Feasibility of Using Computer-Tailored and Internet-Based Interventions to Promote Physical Activity in Underserved Populations

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Abstract

Objective: Computer-tailored and Internet-based interventions to promote physical activity behavior have shown some promise, but only few have been tested among African Americans. We examined the feasibility and efficacy of three 1-year, multiple contact physical activity interventions (Tailored Internet, Tailored Print, Standard Internet) in a subsample of African American participants ($n = 38$) enrolled in a randomized controlled trial. **Materials and Methods:** Participants randomly assigned to Tailored Internet and Print programs received individually tailored computer expert system feedback delivered via Internet or print. Participants in the Standard Internet program received access to six currently available physical activity Web sites. Self-reported physical activity was assessed at baseline and 6 and 12 months with the 7-Day Physical Activity Recall. **Results:** Across all participants, physical activity changed from 17.24 min/week (standard deviation [SD] = 20.72) at baseline to 139.44 min/week (SD = 99.20) at 6 months, to 104.26 min/week (SD = 129.14) at 12 months. According to available consumer satisfaction data ($n = 30$), 70% reported reading most or all of the

physical activity information received by Internet or mail. Most participants described the Internet- and print-based physical activity programs as “somewhat” or “very” helpful (80%) and enjoyable (87%). **Conclusions:** These findings suggest that computer-tailored and Internet-based interventions are able to produce long-term increases in physical activity and associated process variables among African American participants. Future studies with larger numbers of African American participants are needed to determine which of the programs (Tailored Print, Tailored Internet, Standard Internet) are more effective and what program modifications might be helpful in assisting this population in becoming more active.

Key words: e-health, cardiology/cardiovascular disease, technology

Introduction

Research has shown associations between physical activity and reduced risk for numerous conditions, including coronary heart disease, hypertension, type 2 diabetes mellitus, osteoporosis, colon cancer, anxiety, and depression.¹ Despite the well-established health benefits, most Americans are not sufficiently active.² African Americans report particularly high rates of sedentary behavior (54.6%) relative to other groups in the United States (Non-Hispanic Whites, 35.5%) and are disproportionately burdened by related chronic illnesses.² For example, African Americans face higher death rates from heart disease, diabetes, stroke, and cancer and lower life expectancies (73.1 years) than Non-Hispanic Whites (78.3 years).²

Thus, effective physical activity interventions that leverage state-of-the-art theory and technology are needed to address the existing health disparities. Individually tailored interventions that are driven

by a computer-based algorithm (i.e., expert system) can be delivered via mailed print materials or Internet and have great potential for promoting physical activity among African Americans. Such programs bypass barriers frequently cited by African Americans, such as child care and monetary costs,³ by not requiring clinic visits and have already shown promising results among predominantly White samples.⁴⁻⁸ For example, in the parent study (Step into Motion), 249 sedentary adults were randomly assigned to an individually Tailored Internet, individually Tailored Print, or Standard Internet intervention (i.e., links to publically available physical activity promotion Web sites). After the 12-month programs, participants reported engaging in a median of 90, 90, and 80 min of physical activity per week, respectively.⁷

Unfortunately, there has been little research in this area conducted among African Americans. A recent review of physical activity promotion studies among African Americans⁹ did not identify any computer-tailored or Internet-based interventions and only two print-based programs.^{10,11} More specifically, Cardinal and Sachs¹⁰ examined the efficacy of mailed print materials among healthy female clerical staff at a major university (62.8% African American). Participants were randomly assigned to three groups: control packet, lifestyle exercise packet, and structured exercise packet. Both exercise packets included information targeted to the participant's stage of change. Outcomes were assessed at 1 month after mailing of the print materials. All groups reported significant increases in their weekly leisure-time activity behavior; however, participants who received the lifestyle exercise packet reported significantly higher activity levels than the control group.

Another study¹¹ utilized mail-delivered, stage-matched interventions among low-income primary care patients (69% African American) with high rates of chronic conditions, such as diabetes (30%), hypertension (66%), obesity (59%), and hyperlipidemia (41%). Analyses indicated that the intervention produced significantly greater increases in self-reported physical activity and movement through the stages of change at 1 month when compared with an attention control, but gains had attenuated by 6 months.

These studies show preliminary efficacy—at least in the short term—of mediated physical activity interventions among predominantly African American populations. However, there is no evidence of long-term efficacy (i.e., beyond 1 month), perhaps as a result of the use of one-time mailings. Moreover, the Internet may have advantages over print-based programs, such as more immediate interactivity and potential reach. And, using computer expert systems to tailor the physical activity information may increase the relevance of the intervention from the perspective of the participants.¹²

Therefore, this study examined the feasibility and efficacy of 1-year, multiple-contact physical activity interventions (Tailored Internet, Tailored Print, Standard Internet) among a subsample of African Americans enrolled in a large randomized controlled trial (Step Into Motion).⁷ Specifically, we hypothesized that the African American participants would report significant increases in physical activity and related process variables (i.e., stage and processes of change, self-efficacy, decisional balance) and would rate the program as desirable based on a consumer satisfaction questionnaire.

Materials and Methods

DESIGN

Data are taken from a larger randomized controlled trial (the Step Into Motion trial) comparing three physical activity interventions: a Tailored Print condition, a Tailored Internet condition with equivalent intervention content, and a Standard Internet condition that did not use individual tailoring.⁷ There was no true control condition in the Step Into Motion trial, because the content of the tailored print condition was previously shown to be efficacious when compared with a wellness contact control condition.⁵ The dependent variable was self-reported physical activity, which was assessed using the 7-Day Physical Activity Recall (7-Day PAR) at baseline and 6 and 12 months.

PARTICIPANTS

The sample included 38 participants enrolled in a large randomized controlled trial ($n = 249$) who self-identified as African American. Participants in the parent study were recruited from communities near our research institutions (Brown University in Providence, RI and University of Pittsburgh in Pittsburgh, PA) primarily through newspaper and radio advertisements. The eligibility criteria included age (18–65), sedentary lifestyle (≤ 90 min of physical activity per week), access to a computer with a modem, and good health status (i.e., body mass index < 35 , no history of coronary or valvular heart disease, hypertension, diabetes, chronic obstructive pulmonary disease (COPD), stroke, osteoarthritis, orthopedic problems, any other medical condition that would make physical activity unsafe).^{13,14} Issues regarding medical eligibility were referred to the study physician (Alfred Parisi, M.D.). Individuals were excluded from participation if they reported planning to move from the area within the next year, consuming three or more alcoholic drinks per day on 5 or more days of the week, current or planned pregnancy, current suicidal ideation or psychosis, current clinical depression, and/or hospitalization because of a psychiatric disorder in the past 6 months.

PROCEDURE

Participants completed a telephone screening interview, orientation session, and two assessment visits before being randomly assigned to one of three conditions: (1) Tailored Print; (2) Tailored Internet; and (3) Standard Internet. Participants in the tailored intervention arms^{5,7} completed monthly questionnaires and received individually tailored feedback related to their responses. The feedback was generated by a computer expert system, based on constructs from the Transtheoretical Model¹⁵ and Social Cognitive Theory,^{16,17} and delivered via mailed print materials or the Internet, depending on group assignment. The Standard Internet condition comprised six currently available Web sites (e.g., American Heart Association, Shape Up America, Mayo Clinic Fitness and Sports Medicine Center, American Academy of Family Physicians, American Council on Exercise, and American College of Sport Medicine). All groups self-monitored their physical activity and received incentives for completed activity logs.

MEASURES

The main outcome measure for the study was the 7-Day PAR.^{18,19} This interview provides an estimate of weekly minutes of physical activity and uses multiple strategies for increasing accuracy of recall, such as breaking down the week into daily segments (i.e., morning, afternoon, and evening) and asking about many types of activities, including time spent sleeping and in moderate, hard, and very hard activity. The 7-Day PAR has been used across many studies of physical activity and has consistently demonstrated acceptable reliability, internal consistency, and congruent validity with other more objective measures of activity levels.²⁰ In addition, past research indicates that the 7-Day PAR is sensitive to changes in moderate-intensity physical activity over time.^{21,22}

Participants were categorized into one of the five stages of motivational readiness for behavior change (precontemplation, contemplation, preparation, action, and maintenance) by a four-item instrument, which has demonstrated reliability (kappa = 0.78; intraclass correlation $r = 0.84$) as well as shown acceptable concurrent validity with measures of self-efficacy and current activity levels.²³

Processes of change, or strategies used to increase motivational readiness for behavior change, were assessed by a 40-item measure,²⁴ which contains 10 subscales addressing a variety of processes of activity behavior change. Internal consistency of the subscales ranged from 0.62 to 0.96.

Self-efficacy, or confidence in one's ability to persist with exercising in various situations, such as when feeling fatigued or encountering inclement weather, was measured with a five-item instrument.²³ Internal consistency was 0.82 and test-retest reliability over a 2-week period was 0.90.

Decisional balance, or perceived advantages and disadvantages to physical activity, was assessed by a 16-item scale,²⁵ which has shown internal consistency in past studies (alpha for pros = 0.79; alpha for cons = 0.95).

Feasibility and acceptability were assessed using a 27-item consumer satisfaction measure that Marcus and colleagues⁵ have used across multiple trials.

STATISTICS

Descriptive analyses were conducted to summarize demographic variables. *t*-Tests were conducted to examine changes in physical activity behavior and related process variables (processes of changes, self-efficacy, and decisional balance). Analyses were restricted to participants who completed the relevant outcome (e.g., 7-Day PAR) or process measure (e.g., self-efficacy) and collapsed across study condition because of small cell sizes (Tailored Print [$n = 15$], Tailored Internet [$n = 11$], and Standard Internet [$n = 12$]). *n* sizes for each analysis are reported below.

Results

These analyses were conducted on African American participants enrolled in the parent study (Step Into Motion). The subsample ($n = 38$) was comprised of mostly obese, middle-aged women with relatively high education and income levels. Sample characteristics are summarized in Table 1.

CHANGES IN SELF-REPORTED PHYSICAL ACTIVITY

Results indicated changes in weekly physical activity from 17.24 min (standard deviation [SD] = 20.72) at baseline to 139.44 min (SD = 99.20) at 6 months, to 104.26 min (SD = 129.14) at 12 months. Interestingly, physical activity significantly increased from baseline to 6 months ($t(35) = -7.78$, $p < 0.001$), but not from 6 to 12 months. These findings suggest that most of the change in activity behavior occurred in the first 6 months.

CHANGES IN PHYSICAL ACTIVITY PROCESS VARIABLES

African American participants reported significant increases in cognitive ($t(23) = 2.50$, $p < 0.05$) and behavioral processes of change ($t(23) = 5.64$, $p < 0.05$) from baseline to 12 months, but there were no

Table 1. Sample Characteristics (*n* = 38)

CHARACTERISTIC	FREQUENCY
Gender	92.6% female
Age	Mean = 42.58, SD = 9.87
BMI	Mean = 31.32, SD = 5.38
Education	
High-school graduate	7.9%
Some college	39.5%
College graduate	36.8%
Postgraduate work	15.8%
Annual household income	
\$10,000–\$19,999	7.9%
\$20,000–\$29,999	7.9%
\$30,000–\$39,999	28.9%
\$40,000–\$50,000	15.8%
Over \$50,000	34.2%
Do not know/refused	5.3%

SD, standard deviation; BMI, body mass index.

Table 2. Changes in Physical Activity Process Variables from Baseline to 12 Months

MEASURE ^a	<i>N</i>	MEAN CHANGE	<i>T</i>	<i>P</i>
Pros to physical activity	24	0.06	0.51	0.62
Cons to physical activity	24	0.08	0.53	0.60
Self-efficacy	24	0.32	1.5	0.15
Behavioral processes	24	0.79	5.64	0.00
Cognitive processes	24	0.39	2.5	0.02

^aPossible ranges for each measure were 1–5.

significant changes in decisional balance or self-efficacy (*Table 2*). In addition, 50% (*n* = 15) progressed by at least one stage of change from baseline to 12 months, whereas 46.7% (*n* = 14) maintained and 3.3% (*n* = 1) regressed.

FEASIBILITY AND ACCEPTABILITY

As only few studies have utilized mediated approaches for delivering physical activity interventions among African American samples, several items regarding consumer satisfaction were administered postintervention to gauge the feasibility and acceptability of such programs in our target population. The findings were mostly supportive; for example, 70% of the African Americans who completed the questionnaire (*n* = 30) reported reading most or all of the physical activity information received by Internet or in the mail. Most participants described the Internet- and print-based physical activity programs as “somewhat” or “very” helpful (80%) and enjoyable (87%). Seventy-seven percent said they would recommend this program to a friend. Further, participants expressed a slight preference for receiving physical activity information through self-help print materials mailed to their home or office (43%, *n* = 13), rather than through Web sites and e-mails (33%, *n* = 10), or no preference at all (*n* = 7).

Discussion

Results from this study support the feasibility of using computer-tailored and Internet-based interventions to promote long-term increases in physical activity and associated process variables among African American participants. Further, data from the consumer satisfaction questionnaire indicated that this program was well received by this sample. Limitations to this study include reliance upon community volunteers and overrepresentation of women, as both sample characteristics limit the generalizability of these preliminary results to the larger community. Future studies are also needed with large numbers of African American participants to examine the relative efficacy of the programs (Tailored Print, Tailored Internet, Standard Internet), and determine what program modifications might be helpful in assisting this population in becoming more active. For example, most of the change in activity behavior occurred during the first 6 months, so more intensive intervention (e.g., prompts delivered via e-mail and/or text messaging) from 6 to 12 months may help participants continue to increase their activity throughout the year.

Novel aspects of this study include the application of behavioral informatics to increase physical activity in a sample of African

Americans. Using computer systems to individually tailor physical activity interventions and then delivering the information through Internet and print could provide a relatively low-cost²⁶ high-reach approach for promoting activity among this underserved population. African Americans currently represent the largest racial minority group in the United States and the leading causes of death in this group are heart disease, cancer, stroke, and diabetes,² all of which can be positively influenced by participation in a physically active lifestyle. Therefore, such research has the potential for substantially benefiting public health.

Other strengths of this study include length of follow-up (1 year). Most physical activity intervention studies conducted among African Americans report only on short-term (i.e., less than 6 months) findings.^{9,27} As the health benefits of such short-term activity gains are questionable, the emphasis needs to shift toward producing enduring changes in activity levels among African Americans.

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Disclosure Statement

No competing financial interests exist.

REFERENCES

1. U.S. Department of Health and Human Services. *2008 physical activity guidelines for Americans*. Washington, DC: U.S. Department of Health and Human Services, 2008.
2. National Center for Health Statistics. *Health, United States, 2007 with chartbook on trends in the health of Americans*. Hyattsville, MD: National Center for Health Statistics, 2007.
3. Richter DL, Wilcox S, Greaney ML, Henderson KA, Ainsworth BE. Environmental, policy, and cultural factors related to physical activity in African American women. *Women's Health* 2002;36:91–109.
4. Bock BC, Marcus BH, Pinto BM, Forsyth LH. Maintenance of physical activity following an individualized motivationally tailored intervention. *Ann Behav Med* 2001;23:79–87.
5. Marcus BH, Napolitano MA, King AC, Lewis BA, Whiteley JA, Albrecht A, Parisi A, Bock B, Pinto B, Sciamanna C, Jakicic J, Papandonatos, GD. Telephone versus print delivery of an individualized motivationally-tailored physical activity intervention: Project STRIDE. *Health Psychol* 2007;26:401–409.
6. Marcus BH, Bock BC, Pinto BM, Forsyth LH, Roberts MB, Traficante RM. Efficacy of an individualized, motivationally-tailored physical activity intervention. *Ann Behav Med* 1998;20:174–180.
7. Marcus BH, Lewis BA, Williams DM, Dunsiger S, Jakicic JM, Whiteley JA, Albrecht AE, Napolitano MA, Bock BC, Tate DF, Sciamanna CN, Parisi AF. A comparison of Internet and print-based physical activity interventions. *Arch Intern Med* 2007;167:944–949.
8. Spittaels H, De Bourdeaudhuij I, Brug J, Vandelanotte C. Effectiveness of an online computer-tailored physical activity intervention in a real-life setting. *Health Educ Res* 2007;22:385–396.
9. Pekmezi D, Jennings E. Interventions to promote physical activity among African Americans. *Am J Lifestyle Med* 2009;3:173–184.
10. Cardinal BJ, Sachs M. Effects of mail-mediated, stage-matched exercise behavior change strategies on female adults' leisure-time exercise behavior. *J Sports Med Phys Fitness* 1996;36:100–107.
11. Whitehead DF, Bodenlos JS, Jones GN, Cowles M, Brantley PJ. A stage targeted physical activity intervention among a predominantly low-income African American primary care population. *Am J Health Promot* 2007; 21:160–163.
12. Lustria ML, Cortese J, Brown LL. Dissecting Computer-Tailored Health Interventions Delivered Over the Web. Paper presented at the 58th Annual Conference of the International Communication Association (May 22–26, 2008) Montreal, Quebec, Canada.
13. Canadian Society for Exercise Physiology. *PAR-Q and you*. Gloucester, Ontario: Canadian Society for Exercise Physiology, 1994.
14. American College of Sports Medicine. *ACSM's guidelines for exercise testing and prescription*. Philadelphia, PA: Lippincott Williams & Wilkins, 2006.
15. Prochaska JO, DiClemente CC. Stages and processes of self-change of smoking: Toward an integrative model of change. *J Consult Clin Psychol* 1983; 51:390–395.
16. Bandura A. *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall, 1986.
17. Bandura A. *Self-efficacy: The exercise of control*. New York, NY: WH Freeman & Co., 1997.
18. Sallis JF, Haskell WL, Wood PD, Fortmann SP, Rogers T, Blair SN, Paffenbarger RS Jr. Physical activity assessment methodology in the Five-City Project. *Am J Epidemiol* 1985;121:91–106.
19. Blair SN, Haskell WL, Ho P, Paffenbarger RS Jr, Vranizan KM, Farquhar JW, Wood PD. Assessment of habitual physical activity by a seven-day recall in a community survey and controlled experiments. *Am J Epidemiol* 1985;122:794–804.
20. Pereira MA, FitzerGerald SJ, Gregg EW, Joswiak ML, Ryan WJ, Suminski RR, Utter AC, Zmuda JM. A collection of physical activity questionnaires for health-related research. *Med Sci Sports Exerc* 1997;29(Suppl 6):S1–S205.
21. Dunn AL, Andersen RE, Jakicic JM. Lifestyle physical activity interventions. History, short- and long-term effects, and recommendations. *Am J Prev Med* 1998;15:398–412.

22. Dunn AL, Marcus BH, Kampert JB, Garcia ME, Kohl HW, Blair SN. Comparison of lifestyle and structured interventions to increase physical activity and cardiorespiratory fitness: A randomized trial. *JAMA* **1999**;281:327–334.
23. Marcus BH, Selby VC, Niaura RS, Rossi JS. Self-efficacy and the stages of exercise behavior change. *Res Q Exerc Sport* **1992**;63:60–66.
24. Marcus BH, Rossi JS, Selby VC, Niaura RS, Abrams DB. The stages and processes of exercise adoption and maintenance in a worksite sample. *Health Psychol* **1992**;11:386–395.
25. Marcus BH, Rakowski W, Rossi JS. Assessing motivational readiness and decision making for exercise. *Health Psychol* **1992**;11:257–261.
26. Sevcik MA, Napolitano MA, Papandonatos GD, Gordon AJ, Reiser LM, Marcus BH. Cost-effectiveness of alternative approaches for motivating activity in sedentary adults: Results of Project STRIDE. *Prev Med* **2007**;45:54–61.
27. Banks-Wallace J, Conn V. Interventions to promote physical activity among African American women. *Public Health Nurs* **2002**;19:321–335.

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