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Text Messaging-Based Smoking Cessation Intervention: A Narrative Review

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Abstract

Introduction—Smoking cessation interventions delivered via text messaging on mobile phones may enhance motivations to quit smoking. The goal of this narrative review is to describe the text messaging interventions' theoretical contents, frequency and duration, treatment outcome, and sample characteristics such as age and motivation to quit, to better inform the future development of this mode of intervention.

Methods—Studies were included if text messaging was primarily used to deliver smoking cessation intervention and published in English in a peer-reviewed journal. All articles were coded by two independent raters to determine eligibility and to extract data.

Results—Twenty-two studies described 15 text messaging interventions. About half of the interventions recruited adults (ages 30–40s) and the other half targeted young adults (ages 18–29). Fourteen interventions sent text messages during the quit phase, 10 had a preparation phase and eight had a maintenance phase. The number of text messages and the duration of the intervention varied. All used motivational messages grounded in social cognitive behavioral theories, 11 used behavioral change techniques, and 14 used individually tailored messages. Eleven interventions also offered other smoking cessation tools. Three interventions yielded smoking cessation outcomes greater than the control condition.

Conclusions—The proliferation of text messaging in recent years suggests that text messaging interventions may have the potential to improve smoking cessation rates. Detailed summary of the interventions suggest areas for future research and clinical application. More rigorous studies are needed to identify components of the interventions that can enhance their acceptability, feasibility and efficacy.

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Keywords

Text messaging; mobile phones; smoking cessation intervention; review

1. Introduction

Text messaging, also known as short message service (SMS), is an increasingly available and affordable method of communication for many individuals. In the United States, monthly text messaging increased ten-fold from 19 billion in 2006 to 193 billion in 2011 (CTIA The Wireless Association, 2011). The popularity of text messaging and accessibility to mobile phone technology is likely to increase and become a mainstream way of communication and it has great potential to deliver health care and promote behavior change in many individuals, including vulnerable populations. It has been utilized to increase physical activity (Hurling et al., 2007), to improve outcomes in medication compliance (Andrade et al., 2005), and to manage asthma and diabetes (Kim & Kim, 2008; Ostojic et al., 2005). This popular communication technology may also be promising for smoking cessation (Whittaker et al., 2009; Whittaker et al., 2012).

Tobacco use is the leading cause of preventable disease worldwide (World Health Organization, 2009), and existing interventions aimed to reduce tobacco use rates have limited success. In the United States, 70% of adult smokers want to quit smoking but about 52% actually attempt to quit and only 6% are successful (Centers for Disease Control, 2011; Messer, Trinidad, Al-Delaimy, & Pierce, 2008). These rates suggest the need to develop effective and innovative interventions that appeal to smokers and can enhance treatment delivery.

Smoking cessation interventions delivered via text messaging may increase treatment accessibility because it requires minimal effort and resources. A recent economic evaluation showed that text-based smoking cessation interventions are cost effective (Guerriero et al., 2012). While traditional face-to-face smoking cessation interventions can be time-consuming and burdensome to both health care providers and clients, text messaging can ease the burden by providing real-time, proactive, and tailored support in a relevant context. Additionally, text messaging may appeal to traditionally hard-to-reach, at-risk populations who experience barriers to smoking cessation interventions, such as adolescents and young adults, socioeconomically disadvantaged individuals and individuals from ethnic/racial minority backgrounds (Cokkinides, Halpern, Barbeau, Ward, & Thun, 2008; Fagan et al., 2004; Garrett, Dube, Trosclair, Caraballo, & Pechacek, 2011), all of whom who have high rates of mobile phone and text messaging use (Smith, 2011).

Several recent reviews have examined the evidence of efficacy of text messaging as a tool for behavior change for an array of targeted behaviors such as disease prevention and management, including smoking cessation (See reviews by Buhi et al., 2012; Cole-Lewis & Kershaw, 2010; Ehrenreich, Richter, Rocke, Dixon, & Himelhoch, 2011; Fjeldsoe, Marshall, & Miller, 2009; Free et al., 2013; Gurman, Rubin, & Roess, 2012; Krishna, Boren, & Balas, 2009; Riley et al., 2011). In order to assess the utility of interventions using text messaging specifically for smoking cessations, we need to broaden our understanding of the specific components of the interventions, for whom and how they can be used, and identify areas to improve already existing interventions and identify future research areas. Thus, we closely examined the collective evidence on the components of the text messaging interventions solely focusing on smoking cessation.

Two meta-analyses (Whittaker et al., 2009; Whittaker et al., 2012) to-date reviewed the efficacy of text messaging interventions for smoking cessation through evaluating publications that met stringent inclusion criteria and which excluded non-randomized, feasibility studies. The earlier publication reviewed four studies and found evidence of short-term self-reported quitting (RR 2.18, 95% CI 1.80 - 2.65) at 4- to 6-week end-of-treatment; however, long-term efficacy could not be determined because of heterogeneity in the outcome measures. Additionally, two of the four studies included in the meta-analysis examined both Internet and text messaging interventions; therefore, making it difficult to attribute the positive treatment effects solely to text messaging. In the subsequent publication, Whittaker et al. (2012) reviewed five studies that primarily used text messaging for smoking cessation and demonstrated evidence supporting efficacy up to six months (RR 1.71, 95% CI 1.47 - 1.99). The results of these meta-analyses indicated that text messaging intervention may be a promising tool for improving smoking cessation outcomes; however, research synthesizing the components of the interventions to inform clinicians and researchers and improve feasibility and efficacy is lacking. Better understanding of these factors may also improve currently existing interventions. Ybarra et al. (2012) and Cole-Lewis and Kershaw (2010) have noted that because text messaging is an intervention delivery tool, attention to factors such as how the messages are tailored and provided to various target groups needs to be carefully considered. Thus, this current narrative review attempts to expand upon the meta-analyses of the efficacy of smoking cessation interventions by Whittaker et al. (2009; 2012) by examining a wide-range of smoking cessation interventions that used text messaging as a treatment delivery tool and describe the components of the interventions, such as the theoretical model in which the message contents were based, frequency of the text messages, duration of the interventions, other treatments offered in conjunction with the text messaging intervention, and treatment outcome rates. To examine these components and given the relative novelty of this mode of intervention delivery, we included all available feasibility and acceptability studies to identify trends in the development of such intervention.

2. Methods

Terms related to text messaging such as, “short message service (SMS)” “text message,” “txt,” “multimedia messaging service (MMS),” “mobile phone,” and “cellular phone” combined with “smoking,” “tobacco,” “cigarette,” and “cessation,” published in English in a peer-reviewed journals were searched using Medline, PsycINFO, Scopus, and Google Scholar in June 2013. Relevant reference lists were also reviewed to uncover additional articles. We identified 142 studies through the searches and first excluded the articles if their primary focus was not smoking cessation, then remaining articles were excluded if they did not provide a description of a smoking cessation intervention, and finally, articles were excluded if text messaging was not used to deliver the intervention (See Figure 1). Two reviewers (GK and DE) independently determined eligibility and two reviewers (GK and DC) coded the eligible articles on baseline sample characteristics (age, baseline smoking, and motivation to quit) and intervention related themes, such as the location, mobile phone requirements, text messaging frequency, duration of the treatment, treatment outcome rates, message contents and their theoretical models, and other types of smoking cessation treatments offered. Any differences were discussed and resolved through additional reviews.

3. Results

Table 1 describes the intervention and participant characteristics and Table 2 describes the specific text message components.

3.1 Study/Intervention Characteristics

Twenty-two studies described 15 text messaging interventions for smoking cessation. Five interventions (Happy Ending, STUB IT, Txt2Stop, Unspecified 1, Unspecified 2 [see Table 1 for citations]) have two published articles each describing the intervention, with the earlier publication reporting pilot data or data from a smaller trial. Two interventions (STOMP, OnQ) have two publications using the same data but comparing different groups. For instance, Rodgers et al. (2005) reported the primary outcomes of the STOMP intervention of the overall sample and Bramley et al. (2005) compared the treatment effects between Maori (the indigenous group in New Zealand) and non-Maori populations. Two publications using the same data described OnQ, with one (Balmford, Borland, Benda, & Howard, 2013) reporting acceptability of the intervention and the other (Borland, Balmford, & Benda, 2012) reporting the treatment outcome of the randomized control trials (RCT). Of the 15 interventions, five (Quittext, RPI for NHSSSS, Text2Quit, Unspecified 2, Unspecified 3) were feasibility studies that did not include a control condition and 10 were randomized control studies (Happy Ending, iQuit, MiQuit, OnQ, STOMP, SMS Turkey, SMS USA, STUB IT, Txt2Stop, Unspecified 1). Two interventions did not provide treatment outcome data (iQuit, Text2Quit).

The sample sizes of the RCT were large (ranging from $n = 151$ (Ybarra, Baci Bosi, Korchmaros, & Emri, 2012) to $n = 5,800$ (Free et al., 2011)) and the single group feasibility studies were smaller (ranging from $n = 15$ (Whittaker et al., 2008) to $n = 202$ (Snuggs et al., 2012)). All studies were published between 2004 and 2013, with about half of the studies ($n = 12$) were published in 2011 and later (Balmford et al., 2013; Borland et al., 2012; Free et al., 2011; Haug, Meyer, Dymalski, Lippke, & John, 2012; Jamison, Sutton, & Gilbert, 2012; Naughton, Prevost, Gilbert, & Sutton, 2012; Pollak et al., 2013; Snuggs et al., 2012; Sutton et al., 2013; Whittaker et al., 2011; Ybarra, Baci Bosi, et al., 2012; Ybarra, Holtrop, Prescott, Rahbar, & Strong, 2013).

3.2 Sample Characteristics

Six interventions recruited general adult population ranging from ages 30 to 43 (Happy Ending, OnQ, Quittext, RPI for NHS-SSS, SMS-Turkey, Txt2Stop), seven recruited younger population between ages 18 and 29 (STOMP, SMS USA, STUB IT, Text2quit, Unspecified 1, Unspecified 2, Unspecified 3), one targeted adult pregnant women (average age 26.8; MiQuit), and one did not provide participant age (iQuit).

One intervention recruited participants who were already abstinent for a relapse prevention study (RPI for NHS-SSS) and another intervention (OnQ) recruited both current (87.6%) and former smokers (12.6%). The remaining 13 interventions recruited current smokers with varying baseline smoking rates: six interventions included average baseline number of cigarette smoking per day to be about 10 or greater (Happy Ending, STOMP, SMS Turkey, SMS USA, Unspecified 1, Unspecified 2) and seven reported daily or current smoking with fewer than 10 cigarettes per day (iQuit, MiQuit, Quittext, STUB IT, Text2Quit, Txt2Stop, Unspecified 3). Of these 13 interventions, all except for one (Unspecified 1) recruited smokers who were willing to quit smoking. Unspecified 1 intervention recruited young adult smokers with varying levels of motivation to quit and tailored the intervention to their level.

All interventions required participants to have their own mobile phones with text messaging capabilities. One intervention (STUB IT) that also used video messages required participants to have video messaging capabilities. Two interventions reimbursed participants with mobile phone-related costs. Txt2stop intervention provided monetary vouchers for those who had pay-as-you-go services and STOMP provided free month of outgoing text messages for participants.

The location of the interventions varied: eight were conducted in Europe (Happy Ending, iQuit, MiQuit, Quittext, RPI for NHS-SSS, SMS-Turkey, Txt2stop, Unspecified 1), one in Australia (OnQ), two in New Zealand (STOMP, STUB IT), and four in the United States (SMS USA, Text2Quit, Unspecified 2, Unspecified 3).

3.3 Message Content

See Table 2 for the description of the theoretical models in which the contents of the text messages were based, frequency and duration of the text messages, and other smoking cessation interventions offered. All interventions used standard text messages to deliver motivational messages grounded in cognitive behavioral and social cognitive theories that focused on increasing self-efficacy and provided encouragements to motivate quit smoking or maintain quit status. One intervention used role modeling videos for observational learning and enhancing self-efficacy as well as the anti-tobacco video clips from the “truth” campaign (STUB IT). Eleven interventions (iQuit, OnQ, Quittext, STOMP, SMS Turkey, SMS USA, STUB IT, Text2Quit, Txt2Stop, Unspecified 1, Unspecified 3) also used behavior change techniques and provided smoking quit tips, such as identifying triggers for smoking and applying coping strategies when experiencing cravings to smoke.

3.4 Individual Tailoring

All interventions except for one (Happy Ending) provided the option to receive instant support by texting preset words. Some examples of these words included, “CRAVE” to receive immediate tips on how to deal with cravings, “RELAPSE” to get assistance on how to reset a quit date and receive motivational messages, and “GOALS” to track smoking against preset goals. Eight interventions (iQuit, MiQuit, Quittext, STOMP, Text2Quit, Txt2Stop, Unspecified 1, Unspecified 2) tailored the text messages by incorporating participant’s responses to the smoking and other related questions at baseline. For example, high risk times for smoking were identified prior to treatment and text messages were sent during those times. Other tailoring included message contents relevant to the stages of quit status or motivation to quit status (OnQ, SMS Turkey, SMS USA, MiQuit, Quittext, Text2Quit, Unspecified 1), addressing the participant by a nickname of his/her choice (STOMP), having a fictitious peer ex-smoker who is matched on gender offering support via text messages (Text2Quit), and choosing a role model who sends motivational messages (STUB IT).

3.5 Format and Duration of the Interventions

The format and the duration of the text message interventions varied. Ten interventions (Happy Ending, OnQ, SMS Turkey, SMS USA, STOMP, STUB IT, Text2Quit, Txt2Stop, Unspecified 2, Unspecified 3) had a preparation phase one to four weeks prior to quitting in which messages were focused on increasing motivation to quit leading up to a quit date. Fourteen interventions (Happy Ending, iQuit, MiQuit, Quittext, OnQ, SMS Turkey, SMS USA, STOMP, STUB IT, Text2Quit, Txt2Stop, Unspecified 1, Unspecified 2, Unspecified 3) had an active quit phase that ranged from 1 to 13 weeks when participants were actively quitting. The number of text messages sent to participants in both phases ranged from nine text messages per day to three per week, with the frequency increasing during the active quit phase. Eight interventions (Happy Ending, OnQ, RPI for NHS-SSS, SMS Turkey, SMS USA, STOMP, STUB IT, Txt2Stop) had a maintenance phase that lasted from 4 days to 26 weeks when the frequency of text messages generally decreased from about one to four messages per day to three per week with the goal of maintaining the quit smoking status. Of the eight interventions, one (RPI for NHS-SSS) was primarily focused on relapse prevention and recruited former smokers who had been abstinent for four weeks prior to enrolling in the study, and once enrolled, text messages were sent once a week focusing on remaining abstinence for 12 weeks and then fortnightly for six months.

3.6 Treatment Outcomes

Nine interventions (Happy Ending, MiQuit, OnQ, SMS Turkey, SMS USA, STOMP, STUB IT, Txt2Stop, Unspecified 1) reported the quit rates of treatment and control conditions, and of those, five verified self-reported abstinence with either carbon monoxide or cotinine levels (MiQuit, STOMP, SMS Turkey, STUB IT, Txt2Stop). Three interventions (Happy Ending, STOMP, Txt2Stop) yielded smoking cessation outcome rates greater than the control conditions. Of these, one intervention (STOMP) reported biochemically confirmed 7-day point prevalence abstinence to be significantly greater than the control condition at 6 weeks and another (Txt2Stop) at 6 months, and one intervention (Happy Ending) did not biochemically confirm abstinence but found self-reported abstinence to be significantly higher in the intervention group compared to the control group up to 12 months. Five interventions (Quittext, RPI for NHS-SSS, Text2Quit, Unspecified 2, Unspecified 3) reported quit rates without comparison groups, and of those, two interventions (RPI for NHS-SSS, Unspecified 3) biochemically verified abstinence.

Self-reported questions used to assess smoking cessation at the end-of-treatment varied: 7-day point prevalence of abstinence, sustained abstinence, repeated point abstinence number of cigarettes smoked per day, and self-reported quitting. The time period used to determine abstinence also varied, ranging from one week to one year.

3.7 Other Treatments Offered

Four interventions did not offer other types of smoking cessation interventions other than the text messaging intervention (STUB IT, Quittext, Unspecified 1, Unspecified 3). Six interventions (Happy Ending, iQuit, OnQ, SMS USA, Text2Quit, Unspecified 2) used other media communication tools, such as voice recording on mobile phones, e-mail, and website. Three interventions used other smoking cessation treatments, such as self-help booklets on quitting (Happy Ending, MiQuit) and nicotine lozenges (RPI for NHS-SSS), and four interventions incorporated peer supports (STOMP, SMS USA, Txt2stop, Unspecified 2). An example of the peer support component included being paired with a quit buddy with similar smoking characteristics matched on quit day so that they can support each other during quitting via text messaging (STOMP). Three interventions (SMS Turkey, STOMP, Text2Quit, Txt2Stop) did not offer other specific interventions but encouraged the use of other available cessation interventions, such as quit smoking hotlines and nicotine replacement therapy.

4. Discussion

We conducted a comprehensive narrative review of 15 smoking cessation interventions delivered via text messaging on mobile phones (described in 22 studies). Previous meta-analyses of text messaging interventions for tobacco cessation revealed short-term (Whittaker et al., 2009) and long-term efficacy (Whittaker et al., 2012); however, specific components of the interventions and the description of the commonalities and the differences of the interventions and the participants that can improve existing interventions and guide practitioners in the field on how to best use text messaging for smoking cessation are not yet understood. Therefore, we detailed intervention and participant characteristics to outline areas for future research to improve this method of treatment delivery.

4.1 Targeted Populations

One of the potential benefits of the text messaging intervention is the low cost that allows for widespread dissemination to reach vulnerable populations who may be at risk for smoking and who may have difficulty accessing traditional face-to-face smoking cessation interventions, such as adolescents and young adults. Compared to adult smokers, young

adults smokers are less likely to use effective smoking cessation interventions such as pharmacotherapy (Curry, Sporer, Pugach, Campbell, & Emery, 2007). Appropriately, close to half of the interventions in this review targeted young adults (ages 18-29), indicating the utility of using this mode of intervention for this age group. Despite the focus on young adult populations, we observed that very few studies have examined the utility of text messaging interventions for smoking cessation among other vulnerable populations. No interventions targeted adolescents between the ages of 13 and 17. More research is needed to assess whether text messaging intervention can be also used to engage adolescent smokers. Concerted effort at developing innovative and effective smoking cessation and prevention intervention modality for this vulnerable age group is needed given that close to 90% adult smokers initiate smoking before the age of 18 (Centers for Disease Control, 2006). Interventions using technology such as text messaging on mobile phones may be especially appealing to adolescent smokers and increase motivation to quit smoking considering that this age group has high rates of use of communication technology (Smith, 2011).

Women may be another group that could benefit from smoking cessation intervention delivered via text messaging. Only one study (MiQuit, Naughton et al., 2012) targeted the intervention to adult pregnant women. Evidence shows that women have lower quit rates when compared to men (e.g., Piper et al., 2010) and also tend to report more tobacco withdrawal symptoms including negative affect when they are abstinent (Leventhal et al., 2007). Text messaging interventions could be tailored to provide support for such acute abstinence symptoms especially considering that text messaging was considered feasible and acceptable to pregnant smokers (Naughton et al., 2012).

Other groups that may benefit from this mode of intervention are smokers from ethnic/racial minority backgrounds and low socioeconomic status, who despite being at elevated risk for smoking and tobacco-related diseases compared to whites and individuals from high socioeconomic status (Fagan et al., 2004; Garrett et al., 2011), underutilize smoking cessation interventions (Levinson, Pérez-Stable, Espinoza, Flores, & Byers, 2004; Zhu, Melcer, Sun, Rosbrook, & Pierce, 2000). The underutilization of treatment may be related to barriers to treatment such as time and economic constraints, and transportation and childcare issues. Text messaging could reduce some of these barriers to treatment. Contrary to the notion of digital divide that presumes that individuals from low socio-economic class and ethnic/racial minorities are less likely to use electronic devices such as the computer and mobile phones (Wareham, Levy, & Shi, 2004), recent data suggest that individuals from these backgrounds have high rates of mobile phone and text messaging usage, indicating that they may benefit from this type of intervention (Brown, Campbell, & Ling, 2011; Samal et al., 2010). However, studies examining the utility of text messaging in disadvantage groups are lacking. Only one study (Bramley et al., 2005) examined the efficacy of text messaging intervention separately for Maori (indigenous group in New Zealand) and non-Maori individuals and found that both Maori and non-Maori individuals had higher cessation outcomes compared to the rates of the control group at the end-of-treatment at 6 weeks, suggesting that minority groups such as Maori individuals can be engaged in treatment.

Another difficult-to-treat population is smokers who are unmotivated to quit or ambivalent about quitting. All interventions included in this review recruited daily or current smokers motivated to quit, except for one intervention (Unspecified 1) that recruited smokers at different levels of motivations to quit and tailored the content of the text messages to the level of motivation; however, the efficacy of the intervention could not be determined because these trials did not report cessation outcomes. Future studies should continue to examine how smoking cessation messages can be tailored to further enhance motivations to quit smoking and engage smokers at different levels of motivation.

Although young adult and pregnant women were targeted, more studies are needed to examine whether text messaging can be used to increase smoking cessation treatment access in other vulnerable populations and identify ways to improve current interventions to even make it more accessible. For instance, all interventions in this review required participants to have their own phones with text messaging capabilities and only two studies offered some type of reimbursement for their use of text messaging. This requirement may be challenging for certain individuals. Perhaps, making mobile phones and text messaging plans even more affordable by offering free data plans, reimbursements for pay-as-you-go capacities, or offering mobile phones to those without a phone for the duration of the intervention can increase accessibility (Jamison, Naughton, Gilbert, & Sutton, 2013).

4.2 Intervention Components

The frequency of the text messages and the duration of the interventions varied. While all interventions sent text messages during the active quit phase (varying from 1 to 13 weeks), some also used text messaging during the preparation and maintenance phases to prepare smokers to quit smoking and to maintain quit status. It is unclear whether preparation and maintenance phases are necessary. A qualitative study examining the perceptions of text messaging intervention for smoking cessation indicated that smokers prefer to quit immediately without the preparation phase (Bock, Heron, Jennings, Magee, & Morrow, 2013); therefore, it is possible that the preparation phase is unnecessary for smokers who are ready to quit. However, such phase may be encouraging for smokers with low motivation to quit. The maintenance phase may be also important for those who lapse; therefore, the best use of these phases should be further evaluated.

The number of text messages also ranged; some interventions sent nine per day and others sent about three per week, with frequency increasing during the active quit phase and decreasing thereafter. The optimal frequency of the text messages and the optimal length of the intervention remain undetermined. Haug, Meyer, Schorr, Bauer, and Ulrich (2009, Unspecified 1) compared three conditions (one text message per week, three text messages per week and a control condition with no text messages) and found that the number of cigarettes smoked at 3-month post-treatment between the three groups and participant satisfaction ratings between the two treatment conditions did not differ. This study finding suggests that the number of text messages may not be important in determining smoking cessation outcomes; however, it is possible that one to three text messages per week may not be frequent enough to help people quit smoking because neither treatment conditions produced significant quit smoking outcomes compared to the control condition. In contrast, a qualitative study results indicate that smokers prefer to receive fewer text messages per day (Bock et al., 2013). Rather than identifying specified number of texts, texting during appropriate times such as early in the day or at the end of the day and at high-risk situations for smoking may be beneficial (Jamison et al., 2013).

Eleven interventions offered or informed participants to use other tobacco cessation treatments in conjunction with the text messaging intervention, such as peer support through e-mail and website, self-help booklets, or medication. Inclusion of additional treatments makes determining the relative impact of the text messaging intervention difficult. Some evidence suggests that adjunctive smoking cessation treatments may not further improve cessation rates. For example, Txt2Stop encouraged participants to use other smoking cessation interventions, such as telephone helpline and nicotine replacement therapy; however, they found that the use of these adjunctive services did not increase during the treatment phase and text messaging intervention yielded higher quit rate than the control condition. Future studies should try to isolate the effects of text messaging from other types of interventions to determine whether text messaging intervention alone or its use as an add-on to an already existing intervention is more effective.

All the interventions we examined used motivational messages grounded in social cognitive and cognitive behavioral theories, and which focused on increasing self-efficacy to motivate individuals towards quitting or maintaining quit status. Eleven interventions also focused on behavior change techniques, such as identifying triggers for smoking and applying coping techniques like distraction when experiencing cravings to smoke. One of the unique benefits of the text messaging interventions is the ability to tailor the messages to the individual needs and provide assistance in the natural environment. All interventions except for one used individually tailored messages. Tailored messages may be particularly useful for those who lapse and those with low motivation to quit (Strecher, 1999). Qualitative evidence also supports the utility of tailored messages. Smokers preferred to receive messages that include daily, practical tips for dealing with cravings and incorporate personal information, such as personal goals for quitting smoking collected at the onset of treatment (Bock et al., 2013).

4.3 Future Directions & Limitations

As mobile phone technology continues to advance and with the growing popularity of smart phones, text messaging interventions for smoking cessation may also evolve. Currently, all interventions delivered motivational messages via text messaging, therefore, it is difficult to conclude whether it is the text messaging or the contents of the messages or both that is actually helpful in smoking cessation. Future studies should compare text messaging with other intervention modalities to isolate its effect. Perhaps text messaging is an effective tool for disseminating empirically validated behavioral interventions and it could be used to deliver cognitive behavioral therapy using interactive features and adapted to deliver other forms of empirically validated interventions such as contingency management (CM) for smoking cessation. Mobile phones have also been used to deliver contingencies of reinforcement for decreasing other substances such as alcohol (Alessi & Petry, 2013). While most interventions in this review sent standard text messages, other innovative methods like the video messages via mobile phones have also been used. Many more possibilities exist. For instance, incorporating social networking to mobile phones can enhance attractability and usability of the intervention by young smokers (Bock et al., 2013).

This review has several limitations. First, we limited our searches to English-language publications, and given that close to 75% of the text messaging interventions for smoking cessation were developed outside of the United States, and the growing impact of mobile phones in developing countries (James, 2010), there may be other text messaging interventions for smoking cessation developed in other nations and not published in English. Second, we did not provide a quantitative review of the treatment outcomes because of the inclusion of single-group feasibility studies. Our primary goal was to describe the components of text messaging interventions by examining a wide range of interventions at different developmental stages to understand how text messaging can be used for smoking cessation and detect trends in this area of research. As evidenced by this study, many interventions are in the developmental stages and data are still emerging. Future studies that are sufficiently powered with rigorous methodology and biochemical measures to confirm abstinence as well as appropriate follow ups are needed to further test text messaging as a delivery mechanism for smoking cessation interventions. In this endeavor, through a careful review of up-to-date information we have dissected aspects of text messaging interventions to learn ways to increase participant engagement and efficiently deliver the program content, as well as the actual content of the intervention being delivered.

In summary, this narrative review described the intervention and sample characteristics of smoking cessation interventions using text messaging and identified areas that need further examination to improve the quality of research in this area. Future area for research includes identifying how to increase intervention accessibility to reach vulnerable populations and understanding the components of the intervention to improve its efficacy and feasibility.

Other innovative use for text messaging interventions for smoking cessation is also discussed.

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Highlights

- We reviewed 15 smoking cessation interventions delivered via text messaging.
- All interventions used motivational messages grounded in social cognitive theories
- 11 interventions used behavioral change techniques and 14 used tailored messages.
- The number of text messages and the duration of the intervention varied.
- 3 interventions yielded cessation outcomes greater than the control conditions.

Figure 1.
Reasons for article exclusion

Table 1

Intervention and Participant Characteristics

Intervention (Location)	Authors, year (N)	Design	Participant Age (M, SD)	Baseline smoking: cigarettes/day (M, SD)	Motivated to quit	Access to text messaging	Quit smoking defined	Quit rates	
								Intervention	Control
Happy Ending (Norway)	Brendryen & Kraft, 2008 (N = 396)	RCT	I: 35.9, 10.0 C: 36.4, 10.5	I: 18.3, 5.9 C: 18.1, 5.8	Yes	Yes	Repeated point abstinence at 1, 3, 6, and 12 months. Abstinence at each time point was determined by self-reported 7-day point prevalence abstinence	1 yr: 22.3% *, <i>a</i>	13.1%
	Brendryen et al., 2008 (N = 290)		I: 39.5, 11.0 C: 39.7, 10.8	I: 16.6, 7.2 C: 17.6, 7.0				1 yr: 20.0% *, <i>a</i>	7.0%
iQuit (United Kingdom)	Sutton et al., 2013 (N = 600, anticipated)	RCT	n/a	Daily smokers, at least 1 cigarette/day, anticipated	Yes	Yes	Self-reported prolonged abstinence, CO verified, anticipated	8 wk: n/a 6 mth: n/a	n/a n/a
MiQuit (United Kingdom)	Naughton et al., 2012 (N = 207)	RCT	26.8, 6.3	Median 6-10 (inclusion criteria 7 cigarettes/day)	Yes	Yes	Primary outcome: Self-reported 7-day point prevalence abstinence, Self-reported 7-day point prevalence abstinence, cotinine confirmed	3 mth: 22.9% <i>a</i> 3 mth: 12.5%	19.6% 7.8%
OnQ (Australia)	Borland et al., 2012, Balmford et al., 2013b (N = 3530)	RCT comparing (1) OnQ, (2) QuitCoach (web-based intervention), (3) Integrated (combined OnQ & QuitCoach), (4) Choice (Users choose either or both) (5) control	42.1 (range 18-80)	16.9 (87.4% current smokers) 12.6% former smokers	Yes, and 12.6% already quit within 2 months prior	Yes	Self-reported 6 months sustained abstinence (missing coded as smoking)	7 mo: (1) 9.0% <i>a</i>	(2) 8.7% (3) 8.7% (4) 9.1% (5) 6.2%
Quittext (United Kingdom)	Jamison et al., 2012 (N = 30)	Single arm feasibility	40.0 (SD not provided)	Median 1-10	Yes	Yes	Self-reported quitting	6 wk: 39% (7/18 with complete data) 23% (7/30 recruited)	n/a
RPI for NHS-SSS (United Kingdom)	Snuggs et al., 2012 (N = 202)	Single arm feasibility	43.0 (12.1)	CO validated 4 week abstinent prior to being	Yes	Yes	6-month sustained abstinence, CO validated	6 mth: 18% <i>a</i>	n/a

Intervention (Location)	Authors, year (N)	Design	Participant Age (M, SD)	Baseline smoking: cigarettes/day (M, SD)	Motivated to quit	Access to text messaging	Quit smoking defined	Quit rates	
								Intervention	Control
STOMP (New Zealand)	Rodgers et al., 2005 (N = 1705)	RCT	Median: 22 Mean: 25	15.0, 3.0	Yes	Yes	Self-reported 7-day point prevalence abstinence, cotinine confirmed on randomly selected sample	6 wk: 28.10% ^a	12.8%
	Bramley et al., 2005 ^c (N = 1705)							6 wk: Maori: 26.1% ^a , Non-Maori: 28.6% ^a	11.2% 13.2%
Stop My Smoking (SMS Turkey; Turkey)	Ybarra et al., 2012 (N = 151)	RCT	I: 36.1, 9.5 C: 35.6, 10.3	I: 18.7, 7.2 C: 20.4, 9.2	Yes	Yes	Self-reported 3-month sustained abstinence, CO confirmed	3 mth: 11% ^a	5%
Stop My Smoking (SMS USA; United States)	Ybarra et al., 2013 (N = 164)	RCT	21.6, 2.1	I: 12.4, 6.3 C: 11.9, 5.7	Yes	Yes	Self-reported 3-month sustained abstinence confirmed by significant other	3 mth: 40% ^a	30%
STUB IT (New Zealand)	Whittaker et al., 2011 (N = 226)	RCT	I: 27.9, 9.5 C: 26.6, 7.8	Daily smokers, not specified	Yes	Yes, video message on mobile phone	Self-reported 6-month continuous abstinence, cotinine confirmed	6 mth: 26.4% ^a	27.6%
	Whittaker et al., 2008 (N = 15)	Single arm feasibility	Median: 20-24					4 wk: 69%	n/a
Text2Quit (United States, Washington DC)	Abroms et al., 2012 (N = 23)	Single arm feasibility	20.9 (SD not provided)	5 (SD not provided)	Yes	Yes	n/a	4 wk: n/a	n/a
Txt2Stop ^d (United Kingdom)	Free et al., 2011 (N = 5800)	RCT	I: 36.8, 11.1 C: 36.9, 11.1	Current smoker, not specified	Yes	Yes	Self-reported 7-day point prevalence abstinence, cotinine confirmed	6 mth: 10.7% ^a	4.9%
	Free et al., 2009 (N = 200)		36.0, 9.0	Median 20 (Interquartile range: 12-22)				1 mth: 25.5% ^a	12.2%
Unspecified 1 (Switzerland/Germany)	Haug et al., 2012 (N = 910)	RCT	Adolescents and young adults (age not provided)	daily or occasional smokers (4 cigarettes/m)	No	Yes	n/a	n/a	n/a

Intervention (Location)	Authors, year (N)	Design	Participant Age (M, SD)	Baseline smoking: cigarettes/day (M, SD)	Motivated to quit	Access to text messaging	Quit smoking defined	Quit rates	
								Intervention	Control
Unspecified 2 (United States, Washington DC)	Haug et al., 2009 (N = 174)	3-arm RCT ^e	1 st I: 25.2, 4.8 2 nd I: 24.3, 3.8 C: 25.4, 4.9	1 st I: 12.4, 7.3 2 nd I: 11.2, 6.3 C: 11.7, 7.5			Cigarettes smoked /day (M, SD)	3 mth: Group 1: 10.2, 6.5 Group 2: 9.7, 6.4	9.5, 5.5
	Obermayer et al., 2004 (N = 46)	Single arm feasibility	19.9, 1.5	10.0 (SD not provided)	Yes	Yes	Self-reported 7-day point prevalence abstinence, cotinine confirmed	3 wk: 17% ^a 6 wk: 17%	n/a
	Riley et al., 2008 (N = 31)		18-24 years (age not provided)	32% < 10, 68% > 10 (SD not provided)	Yes			6 wk: 42%	n/a
Unspecified 3 (United States, North Carolina)	Pollak et al. (2013) (N = 31)	2-arm feasibility ^f	Support arm: 27.0, 6.0 Support +SGR arm: 29, 6	Smoked 5 in the prior 7 days before baseline	Yes	Yes	Self-reported 7-day point prevalence abstinence, cotinine confirmed	1 wk: Support: 7.5% Support + SGR: 13.4%	n/a

Note: RCT=randomized control trial, I=intervention, C=control, wk. = week, mth. = month.

* The outcome rates are significantly different from the control condition.

^a Other smoking cessation outcomes are reported in the original article but not reported here.

^a Balmford et al., (2013) reported acceptability of the intervention and Borland et al. (2012) reported the treatment outcome rates.

^c Used the same data as Rodgers et al. (2005) but analysis examined the difference between Maori vs. non-Maori.

^d Not included in this review is Devries et al. (2013)'s analysis of a subset of sample who sent lapse or crave message during the tx2stop trial.

^e 3-arm conditions composed of control and two intervention groups (1st: 1 text message per week vs. 2nd: 3 text messages per week).

^f Both arms examined text messaging components with the Support arm examining text messaging alone and the Support + SGR arm examining text messaging plus a scheduled gradual reduction.

Table 2

Components of the text message intervention for smoking cessation.

Intervention (author, year)	Frequency/Duration	Content/Theory	Individual Tailoring	Other Treatments
Happy Ending (Brendryen et al., 2008; Brendryen & Kraft, 2008)	<ul style="list-style-type: none"> Preparation phase (wks. 1-2): 2 messages/day Quit phase (wks. 3-6): 3 messages/day Maintenance phase (wks. 7-8): decreased from 3 to 1 messages/day <p>Weeks 9-10: 1 message/day Weeks 11-15: 2 messages/wk. Weeks 16-54: 1 message/wk.</p>	<p>Motivational messages utilizing cognitive behavior and social skills training</p>	none	Brendryen & Kraft (2008) trial offered E-mail, webpage, interactive voice response service, and nicotine replacement therapy. Both trials offered self-help booklet on quitting smoking
iQuit (Sutton et al., 2013)	<p>Quit phase (90 days): 0, 1, or 2 messages/day with fewer messages toward the end of the intervention.</p>	<ul style="list-style-type: none"> Motivational messages based on social cognitive theory and behavioral change model Behavior change techniques (e.g., tips to cope with difficult situations) 	<ul style="list-style-type: none"> Tailored to smoking-related baseline characteristics and information collected via text messaging Received instant support by texting HELP, SLIP if they experience a lapse 	Web-based program that will be used by a smoking cessation advisor to provide a tailored smoking cessation advice
MiQuit (Naughton et al., 2012)	<p>Quit phase (wks. 1-11): 0, 1, or 2 messages/day. The frequency of text was highest during the first 4 weeks with 80 texts over 11 weeks total</p>	<ul style="list-style-type: none"> Motivational messages utilizing social cognitive theory, perspectives on change model, and elaboration likelihood model 	<ul style="list-style-type: none"> Tailored to smoking-related baseline characteristics and pregnancy related factors (e.g., harms of prenatal smoking) At the end of 3rd and 7th week, based on the smoking status, individuals received tailored messages appropriate to the smoking status Received instant support by texting HELP, SLIP if they experience a lapse, and participants could stop receiving all texts by sending STOP 	Individually tailored, 4-page self-help leaflet on quitting smoking
OnQ (Balmford et al., 2013; Borland et al., 2012)	<p>The number of messages is tailored to the quit stage.</p> <ul style="list-style-type: none"> Preparation phase: No Date stage (up to 20 days; quit date is not set yet); 1-4 messages/day; Committed stage (can be up to 21 days) 2-8 messages/day 	<ul style="list-style-type: none"> Motivational messages Behavior change techniques (e.g., quit smoking advice) based on cognitive behavioral principles 	<ul style="list-style-type: none"> Tailored to stage of change Can opt to receive fewer number of texts Received messages in crisis situations (e.g., texting SLIP if they experience a 	The integrated condition received OnQ and personalized tailored Internet-delivered advice program

Intervention (author, year)	Frequency/Duration	Content/Theory	Individual Tailoring	Other Treatments
	<ul style="list-style-type: none"> Quit phase (7 days): Implementation stage: 3-8 messages/day Maintenance phase (30 days): 1-4 messages/day 		lapse, BORED for ideas on distraction)	
Quittext (Jamison et al., 2012)	Quit phase (wks. 1-6): Day 1-21: 2 messages/day, except for 5 days when one message/day was sent Day 21-33: 1 message/day, except for 3 days when 2 messages were sent Day 33-42 1 text/day, 0 sent on 3 days	<ul style="list-style-type: none"> Motivational messages Behavior change techniques (e.g., quit tips) 	<ul style="list-style-type: none"> Tailored to smoking-related baseline characteristics (e.g., reminders about personal reasons for quitting) At the end of 2nd and 4th week, based on the smoking status, messages were tailored to either motivate a quit attempt or support ongoing quitting Received instant support for coping with craving by texting HELP or SLIP in case of a lapse 	none
RPI for NHS-SSS (Snuggs et al., 2013)	Relapse prevention for those who achieved abstinence for 4 weeks <ul style="list-style-type: none"> Weekly messages for 12 weeks then fortnightly for 6 months 	<ul style="list-style-type: none"> Motivational messages to remain abstinent focusing on relapse prevention 	<ul style="list-style-type: none"> Personalized messages that included participant names and interactive messages that received a reply 	<ul style="list-style-type: none"> Nicotine lozenges were provided
STOMP (Bramley et al., 2005; Rodgers et al., 2005)	<ul style="list-style-type: none"> Preparation phase (1 wk.): 5 messages/day Quit phase (4 wks.): 5 messages/day Maintenance phase (26 wks.): 3 messages/wk. 	<ul style="list-style-type: none"> Motivational messages (e.g., success stories, feedback on monetary amount and life years saved by quitting) Behavior change techniques (e.g., tips to cope with cravings) Breathing exercises Distraction (e.g., general interest topic areas on sports, trivia, quizzes) 	<ul style="list-style-type: none"> Tailored messages were produced using an algorithm matching participants to keywords based on smoking history, barriers to cessation, etc. Used nicknames to address participants Received immediate feedback on coping with craving by texting CRAVE 	<ul style="list-style-type: none"> Quit Buddy: participants with similar characteristics and quit days were put in touch with each other to provide support Informed of telephone quitline and government subsidized nicotine replacement therapy
Stop My Smoking (SMS Turkey; Ybarra et al., 2012)	<ul style="list-style-type: none"> Preparation phase (wks. 1-2): 5 messages/day, increasing as the quit date approached, with most messages on the quit day and the day after Quit phase (wks. 3-6): Early Quit (wk. 3) & Late Quit (wks. 	<ul style="list-style-type: none"> Motivational messages Behavior change techniques (e.g., strategies to cope with cravings) based on cognitive behavioral and self-efficacy theory 	<ul style="list-style-type: none"> Participants were assigned to "relapse" arm and received text messages focused on helping them to recommit to abstinence if lapsed on days 2 and 7 after quit date and to "encouragement" arm if lapsed on days 2 and 7 and received text messages that suggested quitting 	<ul style="list-style-type: none"> Those who smoked 10 or more cigarettes were encouraged to use pharmacotherapy to quit

Intervention (author, year)	Frequency/Duration	Content/Theory	Individual Tailoring	Other Treatments
	<ul style="list-style-type: none"> 4-6): unspecified messages/day wk. 6: 1 message/day Maintenance phase (4 days) Relapse arm: 146 messages total Encouragement arm: 91 messages in total 		<p>smoking at a later time and provided norms for quitting.</p>	
Stop My Smoking (SMS USA; Ybarra et al., 2013)	<ul style="list-style-type: none"> Preparation phase (wks. 1-2): 4 messages/day, except for day 1 and 14 when 5 and 6 messages were sent Quit phases: Early Quit (wk. 3): 9 messages on days 1 & 2, 8 messages on day 3, one fewer message each day until day 7 Late Quit (wks. 4-6): 2 messages/day for 2 weeks, 1 message/day for 1 week Maintenance phase (4 days) Relapse arm: 2 messages/day Encouragement arm: 1 message/day 	<ul style="list-style-type: none"> Motivational messages Behavior change techniques (e.g., tips to deal with stress) based on cognitive behavioral and self-efficacy theory 	<ul style="list-style-type: none"> Participants were assigned to "relapse" arm and received text messages focused on helping them to recommit to abstinence if lapsed on days 2 and 7 after quit date and to "encouragement" arm if lapsed on days 2 and 7 and received text messages that suggested quitting smoking at a later time and provided norms for quitting. Received immediate feedback on coping with craving by texting CRAVE 	<ul style="list-style-type: none"> Text Buddy: participants with similar quit days were anonymously put in touch with each other to provide support A project website that provided quit resources, discussion forum, technical assistance
STUB IT (Whittaker et al., 2011; Whittaker et al., 2008)	<ul style="list-style-type: none"> Preparation phase (wk. 1): 1 message/day Quit phase (wks. 2-5): 3 messages/day (wks. 5-6): 1 message/2 days Maintenance phase (wks. 6-27): 1 message/4 days 	<ul style="list-style-type: none"> Motivational messages using anti-tobacco video clips (e.g., "truth" campaign) and role models Behavior change techniques using short video diary messages from role models going through the quitting process (e.g., setting goals, identifying and avoiding smoking triggers, using social support). Based on social cognitive theory and social marketing 	<ul style="list-style-type: none"> Chose a role model who sent motivational messages Texted CRAVE and the context, such as BORED, STRESS, DRINKING for relevant video or text message on how to beat smoking cravings and texted RELPASE to get 3 messages to receive motivations and quit tips to reset a quit attempt 	<p>none</p>
Text2Quit (Abrams et al., 2012)	<ul style="list-style-type: none"> Preparation phase (wks. 1-4): 3 messages/wk. and 18 messages/wk. one week before quit date Quit phase: Wk. 5: 25 messages/wk. Wk. 6: 12 messages/wk. Wk. 7: 7 messages/wk. Wk. 8: 4 messages/wk. If a participant did 	<ul style="list-style-type: none"> Motivational messages Behavior change techniques (e.g., quit tips) based on social cognitive theory 	<ul style="list-style-type: none"> Tailored based on responses at baseline (e.g., reasons for quitting, money saved based on estimates calculated from cigs smoked/day) After the quit date, received positive reinforcement feedback if quit 	<ul style="list-style-type: none"> 1-2 e-mails/week and study website provided tools and resources for quitting smoking Recommended calling a quitline and using approved

Intervention (author, year)	Frequency/Duration	Content/Theory	Individual Tailoring	Other Treatments
	not quit, 3 messages/week were sent		<ul style="list-style-type: none"> Fictitious peer ex-smoker matched on gender offered social support Texted DATE to reset a quit date, CRAVE to receive tip on coping with cravings or play a trivia game, GOALS to track smoking against preset goals, REASONS to request their reasons for quitting, WHY QUIT to receive others' reasons for quitting, and PLEDGE to make a pledge to be smoke free 	pharmacotherapy to quit smoking
Tx2Stop (Free et al., 2011; Free et al., 2009)	<ul style="list-style-type: none"> Preparation phase (wks. 1-2): 1 message/day- countdown to quit date Quit phase (4 wks.): 5 messages/day Maintenance phase (26 wks.): 3 messages/wk. 	<ul style="list-style-type: none"> Motivational messages Behavior change techniques (e.g., quit tips) 	<ul style="list-style-type: none"> Tailored using an algorithm based on baseline information, such as concerns about weight gain after quitting. Texted CRAVE to receive messages to distract them from cravings or LAPSE to receive quit tips 	<ul style="list-style-type: none"> Encouraged to use other smoking cessation interventions such as telephone helpline and nicotine replacement therapy Participants can request a quit buddy contacted by mobile phone
Unspecified 1 (Haug et al., 2012; Haug et al., 2009)	Quit phase (12 wks.): participants were randomized to: one weekly text arm, three weekly text arm, and no intervention arm	<ul style="list-style-type: none"> Motivational messages Behavior change techniques based on stages of motivation to change (e.g., strategies to cope with smoking craving) based on cognitive behavioral and motivational approaches 	<ul style="list-style-type: none"> Tailored feedback based on participant's stage of change (precontemplation, contemplation, preparation) Up to 10 different messages could be requested in each of the 6 problems areas: cravings, concentration, tiredness, nervousness, headache, weight gain 	none
Unspecified 2 (Obermayer et al., 2004; Riley et al., 2008)	<ul style="list-style-type: none"> Preparation phase (wks. unspecified): 1-3 texts/day was sent with increasing frequency toward the quit date. Quit phase (wks. unspecified): messages are sent at times anticipated to have the likelihood of smoking on the quit date, on all subsequent days sent at least 2 messages/day. Reduced frequency after 2 weeks abstinence 	<ul style="list-style-type: none"> Motivational messages based on behavioral self-regulation and transtheoretical theories 	<ul style="list-style-type: none"> Tailored to a specified quit date and messages sent on likely times for various smoking cues Received instant support by texting SOS when craving a cigarette 	<ul style="list-style-type: none"> Website provided educational modules on quit topics and self-monitoring of smoking during the preparation stage Option of having a support person to log on to the website to leave messages and provide assistance

Intervention (author, year)	Frequency/Duration	Content/Theory	Individual Tailoring	Other Treatments
Unspecified 3 (Pollack et al. 2013)	<ul style="list-style-type: none"> Total duration: 5 wks, sent up to 5 messages/day Preparation phase (2-3wks) Quit phase (2-3 wks) 	<ul style="list-style-type: none"> Motivational messages (i.e., support messages) Behavior change techniques (e.g., handling slips, dealing with partner smoking) The Scheduled Gradual Reduction condition focused on gradual reduction in smoking towards quitting 	<ul style="list-style-type: none"> The SGR condition had an interactive component that had women text each time they smoked, when they woke up and went to bed for 3 weeks to reach 0 cigarettes at the end of week 4. Received a phone call from the staff to adjust schedule and obtain commitment for the study if smoked 3 times off schedule in the SGR condition 	n/a

Note. Wk. = week, mth. = month.

^a Both arms examined text messaging components with the Support arm examining text messaging alone and the Support + SGR arm examining text messaging plus a scheduled gradual reduction.