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TABLE OF CONTENTS

HEADER . . . 1
ABSTRACT . . . 1
PLAIN LANGUAGE SUMMARY . . . 2
SUMMARY OF FINDINGS FOR THE MAIN COMPARISON . . . 3
BACKGROUND . . . 4
OBJECTIVES . . . 4
METHODS . . . 4
RESULTS . . . 5
Figure 1. . . . 8
Figure 2. . . . 10
Figure 3. . . . 11
DISCUSSION . . . 11
AUTHORS' CONCLUSIONS . . . 12
ACKNOWLEDGEMENTS . . . 12
REFERENCES . . . 12
CHARACTERISTICS OF STUDIES . . . 19
DATA AND ANALYSES . . . 44
Analysis 1.1. Comparison 1 Mobile phone intervention versus control, Outcome 1 26-week cessation outcomes all studies. . . . 45
Analysis 1.2. Comparison 1 Mobile phone intervention versus control, Outcome 2 26-week continuous abstinence. . . . 46
Analysis 1.3. Comparison 1 Mobile phone intervention versus control, Outcome 3 26-week 7-day point prevalence. 47
Analysis 1.4. Comparison 1 Mobile phone intervention versus control, Outcome 4 Biochemically verified 26-week abstinence. . . . 48
Analysis 2.1. Comparison 2 Text messaging-only interventions, Outcome 1 26-week quitting outcomes. . . . 49
Analysis 3.1. Comparison 3 Text messaging plus face-to-face interventions, Outcome 1 Text message plus face-to-face interventions. . . . 50
APPENDICES . . . 50
WHAT'S NEW . . . 50
HISTORY . . . 51
CONTRIBUTIONS OF AUTHORS . . . 51
DECLARATIONS OF INTEREST . . . 51
SOURCES OF SUPPORT . . . 52
DIFFERENCES BETWEEN PROTOCOL AND REVIEW . . . 52
INDEX TERMS . . . 52

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[Intervention Review]

Mobile phone-based interventions for smoking cessation

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ABSTRACT

Background

Access to mobile phones continues to increase exponentially globally, outstripping access to fixed telephone lines, fixed computers and the Internet. Mobile phones are an appropriate and effective option for the delivery of smoking cessation support in some contexts. This review updates the evidence on the effectiveness of mobile phone-based smoking cessation interventions.

Objectives

To determine whether mobile phone-based smoking cessation interventions increase smoking cessation in people who smoke and want to quit.

Search methods

For the most recent update, we searched the Cochrane Tobacco Addiction Group Specialised Register in April 2015. We also searched the UK Clinical Research Network Portfolio for current projects in the UK, and the ClinicalTrials.gov register for ongoing or recently completed studies. We searched through the reference lists of identified studies and attempted to contact the authors of ongoing studies. We applied no restrictions on language or publication date.

Selection criteria

We included randomised or quasi-randomised trials. Participants were smokers of any age who wanted to quit. Studies were those examining any type of mobile phone-based intervention for smoking cessation. This included any intervention aimed at mobile phone users, based around delivery via mobile phone, and using any functions or applications that can be used or sent via a mobile phone.

Data collection and analysis

Review authors extracted information on risk of bias and methodological details using a standardised form. We considered participants who dropped out of the trials or were lost to follow-up to be smoking. We calculated risk ratios (RR) and 95% confidence intervals (CI) for each included study. Meta-analysis of the included studies used the Mantel-Haenszel fixed-effect method. Where meta-analysis was not possible, we presented a narrative summary and descriptive statistics.

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Main results

This updated search identified 12 studies with six-month smoking cessation outcomes, including seven studies completed since the previous review. The interventions were predominantly text messaging-based, although several paired text messaging with in-person visits or initial assessments. Two studies gave pre-paid mobile phones to low-income human immunodeficiency virus (HIV)-positive populations - one solely for phone counselling, the other also included text messaging. One study used text messages to link to video messages. Control programmes varied widely. Studies were pooled according to outcomes - some providing measures of continuous abstinence or repeated measures of point prevalence; others only providing 7-day point prevalence abstinence. All 12 studies pooled using their most rigorous 26-week measures of abstinence provided an RR of 1.67 (95% CI 1.46 to 1.90; I^2 = 59%). Six studies verified quitting biochemically at six months (RR 1.83; 95% CI 1.54 to 2.19).

Authors' conclusions

The current evidence supports a beneficial impact of mobile phone-based smoking cessation interventions on six-month cessation outcomes. While all studies were good quality, the fact that those studies with biochemical verification of quitting status demonstrated an even higher chance of quitting further supports the positive findings. However, it should be noted that most included studies were of text message interventions in high-income countries with good tobacco control policies. Therefore, caution should be taken in generalising these results outside of this type of intervention and context.

PLAIN LANGUAGE SUMMARY

Can programmes delivered by mobile phones help people to stop smoking?

Background

Mobile phones are being used more to support healthy lifestyles. We wanted to know whether they could be used to support people to stop smoking. We reviewed the evidence on the effect of quit smoking programmes delivered by mobile phones to people who want to stop smoking.

Study characteristics

We found 12 studies up to April 2015 that could be included. These studies included 11,885 people who were monitored to see if they managed to quit smoking and if they were still quit six months later.

Key results

When the information from all the studies were combined, smokers who received the support programmes were around 1.7 times more likely to stay quit than smokers who did not receive the programmes (9.3% quit with programmes compared with 5.6% quit with no programmes). Most of the studies were of programmes relying mainly on text messages.

Quality and completeness of the evidence

We are moderately confident in the findings of this review. However, all studies took place in high-income countries and mainly used text messages, so these results may not hold true in people from poorer countries or with other types of mobile phone programmes. There were no published trials of smartphone 'apps' to help people stop smoking that met the inclusion criteria.

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SUMMARY OF FINDINGS FOR THE MAIN COMPARISON [Explanation]

Mobile phone-based interventions for smoking cessation

Patient or population: people who smoke
Setting: mobile phone technology
Intervention: mobile phone smoking cessation interventions
Comparison: controls

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed quitters without intervention	Estimated quitters with mobile phone interventions				
26-week smoking cessation	Study population		RR 1.67 (1.46 to 1.90)	11,885 (12 RCTs)	⊕⊕⊕◯ Moderate [1]	There was evidence of moderate heterogeneity across the included studies
	56 per 1000	93 per 1000 (81 to 106)				

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: confidence interval; **RCT:** randomised controlled trial; **RR:** risk ratio

GRADE Working Group grades of evidence
High quality: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate quality: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low quality: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low quality: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

[1] There was evidence of moderate heterogeneity. Sensitivity analyses around potential explanations for heterogeneity did not make substantial differences to the findings.

BACKGROUND

This is the second update of a review of the evidence on the effectiveness of mobile phone-delivered smoking cessation support. Since the previous review, the use of mobile phones globally has continued to increase at an exponential rate, far exceeding access to the Internet or fixed telephone lines in many regions. The International Telecommunications Union (ITU) estimated that there were more than seven billion mobile phone subscriptions in 2015; approximately 96.8 per 100 inhabitants, ranging from 120.6/100 in high-income countries to 91.8/100 in low-income countries. Access to mobile broadband is also growing fast, with an estimated 47% of the world's population subscribing to mobile broadband, compared with the 29% who have fixed broadband subscriptions (ITU 2015). The smartphone (mobile phone with a computer operating system) is fast becoming the computer of choice, or at least the most accessible computer, in many countries. It is reported that about 45% of global mobile phone subscriptions are associated with smartphones and that, with 75% of new sales of mobile phones being smartphones, this will continue to increase (Ericsson 2015).

Mobile phones are increasingly useful in health information and healthcare delivery around the world. Text messaging has been used for health service appointment reminders, preventive activities and medication adherence (Free 2013). Mobile phones have also been used in monitoring and the self management of chronic disorders such as diabetes (Holtz 2012). In addition, smartphone applications for health and wellness are proliferating, although there is little published research in this area (Abroms 2011).

Smoking cessation services internationally are using mobile phones to deliver support, particularly as adjuncts to other services. In 2014, the UK's National Health Service rolled out text messaging integrated into routine clinical practice and in 2013 almost half of US quitlines offered text messaging in addition to phone counselling services (Abroms 2015). The potential benefits of mobile phone-based smoking cessation interventions include: the ease of use anywhere at anytime; cost-effective delivery and scalability to large populations, regardless of location; the ability to tailor messages to key user characteristics (such as age, sex, ethnicity); the ability to send time-sensitive messages with an 'always on' device; the provision of content that can distract the user from cravings; and the ability to link the user with others for social support.

It is likely that the use of mobile phones for smoking cessation will continue to grow as they become even more ubiquitous and as technological advances increase the number of applications and functions available. While mobile technology continues to change, it is important to review the body of research on interventions using mobile phones regularly to support people to stop smoking. This is particularly so, given the exponential increase in access to mobile phones in high-income countries (ITU 2015), where the burden of tobacco-related morbidity and mortality is predicted to be greatest (Jha 2014).

OBJECTIVES

To determine whether mobile phone-based smoking cessation interventions increase smoking cessation in people who smoke and want to quit.

METHODS

Criteria for considering studies for this review

Types of studies

Randomised or quasi-randomised trials.

Types of participants

Any smokers who want to quit smoking.

Types of interventions

We included studies that examined any type of mobile phone-based intervention for smoking cessation. This included any intervention aimed at mobile phone users, based around delivery via mobile phone, and using any functions or applications that could be used or sent via a mobile phone. We excluded trials where mobile phones were seen as an adjunct to face-to-face or Internet-based programmes, such as to remind participants of appointments or where the effects of the various components of a multifaceted programme could not be separated.

Types of outcome measures

The primary outcome was smoking abstinence at six months or longer from the start of the intervention. When available, we preferred sustained abstinence to point prevalence abstinence and biochemically validated results to self report.

Search methods for identification of studies

For the present update of the review, we searched the Specialised Register of the Cochrane Tobacco Addiction Review Group in April 2015 using the terms 'mobile phone', 'cell phone', 'txt', 'pxt', 'sms', or 'mms' in the title, abstract or keyword fields. The Specialised Register includes reports of possible controlled trials of smoking cessation interventions identified from sensitive searches of databases. At the time of the search, the Register included the results of searches of the Cochrane Central Register of Controlled trials (CENTRAL; 2015 Issue 3); MEDLINE (via Ovid, to update 13 March 2015), EMBASE (via Ovid, to update week 12 2015) and PsycINFO (via Ovid; to 23 March 2015). See the Cochrane Tobacco Addiction Module in *The Cochrane Library* for full search

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strategies and a list of other resources searched. We also searched the UK Clinical Research Network Portfolio for current projects in the UK and the US ClinicalTrials.gov register for ongoing or recently completed studies. We searched through the reference lists of identified studies and attempted to contact the authors of ongoing studies.
We placed no restrictions on language or publication date.

Data collection and analysis

Selection of studies

The Tobacco Addiction Group Trial Search Co-ordinator prescreened the titles and abstracts of records identified from the Register search to exclude reports that had no relevance to the topic and to provide a list of potentially relevant citations. Two review authors (RW, YG) identified potentially eligible studies and obtained full-text copies. The same review authors independently selected studies to be included against the criteria listed above and resolved any disagreements by discussion, by contacting study authors, or by referring to a third review author (HM) to act as arbiter where required. We recorded reasons for exclusion of studies.

Data extraction and management

We extracted the following methodological details from the included study reports and presented them in the Characteristics of included studies table. Two review authors (RW, YG) independently extracted data using a standardised form. Articles were not blinded for authors, institution and journal, because the review authors who performed the quality assessment were familiar with the literature. If an article did not contain enough information on methodological criteria, that is, if one or more of the risk of bias criteria were scored 'unclear', we contacted the trial authors for additional information.

Characteristics of study participants

- Definition of smoking status used in the study.
- Age and any other recorded characteristics of study participants.
- Inclusion criteria.
- Exclusion criteria.

Interventions used

- Type and 'dose' of mobile phone intervention used.
- Type of control used.
- Duration of intervention.
- Length of follow-up.

Assessment of risk of bias in included studies

We also extracted information on the following criteria from included studies.

- Method of randomisation.
- Presence or absence of blinding to treatment allocation (non-blinded/open label, single blind, double blind, triple blind).
- Quality of allocation concealment (adequate, unclear, inadequate, not used).
- Number of participants randomised, excluded and lost to follow-up.
- Whether an intention-to-treat (ITT) analysis was carried out.
- Whether a power calculation was reported.
- Duration, timing and location of the study.

Measures of treatment effect

We recorded the information below where available.

- Definition of smoking cessation as used in the study.
- Smoking cessation rates at four weeks (self reported abstinence or biochemically verified abstinence, or both).
- Smoking cessation at rates at six months (self reported abstinence or biochemically verified abstinence, or both).
- Smoking cessation rates at final follow-up (if follow-up greater than six months and where these data were available).

We calculated risk ratios (RR) and 95% confidence intervals (CI) for each outcome for each included study.

Dealing with missing data

We regarded those trial participants who dropped out of the trials or were lost to follow-up as continuing to smoke according to the Cochrane Tobacco Group's guidelines.

Data synthesis

We conducted a meta-analysis of the included studies, using the Mantel-Haenszel fixed-effect method to pool RRs. This pooling method was chosen given the undesirable weighting properties of random-effects models when small studies are present (Peto 2013). In the presence of substantial statistical heterogeneity as assessed by the I^2 statistic (Higgins 2003), we planned to evaluate possible explanations for this heterogeneity using subgroup analyses.

RESULTS

Description of studies

Results of the search

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The previous review (published in 2012) included five studies from the 68 initially identified (Borland 2013; Free 2009; Free 2011; Rodgers 2005; Whittaker 2011). For this update of our review, the literature search identified 37 new studies. Many were unrelated and were immediately excluded, leaving 21 potentially relevant papers. Some of these were not focused around delivery via mobile phone (Fraser 2014; Mehring 2014; Peng 2013; Skov-Ettrup 2013; Stanczyk 2014); one was not randomised (Pechmann 2015); one was a pilot study with only two-month follow-up (Bricker 2014); four only followed participants up to three-months (Buller 2014; Mehring 2014; Shi 2013; Vilaplana 2014); one was investigating gradual reduction of smoking in pregnant women, rather than quitting (Pollak 2013); and one compared tailored with untailored text messages (Skov-Ettrup 2014) (see Discussion).

Approaching authors of ongoing studies revealed several that were in the process of being finalised or submitted for publication. We were able to get data directly from the authors of five studies - two of which we included (Ferguson 2015; Shelley 2015); however, one study was not eligible, with only three months' follow-up (Jordan 2015), and a further two were focused on cardiovascular disease secondary prevention rather than smoking cessation (Chow 2012; Dale 2014).

Details of excluded and ongoing studies can be found in the Characteristics of excluded studies and Characteristics of ongoing studies tables.

In this update, our literature search identified seven new randomised controlled trials (RCT) with six-month outcomes (Abroms 2014; Bock 2013; Ferguson 2015; Gritz 2013; Haug 2013; Naughton 2014; Shelley 2015).

Included studies

Intervention programmes

Almost all of the included trials used text messaging (SMS) as a central component of the intervention. A major exception to this was Gritz 2013 who gave pre-paid mobile phones to participants, which were used to provide cognitive behavioural and motivational counselling, and access to a reactive telephone helpline. The intervention was based on US guidelines around cognitive-behavioural and motivational interviewing techniques over the mobile phone (Fiore 2008). Shelley 2015 also gave mobile phones to participants in a three-arm trial comparing standard pharmacotherapy, with pharmacotherapy plus text messages, and with pharmacotherapy plus text messages and phone counselling. We included this as the pre-paid mobile phone was specifically provided as part of the study to facilitate the interventions (indicating it could not have been delivered without the mobile phone), and this was very similar in concept to the Gritz 2013 study. Whittaker 2011 sent SMS containing links to theoretically driven video messages from 'ordinary' role models coping with quitting.

Several studies paired SMS with in-person visits or assessments (Bock 2013; Gritz 2013, Haug 2013; Naughton 2014; Shelley 2015). The remainder were purely text messaging interventions (Abroms 2014; Borland 2013; Ferguson 2015; Free 2009; Free 2011; Rodgers 2005; Whittaker 2011).

Many of the studies stated that their interventions were theory based (Abroms 2014; Bock 2013; Gritz 2013; Naughton 2014; Whittaker 2011; Haug 2009). In Haug 2013, the intervention was said to be based on cognitive behavioural components, stages of change and the social norms approach, with an online assessment that allowed tailoring based on stage of change and other baseline data.

Bock 2013 conducted an initial counselling session then randomised participants to an eight-week intervention based on national guidelines, social cognitive theory and the stages of change. The programme was tailored to stage of readiness, starting with either 'not ready' or 'prepared to quit', that could change according to text message questions and answers. There were also on-demand components.

The text messaging intervention in Rodgers 2005 was developed in New Zealand, and later adapted for the UK and tested in a pilot study (Free 2009), and then a large randomised controlled study (Free 2011). Messages commenced prior to quitting and were based on effective brief interventions including quitting advice and motivational messages. Interactive components included the ability to text in for more support (in the instance of cravings or lapses) and an optional Quit Buddy in Rodgers 2005. A cost-effectiveness analysis was also conducted as part of the Free 2011 trial (Guerriero 2013). This showed that the cost of text-based support per 1000 enrolled smokers was GBP278 per quitter. When the future health service costs saved (as a result of reduced smoking) were included, text-based support was considered to be cost saving, with 0.5 quality-adjusted life years (QALYs) gained per quitter.

In Borland 2013, participants received offers of support via a personalised tailored Internet programme, an SMS programme, both programmes, a choice of all three or a minimal control. The SMS programme provided advice on strategy and motivational messages relevant to their stage of readiness for quitting, plus messages on demand. For the purposes of meta-analyses, we compared the SMS group with the control group.

In Naughton 2014, the intervention group received the 'usual care' received by the control group (described below), as well as a four-page tailored advice report and a tailored theoretically based SMS message programme for 90 days, with interactive components (i.e. they could text for help when in difficult situations, or if they had lapsed).

Control programmes

The control programmes across the studies varied from nothing (Haug 2013), to fortnightly (Free 2009; Free 2011; Rodgers 2005; Whittaker 2011) or daily (Bock 2013) text messages, written/

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Internet untailored materials (Abroms 2014; Ferguson 2015; Gritz 2013), and untailored messages, to standard cessation advice and treatment (Naughton 2014; Shelley 2015).

The control group of Naughton 2014 received support from practice staff who had received smoking cessation training. This support included setting a quit date within 14 days, a prescription for pharmacotherapy, the opportunity for multiple follow-up visits and routine measurement of carbon monoxide (CO) in expired breath.

Context and participants

The settings and recruitment methods, and therefore the participants, varied considerably across studies. Two studies targeted young people (Haug 2009; Whittaker 2011). Bock 2013 found usual in-person recruitment methods slow and shifted to online recruitment methods during the study. Borland 2013 and Abroms 2014 also used online recruitment via Internet advertisements. In Abroms 2014, this initially led to some fraudulent participants who were discovered and disqualified, and extra procedures were put in place to prevent this from happening again.

Naughton 2014 was set in primary care practices in the UK with trained smoking cessation advisors providing smoking cessation advice. The Gritz 2013 study recruited in a human immunodeficiency virus (HIV)-positive, multi-ethnic, low-income population. Participants in this study were 76% African American, 79% unemployed, with high levels of depression and other alcohol/drug problems. Shelley 2015 similarly recruited from urban HIV clinics in a different region of the US.

Haug 2013 recruited in vocational schools and differed from the other studies by allowing the inclusion of occasional smokers (at least four cigarettes in the past month or at least one in the preceding week). All other studies used a definition related to daily smoking.

Where recorded, participants in most of the studies had similar degrees of nicotine dependence, although in Whittaker 2011, the 'Hooked on Nicotine Checklist' mean scores of 8 indicated a more highly addicted group (Wellman 2006).

Participants in three trials were younger (mean age 18.2 years in Haug 2013, 22 years in Rodgers 2005, and 27 years in Whittaker 2011) than in the other trials (means ranged from 30.7 years in Bock 2013 to 44.8 years in Gritz 2013). Most trials had slightly more women than men, with the exception of Gritz 2013 with 70% male participants.

The Characteristics of included studies table gives further details on the included studies.

Risk of bias in included studies

Randomisation was adequate in all trials. Haug 2013 was the only cluster randomised trial, and recruited via vocational schools. The vocational school class was the unit of randomisation, stratified by school and with randomly permuted blocks of four cases.

In all trials except for Borland 2013, participants were not blinded to treatment assignment, although research staff were blind to allocation at follow-up data collection. As seen in Figure 1, all trials but Rodgers 2005 were at low risk of bias in all domains.

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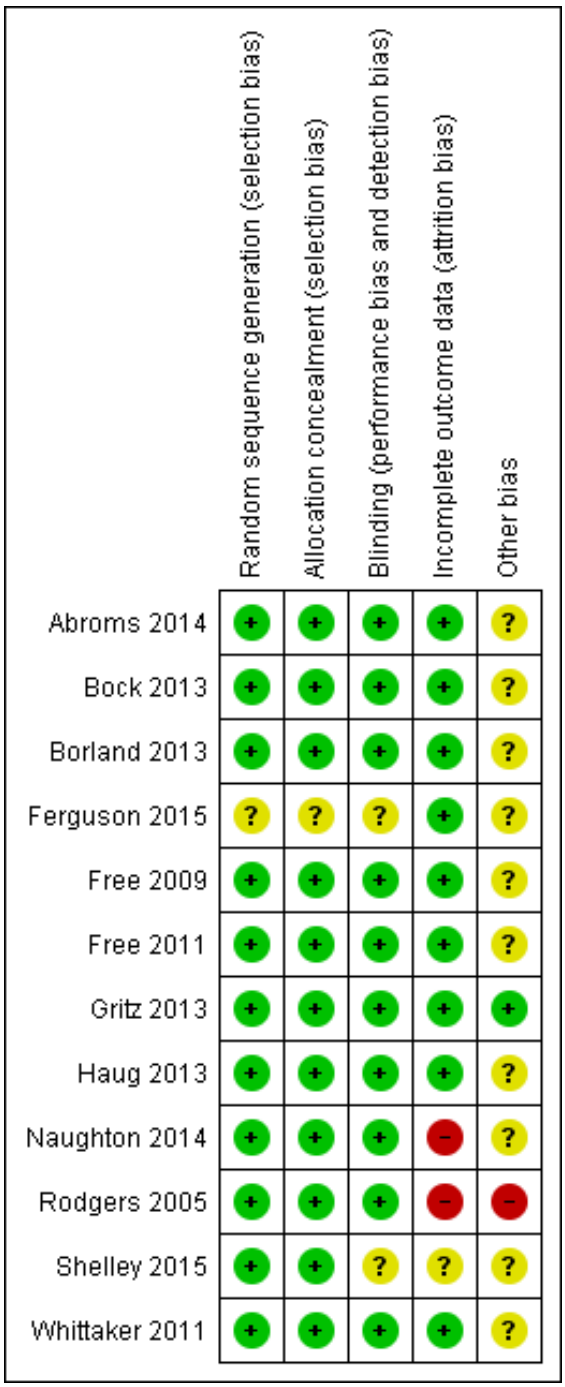
Figure 1. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



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In Rodgers 2005, incentives for providing final follow-up data differed between groups - one month of free text messaging was received by the control group on completion of follow-up whereas the intervention group had already received their month of free text messaging from their Quit Day and did not receive a further incentive at follow-up. This may have caused the differential loss to follow-up seen at six months (69.4% providing data at six months in the active group compared with 79% in the control group), which in turn may have affected the long-term results of this study. The authors also suggested that some participants in the control group may have thought their month of free text messaging depended on reporting quitting. This could account for an unexpected increase in control group participants reporting quitting from six weeks (109 participants) to six months (202 participants reporting no smoking in the past seven days). Both of these elements may have potentially led to an underestimation of the effect of the intervention.

Two papers stated that they had difficulty recruiting their target sample size (Haug 2013; Whittaker 2011). Both targeted a younger population and, as a result, did not recruit their target sample size.

All studies presented long-term outcomes at six months, either as self reported point prevalence (no smoking in past seven to 28 days) or repeated measures of point prevalence abstinence (Abroms 2014; Bock 2013; Gritz 2013) (or both), or continuous abstinence, defined as no smoking since quit day, but with up to three lapses (Rodgers 2005), or five cigarettes (Free 2009; Free 2011; Whittaker 2011), allowed.

Seven of the trials sought biochemical verification of self reported six-month abstinence with salivary cotinine (Abroms 2014; Free 2009; Free 2011; Gritz 2013; Rodgers 2005) or expired CO (Ferguson 2015; Shelley 2015). Those reporting response rates for verification varied from 39% in Rodgers 2005 to 92% in Free 2011, with little difference between intervention and control groups within studies. Of those participants that were tested, 76% in Abroms 2014 and 72% in Free 2011 were verified as abstinent. The proportion was lower in Rodgers 2005 (55% in the intervention group and 33.3% in the control group) and Free 2009 (53% (8/15) in the intervention group and 40% (6/15) in the control group). Naughton 2014 also verified quitting but only at four-week and not at six-month follow-up.

All trials conducted ITT analyses, where participants with missing data were assumed to be smokers. Any differential loss to follow-up by group can create potential bias when all are inferred to be smokers. Sensitivity analyses were used to test the effects of other potential reasons for drop out. Free 2011 and Haug 2013 used multiple imputation, by using the observed predictors of outcomes and the predictors of loss to follow-up to impute missing outcome data.

A further potential source of bias could be any differential use of other cessation interventions. In Borland 2013, where use of the studied interventions was low, it is possible that participants were motivated to try other cessation programmes.

The Characteristics of included studies table provides details of risk of bias judgements for each domain of each included study. Figure 1 illustrates judgements for each included study.

Effects of interventions

See: **Summary of findings for the main comparison** Mobile phone-based interventions for smoking cessation

Standard ITT analyses are presented here, with all participants lost to follow-up counted as continuing smokers. This may differ from how results were presented by the individual studies due to variations in primary outcomes and in analytic methods used. For example, Free 2011 used multiple imputation by chained equations, and the Bock 2013 paper reported a significant main effect of a two (treatment groups) x three (time points) generalised estimating equations (GEE) repeated measures analysis with higher odds of point prevalence abstinence compared with a control group (odds ratio (OR) 4.52, 95% CI 1.24 to 16.53). However, individual time point comparisons did not show significant differences.

Although Naughton 2014 did not find a significant difference in their primary outcome (of two-week point prevalence) at eight weeks (45.2% with intervention programme versus 40.3% with control programme; OR 1.22, 95% CI 0.88 to 1.69), by six months there was an effect on self reported prolonged abstinence (15.1% with intervention programme versus 8.9% with control intervention; OR 1.81, 95% CI 1.09 to 3.01) and using a continuous abstinence measure that included outcomes at four weeks, eight weeks and six months (11.4% with intervention programme versus 6.3% with control programme; OR 1.92, 95% CI 1.07 to 3.45).

We undertook meta-analyses on the 12 included studies (Abroms 2014; Bock 2013; Borland 2013; Ferguson 2015; Free 2009; Free 2011; Gritz 2013; Haug 2013; Naughton 2014; Rodgers 2005; Shelley 2015; Whittaker 2011). First, we pooled all 12 studies using their most rigorous 26-week measures of abstinence, giving an RR of 1.67 (95% CI 1.46 to 1.90; 12 studies; 11,885 participants; I^2 = 59%) (Analysis 1.1; Figure 2). Both the Free 2009 pilot study and the Whittaker 2011 study were underpowered and individually did not find an effect. When we removed these two studies from the analysis, the results produced an RR of 1.81 (95% CI 1.57 to 2.09; I^2 = 32%; 10 studies; 11,459 participants). In addition, we carried out this main analysis, removing Haug 2013, to see if the result was sensitive to the inclusion of this cluster randomised controlled trial. However, this had very little impact on the result (RR 1.69, 95% CI 1.47 to 1.94; I^2 = 62%; 11 studies; 11,130 participants). Due to the amount of heterogeneity detected, we also made a post-hoc decision to re-calculate the main

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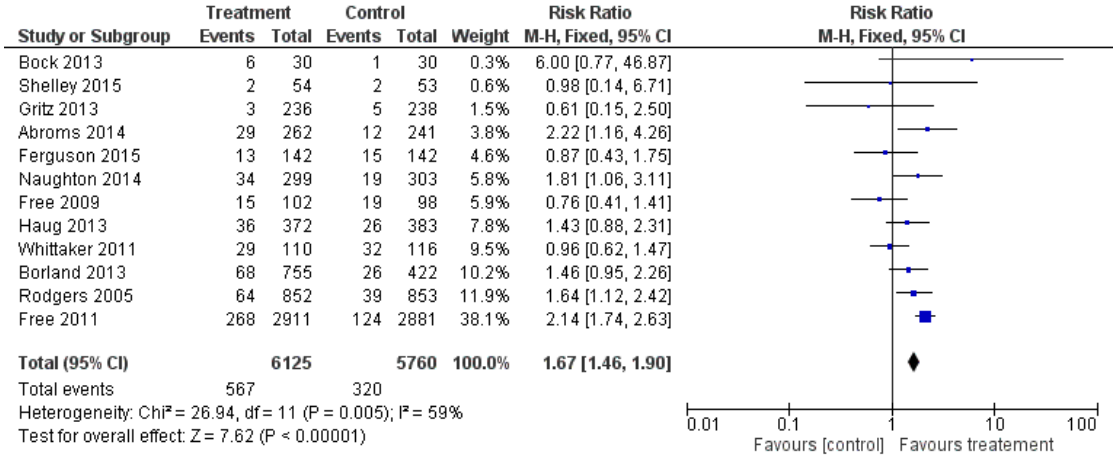
analysis using a random-effects model. This resulted in an RR of 1.42 (95% CI 1.11 to 1.83; 12 studies; 11,885 participants), and therefore none of the adjustments had an impact on the interpretation of the results, and none of the sensitivity analyses accounted for the majority of the heterogeneity.

Figure 2. Forest plot of comparison: 1 Mobile phone intervention v ersus control, outcome: 1.1 26-week cessation outcomes all studies.



Subgroup analyses

We then grouped studies according to definition of abstinence used (continuous abstinence, point prevalence, biochemically verified or not) and by differences in intervention (text messaging alone, text messaging plus some form of personal contact and phone counselling).

Abstinence

Continuous abstinence

We pooled data from the eight studies reporting continuous abstinence, with those reporting repeated measures of point prevalence abstinence used as a proxy for continuous abstinence (Abroms 2014; Borland 2013; Free 2009; Free 2011; Gritz 2013; Naughton 2014; Rodgers 2005; Whittaker 2011). This gave an RR of 1.72 (95% CI 1.50 to 1.98; I^2 = 68%; eight studies; 10,679 participants), with moderate heterogeneity.

Point prevalence

We pooled studies presenting point prevalence abstinence measures at six months separately (Abroms 2014; Bock 2013; Ferguson 2015; Gritz 2013; Haug 2013; Rodgers 2005; Shelley 2015). This analysis showed a marginally statistically significant effect of intervention programmes over control programmes (RR 1.18, 95% CI 1.03 to 1.35; I^2 = 24%; seven studies; 3,888 participants) (Analysis 1.3).

Bock 2013 was a small study early in the acceptability phase of testing, with a consequently wide CI. Ferguson 2015, Gritz 2013, and Shelley 2015 had little difference between groups. Haug 2013 and Rodgers 2005 favoured the intervention but without statistical significance.

Biochemically verified abstinence

We pooled studies that biochemically verified quitting separately at 26 weeks (Abroms 2014; Ferguson 2015; Free 2009; Free 2011; Gritz 2013; Shelley 2015). This resulted in an RR of 1.83 (95% CI 1.54 to 2.19; I^2 = 71%; six studies; 7,360 participants) (Analysis 1.4; Figure 3).

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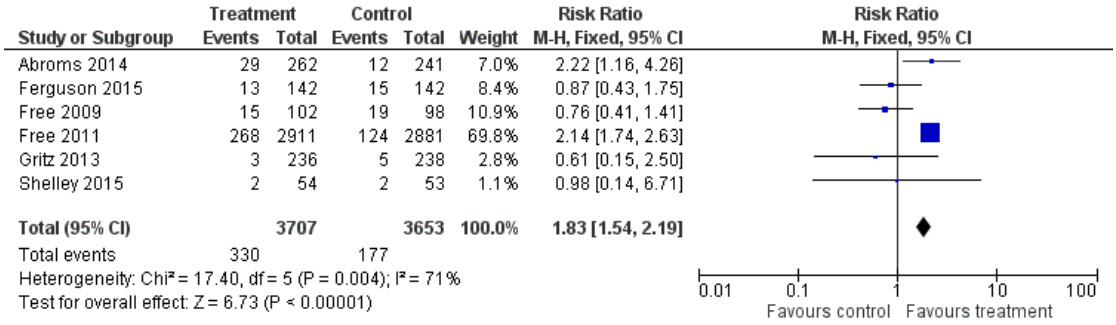
Figure 3. Forest plot of comparison: 1 Mobile phone intervention versus control; outcome: 1.4 26-week biochemically verified cessation outcomes (six studies).



Differences in interventions

Text message alone interventions

When we removed studies with interventions that included in-person contacts from the main analysis (all studies 26 week outcomes) in order to examine only those interventions that used text messaging only, there was no difference in the results (RR 1.69, 95% CI 1.46 to 1.95, I^2 = 74%; seven studies; 9887 participants) (Analysis 2.1) (Abroms 2014; Borland 2013; Ferguson 2015; Free 2009; Free 2011; Rodgers 2005; Whittaker 2011).

Active versus minimal control

We carried out a sensitivity analysis on the main analysis of all studies' 26 week outcomes (12 studies). We removed studies with more active control programmes (of standard cessation practice - Naughton 2014 and Shelley 2015); however, again this made minimal difference to the overall result of the pooled analysis (RR 1.66, 95% CI 1.45 to 1.91, I^2 = 66%; 10 studies; 11,176 participants).

DISCUSSION

Summary of main results

We included seven further studies of mobile phone smoking cessation interventions meeting our inclusion criteria since the previous version of this review, giving a total of 12 included studies. The first systematic review in 2009 showed short-term benefits, but found no long-term effects, of mobile phone-only interventions. The second update, with five studies, showed an overall long-term benefit of mobile phone interventions for smoking cessation, though there was a high level of statistical heterogeneity in the pooled result. This update of 12 studies also suggested a positive effect of mobile phone interventions on smoking cessation at six months in comparison with 'usual care', although there was still significant unexplained heterogeneity. Our findings appeared to have been strengthened by the highest quality studies, that is, those studies using stricter outcome definitions, including biochemical verification. The benefits were large, and similar in size to those seen using of other effective treatments such as nicotine replacement therapy (Stead 2012).

Overall completeness and applicability of evidence

Our review currently includes 12 studies with 11,885 participants. There has been a steady increase in the number of studies eligible for this review over time. All of the studies included were conducted in high-income countries with mature tobacco control policies; although two studies specifically recruited from low-income populations (Gritz 2013; Shelley 2015). This means that it is possible that text messaging interventions may not be appropriate or effective in other contexts, or alternatively they may be even more effective in those settings where cessation information and support is relatively new. Clearly there is a major gap in the current evidence.

We also found 25 ongoing studies. As the body of evidence supporting the effectiveness of text messaging in high-income countries grows, it is hoped that some of these are being conducted in other contexts or with different populations. It is interesting to note that there were no trials of smartphone 'app'-based interventions that met our eligibility criteria despite the proliferation of available cessation apps. In 2011, one review of available smoking cessation apps found them to be lacking in adherence to cessation guidelines or theory (Abroms 2011).

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There is as yet little research into the different functional components, message content, mediators and moderators of mobile phone programmes, in order to learn what type of programmes work best for whom. Skov-Ettrup 2014 conducted a study, based on an ongoing online programme, of untailored messages compared with tailored messages. Participants were randomised first and then offered text messages on top of the online programme. Overall, there was no significant difference between groups in long-term quit rates; however, when restricted to only those who chose to receive the text messages, there was an effect of tailored over untailored messages (OR 1.45, 95% CI 1.01 to 2.08; 1,809 participants). As the tailored messages were also more frequent, it is not clear whether this effect was due to intensity, tailoring or both.

Quality of the evidence

The studies included varied in size from 60 to 5800 participants, but were generally all of a reasonable quality with a low risk of bias. They were all randomised controlled trials, with one cluster randomised trial (the result of analyses were not sensitive to removal if this study), and with similar outcomes measures. Substantial heterogeneity was detected across analyses; however, a post hoc decision to conduct the main analysis using a random-effects model resulted in no difference in the interpretation of findings. Half of the included studies attempted to biochemically verify self reported quitting outcomes. When we pooled these studies separately, the result was similar, if not more strongly in favour of the intervention.

Two studies reported that they were unable to recruit their target sample sizes, both of which were targeting a younger population (Haug 2013; Whittaker 2011). Both studies found no statistically significant effect of the intervention, but were reported to be slightly underpowered. More research is needed in young adults to determine the acceptability and effectiveness of mobile phone based interventions. Overall, we are moderately confident in the main effect estimate generated through our analysis (Summary of findings for the main comparison).

AUTHORS' CONCLUSIONS

Implications for practice

At least in high-income countries with existing tobacco control policies, media and education, text message-based smoking cessation interventions, either alone or in combination with face-to-face assessments or online programmes, appear to be a helpful option to offer to quitters. It is not yet clear whether this translates to other contexts, such as low- or middle-income countries, and younger people; however, many are proceeding to implement such programmes anyway. High-quality evaluations of these implemented programmes will be valuable.

Implications for research

Research into the effectiveness of mobile phone-based cessation programmes for young people, in low- and middle-income countries and countries with little active tobacco control policy, is still required. There is also a lack of research into the effectiveness of individual components of programmes, in order to determine what works best for whom. There does not appear to be any rigorous trials of smartphone-based programmes published as yet. Due to their widespread availability, it would be useful to know if the broader functionality available in apps can be harnessed effectively to support cessation.

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* *Indicates the major publication for the study*

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CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Abroms 2014

Methods	RCT in US
Participants	503 participants aged ≥ 18 years recruited via online advertisements when Internet searching for 'quitting smoking'. 34% men, mean age of 35.7 years, and mean FTND score of 5.3 Eligibility criteria included smoking ≥ 5 cigarettes/day, having an e-mail address, a mobile phone number with an unlimited SMS plan, an interest in quitting smoking in the next month and not pregnant
Interventions	Automated bidirectional text messages, personalisation and interactive components, automated unidirectional emails and an Internet portal - has been revised since pilot study Text2Quit: a 6-month SMS programme with the first 3 months offering both outgoing messages about quitting smoking and on-demand help using keywords. Outgoing messages peaked in the period just prior to and following the quit date. Participants received 5 messages on their quit date and approximately 2/day in the week after the quit date. Frequency declined in the subsequent weeks to approximately 3/week for the next 2 months and then < 1/week for the remaining portion of the outgoing phase. After the outgoing messages stopped, participants could still text at any time for help through keywords - to reset a quit date (DATE), get help with a craving through a tip or a trivia game (CRAVE); get a summary of their quitting statistics (STATS) and to indicate that they had smoked (SMOKED). The SMS were supplemented by a personalised Internet portal (text2quit.com) and e-mails Control: sent an Internet link to Smokefree.gov, a leading website with quitting smoking information run by the National Cancer Institute. Later, once the website began to offer an SMS programme, a guidebook on quitting smoking was offered via an Internet link that led participants to a document containing similar advice and information as Smokefree.gov
Outcomes	Primary outcome: biochemically confirmed repeated point prevalence abstinence, defined as a self report of no smoking in the past 30 days on the 3- and 6-month surveys and a cotinine level ≤ 15 ng/mL at 6 months Secondary outcomes: 7- and 30-day abstinence at 1-, 3-, and 6-month follow-up and biochemically confirmed abstinence at the 6-month follow-up
Notes	Enrolment procedures were modified after a group of participants was discovered to be fraudulent and disqualified

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomised via computer system

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Abroms 2014 (*Continued*)

Allocation concealment (selection bias)	Low risk	Recruited and randomised online
Blinding (performance bias and detection bias) All outcomes	Low risk	Participants completed questionnaires online
Incomplete outcome data (attrition bias) All outcomes	Low risk	52 in control and 70 in intervention group lost to follow-up at 6 months but ITT analysis presented
Other bias	Unclear risk	13 participants from the control group (5%) indicated on their 3-month survey that they had used a texting programme for smoking cessation since enrolling in the study Saliva was collected by mail for participants reporting abstinence at 6 months. There was a low response rate (64.7%) among participants eligible for providing a saliva sample for biochemical verification although this did not differ across the groups. Of those participants who provided a sample, 21 (24.4%) had high levels of cotinine and were coded as smokers in analyses

Bock 2013

Methods	Pilot RCT in US
Participants	Adults aged ≥ 18 years of age current daily smokers recruited online and eligible if interested in quitting smoking in the next 30 days, with a mobile phone with SMS text messaging capability, and using SMS text messaging at least once monthly. 43% men, mean age 30.7 years (range 18-52 years), and mean FTND of 4.9 (moderate level of dependence on nicotine)
Interventions	All participants received a single individual 30-minute smoking cessation counselling session TXT-2-Quit: an 8-week programme with 1-4 text messages/day (depending on quit stage). Smoking cessation messages were tailored to the participant's stage of smoking cessation, with specialised messages provided on-demand based on user requests for additional support, and an optional peer-to-peer social support network Control: an 8-week programme of daily non-smoking related text messages
Outcomes	Primary outcome: 7-day point-prevalence abstinence using a 2 (treatment groups) × 3 (time points) repeated measures design across 3 time points: 8 weeks, 3 months and 6 months; showed a significant main effect for treatment group (P value = 0.02) with higher odds of quitting in the intervention group compared with the control group (odds ratio 4.52, 95% CI 1.24 to 16.53). Although there was no individual time point difference between groups at 6 months (20% with intervention programme vs. 3.6% with control programme; odds ratio 6.75, 95% CI 0.76 to 60.15) it was likely to have been affected by reduced statistical power Secondary outcome: 24-hour point prevalence abstinence at 8 weeks, 3 months and 6 months

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Bock 2013 (*Continued*)

Notes	Designed as a small study to develop and provide initial testing of the system During the 6 months' follow-up, there was a significant improvement in Mood and Physical Symptoms Scale (MPSS) mood symptoms of nicotine withdrawal (P value = 0. 03) among the TXT-2-Quit participants as compared with the control participants

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Simple randomisation via computerised random number generator
Allocation concealment (selection bias)	Low risk	Assignments in a sealed envelope delivered after completion of the baseline data collection
Blinding (performance bias and detection bias) All outcomes	Low risk	Participants completed questionnaires online. Research assistants and counsellors were blind to allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	2 participants in control group appeared to be missing at 6 months; however, ITT analysis presented
Other bias	Unclear risk	Self report and not biochemically verified

Borland 2013

Methods	RCT in Australia
Participants	3530 participants in total (control = 422; onQ = 756; QuitCoach = 809; both = 785; participant choice = 758). 60% female, mean age 42.1 years, and 87.4% were currently smoking a mean of 16.9 cigarettes/day
Interventions	onQ programme: provides a stream of SMS messages to the person that mixes snippets of advice on strategy and motivational messages. The user can interact with it by indicating their stage of quitting so that appropriate stage-specific messages are sent, and once quit can also call up messages in crisis situations QuitCoach: a personalised, automated tailored cessation programme delivered via the Internet. It generates letters of advice based on answers to an assessment questionnaire, including suggestions about strategy and motivational messages. It also provides further untailored supplementary resources Control: brief information on Internet- and phone-based assistance available in Australia
Outcomes	Self reported 6-month sustained abstinence at 7-month follow-up Intention-to-quit analysis and sensitivity analysis around treatment of missing data
Notes	Only onQ and control arms used in analysis

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Borland 2013 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computerised random number generator embedded within the baseline survey
Allocation concealment (selection bias)	Low risk	Not a typical RCT as participants were enrolled in a study described to them as being about "the effectiveness of Internet and telephone-based resources in helping smokers quit", and were only then randomised to a condition that they were offered with no obligation to use
Blinding (performance bias and detection bias) All outcomes	Low risk	Not a typical RCT as participants were enrolled in a study described to them as being about "the effectiveness of Internet and telephone-based resources in helping smokers quit", and were only then randomised to a condition that they were offered with no obligation to use
Incomplete outcome data (attrition bias) All outcomes	Low risk	Loss to follow-up 475 (13% total) with similar numbers across groups (control = 66, onQ = 89, QuitCoach = 104, both = 121, participant choice = 95); 2 excluded as reported to have died at 7-month follow-up
Other bias	Unclear risk	Nothing else described

Ferguson 2015

Methods	RCT in Australia
Participants	Participants recruited via advertisements in traditional and social media in Tasmania, Australia. 49% male, mean age 42.1 years and mean FTND of 4.8, and with a high motivation to quit (≥ 75 on 100-point scale) Eligibility criteria included: daily smokers of > 10 cigarettes/day for past 3 years
Interventions	Intervention: Self-help Quit booklet plus 4 or 5 randomly timed text messages/day containing quit smoking advice and encouragement tailored to participants' current quit status (preparing to quit, first week of the quit attempt, second week of attempt etc.). Participants could request additional text messages Control: Self-help Quit booklet containing tips for quitting and cognitive and behavioural coping mechanisms Study visit days: -11 (enrolment/randomisation), -7 (commence study group), 0 (QD), day 7, day 28, and day 180 post quit
Outcomes	Primary outcome: 7-day point prevalence abstinence verified by expired CO Secondary outcomes: 1-month abstinence, cigarette consumption by time-line follow back, mean time to first lapse

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Ferguson 2015 (*Continued*)

Notes	Not published as yet	
Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	No information
Allocation concealment (selection bias)	Unclear risk	No information
Blinding (performance bias and detection bias) All outcomes	Unclear risk	No information
Incomplete outcome data (attrition bias) All outcomes	Low risk	20 in control and 22 in intervention did not commence study. ITT analysis presented in this meta-analysis
Other bias	Unclear risk	No information

Free 2009

Methods	Pilot RCT in UK
Participants	200 participants aged ≥ 16 years; smoking daily and interested in quitting; current owner of mobile phone. 63% men, median age 36 years, median 20 cigarettes/day, 7% FTND dependence score > 5
Interventions	6-month programme delivered solely over mobile phone based on programme in Rodgers 2005 but messages adapted for UK population. Participant nominates QD and receives regular personalised text messages with advice, support and distraction, with a countdown to QD, intensive 4 weeks of 5 or 6 messages/day then maintenance phase of 1 message/2 weeks. Messages selected from database matched to participant characteristics. Free month of text messaging from QD. Optional Quit Buddy, and Text Crave (messages on demand). Interactive polls and quizzes Control: 1 text message/fortnight
Outcomes	Primary outcome: point prevalence abstinence (no smoking in past 7 days) at 6 weeks post randomisation (approximates 4 weeks post-QD) Secondary outcomes: point prevalence abstinence and continuous abstinence (< 5 cigarettes) at 26 weeks. Verification with salivary cotinine in quitters at 26 weeks
Notes	Pilot study - full trial is Free 2011
Risk of bias	
Bias	**Authors' judgement**	**Support for judgement**

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Free 2009 (*Continued*)

Random sequence generation (selection bias)	Low risk	Central computerised randomisation
Allocation concealment (selection bias)	Low risk	Concealed until after assignment
Blinding (performance bias and detection bias) All outcomes	Low risk	Single blind (participants not blinded)
Incomplete outcome data (attrition bias) All outcomes	Low risk	Lost to follow-up: 4 (control) and 1 (intervention) at 4 weeks (98% follow-up); 8 (control) and 8 (intervention) at 6 months (92% follow-up)
Other bias	Unclear risk	None described

Free 2011

Methods	RCT in UK
Participants	5800 participants aged ≥ 16 years, willing to make an attempt to quit smoking in the next month and owned a mobile phone. 45% women, mean age of 37 years, 89% white and 25% students/unemployed. 60% of participants had an FTND dependence score of ≤ 5
Interventions	6-month programme: delivered solely over mobile phone based on programme in Rodgers 2005. Participants asked to set a QD within 2 weeks of randomisation. They received 5 text messages/day for the first 5 weeks and then 3/week for the next 26 weeks. Intervention included motivational messages and behaviour-change techniques. The programme was also personalised with an algorithm based on demographic and other information gathered at baseline, such as smoker's concerns about weight gain after quitting. The core programme consisted of 186 messages and the personalised messages were selected from a database of 713 messages. For instance, by texting the word "lapse", participants received a series of 3 text messages that encouraged them to continue with their quit attempt. Participants could also request the mobile phone number of another trial participant so that they could text each other for support. Participants in the intervention group using pay-as-you-go mobile phone schemes were given a £20 top-up voucher to provide sufficient credit to participate in the intervention Control: fortnightly, simple, short, text messages related to the importance of trial participation
Outcomes	No more than 5 cigarettes smoked since the start of the abstinence period at 6 months of follow-up, self reported and verified by postal salivary cotinine testing or a CO test in person
Notes	
Risk of bias	

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Free 2011 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	An independent telephone randomisation system
Allocation concealment (selection bias)	Low risk	Concealed until after assignment
Blinding (performance bias and detection bias) All outcomes	Low risk	Single blind (participants not blinded)
Incomplete outcome data (attrition bias) All outcomes	Low risk	176 intervention and 92 control lost to follow-up (< 5% total)
Other bias	Unclear risk	None described

Gritz 2013

Methods	RCT in US
Participants	474 participants aged ≥ 18 years recruited from an HIV clinic in a low-income multi-ethnic urban population in Texas, USA. 70% men, mean age 44.8 years, mean FTND 5.8 Inclusion criteria: HIV-positive, current smoker (≥ 5 cigarettes/day and expired CO ≥ 7 ppm), willing to set a QD within 7 days, and ability to speak English or Spanish
Interventions	Participants in the mobile phone intervention group received the usual care components plus a mobile phone-delivered counselling intervention over 3 months and access to a supportive hotline. They were provided with a pre-paid mobile phone on which a series of 11 proactive counselling sessions were conducted. The phone calls spanned a 3-month period but were front loaded such that the frequency of the calls was highest near the time of scheduled quit attempt. Counselling session content was primarily drawn from a cognitive-behavioural foundation emphasising problem solving and skills training techniques Control: participants completed an audio computer-assisted self interview, then received provider advice to quit smoking. Usual care was provided with targeted written smoking cessation materials (i.e. a "tip sheet" designed to address concerns of HIV-positive smokers) and instructions on how to obtain nicotine-replacement therapy in the form of nicotine patches at the clinic
Outcomes	Primary outcome: self reported repeated measures 7-day point prevalence at 3, 6 and 12 months Secondary outcomes: 3, 6 and 12 months' smoking abstinence (24 hours, 7 days and 30 days), CO verified quitting, number of quit attempts, length of abstinence (in days), use of nicotine-replacement therapy, use of other cessation treatments and exposure to other forms of tobacco. Other smoking-related measures included the FTND, the Reasons for Quitting scale (intrinsic and extrinsic quit motivation) and the 9-item quitting self efficacy scale. Depressive symptoms: Center for Epidemiologic Studies Depression (CES-

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Gritz 2013 (*Continued*)

	D), State Trait Anxiety Inventory. Quality of life: Medical Outcomes Study HIV Health Survey (MOS-HIV). Alcohol use: Alcohol Use Disorders Identification Test. A single item was used to assess illicit drug use in the past month
Notes	Expanded programme based on Vidrine 2006 Varied from the other interventions in using pre-paid provided mobile phones to provide counselling instead of an SMS intervention. Many smokers were excluded (40%) due to not meeting 5 cigarettes/day and CO ≥ 7 ppm). Low absolute quit rates may be due to high nicotine dependence, high rate of alcohol and drug use, and the substantial burden of mental illness amongst participants

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomised - method not stated
Allocation concealment (selection bias)	Low risk	Allocated after baseline data collected
Blinding (performance bias and detection bias) All outcomes	Low risk	Risk was minimised with the following measures: • baseline assessments and administration of the usual care components (which all participants received) were performed prior to randomisation • phone counsellors did not perform follow-up assessments • research staff who performed the follow-up assessments did not know the group allocation • participant's self completed follow-up assessments
Incomplete outcome data (attrition bias) All outcomes	Low risk	51 in control and 61 in intervention did not complete 6-month follow-up but ITT analysis presented
Other bias	Low risk	Expired CO to validate smoking status. Use of a single HIV clinic, a county site with a large patient population

Haug 2013

Methods	Cluster RCT in Switzerland
Participants	755 daily or occasional smokers (≥ 4 cigarettes in the preceding month and ≥ 1 cigarette during the preceding week) recruited at 24 vocational schools (178 classes). 48% male, mean age 18.2 years (SD 2.3)
Interventions	SMS-COACH: a 3-month programme including a weekly SMS text message assessment of smoking-related target behaviour, 2 weekly text messages tailored to baseline data and responses to the SMS text message assessments, and an optional further integrated QD preparation and relapse prevention SMS programme. Participants who did not use

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Haug 2013 (*Continued*)

	the integrated programme for QD preparation and relapse prevention received a total of 37 text messages (1 welcome message, 11 assessment messages, 24 tailored feedback messages, 1 goodbye message). Participants, who used the QD preparation and relapse-prevention programme for the whole period from 1 week before the scheduled quit date until 3 weeks afterwards, received an additional 42 text messages Control: all students in participating classes were invited to participate in an online health screening survey during a regular school lesson reserved for health education. The control group did not receive anything else
Outcomes	Primary outcome: 7-day point prevalence smoking abstinence at 6 months Secondary outcomes: 4-week point prevalence smoking abstinence, the number of cigarettes smoked/day, stage of change and number of attempts to quit smoking
Notes	The study did not reach the target sample size of 910 participants due to smaller class size than expected and time restrictions. Nicotine dependence was not calculated but number of cigarettes smoked/day used as an indicator and outcome variable

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Cluster randomisation with class as the unit of randomisation, stratified by school to control for heterogeneity between schools. Block randomisation with computer-generated randomly permuted blocks of 4 cases
Allocation concealment (selection bias)	Low risk	Students recruited prior to randomisation and informed after baseline
Blinding (performance bias and detection bias) All outcomes	Low risk	Baseline and follow-up assessors blinded to allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	111 in control and 85 in intervention were lost to follow-up at 6 months. ITT analysis conducted
Other bias	Unclear risk	Self report outcomes

Naughton 2014

Methods	RCT in UK
Participants	Participants aged 18-75 years and current smokers (≥ 1 cigarette /day and smoked within previous 7 days) who were willing to quit within 14 days of randomisation, recruited in primary care. Primary care practices were those that had smoking cessation advisors (primary care nurses or healthcare assistants) providing level 2 cessation advice. Participants were self referred or referred by a health professional. 47% men, mean age 41. 8 years (range 18-75 years), able to read English and provide written informed consent,

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	with a mobile phone and familiar with sending and receiving text messages and not enrolled in another formal smoking cessation study or other cessation programme
Interventions	Intervention: usual care plus a tailored advice report and a 90-day programme of tailored text messages generated by the iQuit system (number of messages sent each day varied from 0 to 2, mean/day over 90 days 1.2). The messages were designed to advise smokers on their quit attempt, provide information about the consequences of smoking and expectations for quitting, provide encouragement, boost self efficacy, maintain motivation to quit and remind smokers how to cope with difficult situations Control: 'usual care' consisted of routine 'level 2' smoking cessation advice delivered by smoking cessation adviser. This included a brief discussion about smoking habits and history, measurement of expired-air CO, brief advice to quit, setting a QD within the next 14 days, options for pharmacotherapy, a prescription and arranging a follow-up visit. Usually the opportunity for multiple follow-up visits was offered
Outcomes	Primary outcome: self reported 2-week point prevalence abstinence at 8 weeks Secondary outcomes: CO-verified abstinence at 4-week for at least 2 weeks, assessed by a smoking cessation adviser (a CO reading assessed 25-42 days from QD that was < 10 ppm), self reported 3-month prolonged abstinence at 6 months, 6-month prolonged abstinence at 6-month follow-up and a strict continuous abstinence measure using all outcome time points: CO-validated 2-week point prevalence abstinence at 4 weeks, 4-week point prevalence abstinence at 8 weeks and 6-month prolonged abstinence at 6 months
Notes	Outcomes used in this meta-analysis were self reported. Control programme was fairly intensive, i.e. smoking cessation advice provided in-person

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomised by online programme
Allocation concealment (selection bias)	Low risk	Randomised by online programme once baseline data collected
Blinding (performance bias and detection bias) All outcomes	Low risk	6-month data collected by postal questionnaire or by researchers blinded to allocation
Incomplete outcome data (attrition bias) All outcomes	High risk	65 in control and 70 in intervention lost to follow-up at 6 months but ITT analyses presented
Other bias	Unclear risk	Self reported outcomes included

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Rodgers 2005

Methods	RCT in New Zealand
Participants	1705 participants aged ≥ 16 years recruited by direct advertising, smoking daily, wanting to quit within the next month, and were able to send and receive text messages on their own mobile phone 58% female, median age 22 years, 20.8% Maori (indigenous population), smoked mean 15 cigarettes/day and mean FTND dependence score 5
Interventions	6-month programme delivered solely over mobile phone. Participant nominated QD and received regular personalised text messages with advice, support and distraction, with a countdown to QD, intensive 4 weeks of 5 or 6 messages/day then maintenance phase of 1 message/2 weeks. Messages selected from database matched to participant characteristics. Free month of text messaging from QD. Optional Quit Buddy and Text Crave (messages on demand). Interactive polls and quizzes Control: 1 text message/fortnight
Outcomes	Primary outcome: point prevalence abstinence (no smoking in past 7 days) at 6 weeks' post-randomisation (approximates 4 weeks post-QD). Verification with salivary cotinine in small number of quitters at 6 weeks Secondary outcome: point prevalence abstinence at 12 and 26 weeks, and continuous abstinence at 26 weeks
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Central computerised randomisation
Allocation concealment (selection bias)	Low risk	Concealed until after assignment
Blinding (performance bias and detection bias) All outcomes	Low risk	Single blind (participants not blinded)
Incomplete outcome data (attrition bias) All outcomes	High risk	Lost to follow-up: 35 control (95.9%) and 46 intervention (94.6%) followed up at 6 weeks; but differential loss to follow-up at 6 months (79% control vs. 69% intervention). Possibly due to incentive being offered to control group for follow-up, may in turn have affected long-term results of study (by underestimating effect)
Other bias	High risk	The authors suggested that some participants in the control group may have thought their incentive at follow-up (month of free text messaging) depended on reporting quitting. This could account for an unexpected increase in control group participants reporting quitting from 6 weeks (109 participants) to 6 months (202 participants reporting no smoking in the past 7

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Rodgers 2005 (*Continued*)

		days), which could have led to an underestimation of the effect of the intervention

Shelley 2015

Methods	3-arm RCT in US
Participants	Participants aged ≥ 18 years recruited from large urban HIV clinics in the USA Inclusion criteria: current patient of the clinics, current or regular smoker (≥ 5 cigarettes/day), CO ≥ 8 ppm, willing to set a QD within the next 2 weeks, willing to use a mobile phone and able to read text messages, and eligible to take varenicline Exclusion criteria: alcohol dependence and active drug abuse, and conditions that would prevent the use of varenicline
Interventions	Intervention: participants received standard care (see below) and 2 text messages/day for 12 weeks. 1 message reminding them to take their medication and 1 motivational message regarding cessation Control group: received standard care, which consisted of a self help information sheet, tailored to HIV-positive smokers and an offer of varenicline for 12 weeks according to the standard dosage schedule. Participants needed to return to the clinic each 4 weeks to receive further medication. All participants were provided with a pre-paid mobile phone - the control group received phones to facilitate their ability to call the quit line and receive text message appointment reminders only A third arm received standard care, text messages, plus behavioural therapy delivered via 7 proactive mobile phone-delivered counselling sessions over a 6-week period. These combined cognitive behavioural therapy and motivational interviewing techniques
Outcomes	Primary outcome: 7-day point prevalence abstinence verified by CO < 8 ppm at 24 weeks, also measured at 1, 4, 8 and 12 weeks
Notes	Unpublished - we did not have the participant characteristics tables

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation schedule, stratified by people smoking 5-10 and people smoking > 10 cigarettes/day
Allocation concealment (selection bias)	Low risk	After consent and baseline data collected, the research assistant called to receive the assignment
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Participants self complete questionnaires through audio computer-assisted self interviewing

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Shelley 2015 (*Continued*)

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	21 participants in the control group, 19 in the text message group (and 24 in the text message + phone counselling group) did not complete 24-week follow-up visits. ITT analysis is used in this meta-analysis
Other bias	Unclear risk	None described

Whittaker 2011

Methods	RCT in New Zealand
Participants	226 participants aged ≥ 16 years recruited by advertising if they were current daily smokers ready to quit, and had a video message-capable phone. Advertising particularly targeted young adults. 47% female, 24% Maori (indigenous population), mean age 27 years and appeared to be highly addicted due to the Hooked on Nicotine Checklist mean scores of 8 (SD 1.9) out of 10
Interventions	Intervention group: received an automated package of video and text messages over 6 months that was tailored to self selected quit date, role model and timing of messages. Video messages were video diary-style from a selected 'ordinary' person going through a quit attempt in advance of the participant. Frequency of messages varied from 1/day in the lead up to QD, 2/day from QD for 4 weeks, then reducing to 1 every 2 days for 2 weeks and then 1 every 4 days for about 20 weeks until 6 months after randomisation. Extra messages were available on demand to beat cravings and address lapses. Additional website for intervention group participants to review video messages they had been sent (and rate them if desired), change their selected time periods and change (or add to) their selected role model Control: also set a QD and received a general health video message sent to their phone every 2 weeks
Outcomes	Self reported continuous abstinence - no more than 5 cigarettes smoked since the start of the abstinence period at 6 months of follow-up
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Central computerised randomisation
Allocation concealment (selection bias)	Low risk	Concealed until after assignment
Blinding (performance bias and detection bias) All outcomes	Low risk	Single blind (participants not blinded)

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Whittaker 2011 (*Continued*)

Incomplete outcome data (attrition bias) All outcomes	Low risk	32% intervention and 22% control lost to follow-up at 6 months
Other bias	Unclear risk	None described

CI: confidence interval; CO: carbon monoxide; FTND: Fagerström Test of Nicotine Dependence; HIV: human immunodeficiency virus; ITT: intention to treat; ppm: parts per million; QD: quit day; RCT: randomised controlled trial; SD: standard deviation; SMS: short messaging service.

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Applegate 2007	Abstract describing intervention to increase adherence to the use of nicotine replacement gum in people attempting to quit smoking. Duration 8 weeks
Bennett 2011	Editorial comment on the Free 2011 trial
Blasco 2012	Internet-based telemonitoring programme for secondary prevention in cardiovascular disease with parameters sent by mobile phone
Brendryen 2008a	Mobile phone intervention confounded with Internet intervention (previously included in Whittaker 2009)
Brendryen 2008b	Mobile phone intervention confounded with Internet intervention (previously included in Whittaker 2009)
Bricker 2014	Pilot study with 2-month follow-up only
Buller 2014	Follow-up only to 3 months
Chow 2012	Focused on cardiac rehabilitation
Dale 2014	Focused on cardiac rehabilitation
Fingrut 2014	Not focused on delivery by mobile phone
Fraser 2014	Not focused on delivery by mobile phone
Haug 2008	Non-randomised feasibility study. Duration 12 weeks
Haug 2009	Mainly about acceptability, 3 months' follow-up
Haug 2014	Protocol for a study on alcohol and smoking in adolescents
Jordan 2015	3 months' follow-up

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(*Continued*)

Kiselev 2011	Not focused on smoking cessation
Lazev 2004	Not randomised. No control group. Feasibility study for the programme presented in Vidrine 2006
Mehring 2014	Not focused on delivery by mobile phone
Naughton 2012	Randomised controlled trial with pregnant smokers, follow-up to 3 months
Obermayer 2004	Not randomised. No control group
Pechmann 2015	Not randomised
Peng 2013	Not focused on delivery by mobile phone
Pollak 2013	Gradual reduction in pregnant women
Riley 2008	Small non-randomised study with only 6 weeks' follow-up
Shi 2013	Follow-up only 3 months
Skov-Ettrup 2013	Not focused on delivery by mobile phone
Skov-Ettrup 2014	Compared tailored with un-tailored text messages - no control group
Snider 2011	Not a trial
Stanczyk 2014	Not focused on delivery by mobile phone
Vidrine 2006	Randomised trial of phone counselling with mobile phones, follow-up only 3 months
Vilaplana 2014	Follow-up only 3 months
Wizner 2009	Not focused on smoking cessation
Ybarra 2012	Pilot RCT, follow-up only 3 months
Ybarra 2013	Pilot RCT, follow-up only 3 months
Yuhongxia 2011	Single-blind RCT, follow-up 24 weeks, but with no details available on the randomisation method or the intervention content. Abstract only, unable to contact authors

RCT: randomised controlled trial.

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Characteristics of ongoing studies *[ordered by study ID]*

BinDhim 2014

Trial name or title	Assessing the Effect of an Interactive Decision-Aid Smartphone Smoking Cessation Application (app) on Quit Rates: a Double-Blind Automated Randomised Control Trial Protocol
Methods	RCT
Participants	Daily smokers aged ≥ 18 years in Australia, Singapore, the UK and the US
Interventions	Smoking cessation app
Outcomes	Continuous abstinence at 1 and 6 months
Starting date	May 2014
Contact information	Nasser F BinDhim; nbin6641@uni.sydney.edu.au
Notes	

Cooper 2015

Trial name or title	MiQuit Trial: Tailored Text Messages for Pregnant Women
Methods	RCT
Participants	Smokers aged ≥ 16 years, pregnant, in UK
Interventions	MiQuit is an automated responsive text message support programme lasting 12 weeks
Outcomes	Continuous abstinence from 4 weeks after randomisation until follow-up at the end of pregnancy
Starting date	February 2014
Contact information	Tim Coleman, University of Nottingham
Notes	

NCT01103427

Trial name or title	Internet and Text Messaging Intervention in Norway
Methods	RCT
Participants	Current smokers aged ≥ 16 years
Interventions	Internet-based smoking cessation versus Internet plus text messaging

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NCT01103427 (*Continued*)

Outcomes	Point prevalence abstinence at 1, 3, 6 and 12 months
Starting date	2011
Contact information	Professor Gram, Faculty of Health Sciences, Institute of Community Medicine, University of Tromsø, Norway, inger.gram@uit.no
Notes	

NCT01723163

Trial name or title	Abstinence Reinforcement Therapy for Rural Veteran Smokers
Methods	RCT
Participants	Durham VA enrolees
Interventions	Cognitive behavioural telephone counselling, telemedicine clinic for access to nicotine-replacement therapy, mobile contingency management
Outcomes	Quality-adjusted life years at 12 months
Starting date	November 2013
Contact information	Patrick Calhoun, Durham VA Medical Center, Durham NC
Notes	

NCT01746069

Trial name or title	Effectiveness of Messages to Mobile Phone in Smoke Cessation
Methods	RCT
Participants	Current smokers aged > 18 years in Spain
Interventions	Quit advice by a doctor and support messages to mobile phones
Outcomes	Continuous abstinence at 6 months
Starting date	December 2012
Contact information	Raquel Cobos Campos, Basque Health Service
Notes	

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NCT01817842

Trial name or title	Study of Mobile Phone Support for the DC Tobacco Quitline
Methods	RCT
Participants	Current smokers aged ≥ 18 years in US
Interventions	Internet-based system using mobile phones to increase the quality, frequency and accessibility of support
Outcomes	Point prevalence abstinence at 3, 6 and 9 months
Starting date	July 2010
Contact information	Thomas Kirchner, American Legacy Foundation
Notes	

NCT01952236

Trial name or title	Web and Mobile Smoking Cessation
Methods	RCT
Participants	Smokers aged ≥ 18 years in US
Interventions	Internet plus mobile compared with Internet only
Outcomes	Point prevalence 3 and 6 months
Starting date	April 2015
Contact information	Brian Danaher briand@ori.org
Notes	

NCT01982110

Trial name or title	A Mindfulness Based Application for Smoking Cessation
Methods	RCT
Participants	Smokers aged ≥ 18 years in the US
Interventions	A mindfulness based smartphone app
Outcomes	Number of cigarettes smoked at 6 months
Starting date	September 2013

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NCT01982110 (*Continued*)

Contact information	Jennifer Penberthy jkp2n@virginia.edu
Notes	

NCT01983150

Trial name or title	A Randomised Controlled Trial to Test the Effect of a Smartphone Quit Smoking Intervention on Young Adult Smokers
Methods	RCT
Participants	Smokers aged 19-29 years in Canada
Interventions	Crush The Crave smartphone application
Outcomes	Point prevalence (30 day) at 6 months
Starting date	January 2014
Contact information	
Notes	

NCT01990079

Trial name or title	Use of Technological Advances to Prevent Smoking Relapse Among Smokers with PTSD
Methods	RCT
Participants	Smokers aged 18-70 years in US
Interventions	Quit4ever combines counselling sessions, bupropion and nicotine-replacement therapy, mobile contingency management and the smartphone application Stay Quit Coach
Outcomes	Point prevalence abstinence at 3 and 6 months
Starting date	December 2013
Contact information	Jean Beckham, Duke University
Notes	

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NCT02021175

Trial name or title	Korean Youth Smoking Cessation Study
Methods	RCT
Participants	Smokers aged 14-19 years Korean/American youth in US
Interventions	Tailored interactive cognitive behavioural motivation enhancement therapy delivered through Internet and mobile phones
Outcomes	Point prevalence abstinence at 6 months
Starting date	June 2016
Contact information	Steve Shoptaw sshoptaw@mednet.ucla.edu
Notes	

NCT02037360

Trial name or title	Mobile Mindfulness Training for Smoking Cessation
Methods	RCT
Participants	Smokers aged 18-65 years in US
Interventions	Smartphone-based training programme
Outcomes	Point prevalence abstinence at 6 months
Starting date	August 2015
Contact information	Judson Brewer judson.brewer@yale.edu
Notes	

NCT02134509

Trial name or title	Smartphone Application for Smoking Cessation
Methods	RCT
Participants	Smokers aged 18-65 years in US
Interventions	3-week smartphone-based training programme
Outcomes	Point prevalence at 6 months

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NCT02134509 (*Continued*)

Starting date	October 2014
Contact information	Kathleen Garrison, Yale University
Notes	

NCT02136498

Trial name or title	Internet-Based Medication Adherence Program for Nicotine Dependence Treatment
Methods	RCT
Participants	Smokers aged 18-65 years
Interventions	My Mobile Advice Program via smartphone or Internet device
Outcomes	Point prevalence abstinence at 5 months
Starting date	October 2014
Contact information	
Notes	

NCT02164383

Trial name or title	A Quit Smoking Study Using Smartphones
Methods	RCT
Participants	Smokers aged ≥ 18 years in the US
Interventions	Mobile games
Outcomes	Number of cigarettes/day
Starting date	October 2014
Contact information	Tanya Schlam trschlam@ctri.wisc.edu
Notes	

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NCT02207036

Trial name or title	Social Media Intervention for Young Adult Smokers
Methods	RCT
Participants	Smokers aged 18-25 years in the US
Interventions	3 month Facebook intervention
Outcomes	Point prevalence abstinence at 6 and 12 months
Starting date	October 2014
Contact information	Danielle A Ramo, UCSF
Notes	

NCT02218281

Trial name or title	Developing a Smartphone App With Mindfulness Training for Teen Smoking Cessation
Methods	RCT
Participants	Smokers aged 13-19 years in US
Interventions	Smoking cessation treatment delivered through a smartphone app via mindfulness training
Outcomes	Point prevalence abstinence at 3 and 6 months
Starting date	September 2014
Contact information	Lori Pbert, University of Massachusetts
Notes	

NCT02218944

Trial name or title	Smoking Response Inhibition Training
Methods	RCT
Participants	Smokers aged 18-45 years in US
Interventions	Smoking-specific response inhibition training programme in the context of a quit attempt. The task is based on a modified stop-signal task
Outcomes	Smoking relapse at 6 months

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NCT02218944 (*Continued*)

Starting date	September 2014
Contact information	Robert D Dvorak, North Dakota State University
Notes	

NCT02237898

Trial name or title	Harnessing the Power of Technology: MoMba for Postpartum Smoking
Methods	RCT
Participants	Smokers aged 18-50 years in US
Interventions	MoMba Live Long Smartphone application
Outcomes	Point prevalence abstinence at 21 months
Starting date	February 2016
Contact information	Ruth M Arnold, ruth.arnold@yale.edu
Notes	

NCT02245308

Trial name or title	Abstinence Reinforcement Therapy (ART) for Homeless Veteran Smokers
Methods	RCT
Participants	Smokers aged 18-75 years
Interventions	Nicotine patches plus mobile contingency management (participants upload videos of themselves taking carbon monoxide readings. Any time a participant uploads a video that suggests abstinence, he/she is provided with a monetary reward)
Outcomes	Smoking abstinence at 6 months
Starting date	October 2014
Contact information	Angela C Kirby, angela.kirby@va.gov
Notes	

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NCT02302859

Trial name or title	Mobile Media-Rich Interactive Guideline System (MMRIGS) Pilot Study
Methods	RCT
Participants	Smokers aged ≥ 18 years and older
Interventions	Brief advice to quit smoking (tailored video clips) and an 8-week automated intervention (interactive text messages and graphical messages) for support in quitting smoking via smartphone
Outcomes	Smoking abstinence 3 months
Starting date	January 2015
Contact information	Alex Prokhorov, M.D. Anderson Cancer Center
Notes	

NCT02328794

Trial name or title	Randomized Clinical Trial to Reduce Harm From Tobacco
Methods	RCT
Participants	Smokers aged ≥ 18 years
Interventions	eCigarettes, nicotine-replacement therapy and other pharmacotherapy, incentives and a standard programme of support including text messaging
Outcomes	Verified abstinence at 6 months
Starting date	January 2015
Contact information	Kathryn A Saulsgiver kasau@mail.med.upenn.edu
Notes	

NCT02367391

Trial name or title	Penn State TXT2Quit Study
Methods	RCT
Participants	Smokers aged ≥ 21 years
Interventions	Varenicline and motivational text messages
Outcomes	Point prevalence at 3 months

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NCT02367391 (*Continued*)

Starting date	January 2015
Contact information	Jonathan Foulds, Milton S. Hershey Medical Center
Notes	

Valdivieso-Lopez 2013

Trial name or title	Efficacy of a Mobile Application in the Smoking Cessation Among Young People (TOBB_STOP)
Methods	RCT
Participants	Smokers aged 18-30 years in Spain
Interventions	Mobile phone application for smartphone
Outcomes	Smoking cessation at 6 months
Starting date	January 2013
Contact information	Empar Valdivieso López evaldivieso.tarte.ics%40gencat.cat
Notes	

Vidrine 2012

Trial name or title	Smoking Cessation for Low-Income Adults
Methods	RCT
Participants	Smokers aged ≥ 18 years in US
Interventions	Standard care plus mobile phone-delivered text/graphical messaging component plus 11 mobile phone-delivered proactive counselling sessions
Outcomes	Smoking abstinence at 12 months
Starting date	June 2010
Contact information	Alex Prokhorov, MD Anderson Cancer Center
Notes	

RCT: randomised controlled trial.

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DATA AND ANALYSES

Comparison 1. Mobile phone intervention versus control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 26-week cessation outcomes all studies	12	11885	Risk Ratio (M-H, Fixed, 95% CI)	1.67 [1.46, 1.90]
2 26-week continuous abstinence	8	10679	Risk Ratio (M-H, Fixed, 95% CI)	1.72 [1.50, 1.98]
3 26-week 7-day point prevalence	7	3888	Risk Ratio (M-H, Fixed, 95% CI)	1.18 [1.03, 1.35]
4 Biochemically verified 26-week abstinence	6	7360	Risk Ratio (M-H, Fixed, 95% CI)	1.83 [1.54, 2.19]

Comparison 2. Text messaging-only interventions

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 26-week quitting outcomes	7	9887	Risk Ratio (M-H, Fixed, 95% CI)	1.69 [1.46, 1.95]

Comparison 3. Text messaging plus face-to-face interventions

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Text message plus face-to-face interventions	5	1995	Risk Ratio (M-H, Fixed, 95% CI)	1.54 [1.12, 2.11]

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Analysis 1.1. Comparison 1 Mobile phone intervention versus control, Outcome 1 26-week cessation outcomes all studies.

Review: Mobile phone-based interventions for smoking cessation

Comparison: 1 Mobile phone intervention versus control

Outcome: 1 26-week cessation outcomes all studies

Study or subgroup	Treatment n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Bock 2013	6/30	1/30		0.3 %	6.00 [0.77, 46.87]
Shelley 2015	2/54	2/53		0.6 %	0.98 [0.14, 6.71]
Gritz 2013	3/236	5/238		1.5 %	0.61 [0.15, 2.50]
Abroms 2014	29/262	12/241		3.8 %	2.22 [1.16, 4.26]
Ferguson 2015	13/142	15/142		4.6 %	0.87 [0.43, 1.75]
Naughton 2014	34/299	19/303		5.8 %	1.81 [1.06, 3.11]
Free 2009	15/102	19/98		5.9 %	0.76 [0.41, 1.41]
Haug 2013	36/372	26/383		7.8 %	1.43 [0.88, 2.31]
Whittaker 2011	29/110	32/116		9.5 %	0.96 [0.62, 1.47]
Borland 2013	68/755	26/422		10.2 %	1.46 [0.95, 2.26]
Rodgers 2005	64/852	39/853		11.9 %	1.64 [1.12, 2.42]
Free 2011	268/2911	124/2881		38.1 %	2.14 [1.74, 2.63]
Total (95% CI)	**6125**	**5760**		**100.0 %**	**1.67 [1.46, 1.90]**

Total events: 567 (Treatment), 320 (Control)

Heterogeneity: $Chi^2 = 26.94$, df = 11 (P = 0.005); $I^2 = 59\%$

Test for overall effect: Z = 7.62 (P < 0.00001)

Test for subgroup differences: Not applicable

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Analysis 1.2. Comparison 1 Mobile phone intervention versus control, Outcome 2 26-week continuous abstinence.

Review: Mobile phone-based interventions for smoking cessation

Comparison: 1 Mobile phone intervention versus control

Outcome: 2 26-week continuous abstinence

Study or subgroup	Treatment n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Abroms 2014	29/262	12/241		4.4 %	2.22 [1.16, 4.26]
Borland 2013	68/755	26/422		11.8 %	1.46 [0.95, 2.26]
Free 2009	15/102	19/98		6.8 %	0.76 [0.41, 1.41]
Free 2011	268/2911	124/2881		43.9 %	2.14 [1.74, 2.63]
Gritz 2013	3/236	5/238		1.8 %	0.61 [0.15, 2.50]
Naughton 2014	34/299	19/303		6.6 %	1.81 [1.06, 3.11]
Rodgers 2005	64/852	39/853		13.7 %	1.64 [1.12, 2.42]
Whittaker 2011	29/110	32/116		11.0 %	0.96 [0.62, 1.47]
Total (95% CI)	**5527**	**5152**		**100.0 %**	**1.72 [1.50, 1.98]**

Total events: 510 (Treatment), 276 (Control)

Heterogeneity: Chi^2 = 21.54, df = 7 (P = 0.003); I^2 =68%

Test for overall effect: Z = 7.58 (P < 0.00001)

Test for subgroup differences: Not applicable

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Analysis 1.3. Comparison 1 Mobile phone intervention versus control, Outcome 3 26-week 7-day point prevalence.

Review: Mobile phone-based interventions for smoking cessation

Comparison: 1 Mobile phone intervention versus control

Outcome: 3 26-week 7-day point prevalence

Study or subgroup	Treatment n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Abroms 2014	83/262	50/241		16.9 %	1.53 [1.13, 2.07]
Bock 2013	6/30	1/30		0.3 %	6.00 [0.77, 46.87]
Ferguson 2015	13/142	15/142		4.9 %	0.87 [0.43, 1.75]
Gritz 2013	12/236	11/238		3.5 %	1.10 [0.50, 2.44]
Haug 2013	36/372	26/383		8.3 %	1.43 [0.88, 2.31]
Rodgers 2005	216/852	202/853		65.4 %	1.07 [0.91, 1.26]
Shelley 2015	2/54	2/53		0.7 %	0.98 [0.14, 6.71]
Total (95% CI)	**1948**	**1940**		**100.0 %**	**1.18 [1.03, 1.35]**

Total events: 368 (Treatment), 307 (Control)

Heterogeneity: Chi^2 = 7.87, df = 6 (P = 0.25); I^2 =24%

Test for overall effect: Z = 2.46 (P = 0.014)

Test for subgroup differences: Not applicable

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Analysis 1.4. Comparison 1 Mobile phone intervention versus control, Outcome 4 Biochemically verified 26-week abstinence.

Review: Mobile phone-based interventions for smoking cessation

Comparison: 1 Mobile phone intervention versus control

Outcome: 4 Biochemically verified 26-week abstinence

Study or subgroup	Treatment n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Abroms 2014	29/262	12/241		7.0 %	2.22 [1.16, 4.26]
Ferguson 2015	13/142	15/142		8.4 %	0.87 [0.43, 1.75]
Free 2009	15/102	19/98		10.9 %	0.76 [0.41, 1.41]
Free 2011	268/2911	124/2881		69.8 %	2.14 [1.74, 2.63]
Gritz 2013	3/236	5/238		2.8 %	0.61 [0.15, 2.50]
Shelley 2015	2/54	2/53		1.1 %	0.98 [0.14, 6.71]
Total (95% CI)	**3707**	**3653**		**100.0 %**	**1.83 [1.54, 2.19]**

Total events: 330 (Treatment), 177 (Control)

Heterogeneity: Chi^2 = 17.40, df = 5 (P = 0.004); I^2 =71%

Test for overall effect: Z = 6.73 (P < 0.00001)

Test for subgroup differences: Not applicable

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Analysis 2.1. Comparison 2 Text messaging-only interventions, Outcome 1 26-week quitting outcomes.

Review: Mobile phone-based interventions for smoking cessation

Comparison: 2 Text messaging-only interventions

Outcome: 1 26-week quitting outcomes

Study or subgroup	Treatment n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Abroms 2014	29/262	12/241		4.5 %	2.22 [1.16, 4.26]
Borland 2013	68/755	26/422		12.1 %	1.46 [0.95, 2.26]
Ferguson 2015	13/142	15/142		5.5 %	0.87 [0.43, 1.75]
Free 2009	15/102	19/98		7.0 %	0.76 [0.41, 1.41]
Free 2011	268/2911	124/2881		45.3 %	2.14 [1.74, 2.63]
Rodgers 2005	64/852	39/853		14.2 %	1.64 [1.12, 2.42]
Whittaker 2011	29/110	32/116		11.3 %	0.96 [0.62, 1.47]
Total (95% CI)	**5134**	**4753**		**100.0 %**	**1.69 [1.46, 1.95]**

Total events: 486 (Treatment), 267 (Control)

Heterogeneity: Chi^2 = 22.80, df = 6 (P = 0.00087); I^2 =74%

Test for overall effect: Z = 7.18 (P < 0.00001)

Test for subgroup differences: Not applicable

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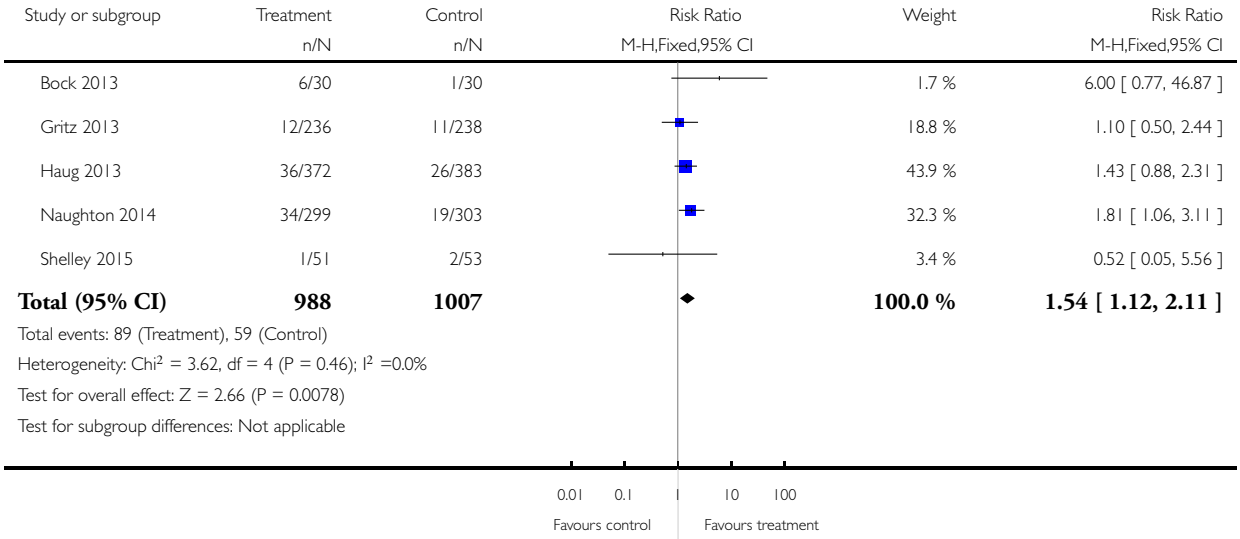
Analysis 3.1. Comparison 3 Text messaging plus face-to-face interventions, Outcome 1 Text message plus face-to-face interventions.

Review: Mobile phone-based interventions for smoking cessation

Comparison: 3 Text messaging plus face-to-face interventions

Outcome: 1 Text message plus face-to-face interventions



APPENDICES

Appendix 1. Tobacco Addiction Group Register search strategy

Searched in Cochrane Register of Studies (CRS) 8 April 2015
#1 Cellular Phone:MH
#2 Cell Phones:MH
#3 MeSH DESCRIPTOR Cellular Phone
#4 MESH DESCRIPTOR Cell Phones
#5 MeSH DESCRIPTOR Text Messaging
#6 (mobile NEAR2 (phone* OR telephon*)):TI,AB,MH,EMT,XKY,KY,KW
#7 (cell* NEAR2 (phone* OR telephon*)):TI,AB,MH,EMT,XKY,KY,KW
#8 smartphone*:TI,AB,MH,EMT,XKY,KY,KW
#9 text messag*:TI,AB,MH,EMT,XKY,KY,KW
#10 (txt OR pxt OR mms OR sms):TI,AB,MH,EMT,XKY,KY,KW
#11 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10

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WHAT'S NEW

Date	Event	Description
1 October 2015	New search has been performed	Updated 2015, seven new studies added and text updated
1 October 2012	New search has been performed	Updated 2012, three new studies added and text updated
1 October 2012	New citation required and conclusions have changed	Three new included studies added, meta-analysis conducted, conclusions changed (pooled effect statistically significant)

HISTORY

Date	Event	Description
15 July 2008	Amended	Converted to new review format.
5 September 2006	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

RW is the lead author of this review.

For the most recent update:

- RW and YG selected studies for inclusion.
- HM reviewed the selected studies for inclusion.
- RW and YG independently extracted data from the papers and undertook the analysis.
- All authors contributed to the writing and editing of the review.

DECLARATIONS OF INTEREST

RW was co-author of one paper on one of the included studies (Bramley 2005). She was a co-investigator on two included studies (Free 2009; Free 2011), and principle investigator of a further included study (Whittaker 2011).

CB and HM were co-authors of Whittaker 2011.

RB was co-author of one of the trials (Borland 2013), and he led the development of the intervention.

AR was a lead author (Rodgers 2005), and a co-author (Free 2009; Free 2011; Whittaker 2011), on included studies.

HM received honoraria from Johnson & Johnson and Pfizer for speaking at educational events and attending advisory group meetings. He has also received investigator initiated research funding from Pfizer.

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RW's institution has received grant money to cover the costs of providing the text messaging intervention for the study described in Free 2011, and there is a grant pending to develop this intervention further for a different audience. The institution has also licensed the STOMP intervention described in Rodgers 2005 to HSAGlobal.

All other authors had no other known conflicts of interest.

SOURCES OF SUPPORT

Internal sources

- National Institute for Health Innovation (Auckland Uniservices), New Zealand.
- Cancer Council Victoria, Australia.

External sources

- No sources of support supplied

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

We have followed the change of policy of the Cochrane Tobacco Addiction Group, and now report our findings using Mantel-Haenszel fixed-effect risk ratios rather than as odds ratios. Previously, we had not pooled studies in the presence of substantial statistical heterogeneity as assessed by the I^2 statistic, but in this update of the review, we report pooled results due to the homogenous nature of the included studies in terms of design, intervention and outcome.

INDEX TERMS

Medical Subject Headings (MeSH)

*Cell Phone; *Smoking Cessation; *Text Messaging; Counseling [*methods]; Randomized Controlled Trials as Topic

MeSH check words

Adult; Humans

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