

Evidence Review

Physical Activity Text Messaging Interventions in Adults: A Systematic Review

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Keywords

text message,
short message
service,
SMS,
cell phone,
mobile phone,
physical activity,
exercise,
intervention study

ABSTRACT

Background: Physical inactivity is a leading health risk factor for mortality worldwide. Researchers are examining innovative techniques including the use of mobile technology to promote physical activity. One such technology, text messaging, is emerging internationally as a method to communicate with and motivate individuals to engage in healthy behaviors, including physical activity.

Aim: Review the existing scientific literature on adult physical activity text messaging interventions.

Methods: This systematic review examined research papers that addressed physical activity text messaging intervention studies in adults. Using multiple databases, the search strategy included published English language studies through October 1, 2011. An author-developed data collection tool was used independently by two reviewers to extract and examine the selected study variables.

Results: The initial search resulted in the identification of 200 publications. Eleven publications representing 10 studies were included in the final review. Studies were conducted in seven countries with over half the studies being randomized controlled trials. Participants of the studies were predominantly young to middle aged women. Physical activity data were mainly obtained by self-report although three studies used pedometers or accelerometers. Interventions ranged from only sending out text messages to combining text messages with educational materials, staff support, and/or Internet technology. Minimal information was given regarding development or number of text messages used. The median effect size for the studies was 0.50.

Conclusions: To date, using text messaging as a method to promote physical activity has only been studied by a small group of researchers. Current physical activity text messaging literature is characterized by small sample sizes, heterogeneous but positive effect sizes, and a lack of specificity as to the development of the text messages used in these studies. Further research in this area is imperative to facilitate the expansion of mobile technology to promote physical activity.

INTRODUCTION

Physical inactivity levels are rising in many countries across the world, causing growing concern in the international healthcare community (Belanger & Foster, 2011; Dumith, Hallal, Reis, & Kohl, 2011; Varo et al., 2003; World Health Organization, 2008, 2012). Almost one-third of the world's citizens are insufficiently active for optimum health, and physical inactivity has been identified as a leading risk factor for mortality (World Health Organization, 2010, 2012). Physical inactivity is partially contributed to by a decrease in leisure time activity as well as an increase in sedentary behaviors occurring during domestic and occupational activities as well as an increase in passive modes of transportation (World Health Organization, 2010, 2012). These decreased physical activity levels place adults at

greater risk for obesity, hypertension, cardiac disease, and diabetes (Roger et al., 2011; World Health Organization, 2010).

Due to the substantial consequences of physical inactivity, healthcare providers and researchers have tried multiple approaches to help individuals become more physically active. One of the most popular methods has been provision, to each individual, of counseling by a healthcare provider (Berg, 2003; VanWormer, Pronk, & Kroeninger, 2009). While such high-intensity counseling (two or more sessions per month for at least the first 3 months of an intervention) has yielded positive results for a segment of the adult population (U.S. Preventive Services Task Force, 2003), many individuals continue to struggle to reach recommended physical activity levels. In addition, high-intensity counseling can be impractical and

costly in busy primary care practices (Tsai & Wadden, 2009). Therefore, researchers have sought out innovative techniques to help people increase their physical activity levels. In the past decade, these innovative techniques have included mobile technology, such as automated phone calls and web-based programs (Carlson, Sallis, Ramirez, Patrick, & Norman, 2012; Goode, Reeves, & Eakin, 2012; King et al., 2007).

Using already available commonplace technology is one way that healthcare providers can use mobile technology to communicate with their patients. There are over 5 billion cell phones globally, and in many countries a high percentage of them are used for text messaging (Central Intelligence Agency, 2011; Radwanick, 2011). In the United States, there are 286 million cell phones with 73% of their owners using text messaging (Central Intelligence Agency, 2011; Smith, 2011). Text messaging is emerging internationally as a method to communicate with and motivate individuals to engage in healthy behaviors (Cohall & Hyden, 2008; Cole-Lewis & Kershaw, 2010; Krishna, Boren, & Balas, 2009). Delivering text messages to inform citizens of public health messages and alert specific groups of people about available resources is also being utilized (Pop-Eleches et al., 2011; U.S. Department of Health and Human Services, 2011; Zurovac et al., 2011). Assisting patients with management of chronic diseases such as diabetes and pulmonary diseases has received attention by text messaging researchers (Liang et al., 2011; McLean et al., 2010; Wolpin, Nguyen, Donesky-Cuenca, Carrieri Kohlman, & Doorenbos, 2011). Reminding people to comply with their prescribed pharmacological regimens is being addressed with text messaging (Adler, 2007). Text messaging is also being used to encourage people to engage in healthier preventive behaviors such as smoking cessation and more healthful eating (Free et al., 2011; Gerber, Stolley, Thompson, Sharp, & Fitzgibbon, 2009). Another emerging text message area is in primary prevention of disease by helping individuals increase their levels of physical activity.

While there have been published articles related to telephone-delivered and web-based interventions to improve physical activity outcomes, the reviews failed to include interventions that used text messaging (Fry & Neff, 2009; Goode et al., 2012; Norman et al., 2007). Four reviews have examined mobile phone text messaging to deliver healthcare interventions to improve health behaviors. While each of these broadly based reviews of text messaging to improve health care included small numbers of studies on physical activity (1–2 each), they also examined text message interventions used for prevention and management of other diseases. As a result of their broader health focus, the reviews provided general information about the text messaging component of the intervention, but did not provide an in-depth review of the text messaging intervention that was specific to physical activity (Cole-Lewis & Kershaw, 2010; Heron & Smyth, 2010; Krishna et al., 2009; Wei, Hollin, & Kachnowski, 2011).

We could find no review that specifically focused on the effect of text messaging on physical activity that also examined text message development and the use of indialer (participant

contacts system) and outdialer (system contacts participant) features related to text messaging. Accordingly, we sought to synthesize the literature that has examined text messaging as an intervention to improve physical activity outcomes, including indialer and outdialer features, by systematically and rigorously reviewing primary studies on this topic. Our systematic review included a detailed study protocol, a literature search of suitable studies based on inclusion criteria, and an analysis plan (Polit & Beck, 2008; Ressing, Blettner, & Klug, 2009).

AIM

The aim of this systematic review was to identify, retrieve, critically appraise, and synthesize the existing scientific literature on physical activity text messaging interventions that have been done in adults. The research question is “Does using text messages about physical activity increase physical activity behavior in adults?”

METHODS

Design and Sample

The structure of this systematic review was based on general systematic guidelines provided by the Centre for Review and Dissemination (Oxford Centre for Evidence-based Medicine, 2009). According to those guidelines, a review question and inclusion criteria are identified. We used the PICO (i.e., Population, Intervention, Comparison, and Outcome) question to guide the review (Joanna Briggs Institute, 2011a). The population in this review is adults, the intervention is text messaging to increase physical activity levels, the comparison group if utilized, is the group that does not receive the text messaging intervention to increase physical activity, and the outcome is an increase in physical activity (Joanna Briggs Institute, 2011a; Melnyk & Fineout-Overhold, 2011).

The authors searched several databases including the National Library of Medicine database www.pubmed.gov, MEDLINE, Cumulative Index to Nursing and Allied Health Literature, SciVerse Scopus, the Cochrane Library of Systematic Reviews and the Joanna Briggs Institute Library of Systematic Reviews. We searched for relevant studies using a combination of three different categories. The first category included key words that focused on the type of intervention and included “text message” (textword); mhealth (textword); short message service (textword); SMS (which is the acronym for short message service) (textword); cell phone (MeSH); and mobile phone (MeSH). The second category included the intended outcome of the intervention and included physical activity (MeSH); exercise (MeSH). The third category was used to hone in on the design of the study and included intervention (MeSH); study (MeSH). We also systematically searched reference lists of included studies, and reference lists of broader technology-related systematic reviews.

Inclusion criteria for studies for the integrative review were: (1) peer-reviewed and published in English; (2) included adults (>18 years old); (3) used text messaging as an intervention to

increase physical activity or exercise; and (4) physical activity or exercise was an outcome variable. Intervention studies included in the systematic review needed to be at the experimental level, since conducting an intervention is a part of the PICO question (Joanna Briggs Institute, 2011a). Studies that met the inclusion criteria and were published before October 1, 2011 were included for review. No starting publication date limitation was applied since publications on text messaging used as a research tool have only appeared in the past decade. Only studies of adults were included because the target population for this systematic review is adults, and text message usage varies significantly between (1) adolescents and teenagers and (2) adults (Lenhart, Ling, Campbell, & Purcell, 2010). Studies were excluded if they focused exclusively on disease rehabilitation, because recommendations for physical activity for persons with chronic diseases such as respiratory or end-stage cardiovascular disease can vary considerably from generally recommended, moderate intensity, physical activity guidelines (Abdool Gaffar et al., 2011; Boulet, Devlin, & O'Donnell, 2011; Jessup et al., 2009; U.S. Department of Health and Human Services, 2008).

The initial search resulted in the identification of 200 publications of which 67 were duplicate titles (Figure 1). The 133

unique titles were then read by two of the authors independently to determine if they met the inclusion criteria. Based on this title review, 71 publications did not meet inclusion criteria, with the majority of these (41) being excluded because they did not include a physical activity text messaging intervention. Of the remaining 62 publications, abstracts were then reviewed independently by the two reviewers. Forty-three of these abstracts were excluded because they did not meet inclusion criteria, again with the majority of these exclusions (32) being related to having no physical activity text messaging intervention present in the study.

Full-text retrieval was conducted for the 19 remaining papers. The two reviewers independently reviewed the complete paper to assess fit with the inclusion criteria. The authors discussed cases where there was a lack of consensus on the appraisals. Eight of the 19 full-text retrieved studies did not meet inclusion criteria. Of these, four did not have a text messaging intervention (Bexelius et al., 2010; Gerber et al., 2009; Lee, Chae, Kim, Ho, & Choi, 2010; Monteiro et al., 2011) and four did not measure PA as an outcome (Joo & Kim, 2007; Kim & Jeong, 2007; Kwon et al., 2004; Patrick et al., 2009). Of the remaining 11 publications, two papers described the same study (Fukuoka, Kamitani, Dracup, & Jong, 2011; Fukuoka,

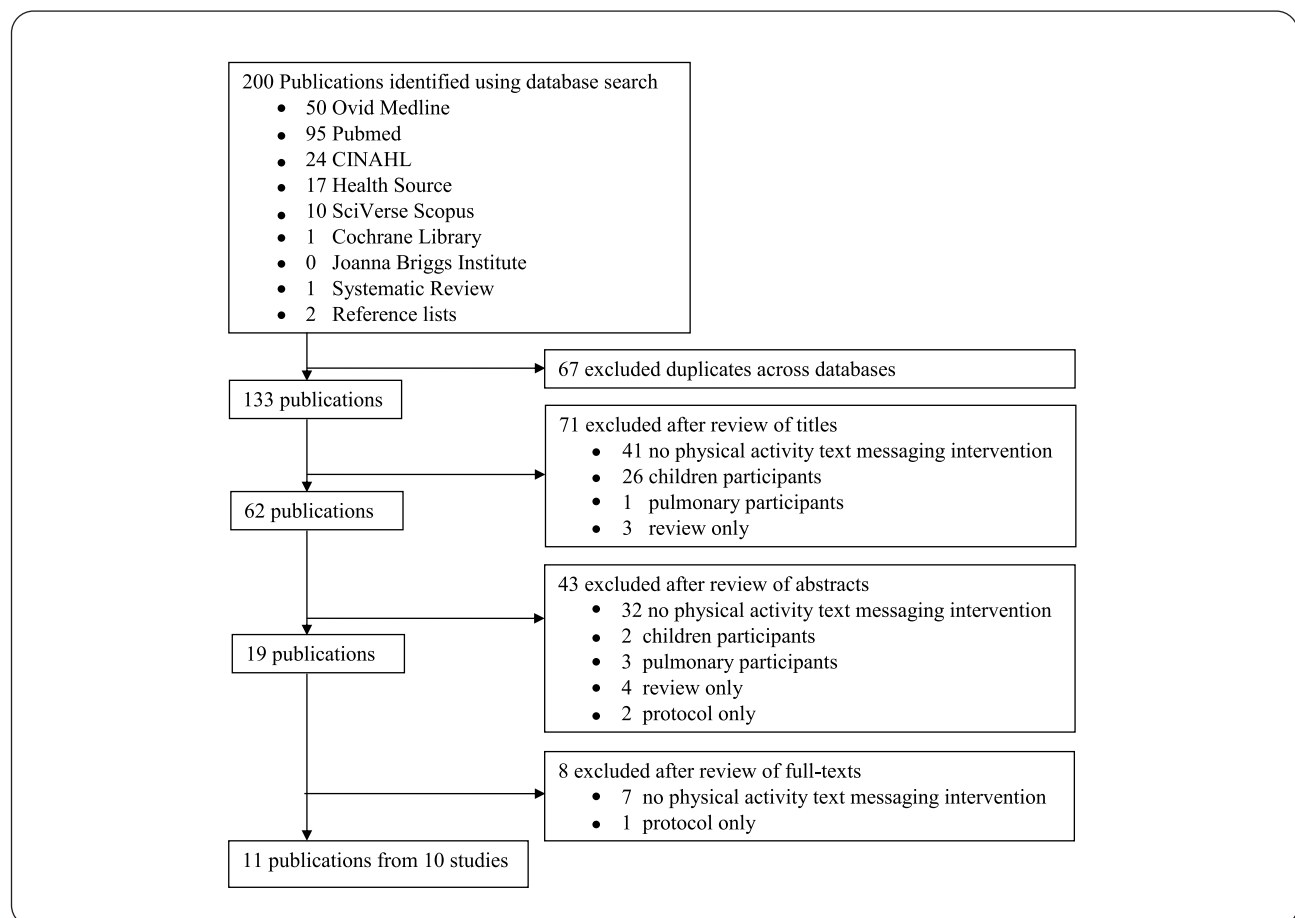


Figure 1. Flow chart of search and retrieval process and results.

Table 1. Design, Duration, Demographics and Physical Activity (PA) Measure

Author (Year), Country	Design and Duration	Participant Demographics	Physical Activity Measure
Cheung, Chow, and Parfitt (2008), Hong Kong	Randomized controlled trial 6 weeks	<i>N</i> = 52 Asian Teachers (41 females, 11 males), age <i>M</i> = 26.5 (<i>SD</i> 1.9)	Pedometer steps/minutes worn for 5 days pre- and post-intervention
Fjeldsoe, Miller, and Marshall (2010), Australia	Randomized controlled trial 12 weeks	<i>N</i> = 88 post-natal Australian females age <i>M</i> = 31 (<i>SD</i> 6)	Self-reported days/week of ≥ 30 minutes and minutes/week of moderate/vigorous PA or walking, at baseline, 6 and 13 weeks
Fukuoka et al. (2010, 2011), USA	Single group 3 weeks	<i>N</i> = 41 sedentary female 59% minorities, age <i>M</i> = 48.4 (<i>SD</i> 13.1)	Pedometer steps/day for 3 weeks pre- and post-intervention; self-reported 7-day Physical Activity Recall (kcal/kg/day) pre- and post-intervention
Haapala, Barengo, Biggs, Surakka, and Manninen (2009), Finland	Randomized controlled trial 52 weeks	<i>N</i> = 125 overweight Europeans (96 females, 28 males/ 1 not reported), age <i>M</i> = 38 (<i>SD</i> 4.7)	Self-reported frequency of leisure time physical activity measured by a single Likert Scale item pre- and post-intervention
Hurling et al. (2007), UK	Randomized controlled trial 9 weeks	<i>N</i> = 77 healthy mainly white adults (51 females, 26 males), age <i>M</i> = 40.1 (<i>SD</i> 7.7)	Accelerometer minutes/day at 3 to 6 MET ^a level at 3 weeks pre- and post-intervention; self-reported MET/minutes measured by the International Physical Activity Questionnaire pre- and post-intervention
Kim, Kim, and Ahn (2006), South Korea	Single group 12 weeks	<i>N</i> = 33 adults with type 2 diabetes (19 females, 14 males), age <i>M</i> = 43.5 (<i>SD</i> 12.6)	Self-reported days/week ≥ 30 minutes of physical exercise or walking from a single item pre- and post-intervention
Lee, Lee, Jeon, Hong, and Park (2011), South Korea	Quasi-experimental 12 weeks	<i>N</i> = 51 Asian females, age <i>M</i> = 45	Self-reported minutes/day of walking pre- and post-intervention
Prestwich, Perugini, and Hurling (2009), UK	Randomized controlled trial 4 weeks	<i>N</i> = 155 college students (90 females, 65 males), age <i>M</i> = 23.76 (<i>SD</i> = 4.64)	Self-reported times/week of moderate intensity exercise measured pre- and post-intervention
Prestwich, Perugini, and Hurling (2010), UK	Randomized controlled trial 4 weeks	<i>N</i> = 149 United Kingdom college students (95 females, 54 males), age <i>M</i> = 23.44 (<i>SD</i> = 5.63)	Self-reported days/week of ≥ 30 minutes of brisk/fast walking and exercise as measured by Self-Report Walking and Exercise Tables pre- and post-intervention
Rossi et al. (2010), Italy	Single group 20 weeks	<i>N</i> = 140 overweight or obese Italian adults (86 females, 54 males), age <i>M</i> = 45.1 (<i>SD</i> 12.4)	Self-reported physical activity as light, moderate and intense pre- and post-intervention

^aMET = metabolic equivalent of task.

Vittinghoff, Jong, & Haskell, 2010). Thus, 11 published papers representing 10 studies were included in the final review.

Measures

The studies in the systematic review were abstracted and examined by selected variables using an author-developed data collection tool (Katrak, Bialocerkowski, Massey-Westropp,

Kumar, & Grimmer, 2004; Oxford Centre for Evidence-based Medicine, 2009). We documented the first author, year of publication, country, design and duration of the study, participant demographics and physical activity measure used (see Table 1). We described the intervention and control groups, and, when available, the number of text messages. In these text messaging interventions, texts were received as well as sent. Each article was appraised to assess if the intervention had an indialer

and/or outdialer feature in their intervention. An indialer feature was present when the participants had to dial or text in on their cell phone and answer specific questions, put in steps, or respond to questions about their physical activity. An outdialer feature was present when the participant received reminders and/or tips to become more physically active. We also provided an effect size for each intervention (see Table 2).

Analytic Strategy

All three authors reviewed the 11 publications included in the final review, and checked for coding inconsistencies. Because the outcome of physical activity lacked statistical homogeneity in that it was not studied using the same measure in all of the retrieved studies, a formal meta-analysis was not possible. Therefore, narrative tables used for data extraction were utilized to display information retrieved from data extraction (Joanna Briggs Institute, 2011b). In addition, effect sizes are reported.

RESULTS

Design, Duration, Demographics, and Physical Activity Measures

These physical activity text messaging intervention studies were conducted in seven countries (Table 1). Over half of the studies (6) were randomized controlled trials (Cheung et al., 2008; Fjeldsoe et al., 2010; Haapala et al., 2009; Hurling et al., 2007; Prestwich et al., 2009, 2010). One study was quasi-experimental (Lee et al., 2011), and the remaining three were single group studies (Fukuoka et al., 2010; Kim et al., 2006; Rossi et al., 2010). The duration of the text messaging interventions ranged from 3 to 52 weeks (mean = 13.4); only one study lasted a full year (Haapala et al., 2009). In all of the studies, the intervention was conducted throughout the entire length of the studies. However, the studies that used pedometers or accelerometers had pre- and post-intervention measures for 5 days to 3 weeks.

For three of the studies, the samples included only women (Fjeldsoe et al., 2010; Fukuoka et al., 2010; Lee et al., 2011). The participants of the other seven studies were predominantly women (Cheung et al., 2008; Haapala et al., 2009; Hurling et al., 2007; Kim et al., 2006; Prestwich et al., 2009, 2010; Rossi et al., 2010). Ages ranged from a mean of 23 years to a mean of 48 years. Two studies focused on overweight adults (Haapala et al., 2009; Rossi et al., 2010). One study was centered on diabetic adults (Kim et al., 2006), one study examined sedentary females (Fukuoka et al., 2010) and another study focused on post-natal females (Fjeldsoe et al., 2010). Teachers made up one sample (Cheung et al., 2008) while two samples were college students (Prestwich et al., 2009, 2010). The sample size range in the studies was 33–155.

One type of outcome measure was self-reported minutes of physical activity or self-reported frequency of physical activity (Fjeldsoe et al., 2010; Haapala et al., 2009; Kim et al., 2006; Lee et al., 2011; Prestwich et al., 2009, 2010; Rossi et al., 2010). The second type of physical activity measure was

recorded steps using either a pedometer or an accelerometer (Cheung et al., 2008; Hurling et al., 2007). Six studies examined physical activity as a primary outcome (Cheung et al., 2008; Fjeldsoe et al., 2010; Fukuoka et al., 2010; Hurling et al., 2007; Prestwich et al., 2009, 2010). The remaining four studies included physical activity as one of the health behaviors used for weight management (Table 1) (Haapala et al., 2009; Kim & Jeong 2007; Lee et al., 2011; Rossi et al., 2010). Several social psychology theoretical frameworks were utilized in the studies, including Social Cognitive Theory (Fjeldsoe et al., 2010), Self-efficacy (Fukuoka et al., 2010; Haapala et al., 2009), the Transtheoretical model (Cheung et al., 2008), Protection Motivation Theory (Prestwich et al., 2009), Health Belief Model (Prestwich et al., 2010) or a combination of theoretical models including Social Comparison, Decisional Balance, Elaboration Likelihood and Goal (Hurling et al., 2007).

Physical Activity Text Message Interventions

Interventions ranged from only sending out physical activity text messages (Fukuoka et al., 2010; Haapala et al., 2009; Kim & Jeong, 2007; Prestwich et al., 2009, 2010), to combining text messages with educational materials (Cheung et al., 2008; Lee et al., 2011), as well as providing counseling sessions delivered by healthcare providers and staff (Table 2) (Fjeldsoe et al., 2010; Rossi et al., 2010). Two studies combined a text messaging intervention with Internet technology (Hurling et al., 2007; Kim & Jeong 2007).

Only one of the studies provided information on the actual number of text messages developed for the study, which was 12 (Cheung et al., 2008). One study noted that they used 42 text messages per participant, but did not state from how large of a text messaging database these specific text messages were retrieved from (Fjeldsoe et al., 2010). Only one study discussed how the text messages were developed. Fjeldsoe et al., (2010) used focus groups and phone interviews, and then conducted a pilot study to develop the text messages used in their study. However, the remainder of the studies did not provide information on text message development (Cheung et al., 2008; Fukuoka et al., 2011; Haapala et al., 2009; Hurling et al., 2007; Kim & Jeong 2007; Lee et al., 2011; Prestwich et al., 2009, 2010; Rossi et al., 2010). Text messaging content varied significantly with the majority of content focusing on the benefits of physical activity, how to overcome barriers, and other advice regarding physical activity (Cheung et al., 2008; Fjeldsoe et al., 2010; Haapala et al., 2009; Hurling et al., 2007; Kim & Jeong 2007; Rossi et al., 2010). Motivational messages were also sent to study participants (Fukuoka et al., 2011; Kim & Jeong 2007; Lee et al., 2011). The other category of text messaging content centered on sending out physical activity goals and reminders (Fukuoka et al., 2011; Prestwich et al., 2009, 2010). Generally, text messages were sent to participants one to four times a week, however, several studies sent a variable amount of text messages, depending on participant preference.

Almost half (four) of the studies utilized both indialer and outdialer features (Table 2) (Fukuoka et al., 2010; Haapala et al.,

Table 2. Physical Activity (PA) Text Message (TM) Intervention

Author (Year),	Intervention (I) and Control (C)	TM Number	Indialer				Outdialer			Effect Size (d)
			Present	Answer Questions	Report Steps	Feedback	Present	Reminder	Tips	
Cheung et al. (2008)	I: TM 3 times/week, educational leaflets; pedometers C: Pedometers	12	No	–	–	–	Yes	No	Yes	0.29
Fjeldsoe et al. (2010) ^a	I: One individualized PA consult plus one phone consult at 6 weeks, TM 3–4 times/week C: One standard PA consult	42	No	–	–	–	Yes	No	Yes	1.21
Fukuoka et al. (2010, 2011)	I: Daily TM prompts, weekly TM feedback on steps C: None	–	Yes	Yes	Yes	Yes	Yes	Yes	Yes	0.26
Haapala et al. (2009)	I: Weight-loss program, 1 st TM initiated by participant with tailored response, variable frequency of TM/week C: No intervention	–	Yes	No	No	Yes	Yes	No	Yes	0.50**
Hurling et al. (2007)	I: Weekly TMs and Internet messages C: No intervention	–	Yes	No	No	Yes	Yes	Yes	Yes	2.22
Kim et al. (2006)	I: Weekly TMs C: None	–	No	–	–	–	Yes	–	Yes	0.50**
Lee et al. (2011)	Two Intervention Groups I-1: Group workshops, phone counseling and bi-weekly TM I-2: Exercise group C: None	–	No	–	–	–	Yes	No	Yes	0.47**
Prestwich et al. (2009) ^b	Three Intervention and Two Control Groups I-1: Implementation intentions and TM I-2: Implementation intention – read motivational message I-3: Read motivational TM, asked if/when wanted TMs C-1: Only completed measures, no TM C-2: Completed measures & read motivational message	–	No	–	–	–	Yes	Yes	Yes	0.40
Prestwich et al. (2010)	Two Intervention and One Control Groups I-1: Implementation intention plus TM plan reminder I-2: Implementation plus TM goal reminder C: No implementation intention or TM	–	No	–	–	–	Yes	Yes	Yes	0.64
Rossi et al. (2010)	I: TM communication with dietician C: None	–	Yes	No	No	Yes	Yes	No	Yes	0.68**

**estimated.

^aTM development based on focus groups and phone interviews.^bParticipants developed their own TM.

2009; Hurling et al., 2007; Rossi et al., 2010). The other six studies had only an outdialer feature (Cheung et al., 2008; Fjeldsoe et al., 2010; Kim & Jeong 2007; Lee et al., 2011; Prestwich et al., 2009, 2010). The indialer feature was mainly used by the participants to provide feedback to the researchers regarding their physical activity behavior (Fukuoka et al., 2010; Haapala et al., 2009; Hurling et al., 2007; Rossi et al., 2010). One study used the indialer feature to also have the participants answer specific questions and report their step count recorded on a pedometer (Fukuoka et al., 2011). All of the studies used text messaging to provide tips. Four of the studies used text messages to send participant-specific reminders (Fukuoka et al., 2010; Hurling et al., 2007; Prestwich et al., 2009; Prestwich et al., 2009).

We determined effect sizes (Cohen's *ds*) for differences in change scores for the text messaging condition versus the control condition. Effect sizes were all greater than 0.20 and the median was 0.50, a medium effect size (Cohen, 1988). Two studies had effect sizes greater than 1.00 (Fjeldsoe et al., 2010; Hurling et al., 2007). There was no obvious reason why these two studies had such a powerful effect size, compared with the other eight studies.

DISCUSSION

To date, using text messaging as a method to promote physical activity has only been studied by a small group of researchers across four continents. These 10 physical activity text messaging studies represent only a seminal literature in this important field of research. The use of mobile technology has exploded globally in the past few years (Radwanick, 2011) and will significantly increase the possibilities of different mobile technology methods that healthcare providers can utilize to be able to communicate with their patients. It is imperative that this body of literature be expanded in the near future to facilitate the expansion of this new technology.

Text Message Development

The majority of studies in this systematic review did not provide detailed information on how text messages were developed for their interventions. Tapping into the intervention participant population for text message development is an important first step in a physical activity text messaging intervention. This is especially true given that tailored physical activity counseling has been shown to be more efficacious than general physical activity counseling (VanWormer et al., 2009). The small number of studies that have conducted formative research to develop physical activity text messages successfully obtained these text messages using both phone and in-person interviews and focus groups (Fjeldsoe et al., 2010; Gerber et al., 2009; Patrick et al., 2009). Specific vulnerable populations, however, have not yet been included in this body of research. For example, researchers have not tailored text messaging to the needs of low-income populations, even though in the United States, adults with lower income levels (household incomes of less

than \$30,000) are more likely to text (58.7%) than adults at the higher end of the income scale (household incomes of \$75,000+; 31.9%) (Smith, 2011). In fact, vulnerable populations until recently have remained understudied in the area of physical activity intervention research in general, and need to be specifically targeted in well-designed methodologically strong studies (Marcus et al., 2006).

Duration and Follow-Up of Studies Using Physical Activity Text Messaging

There is a need to examine interventions over a longer period of time, after the opportunity of adoption of a behavior (around 6 months) has occurred (Marcus et al., 2006; Wilbur, Vassalo, Chandler, McDevitt, & Miller, 2005). Unfortunately, none of the studies demonstrated any long-term follow-up beyond 1 year. Indeed, the majority of studies were 15 weeks or less in duration. These short durations are likely to be due, at least in part, to the newness of using text messaging as an intervention to affect physical activity. Nevertheless, research is needed on the long-term maintenance of physical activity behaviors after a text messaging intervention (Eakin, Glasgow, & Riley, 2000; Gourlan, Trouilloud, & Sarrazin, 2011; Marcus et al., 2006). For example, if short-term adoption of physically active behaviors occurs during a text messaging intervention, but long-term physical activity is not maintained, then perhaps a cost-effective remedy might be something simple such as sending out booster text messages to encourage patients to maintain established physical activity programs.

Ecological Momentary Assessment via Pedometer Feedback

In these studies, text messaging was primarily used to give cues or messages for being more physically active or as part of a weight reduction program. Researchers have not explored text messaging as a self-monitoring tool. It could be used to enter step counts and provide feedback to researchers or healthcare givers on physical activity. Ecological momentary assessment, which examines a participant's behavior repeatedly, in real time and in their own setting, (Shiffman, Stone, & Hufford, 2008) could potentially be accomplished by using pedometers or accelerometers. Evidence is emerging that ecological momentary interventions can be successfully delivered using mobile technology (Heron & Smyth, 2010). For example, pedometer data downloaded directly provides an additional measure of physical activity accrued in addition to self-reports, and provides cross-validation of study findings (Prince et al., 2008).

Using Text Messaging on Physical Activity as a Supplemental Therapy

To date, physical activity text messaging has not been studied when the messaging is used to supplement periodic counseling sessions. Because of the cost and time barriers that exist in primary care settings, it is imperative to find methods to communicate with patients that are cost-effective and

efficient. Mobile health technology may provide healthcare providers with additional methods to reinforce physical activity counseling delivered at in-person visits. Combining physical activity counseling at routine healthcare visits with daily pedometer use and additional reminders, such as intermittent text messages, could provide participants with several opportunities to remember and act upon the need to engage in regular physical activity (Heesch, Dinger, McClary, & Rice, 2005; Klasnja & Pratt, 2011). Another potential method of supplementing physical activity text messaging can be done with healthcare providers providing telephone counseling sessions using motivational interviewing strategies (Levensky, Forcehimes, O'Donohue, & Beitz, 2007; Martins & McNeil, 2009).

Lack of Attention Control Groups in Physical Activity Text Messaging Studies

Although prior studies found significant changes in physical activity due to the text messaging interventions, they were confounded by the lack of an attention control group. Although one of the studies examined different types of interventions against different control groups (Prestwich et al., 2009), none of the studies used an equivalent time/attention control group. Texts that merely provide attention have been used in studies examining health prevention programs, i.e., smoking cessation (Whittaker et al., 2011). Such attention text messages now need to be tested in physical activity research to assess if physical activity improvement occurs because of the specific message, or simply because participants are receiving additional attention from a research team.

CONCLUSIONS

The practice of using text messaging as a way for healthcare providers to communicate with their patients is just beginning to emerge. The small number of intervention studies conducted with physical activity text messaging shows promising early results in improving physical activity outcomes. However, the current literature is characterized by small sample sizes, heterogeneous (but positive) effect sizes, and a lack of specificity as to the characteristics of the text messages used in these studies. In addition, there is a need for examining the cost-effectiveness of delivering interventions through text messaging, especially in conjunction with clinical practice. Physical activity text messages offer an innovative strategy for increasing physical activity and combating the growing epidemic of obesity and chronic diseases. **WVN**

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