). As mentioned previously, both interventions utilized a computer-based expert system platform to guide the delivery of content. The intervention period was for 12 months with a more intensive phase during the first 6 months, and a tapered intervention maintenance phase during the last 6 months. Participants were recruited primarily through newspaper advertisements. Additional sources of recruitment were messages on employees' pay-stubs, email, and Intranet postings, which occurred through a local hospital worksite. Individuals between the ages of 18 to 65 years were recruited for this study. Criteria for study participation were that individuals were healthy and under-active (i.e., participating in moderate or vigorous physical activity for 90 min or less per week).

Individuals were excluded from the study if their body mass index (BMI) was greater than 35 or if they had hypertension, heart disease of any kind or an abnormal electrocardiogram, stroke, chronic infectious disease, any musculoskeletal problem which would limit treadmill testing or impair their ability to exercise, asthma, emphysema, chronic bronchitis, or any other serious medical condition that might make exercise unsafe or unwise. Other exclusion criteria were a schedule that would make adherence unlikely (such as very frequent travel), plans to move from the area within the next year, pregnancy or plans to attempt pregnancy, self-report of more than three alcoholic drinks per day on 5 or more days per week, hospitalization for a psychiatric disorder within the last 6 months, currently suicidal, bipolar, or psychotic, or currently using prescription medication that might impair exercise performance or tolerance, specifically beta blockers. Participants agreed to be randomly assigned to any of the conditions and read and signed an institutionally approved consent form after all their questions were answered.

At the 6- and 12-month evaluations, participants earned a cash incentive for completing assessments. Participants earned \$25 for completing each of the measurement visits at 6 and 12 months and an additional \$50 if they completed both assessments. Participants were required to mail in a physical activity log and a brief questionnaire each month over 12 months. The questionnaires included psychosocial mediators of change (described in more detail below) and a health expense form. The psychosocial measures were used to create the tailored feedback via input into an automated expert system for the treatment groups. A Health Expense form, in which participants noted the costs incurred over the past month, was completed by all participants on a monthly basis to inform the cost analyses for all three groups. Each time a participant mailed in his/her monthly information, he/she received a check for \$10 as partial compensation for the time spent completing measures.

To control for the effect of logging on physical activity, participants in all three arms of the study were instructed to self-monitor their activity. We believe it is important to control for self-monitoring because if the control group does not self-monitor and the intervention group does, self-monitoring becomes a potential confounding factor.

All groups were required to mail in their log/health expense form each month. The two treatment arms were mailed questionnaires (i.e., self-efficacy, processes of change, decisional balance) at interim time points, whereas the wellness arm was only asked to complete this information at baseline, 6, and 12 months. To be consistent across groups, the \$10 compensation occurred monthly for the first 6 months, and again at months 8, 10, and 12.

2.1. Procedure

We recruited 239 individuals who were randomly assigned to one of the three conditions. Randomization occurred via a blocked procedure, with blocking being conducted on stage of motivational readiness and gender. Randomization was successful in that none of the baseline variables of interest (included in Tables 2 and 4) showed significant differences at the $\alpha=0.05$ level. Enrollment occurred on a 'rolling admission' basis over 27 months. At baseline, 6, and 12 months, subjects participated in a sub-maximal treadmill exercise test and provided anthropometric measures along with completing the 7-Day Physical Activity Recall Interview [18] and psychosocial questionnaires. A subsample of the study population (30%) wore an Actigraph motion monitor [19] to validate the data obtained from the physical activity interview. Participants were instructed to wear the monitor for 3 days. Participants wore the monitor on 2 workdays (i.e., typically weekdays) and 1 non-work day (i.e., typically weekend days) to obtain an adequate sample of the participant's physical activity pattern during the week.

2.2. Treatment conditions

Following randomization, participants completed a 45-min individual meeting with a health educator to go over expectations for the study including the monthly activity logs and questionnaires, scheduling of contacts (telephone calls, or mailings depending on intervention condition), and setting goals. At this individual meeting, participants in both treatment conditions were told that their goal should be to increase their moderate intensity physical activity to a level that meets or exceeds the CDC/ACSM recommendations (at least 5 days per week for a total of at least 30 min each day) [1]. Participants were instructed on how to take their heart rate, and to train in the heart rate range that corresponded to moderate intensity-physical activity (55–69% of age predicted maximum heart rate). Participants were first encouraged to focus on the frequency of their activity, and then to focus on the duration of their activity. The schedule and amount of contact in the print-based intervention was the same as in the telephone-based intervention (as outlined in Table 1). At baseline, participants in both intervention conditions also received a packet of printed information (e.g., how to take your heart rate, buying walking shoes, proper walking posture).

Following this individual meeting, participants randomized to either the print or telephone-based conditions received individually-tailored messages, based on the Stages of Motivational Readiness Model and Social Cognitive Theory, that were generated by a computer-based expert system. This computer-based expert system utilizes a participant's responses to important theory-based statements in order to produce a feedback report that is tailored to the individual. Depending on the constellation of responses to each of the selected questionnaire items, the computer expert system will extract an appropriate paragraph that

contains a physical activity counseling message relevant for the participant. These pre-written counseling messages were created by Ph.D. level psychologists experienced in health behavior change. In this way, the computer expert system mimics the types of responses that would be delivered in a face-to-face counseling session with a health educator. The content of the expert system paragraphs covers two broad domains: 1) an assessment of the individual's current stage of motivational readiness for physical activity adoption (*motivational feedback*); 2) an assessment of the individual's self-efficacy [20], decisional balance [21], and use of cognitive and behavioral processes associated with physical activity adoption [22] (*construct feedback*). Following the completion of these questionnaires, the expert system generates two types of feedback: 1) how the participant compares to profiles of individuals who have successfully adopted and maintained physical activity (*normative feedback*); and 2) following the baseline assessment, feedback regarding progress made on: a) the above constructs and b) minutes of physical activity participation since the individual's prior assessment (*progress feedback*) [14].

Regardless of whether delivery channel was phone or print, both groups received the same core information. However, the telephone counselor elaborated on the information when prompted by the participant and addressed other issues when mentioned by the participant. Our goal was to match the content between the telephone and print groups; however, if differences arose as a function of channel, such as the participant asking for more information regarding a topic, the counselor addressed the participant's inquiries. To match this component of the telephone intervention, the print group was encouraged to write to us with follow-up questions. In addition, information was included in a stage-based manual and monthly tip sheets relating to physical activity.

2.2.1. Telephone-based feedback—Participants in the telephone-based feedback condition received telephone contact with the health educator who conducted the 45-min individual session at randomization. The health educator¹ was a doctoral candidate in counseling psychology and had experience in physical activity counseling. There were a total of 14 scheduled intervention calls over the course of 1 year. While the counselor was guided by the expert system report, stage-matched manual, and tip sheets, the counselor was not required to hold rigidly to a formal script. The phone counselor also provided suggestions relating to stretching, and specific examples of moderate intensity physical activities (e.g., walking at 3–4 miles/h). The average length of the telephone calls was 13 min (S.D.=3.84). As will be described in more detail below, these calls were tape-recorded and reviewed for quality control by one of the Ph.D. level co-investigators on the study.

2.2.2. Print-based feedback—Participants in the print-based feedback condition completed a series of questionnaires via mail. Upon completion of the processing of these questionnaires by study staff, participants were mailed a printed report of the feedback generated by the computer expert system, a self-help manual matched to their Stage of Motivational Readiness for physical activity adoption [10,14], and a series of tip sheets. As described in more detail above, use of an expert-system derived feedback report was to

¹During this health educator's 12-week maternity leave, a Ph.D. level psychologist, trained in the treatment protocols delivered the intervention.

enable the participant to have relevant, appropriate, and individualized counseling messages. The expert system is composed of pre-written counseling messages written by Ph.D. level psychologists experienced in health behavior change. These messages were used to target detected deficiencies or reinforce successful efforts and appeared throughout each feedback report [14].

2.2.3. Contact-control delayed treatment group—We chose to use a contact-control group to maximize the likelihood that participants in this arm of the trial were retained in the study. Participants were informed that after 12 months, they were able to select either the print or the telephone-based intervention for 12 months. In order to ensure retention and to control for contact time, health education information focusing on non-physical activity oriented topics was mailed to these individuals on the same schedule as the print/phone participants received physical activity information. Sample topics included the following: stress management, cancer prevention, alternative medicine, and nutrition. These topics have been shown to be of interest to contact-control participants [23,24]. As mentioned previously, to control for the effect of self-monitoring, participants in the contact-control delayed treatment group completed logs tracking their physical activity.

2.2.4. Quality control—One Ph.D. level investigator (BB) conducted quality control checks of the expert system reports generated by the computer to ensure that the computer selected the appropriate counseling messages for participants. Periodically throughout the study, we hand-scored a sub sample of 10% of the assessments. The decision-rule algorithm from the expert system was used to guide selection of the paragraphs for a sample manually-derived report. The resulting report was then compared to the actual report sent to the participant. No errors in report generation were detected. Another Ph.D. level investigator (BP) conducted quality control checks via audio-taped evaluation of health educator telephone counseling sessions throughout the course of the study to ensure that the overall content and scope of the telephone-based counseling intervention remained similar to that represented by the expert system, with 9.3% of the audiotapes being randomly selected for review. In addition, a third investigator (AK) provided independent ratings of therapeutic process of the calls with respect to specific behavioral strategies and counseling techniques (e.g., empathy, goal setting, reflective listening). Rating sheets were developed so that content and process variables could be examined in a consistent manner. To avoid intervention contamination effects, explicit training of the research assistants and health educator by a different Ph.D. level investigator (MN) and ongoing monitoring of intervention protocols occurred throughout the study.

3. Measures

Questionnaires were used to assess physical activity behavior, selected cognitive-behavioral mediators and history variables, intervention preferences, social support, environmental access to physical activity opportunities, and level of depression and anxiety.

3.1. Primary outcome measure

3.1.1. 7-Day Physical Activity Recall (PAR)—The PAR was the primary outcome measure of physical activity behavior for this study. This is an interviewer-administered procedure, originally developed for the Stanford Five-City Project [18,25]. Validity and reliability of this technique have been demonstrated [18,25], and it has been used in numerous studies. This instrument has been shown to be sensitive to change in studies of moderate intensity activity [26,27].

3.2. Secondary outcome measure

3.2.1. Stages of change—The stages of change for exercise behavior were measured by an instrument developed by Marcus and colleagues [22]. The Kappa Index of reliability over a 2-week period was 0.78 [20]. Concurrent validity for this measure is demonstrated by its significant association with the 7-Day Physical Activity Recall (PAR) questionnaire [28]. Also, movement from an early stage (Precontemplation, Contemplation, or Preparation) into Action is significantly associated with positive changes in estimated VO₂ peak [28].

3.3. Fitness data

3.3.1. Submaximal stress test—Participants completed a graded submaximal treadmill exercise test at baseline, and 6 and 12 months. Participants were instructed to abstain from food, alcohol, caffeine, and nicotine for 3 h prior to taking the test [29]. A Balke protocol was used that consisted of 2-min stages beginning at 3 mph and 2.5% grade [30]. The participant was stopped within 20 s after reaching 85% of age predicted maximum heart rate (i.e., 220-age). Blood pressure was assessed during seated rest, standing, at the end of each stage, at exercise termination, and at end recovery. The test was terminated if the participant experienced any of the absolute or relative indications for termination of an exercise test recommended by the American College of Sports Medicine, such as, angina, serious arrhythmias, unusual or severe shortness of breath [29]. Measurement of functional capacity expressed as estimated VO₂ at 85% of age predicted maximum (ml/kg/min) and treadmill duration will be used to determine the differential effect of the intervention on fitness. This submaximal test has been shown to be an accurate assessment individual's fitness [31] and is generally sensitive to systematic changes in physical activity [32].

3.4. Objective physical activity data

3.4.1. Physical activity tracking—In order to control for any non-specific effects of self-monitoring, participants in all three of the study arms completed monthly physical activity logs. The logs were designed to be a monthly calendar in which participants indicated the type and duration of each activity.

3.4.2. Actigraph activity monitor—To validate the physical activity information obtained from the 7-Day Physical Activity Recall, 30% of the sample was randomly selected to wear the Actigraph activity monitor (formerly the CSA) (Actigraph LLC, Fort Walton Beach, FL). The Actigraph is a lightweight, small single axis accelerometer. Actigraph monitor data have been validated against self-report data collected via an activity diary [33]. Previous studies have validated the Actigraph monitor against total energy expenditure [34]

heart rate telemetry [35], pedometers [36,37], and the 7-SDay Physical Activity Recall [38]. The Actigraph also has been found to be effective at detecting bouts of activity, including both continuous and intermittent bouts [33]. Participants, regardless of treatment arm, wore monitors for 3 days at each time-point, including 1 weekend day, since at least 3–4 days of monitoring is needed to achieve 80% reliability in the variance of activity by participant [39]. Participants reported minutes of activity in the moderate, hard, and very hard range. Additionally, the Physical Activity Recall compendium (i.e., list of activities and associated MET values; [40]) was consulted to verify that the self-reported activities fit within the range reported by the participants. The Actigraph data will be correlated with data from the PAR that correspond to the same 3 days on which the participant wore the Actigraph.

3.5. Physiological data

3.5.1. Body weight—At the baseline, 6-, and 12-month assessments, body weight and composition were determined. Body weight was measured on a calibrated Detecto medical scale to the nearest quarter pound and height was measured using a stadiometer to the nearest quarter inch.

3.5.2. Percent body fat—Percent body fat was estimated from skinfolds' thickness measured on the right side at the tricep, suprailiac crest, and thigh for women and chest, abdomen and thigh for men using a Lange caliper [41]. Three measurements were taken at each site and recorded to the nearest 1.0 mm. All measurements were required to be within 1–2 mm of each other and repeat measurements were performed if these criteria were not met. Circumference measures were taken at the same six areas for both men and women (forearm, waist, abdomen, hip, thigh and calf) [42]. Circumference measures were taken on the right side of the body and quality control for measurements and skinfolds was performed on 10% of the subjects.

3.6. Physical activity intervention constructs

We examined several variables we hypothesized would mediate the relationship between the intervention and physical activity behavior change (i.e., mediators). A mediator is defined as an intervening causal variable that is on the pathway between the intervention and physical activity behavior change [43]. In other words, the intervention is effective due to self-reported changes on particular mediating variables, such as improvement in self-efficacy. The following summarizes the measures we used to assess the potential mediators, as guided by the Transtheoretical Model and Social Cognitive Theory.

3.6.1. Exercise self-efficacy—We measured exercise-specific self-efficacy with the measure developed by Marcus and colleagues [20].

3.6.2. Decisional balance—Decision-making for exercise was measured by the Decisional Balance instrument [21]. Internal consistency for the decisional balance measure is 0.79 for the Pros (benefits) scale and 0.95 for the Cons (costs) scale [21].

3.6.3. Processes of change—The processes of change for exercise behavior were measured by an instrument developed by Marcus and colleagues [22]. Internal consistency for the processes of change scales average 0.83 [22].

3.6.4. Social support for exercise [44]—This scale measures the extent to which an individual has family or friends who are sources of support specific to physical activity. Items include: “During the last three months, my family and friends have given me encouragement to stick with my activity program.” This questionnaire has a demonstrated test–retest reliability (ranges from 0.55 to 0.79) and internal consistency (Cronbach's α value ranged from 0.61 to 0.84). For the purposes of this study, friends and family level supports were combined into one value.

3.6.5. Physical Activity Enjoyment Scale (PACES [45])—The PACES scale is an 18-item measure that examines perceived attributes of physical activity. Examples of items include “I dislike it”, “It's very pleasant”, “It's no fun at all”. Studies have demonstrated the reliability and validity of this measure. Specifically, the coefficient α is 0.96, and a test–retest reliability of 0.60 was found for bicycling and 0.93 for jogging [45]. Additionally, enjoyment of physical activity has been significantly related to type of physical activity chosen by participants based on a Fisher's Exact Test ($p=0.05$ [45]).

3.6.6. Exercise-Induced Feeling Inventory (EFI [46])—The EFI is a measure of feeling states that occur with bouts of physical activity. This measure consists of 12 items that assess four feeling states: 1) revitalization; 2) tranquility; 3) positive engagement; and 4) physical exhaustion. Internal consistency of the measure ranges from 0.78 to 0.87 for the revitalization subscale, between 0.80 and 0.91 for the physical exhaustion subscale, between 0.72 and 0.82 for the tranquility subscale, and between 0.82 and 0.74 for the positive engagement subscale.

3.6.7. Outcome expectancies for exercise [47]—This is a 9-item measure designed to assess the anticipated results or expectations for engaging in physical activity. Sample items include: “Exercise makes me feel better physically” and “Exercise gives me a sense of personal accomplishment”. The internal consistency of the measure has ranged from 0.87 to 0.89.

3.7. Physical activity moderating variables

3.7.1. Preference measure [48]—Participants were administered one question at baseline to examine which type of physical activity delivery channel they would prefer to receive (“If you were to receive feedback based on individualized and personalized information, including how you are thinking and feeling about exercise, would you prefer to receive this information from print materials through the mail or through scheduled telephone calls from an exercise counselor?”).

3.7.2. Perceived Stress Scale (PSS)—The 14 items of the PSS assess the extent to which particular situations are evaluated as stressful (e.g., “In the last week, how often have

you been upset because of something that happened unexpectedly?”). The Perceived Stress scale is widely used, and has been shown to have good reliability and validity [49].

3.7.3. Beck Depression Inventory (BDI)—The Beck Depression Inventory is a 21-item measure designed to assess symptoms and attitudes related to depression [50]. Internal consistency of this measure ranged from 0.80 to 0.90 depending on the patient group surveyed. In non-psychiatric samples, the Cronbach's α was 0.81 [51]. Concurrent validity with other measures of depression has been estimated at 0.73 [51].

3.7.4. Environmental access [52]—This questionnaire measures aspects of one's environment that may act as facilitators or barriers to physical activity (e.g., access to convenient facilities, high crime neighborhood). Test–retest reliabilities were 0.68 for the neighborhood scale, 0.80 for convenient facilities, and 0.89 for the home equipment scale. The validity of the scale was evaluated by correlating self-report of physical activity with the subscales. The p values for the correlations are as follows: strength exercise and home equipment ($p<0.001$), vigorous exercise and home equipment ($p<0.001$), and vigorous exercise and convenient facilities ($p<0.05$).

3.8. Data analyses

Data analyses were conducted to provide information on the success of the randomization procedure in balancing baseline covariates between the three treatment arms. Data analyses also were conducted to provide information on the baseline associations among potential mediators and moderators of physical activity behavior change. Continuous variables were compared at baseline using F -tests, whereas Chi square tests were used for categorical variables. Differences in baseline measures by baseline stage of motivational readiness (Precontemplation+Contemplation vs. Preparation) were evaluated via 2-sample t -tests. Linear associations among psychosocial variables and between the 7-day PAR and various fitness-related measures were evaluated using Pearson's product–moment correlation coefficients.

4. Results

4.1. Demographics

Table 2 presents baseline characteristics of the participants randomized to the study. The randomization procedure produced equivalent groups. The study population was predominantly Caucasian (90.3), female (82.0%), and middle-aged (mean=44.5 years). Of the 239 participants, the majority had a college education or above (70.6%) and a total household income above \$50,000 (60.8%).

4.2. Physical activity behavior and physiologic measurement of exercise capacity

The baseline PAR levels indicate that this sample is sedentary (Table 2). The participants averaged 19.8 ± 25.0 min of physical activity/week that was at least of moderate intensity. For the print group the average was 20.2; for the telephone group it was 19.8; and for the delayed treatment group it was 19.4 min of physical activity. These group means were not significantly different. As an objective measure of fitness, the stress test revealed that

participants remained on the treadmill for an average of 7.7 min before their heart rate reached 85% of their age-predicted maximum heart rate. The average estimated VO_2 at 85% of maximum heart rate was 25.6 ml/kg/min. The majority of the sample was in the Contemplation stage of exercise adoption (I intend to exercise in the next 6 months; 64.4%, $N=154$), 3.3% were in Precontemplation (no intention of beginning exercise in the next 6 months, $N=8$), 32.2% were in Preparation (currently exercising, but not regularly, $N=77$). Additionally, 52.1% ($N=124$) preferred telephone as their delivery modality, 45.8% ($N=109$) endorsed print, and 2.1% ($N=5$) were undecided.

Measures of weight and body fat indicated that the sample was, on average, overweight with an average body mass index of 28.5 kg/m². The overall percent body fat as measured by calipers was 34.1% for women and 23.2% for men, which is comparable to other physical activity intervention studies [53]. The average resting blood pressure was a systolic of 113 and a diastolic of 72 with an average resting heart rate of 77 bpm, all of which are considered within normal limits [54–56].

Stage classifications for physical activity were associated with differences in several of the psychosocial variables. Due to the small number of participants in Precontemplation, individuals in this stage were combined with those in the Contemplation stage and compared to Preparation. As indicated from analyses conducted using 2-sample *t*-tests (Table 3), individuals in the Precontemplation/Contemplation stages engaged in fewer behavioral processes of change ($p<0.001$), had significantly less social support for participating in physical activity ($p=0.03$), and reported less enjoyment for physical activity than those in the preparation stage of change ($p<0.001$).

Differences in fitness variables by stage are given in Table 7. The correlations between the PAR and all the fitness variables are given in Table 8. Baseline correlations between the Actigraph and the PAR are as follows: Pearson=0.52 ($p<0.0001$), Spearman=0.48 ($p<0.0001$).

4.3. Baseline relationships among proposed physical activity mediators

The means and standard deviations for the psychosocial variables can be found in Table 4. There were no significant differences between the conditions on these variables at baseline. Correlations between the variables are presented in Table 5. At baseline, the behavioral processes were correlated with cognitive processes ($r=0.69$), self-efficacy ($r=0.38$), decisional balance ($r=0.37$), outcome expectancies ($r=0.25$), enjoyment ($r=0.16$), and social support participation ($r=0.30$). Self-efficacy was also found to correlate with the cognitive processes ($r=0.24$), decisional balance ($r=0.35$), outcome expectancies ($r=0.16$), and enjoyment ($r=0.37$). All of the above are significant at the $\alpha=0.01$ level.

4.4. Baseline relationships among proposed physical activity moderators

Table 6 indicates the correlations among physical activity moderators. Higher baseline levels of depressive symptoms as assessed by the Beck Depression Inventory were negatively correlated with positive feelings about physical activity, indicating less positive engagement ($r=-0.38$), less revitalization ($r=-0.42$), and less tranquility ($r=-0.41$) among individuals reporting higher levels of depressive symptoms.

5. Discussion

This trial is designed to move the field forward by examining non face-to-face approaches for promoting physical activity behavior. In prior studies it has been demonstrated that print-based materials that are individualized, motivationally tailored, and emphasize key social cognitive concepts such as self-efficacy and outcome expectations are effective tools for enhancing physical activity adoption [10,14]. Prior studies have also shown that telephone-based interventions emphasizing social cognitive concepts have demonstrated short- and longer-term efficacy [9,16,57,58]. Thus, the purpose of this study is to examine the relative efficacy of two different channels for delivering a computerized expert-system guided intervention (i.e., print vs. telephone) for physical activity as well as the relative cost of each intervention. Findings from this trial will have implications for the translation of efficacious, theory-based interventions into public health delivery channels that can easily be distributed to large numbers of individuals. This trial could provide information to significantly enhance health and quality of life in the adult population.

To better understand the sample for the current study, we examined several baseline variables and the inter-relationships among these baseline variables (Table 7). The average estimated VO_2 and mean number of minutes on the treadmill during the exercise test was low and similar to previous physical activity intervention trials (e.g., [27,59]). Therefore, our sample is well positioned to benefit from the proposed physical activity interventions.

It is possible that individual preference for telephone versus print interventions would influence both compliance and efficacy of the particular intervention. In this sample, the percentage of participants reporting that they would prefer to receive the telephone intervention was slightly higher than participants reporting that they would prefer the print intervention (52% vs. 46%). Future analyses will explore how receiving the participant's preferred or non-preferred intervention will influence compliance to the study and physical activity adoption.

Research indicates that interventions targeted to the individual's stage of motivational readiness for change are efficacious for increasing physical activity behavior (e.g., [60]). Therefore, it is important to examine how psychosocial variables related to physical activity may vary across these stages of motivational readiness for change. Specifically, when compared to participants in the Preparation stage, participants in the Precontemplation or Contemplation stages reported less support from family and friends for physical activity and reported less enjoyment for physical activity, which is consistent with previous studies [53]. Perhaps social support and enjoyment are important factors for individuals taking steps to becoming active. Therefore, individuals in the Precontemplation and Contemplation stages may particularly benefit from the telephone and print interventions as they target social support and enjoyment. In future analyses, we will explore if changes in social support and enjoyment are important in moving individuals through the stages of change.

Not surprisingly, many of the baseline psychosocial variables correlated with one another. Specifically, we found that use of the behavioral strategies for change were correlated with the cognitive strategies for change as well as self-efficacy, decision making, physical activity

enjoyment, and social support. Self-efficacy was also found to correlate with the cognitive strategies for change, decisional balance, outcome expectations, and enjoyment (Table 8).

Of note, higher levels of depressive symptoms were negatively correlated with positive feelings about physical activity, indicating less positive engagement, less revitalization, and less tranquility among individuals reporting higher levels of depressive symptoms. Perhaps individuals reporting a depressed mood might find getting started with an exercise program to be more challenging than those starting the program less depressed. In future analyses we will examine the effect of depression and exercise expectancies on actual physical activity behavior.

An important aspect of this study is the examination of two delivery channels, telephone and print, for physical activity promotion. This study is unique in that it strives to control for content across delivery channels, using a computerized expert system to guide the content of the intervention. The use of such an expert system to guide program content is unique in the telephone delivery arena, and, if found to be effective, might expand such counseling to health interveners with less specific or formal training or education in the telephone counseling arena (given that the content for each call was structured using the compiled expert system information). Research indicates that both print and telephone-based physical activity interventions are efficacious (e.g., [9, 60]); however, no study to our knowledge has examined both interventions within the same clinical trial. The telephone and print interventions included the same content but differed on a few factors related to the delivery channel. For example, when prompted by the participant, the telephone counselor was instructed to provide more information than the planned content of the telephone session. This additional information was viewed as a function of the delivery channel rather than a deviation from the planned content of the telephone session. Similarly, participants in the print intervention had their information mailed to them, therefore they had the ability to interact with the materials over time and keep them as a reference.

Future analyses will examine the cost-effectiveness of the print and telephone interventions. The analyses will provide information to policy makers regarding the efficacy and cost-effectiveness of non face-to-face delivery channels in a time when cost containment is critical in reaching the large proportion of sedentary individuals. We anticipate that the print intervention will be less costly than the telephone intervention given that for both interventions print reports will need to be generated, but for the print arm, these reports will be mailed, and in the phone arm a counselor will provide this information to the participants. Therefore, if the telephone and print interventions demonstrate an equivalent level of efficacy but the print intervention is less costly, this will inform future decisions related to dissemination of the interventions.

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Table 1

Intervention content and frequency of contacts

	Month	Schedule of calls (mailings)	No. of calls (mailings) per month	Content
Exercise adoption intervention	1	Weekly	4	Week 1: Stage-matched manual Weeks 2–4: Expert system report, tip sheet
	2	Biweekly	2	Week 5–6: Expert system report Week 7–8: Manual and identified tip sheet
	3	Biweekly	2	Weeks 9–10: Expert system report Weeks 11–12: Manual and identified tip sheet
	4	Monthly	1	Weeks 13–16: Expert system report, manual, and identified tip sheet
	5	Monthly	1	Weeks 17–20: Expert system report, manual, and identified tip sheet
	6	Monthly	1	Weeks 21–24: Expert system report, manual, and identified tip sheet
Maintenance Intervention	7		0	Weeks 25–28: No contact
	8	Bimonthly	1	Weeks 29–32: Expert system report, manual, and identified tip sheet
	9		0	Weeks 33–36: No contact
	10	Bimonthly	1	Weeks 37–40: Expert system report, manual, and identified tip sheet
	11		0	Weeks 41–44: No contact
	12	Bimonthly	1	Weeks 45–48: Expert system report, manual, and identified tip sheet
Total number of calls (mailings)=			14	

Summary of baseline characteristics by study group

Variable	Group							
	Print, n=81		Phone, n=80		Delayed, n=78		Total sample, n=239	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Age	43.44	10.42	45.16	8.30	44.79	10.08	44.46	9.92
BMI	28.24	5.52	27.92	4.65	29.50	6.78	28.54	5.72
7-day PAR	20.19	24.15	19.75	26.56	19.36	24.51	19.77	25.00
Exercise test: Time	7.96	3.45	7.54	3.85	7.65	3.08	7.72	3.47
Exercise test: Peak HR	150.84	8.87	149.63	7.07	149.41	8.85	149.97	8.29
Stress test: estimated VO ₂	25.97	6.38	25.32	7.02	25.57	5.62	25.62	6.35
Resting SBP	112.77	14.35	111.90	11.80	115.24	13.64	113.28	13.33
Resting DBP	72.69	8.37	71.50	9.26	72.87	10.00	72.35	9.20
Resting HR	77.33	10.49	77.41	10.86	76.87	12.60	77.21	11.29
Male % body fat	21.90	7.73	22.75	7.79	26.12	6.99	23.22	7.59
Female % body fat	33.16	8.77	34.29	8.18	34.86	8.64	34.13	8.51

Table 3

Baseline measures by baseline stage (precontemplation/contemplation vs. preparation)

Variable	Precontemplation/Contemplation			Preparation			t-test	
	Mean	S.D.	n	Mean	S.D.	n	p-value	
Behavioral process	2.29	0.58	162	2.60	0.51	77	<0.0001	
Cognitive process	2.90	0.74	162	2.91	0.63	77	0.8886	
Self-efficacy	2.60	0.79	162	2.70	0.69	77	0.3854	
Decisional balance	-0.19	12.58	162	1.16	12.94	77	0.4433	
Social support: Participation	6.13	6.09	161	8.10	6.98	77	0.0267	
Social support: Rewards/Punishment	0.24	0.84	161	0.32	0.95	77	0.4669	
Outcome expectations	4.00	0.63	162	4.14	0.67	77	0.1108	
EFT: Physical exhaustion	2.48	1.06	160	2.44	1.09	76	0.8089	
EFT: Positive engagement	2.88	1.02	161	2.94	1.01	77	0.6835	
EFT: Revitalization	1.96	0.99	160	1.99	0.88	77	0.8165	
EFT: Tranquility	2.61	0.98	160	2.49	0.88	77	0.3659	
BDI score	6.42	5.78	156	5.16	3.91	74	0.0533	
Perceived stress	22.09	7.61	162	22.27	6.33	77	0.8524	
Enjoyment	4.56	1.28	109	5.14	1.06	60	0.0029	

Table 4

Baseline psychosocial variables by study groups

Variable	Print, <i>n</i> =81		Phone, <i>n</i> =80		Delayed, <i>n</i> =78		Total sample, <i>n</i> =239	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Behavioral process	2.36	0.55	2.41	0.60	2.41	0.59	2.39	0.58
Cognitive process	2.92	0.76	2.91	0.67	2.86	0.69	2.90	0.71
Self-efficacy	2.53	0.86	2.72	0.66	2.66	0.73	2.64	0.76
Decisional balance	-0.45	13.72	-0.07	11.96	1.29	12.39	0.25	12.69
Social support: Participation	6.96	6.89	6.74	6.11	6.60	6.36	6.77	6.44
Social support: Rewards/Punishment	0.37	1.08	0.14	0.47	0.29	0.96	0.26	0.88
Outcome expectations	3.98	0.68	4.15	0.69	4.01	0.55	4.05	0.65
EFT: Physical exhaustion	2.37	1.04	2.53	1.07	2.50	1.11	2.47	1.07
EFT: Positive engagement	2.89	1.03	2.99	1.01	2.82	1.01	2.90	1.01
EFT: Revitalization	2.11	0.90	1.91	0.98	1.87	0.98	1.97	0.95
EFT: Tranquility	2.49	1.03	2.69	0.88	2.53	0.93	2.57	0.95
BDI score	6.13	6.25	6.38	5.27	5.53	4.03	6.02	5.27
Perceived stress	22.56	7.45	21.79	7.54	22.09	6.66	22.15	7.21
Enjoyment (mean)	5.00	1.06	4.73	1.31	4.54	1.30	4.77	1.24
Environment: Home	5.32	2.90	5.56	2.50	5.48	2.41	5.45	2.61
Environment: Neighborhood	5.78	1.17	5.58	1.46	5.45	1.31	5.61	1.32
Environment: Convenient facilities	9.31	4.52	10.41	4.22	9.51	3.92	9.74	4.24

Table 5

Pearson's correlations among psychosocial variables

	Cognitive process	SE	DB	Outcome	Enjoyment	SS participation	SS rewards/punishment
Behavioral process	0.69	0.38	0.37	0.25	0.16	0.30	0.03
Cognitive process		0.24	0.45	0.22	0.06	0.15	0.00
Self-efficacy (SE)			0.35	0.16	0.37	-0.02	-0.03
Decisional balance (DB)				0.41	0.39	-0.03	-0.01
Outcome expectations (Outcome)					0.45	0.09	0.07
Enjoyment						-0.11	-0.00
Social support (SS): Participation							0.41

All correlations greater than ± 0.15 are significant at the $p < 0.01$ level.

Table 6

Pearson's correlations among affective psychosocial variables

	Positive engagement	Revitalization	Tranquility	BDI score	Perceived stress
EFI: Physical exhaustion	-0.38	-0.56	-0.47	0.42	0.41
EFI: Positive engagement		0.65	0.71	-0.38	-0.62
EFI: Revitalization			0.66	-0.42	-0.46
EFI: Tranquility				-0.41	-0.63
BDI score					0.56

All correlations are significant at the $p<0.0001$ level.

Table 7

Baseline fitness measures by baseline stage (PC/C vs. Prep)

	Precontemplation/Contemplation			Preparation			t-test	
	Mean	S.D.	n	Mean	S.D.	n	p-value	
BMI	28.77	5.80	162	28.08	5.56	77	0.3867	
Stress test: Time	7.40	3.16	161	8.39	3.97	77	0.0580	
Stress test: Peak HR	150.01	8.24	162	149.89	8.46	76	0.9233	
Stress test: estimated VO ₂	25.12	5.92	161	26.67	7.09	77	0.0784	
Resting SBP	113.91	13.97	162	111.97	11.84	77	0.2956	
Resting DBP	72.75	9.26	162	71.51	9.08	77	0.3288	
Resting HR	77.82	11.98	162	75.92	9.64	77	0.1908	
Male % body fat	22.58	8.03	26	24.20	6.99	17	0.5006	
Female % body fat	34.92	8.97	136	32.35	7.13	60	0.0342	

Table 8

Pearson correlations between PAR and fitness variables

	7-day PAR	
	ρ	p-value
BMI	0.0225	0.7295
Stress test: Time	0.0846	0.1936
Stress test: Peak HR	0.0361	0.5797
Stress test: Estimated VO ₂	0.0650	0.3177
Resting SBP	0.0685	0.2916
Resting DBP	-0.0329	0.6129
Resting HR	-0.0818	0.2078
Male % body fat	0.0329	0.8342
Female % body fat	-0.0507	0.4806