

Internet and cell phone based physical activity interventions in adults.

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Objective: Physical activity interventions that address the issue of obesity are becoming common. With Internet and cell phone usage becoming increasingly popular, these interventions are beginning to adopt these new delivery methods. The purpose of the study was to systematically analyze interventions published between 2007 and 2010 that used the Internet or cell phones for promotion of physical activity among adults 21 years and older. **Design:** A systematic search for physical activity interventions using the Internet or cell phones was done using the CINAHL, ERIC, Google Scholar, and Medline databases independently by two researchers. **Results:** A total of 11 articles met the inclusion criteria. Only one study used a cell-phone based intervention. Of these 11 interventions, a majority of them were found to be effective. While all of them utilized a theoretical background, not many measured changes in the theoretical constructs. Of the ones that measured such changes most found no significant changes. In addition, practically significant differences between control and intervention groups were not found in all of the studies. **Conclusion:** Internet-based and cell-phone based interventions were found to have similar effectiveness as face-to-face programs. With the advances in technology these approaches will become more prevalent and future research will be needed to enhance the success of these approaches in promoting physical activity. Recommendations for future interventions are provided.

Arch Exerc Health Dis 2 (2):108-113, 2011

Key Words: obesity, physical activity, Internet, cell phone, adults

INTRODUCTION

Obesity is a salient public health problem leading to other chronic illnesses such as heart disease, diabetes, and some cancers. According to the Behavioral Risk Factor Surveillance System, 26.9% of the population in the United States is obese (3). Studies have shown that individuals that were obese had a 10 to 50% higher risk of mortality from all causes and reports from 2005 indicated that approximately 112,000 excess deaths were due to obesity (5). Factors such as diet and physical activity contribute to the obesity epidemic. Specifically, lack of physical activity means reduced energy expenditure. This reduction enables the body to gain weight, when energy intake increases or is maintained. Currently our society typically leads a sedentary lifestyle, which has served as a lending hand in obese communities. Outside of its vital role in risk reduction of the stated chronic illnesses and

obesity, an increase in mortality and alleviation of mental health disorders has been found (6). In addition, quality of life, especially in the elderly, enhances community engagement/social interactions. The Center for Disease Control and Prevention (3) recommends adults participate in moderate-intensity physical activity for a minimum of 150 minutes per week along with strength training activities twice a week or more. Moderate-intense activity occurs when an individual elevates their heart rate and is sweating. Examples of activities include fast paced walking, water aerobics, riding a bike, tennis, mowing the lawn manually, etc. Recent reports from the BRFFS indicate that only 51% of adults partake in the recommended amounts of physical activity. Evidence showed that it aided in energy consumption and expenditure, and reduced mortality from all causes by 30% (16). With half of the country living a sedentary lifestyle, interventions must adopt innovative approaches. One

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such way is through the use of technology. Access to the Internet and mobile phones is widespread and is consistently growing. Approximately 50% in the U.S. and 74% of individuals in Europe have Internet access. It was found that 55% of the populations using the Internet are accessing health/medical information, and 13% obtain fitness and nutrition related information (9). This has allowed for a new medium of delivery of health education interventions. A vast majority of behavioral health interventions have begun using this new wave of technology, as they are cost-efficient and instantly accessible. Many of these e-based interventions are seen with diabetes, nutrition, smoking cessation, and other health behaviors outside of physical activity (9). A limited number of studies for physical activity through the virtual world have been conducted.

A review of Internet based interventions in 2007 indicated their valuable role in increasing physical activity, although specifics of programs had not been established (18). Another review suggested similar findings (17). The latter review found follow up times to have an impact on behavioral sustainability and amount of contact times with participants. In addition, not all interventions used theoretical backdrops which made effectiveness difficult to determine.

The purpose of this study was to determine the effectiveness of Internet-based physical activity interventions in adults from 2007 to 2010. A systematic review of existing studies that have explored this relationship was used in the study. Studies from 2007 onward were used due to a review conducted in 2007 (18).

MATERIAL AND METHODS

Article searches were conducted on CINAHL, Google Scholar, ERIC and Medline for the time period of 2007 to 2010. Keywords used to search for articles were: Internet based physical activity interventions, web-based physical activity interventions, Internet and cell phone based interventions, and technology-based physical activity interventions. Approximately 60 articles were located and narrowed down to 11 based on the inclusion and exclusion criteria. Two researchers conducted the search independently in arriving at the chosen studies. Articles were fully read to determine eligibility.

Criteria for inclusion were: (i) studies published between 2007 and 2010, (ii) studies in the English language, (iii) focus on adults, (iv) participants must be at least 21 years old, (v) Internet/cell phone use in the intervention, (vi) intervention only involved physical activity, (vii) randomized- controlled design. The exclusion criteria were: (i) articles published before 2007, (ii) non- English articles, (iii) inclusion of participants under 21 years old, (iv) studies using

quasi-experimental design or pre-test/post-test design or qualitative design, (v) studies that involved other health behaviors other than physical activity, (vi) studies that did not use the Internet or cell phones as a primary source of intervention delivery.

RESULTS

The purpose of this review was to determine the effectiveness of Internet-based physical activity interventions in adults from 2007 to 2010. Since only 11 studies met the inclusion and exclusion criteria, it can be said that more studies need to be conducted with a focus on tailored messages. These studies are summarized in Table 1.

Five of the 11 interventions were conducted in the United States, one in Australia, and the rest in Europe. With regard to the domain of the studies, five were conducted with community members in the area of the respective universities, two in health centers, two from worksites (a hospital, and one from random worksites throughout the region), one from school, and one from area churches. Only one intervention was mobile based. The duration of programs ranged from six weeks to one year. The average age of participants ranged from mid 20's to late 50's, with a majority in their 40's and 50's. A large number of participants were Caucasian, except in one study by Pekmezi et al. (10), which focused on the African American community. Participants in the study conducted by Carroll et al. were 59% African American (2). With regard to gender based participation, Dunton et al. (4) was the only study that had all female participants, especially ethnic women. Other studies had both genders as participants in their studies, with a majority of them being women.

Types of measurements conducted in studies were fairly similar. A majority of studies utilized pedometers to measure steps and the seven day recalls. Body fat percentage and waist circumference were also evaluated to determine body composition in relation. Carr et al. determined a cardio risk score based on blood pressure, cholesterol, and C-reactive protein levels (1).

All interventions utilized a theoretical background. In particular, Social Cognitive Theory and the Transtheoretical Model were either used separately or together in a majority of the programs. Theory of planned behavior and the Health Belief Model were also seen in two studies. Carroll et al. found significant increases in behavioral ($p < .001$) and cognitive ($p = .04$) processes of change, but none for self-efficacy or decisional balance (4). Hurling et al. found increases in perceived control and expectations for physical activity (7). Pekmezi et al. reported a 50% progression to the next stage of change and increased cognitive and behavioral processes of change (10). No change in

Table 1: Summary of internet and cell-phone based physical activity interventions from 2007-2010

Study	Year	Age	Theory	Location	Intervention	Duration	Major Findings
Hurling et al.	2007	30-55	mixture of theories	United Kingdom	Internet and mobile based intervention	9 weeks	The intervention group showed a significant increase in self-reported moderate physical activity ($p = .03$), and a significant reduction in percent of body fat ($p = .04$). They also had a significant increase in perceived control ($p < .001$) and expectations ($p < .001$) for physical activity.
Marcus et al.	2007	44.5 + 9.3	Social Cognitive Theory and Transtheoretical Model	Pittsburgh, Pennsylvania	Project Stride: Internet based individually tailored physical activity intervention	12 months	All groups showed a significant increase in physical activity based on self-report from baseline to six months by 5.2% and from 6 months to a year by 5.9%. Significant changes were seen on fitness tests ($p < .001$) for all groups.
Spittaels et al.	2007	25-55	Transtheoretical Model	Belgium	Computer tailored intervention in real life	8 weeks	BMI ($p < .05$), fat percentage ($p < .001$) and diastolic blood pressure ($p < .01$) were significantly reduced for all groups, indicating no significant value with an internet based physical activity program. The e-mail group only had a slightly greater reduction in body fat percentage ($p < .05$). Tailored messages showed no significant impact in increasing physical activity ($p > .05$). Participants frequently used and appreciated the internet based program.
Steele et al.	2007	38.7 + 12	Social Cognitive Theory	Queensland, Australia	Health e-steps: FACE v. IO v. IM	12 weeks	An increase in physical activity (PA) post intervention was seen with all 3 groups ($p < .05$). At 2 mos. and 5 mos. follow up, an increase in PA was seen with FACE ($p < .05$) and IM ($p < .01$). A decrease was seen with the IO group between the 2 and 5 mos. follow up ($p < .01$). Overall, all modes of delivery were proven to be effective.
Winnett et al.	2007	53	Social Cognitive Theory		Guide to Health (GTH)	7 months	GTH-Plus participants showed a significant increase in the number of steps ($p < .01$) taken at post test and follow up and were more likely to reach their goal steps ($p = .023$) than the control group. GTH-Plus and GTH-Only groups indicated an increase in self-regulation behaviors rather than the control groups.
Carr et al.	2008	49.4 + 1.7	Transtheoretical Model and Social Cognitive Theory	Laramie, Wyoming	Active Living Everyday (ALED-I) Program	16 weeks	ALED-I group had a significant increase in steps ($p = .03$) along with a significant reduction in waist circumference, coronary risk ratio ($p = .04$), and triglyceride levels ($p = .01$). Overall physical activity levels in both groups increased but no differences between groups were found.
Dunton et al.	2008	42.8	Health Belief Model and Transtheoretical Model	California	Women's Fitness Planner	12 weeks	Number of minutes walking in the intervention group increased at 3 months ($p = .035$) and a significant increase was also found in MVPA ($p = .045$).
Slootmaker et al.	2009	23-39	Social Cognitive Theory	Netherlands	PAM (physical activity monitor) and PAM-coach in Dutch workers	3 months	No significant results were found.
Wanner et al.	2009	43.7	Transtheoretical Model	Geneva, Switzerland	Active - Online	6 weeks	An increase in the amount of individuals meeting HEPA standards was found at the first ($p = .045$) and third ($p = .002$) follow ups based on self-reports. Objective measures (pedometer) indicated no significant results in any groups.
Carroll et al.	2010	46.4 + 11.4	Transtheoretical Model, Self-Efficacy	Philadelphia, Pennsylvania	The Computerized Health Improvement Project (CHIP)	6 months	No significant changes in increasing physical activity between the control and intervention groups were found based on the 7-day recall. Increases in behavioral ($p < .001$) and cognitive ($p = .04$) processes of change.
Pekmezci et al.	2010	42.58 + 9.87	Social Cognitive Theory and Transtheoretical Model	Providence, Rhode Island	Step Into Motion- African Americans	12 months	All groups showed a significant increase in physical activity ($p < .001$) from baseline to 6 mos only. Participants in the interventions also showed a significant increase in cognitive and behavioral processes of change ($p < .05$) from baseline to the year follow up. 50% of participants progressed to the next stage of change, while 46.7% maintained their stage and 3.3% regressed a stage.

perceived barriers or benefits was indicated in the study by Dunton et al., although the number of participants in the action or maintenance stage increased after three months (4). Hurling et al. (7) indicated an increase in perceived control ($p < .001$) and expectations ($p < .001$).

While programs were based on theory, significant results were not found in every study or were not measured. Measurements on theoretical constructs were not conducted by Carr et al. (1), Marcus et al. (8), and Spittaels et al. (12). Results from process measurements by Wanner et al. (14) were not listed in the article.

A multitude of intervention designs were applied. In one study, primary care physicians were involved (2). Computerized tailored reports were given to patients to help promote physical activity. Reports were based on the self-report physical activity surveys and provided participants with personalized information, such as: activity prescription, questions to ask physicians, and potential health benefits. Results indicated that participants who were initially more active were more likely to show and discuss reports with their physicians.

Dunton et al. (4) developed their intervention component from the "Meals Matter" website that comprised physical activity and dietary behaviors. For this study, a separate webpage was built for its participants to track physical activity. Each participant took an online assessment and was given tailored messages, followed by 10 weekly emails. These emails entailed support messages and provided learning tools to increase physical activity. A significant increase in physical activity was seen three months post intervention.

Hurling et al. (7) incorporated the use of cell-phones with the Internet as part of their intervention. Participants went through an initial assessment on the Internet which determined barriers and levels of physical activity. A physical activity plan for the next seven days, along with implementation intentions was developed. Reminders and "assessors" regarding the plan were sent to participants via email or cell-phone, based on the preference of the participant. In addition, solutions for barriers to physical activity, and motivating benefits (optional) were also sent to them. A significant increase was found on accelerometer readings ($p = .02$), and moderate physical activity was

found from a self-report survey ($p=.03$).

Marcus et al. (8) compared tailored Internet based messages with paper based and a website only group, to determine effectiveness. Educational/motivational materials, goal-settings, and links to beneficial websites, along with email prompts, were given to the intervention group. No significant differences were found with the amount of change in physical activity levels in all three arms. Change in exercise performance was the only significant finding in all groups ($p=.001$). Pekmezi et al. (10) took a similar approach to Marcus et al. (8) with the African American community. Significant increases in physical activity ($p<.001$) were seen in the first six months.

Slootmaker et al. (11) utilized a personal activity monitor (PAM) along with personalized physical activity advice on the Internet for Dutch workers. Activity advice and goals were based off of scores from PAM. No significant results were obtained.

Spiitaels et al. (12) transformed a CD-ROM physical activity program into a website, which allowed for stage-based emails to be sent as reinforcements. A three armed approach was also used in this study. A single point in time tailored intervention, a tailored intervention with repeated feedback and additional contacts, and a control group were set up. Significant increases in physical activity and a reduction in sedentary activities were found at six months post intervention for both intervention groups.

Wanner et al. (14) compared a tailored versus non-tailored website for physical activity promotion. Individualized counseling and feedback for daily activities and strength training or strength and flexibility were given based on diagnostic questions. Reminder emails to use the website were also sent. The non-tailored website offered generic information for enhancing physical activity. While the number of participants meeting physical activity standards, according to self-reports, was significant at the first ($p=.045$) and third ($p=.002$) follow ups, objective measurements found opposing results.

DISCUSSION

The purpose of this study was to systematically analyze physical interventions in adults that used Internet and cell phones, published between 2007 and 2010, and suggest ways to enhance the effectiveness of such interventions. Internet based interventions are not only cost effective and cost efficient but also produce similar results as classroom based or paper based programs. Several consistencies, such as design, trial arms, theories and assessments were seen in the selected studies. A vast majority of beneficiaries in this program were sedentary individuals and these approaches provided necessary tools right at their

fingertips. With regard to participants, Caucasian males and females were predominantly tested, with only limited studies utilizing various diverse ethnic backgrounds. In addition, women tended to be the main gender involved in these studies, while attrition was mainly found with men. While theoretical backdrops in each study strengthened the designs of each program, some significant relationships were found and others failed to measure its impact.

Web-based programs were found to be as significant as face-to-face and paper based programs. Sedentary individuals showed greater improvement from baseline to post-intervention in terms of physical activity than non-sedentary participants. For instance, Carr et al. (1) found the ALED-I program to have similar effective levels as the classroom based intervention. More so, the Internet-based ALED program was more beneficial for sedentary individuals that were overweight/obese. While physical activity increased in participants in both groups, no significant changes were found from baseline reports by Carroll et al. (2). Dunton et al. (4) showed that the Women's Fitness Planner program significantly increased walking and moderate to vigorous physical activity in women after three months. Thus, long-term exposure is necessary for effectiveness. The utilization of cell-phones with the Internet resulted in increased and maintained physical activity by Hurling et al. (7). On the contrary, Slootmaker et al. (11) found the Internet was not an effective means of promoting physical activity.

At the same time, these interventions can be categorized based on personalization, better known as tailored versus non-tailored programs. Marcus et al. (8) and Pekmezi et al. (10) found Internet- tailored interventions to be as feasible as paper-tailored ones. Spittaels et al. (12) and Wanner et al. (14) also had similar findings and noted no difference between single-point and repeated feedback messages.

Results from various studies found mixed results with the duration of interventions. Some studies found no long-term effects, while others did not see a significant increase until six months post-intervention. While Internet based interventions are effective, the question still remains about the length of the programs to reach effective levels.

Overall, Internet based physical activity programs were found to be as efficient as paper-based or face to face interventions. Its cost efficiency along with the ability to reach more individuals, at the flexibility of their time, gives more credence in utilizing an e-based program than traditional methods.

Limitations of the Interventions

Articles located for this review met the set inclusion and exclusion criteria, and provided information

regarding the effectiveness of Internet and mobile based physical activity interventions. In the search, only one article that used cell phones was found. More research utilizing cell phones needs to be conducted as their popularity booms. In addition, studies converted CD-ROM programs into websites or provided external links for resources. Studies failed to use other forms of advanced internet technology such as: chat rooms, web-chatting features through Skype, social networking websites, blogs, etc. The studies in this review only used basic Internet technology, like web pages.

In addition, theoretical backgrounds used for developing interventions served as a limitation. The social cognitive theory and transtheoretical model were predominantly used, leaving room to question the role of other theories in producing effective interventions. Also, all studies did not assess the effectiveness of theories on the study. Therefore, it was hard to determine the significance of their role in program development. It is important that future studies measure the constructs of behavioral theories that they are using and document changes in those constructs.

Participants in these programs were predominantly Caucasian females, with the exception of one study that focused on African Americans. Overall, these interventions failed to measure effectiveness in other ethnicities, socioeconomic levels, and in men. Results might have varied with those that may not have proper access to the Internet, or limited knowledge of Internet use. Age was also a limitation, as most participants were in their mid 40's to late 50's. Results may have varied with different average age groups of participants.

Limitations of this Review

There are some limitations in this review. First, interventions published in English were included and many interventions especially in international settings were published in other languages, which were excluded from this analysis. Second, only interventions published in four databases were included. While these databases are quite extensive they do not tap into all the health literature from all the countries. Finally, studies only measuring physical activity were chosen.

Recommendations for Future Studies

While much research has been conducted on physical activity, there is a lack of Internet and mobile based interventions. Of the 11 articles found, only one made use of mobile phones. More research on mobile phones is needed to obtain a better understanding of its

value in enhancing levels of physical activity. At the same time, more studies with various ethnic and socio-economic backgrounds, along with programs focusing on males, need to be conducted. Interventions using theories outside of the Social Cognitive Theory and the Transtheoretical Model also need to be developed. Finally, designs of the programs need to go beyond simple websites. For instance, chat functions (talk and web camera), social networking websites, blogs and forums, and interactive pages need to be incorporated. This would expand the use and motility of instant access information and perhaps increase outcomes of these programs.

CONCLUSION

Internet and cell phone based physical activity interventions are as effective as paper and classroom based interventions. Few studies exist that use cell-phones as a source of delivery. Of those articles explored, individuals with sedentary behaviors received the most benefit from these modes of delivery. Further research needs to be conducted to obtain a better understanding of its effectiveness, as technology continues to advance and gain popularity.

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