

Mobile phone-based interventions for smoking cessation (Review)

Whittaker R, Borland R, Bullen C, Lin RB, McRobbie H, Rodgers A



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[Intervention Review]

Mobile phone-based interventions for smoking cessation

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ABSTRACT

Background

Innovative effective smoking cessation interventions are required to appeal to those who are not accessing traditional cessation services. Mobile phones are widely used and are now well integrated into the daily lives of many, particularly young adults. Mobile phones are a potential medium for the delivery of health programmes such as smoking cessation.

Objectives

To determine whether mobile phone-based interventions are effective at helping people who smoke, to quit.

Search strategy

We searched MEDLINE, EMBASE, Cinahl, PsycINFO, The Cochrane Library, the National Research Register and the ClinicalTrials register, with no restrictions placed on language or publication date.

Selection criteria

We included randomized or quasi-randomized trials. Participants were smokers of any age who wanted to quit. Studies were those examining any type of mobile phone-based intervention. 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

Information on the specified quality criteria and methodological details was extracted using a standardised form. Participants who dropped out of the trials or were lost to follow up were considered to be smoking. Meta-analysis of the included studies was undertaken using the Mantel-Haenszel Risk Ratio fixed-effect method provided that there was no evidence of substantial statistical heterogeneity as assessed by the I^2 statistic. Where meta-analysis was not possible, summary and descriptive statistics are presented.

Main results

Four studies were excluded as they were small non-randomized feasibility studies, and two studies were excluded because follow up was less than six months. Four trials (reported in five papers) are included: a text message programme in New Zealand; a text message

programme in the UK; and an Internet and mobile phone programme involving two different groups in Norway. The different types of interventions are analysed separately. When combined by meta-analysis the text message programme trials showed a significant increase in short-term self-reported quitting (RR 2.18, 95% CI 1.80 to 2.65). However, there was considerable heterogeneity in long-term outcomes, with the much larger trial having problems with misclassification of outcomes; therefore these data were not combined. When the data from the Internet and mobile phone programmes were pooled we found statistically significant increases in both short and long-term self-reported quitting (RR 2.03, 95% CI 1.40 to 2.94).

Authors' conclusions

The current evidence shows no effect of mobile phone-based smoking cessation interventions on long-term outcome. While short-term results are positive, more rigorous studies of the long-term effects of mobile phone-based smoking cessation interventions are needed.

PLAIN LANGUAGE SUMMARY

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

More evidence is needed to determine if programmes delivered over mobile phones can help people to stop smoking. This review found text message mobile phone programmes to be effective in the short-term (six weeks), and a combined Internet-mobile phone programme to be effective up to 12 months.

BACKGROUND

Since the introduction of mobile phone networks in the 1980s the use of mobile phones has grown exponentially. By the end of 2008 there were reported to be more than four billion mobile cellular subscriptions worldwide with some countries (e.g. United Kingdom and parts of Europe) having more mobile cellular subscriptions than people (ITU 2009). There has been a rapid expansion in the use of text messaging with a reported 78.9 billion text messages sent during 2008 in the UK (MDA 2009) and an estimated one trillion messages during 2008 in the USA (CTIA 2009). Advances in mobile communications technology continue to make new functions available. In a 2005 multinational survey (of 4000 participants from 21 countries) 53% of mobile phone consumers said they are able to access multimedia services (data services like mobile email or browsing mobile websites (Urban 2007)); proportions varied by region and by age with those under 34 years being more likely to have a multimedia phone. In most countries it is young adults who are more likely to own mobile phones, to own new mobile phones and to be using the newer functions of mobile phones (Urban 2007).

Health services around the world now use mobile phones to support patients. In particular mobile phones (voice and text messaging) have been used to improve medication adherence (Puccio 2006), send appointment reminders (Leong 2006; Downer 2006), improve monitoring and self-management of chronic disorders (such as diabetes) (Kim 2006; Gammon 2005; Tasker 2007; Ferrer-Roca 2004), report test results (Menon-Johansson 2007; Dhar 2006), and check in with patients and collect data between

appointments (Freedman 2006; Collins 2003).

Smoking cessation programmes are also starting to use mobile phones, particularly as adjuncts to quitlines and Internet quit coaches, e.g. the NHS Stop Smoking Service's 'Together' programme (<http://gosmokefree.nhs.uk/what-suits-me/support-at-home/>) and the New Zealand Quitline 'Txt2quit' programme (http://www.quit.org.nz/txt2quit/page/txt2quit_5.php). Cessation interventions that are aimed at young adults appear ideally suited for delivery via mobile phones, as young people appreciate the anonymity and confidentiality allowable, and the ease of use anywhere at anytime (Vuckovic 2003; Balch 2004). Other possible benefits of mobile phone-based smoking cessation interventions include: 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 and 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 in cessation will continue to grow as they become even more ubiquitous and as technological advances increase the number of applications and functions available. Therefore it is important to determine if mobile phones can be effective at helping people who smoke, to quit.

OBJECTIVES

To determine whether mobile phone based interventions are ef-

fective at helping people who smoke, to quit.

There were no restrictions placed on language or publication date.

METHODS

Criteria for considering studies for this review

Types of studies

Randomized or quasi-randomized trials.

Types of participants

All smokers who want to quit smoking. No age restrictions applied.

Types of interventions

We included studies which examine any type of mobile phone-based intervention. 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. 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 multi-faceted programme could not be separated.

Types of outcome measures

The primary outcome of interest was smoking abstinence at six months or longer after the start of the intervention. Both sustained abstinence and point prevalence abstinence were considered, and both self-reported and biochemically verified smoking status.

Search methods for identification of studies

We searched the specialised register of the Tobacco Addiction Review group using the terms 'mobile phone' 'cell phone' 'txt' 'pxt' 'sms' 'mms' in the title or abstract or as keywords.

We also searched MEDLINE, EMBASE, Cinahl, PsycINFO and the Cochrane Central Register of Controlled Trials (CENTRAL) on December 10 2008, using the following strategy with small modifications to suit the specific databases:

(cellular phone/ or mobile phone* or "cell* adj phone*" or txt or pxt or sms or mms)

AND

(smoking/ or smoking cessation/ or tobacco use disorder/ or smok* or tobacco or cigar* or nicotine).

We also searched the National Research Register Archive and the UK Clinical Research Network Portfolio for current projects in the UK and the ClinicalTrials 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.

Data collection and analysis

Selection of studies

We ran a comprehensive search using the strategy outlined above. Citations were downloaded and duplicates deleted. From the abstracts and the titles of the downloaded citations two authors (RW and HM) identified potentially eligible studies and obtained full text copies. The same authors independently selected studies to be included against the criteria listed above and any disagreements were resolved by discussion, by contacting study authors, or by referring to RB to act as arbiter where required. Reasons for exclusion of studies were recorded.

Data extraction and management

We extracted from the included studies information on the following methodological details. These are presented in the Table of [Characteristics of included studies](#). The articles were not blinded for authors, institution and journal, because the review authors who performed the quality assessment are familiar with the literature. If an article did not contain enough information on methodological criteria, i.e. if one or more criteria were scored 'unclear', we contacted the trial authors for additional information.

Characteristics of the study participants

- 1) Definition of smoking status as used in the study
- 2) Age and any other recorded characteristics of people who smoke in the study
- 3) Other inclusion criteria
- 4) Exclusion criteria

Interventions used

- 1) Type and 'dose' of mobile phone intervention used
- 2) Type of control/placebo intervention used
- 3) Duration of intervention
- 4) Duration of follow up

Assessment of risk of bias in included studies

We extracted from the included studies information on the following quality criteria:

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

Measures of treatment effect

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

Dealing with missing data

RW and RL independently extracted the data using a standardised form. We regarded those trial participants who dropped out of the trials or were lost to follow up as continuing to smoke.

Data synthesis

We conducted a meta-analysis of the included studies, using the Mantel-Haenszel Risk Ratio, fixed-effect method, provided that there was no evidence of substantial statistical heterogeneity as assessed by the I^2 statistic (Higgins 2003). Where meta-analysis was not possible we present summary and descriptive statistics.

RESULTS

Description of studies

See: [Characteristics of included studies](#); [Characteristics of excluded studies](#); [Characteristics of ongoing studies](#).

Results of the search

103 studies were initially identified by the literature search strategy outlined above. The use of terms with multiple possible meanings in the search strategy (cell, txt, pxt, sms, mms) meant that many unrelated studies were identified and these were immediately excluded, leaving 15 papers. Six were letters about country-specific data on a potential link between the increase in mobile phone use and decline in adolescent smoking, so were excluded as they were not trials. This left nine papers, four of which were excluded as they were small non-randomized feasibility studies (Haug 2008; Lazev 2004; Obermayer 2004; Riley 2008). A further two studies were excluded because follow up was for only eight weeks (Applegate 2007) or three months (Vidrine 2006 - this programme was also considerably different in that the mobile phones were used to make proactive counselling phone calls for free to an HIV-positive population).

Two articles described one trial (Rodgers 2005 and Bramley 2005) separately reporting main results (Rodgers 2005) and an analysis of results for Maori (the indigenous population of New Zealand)

compared with non-Maori (Bramley 2005). There was some debate over whether to include the remaining article (Brendryen 2008a) as the intervention described in the paper placed equal emphasis on Internet/email and mobile phone components. Against inclusion was the fact that the effect of these different components could not be separated. However we included it because the mobile phone component was treated by the authors as a very important focus of the intervention, and involved similar elements to those in other included studies (daily information and motivational text messages and pre-recorded audio messages). Contact with this author revealed another soon-to-be-published study on the same intervention with a different sample which was included and has since been published (Brendryen 2008b). One unpublished pilot study was located and included after the author provided a report and data; this has now been published (Free 2009). Therefore four trials, using two different programmes and reported in five papers, have been included in this review.

Included studies

The first two trials (Rodgers 2005; Free 2009) were based on the same programme, initially developed by Rodgers et al in New Zealand and later adapted for use in the UK by Free et al. In both programmes people wanting to quit, who owned a mobile phone were recruited via advertising. The intervention involved participants setting a quit day within three weeks and then receiving an automated personalised programme of regular text messages. The messages were selected from a database according to participant characteristics and time from quit day - with daily messages leading up to quit day, an intensive month of five to six messages per day, followed by a maintenance phase of one message every two weeks. Messages included quitting advice and motivational messages to encourage abstinence mixed in with some distraction/general interest messages. A database of Maori messages was included in the programme for Maori participants (in the New Zealand programme). Interaction with the programme consisted of polls and quizzes, and the ability to request further text messages on demand to help beat cravings. Participants could also opt to be paired up with a 'Quit Buddy' whom they could text message directly for extra social support. The control group in this trial received one text message every two weeks that provided information about the study.

The remaining two trials (Brendryen 2008a; Brendryen 2008b) involved a single fully automated programme delivered via both the Internet and the mobile phone in which the authors considered that both modes of delivery were equally important. For the first six weeks there was daily proactive contact by email (prompting daily visits to a unique web page for that day) and by text message (1 to three per day). Text messages were used to emphasise important educational points that also appeared on the website, act as a reminder about nicotine replacement therapy (NRT) (in one trial) and about a craving helpline, and to provide motivation. After six weeks the number and frequency of text messages gradu-

ally reduced to zero. The programme also involved user-initiated mobile phone calls to an interactive voice response service (IVRS) to log-on and proactive (programme-initiated) log-off calls asking whether they had been smoking (also automated via IVRS). The IVRS messages included feedback about the likely health effects of quitting, relapse prevention strategies and ensuring engagement with the programme. The control group received a booklet about quitting, the national quitline number and links to online resources. In one trial both groups received a sample packet of NRT and were able to order free NRT by email (Brendryen 2008a), but in the other trial no NRT was included (Brendryen 2008b). The definition of smoking status was similar in all studies: those who smoke daily in Rodgers 2005 and Free 2009; and those who smoke at least 5-10 cigarettes per day in Brendryen 2008a and Brendryen 2008b. Participants in these studies had similar degrees of nicotine dependence: mean Fagerstrom Test of Nicotine Dependence (FTND) scores of 5 in Rodgers 2005; 4.8 and 4.9 in Brendryen 2008a; 4.5 and 4.6 in Brendryen 2008b (not reported in this manner in Free 2009). However participants varied in some characteristics. Participants in Rodgers 2005 were young (mean age 22 yrs) and more women than men (58% female). The other trials had older but similar mean ages (36 years Free 2009 and Brendryen 2008a; 39 years Brendryen 2008b) and there were differences in sex distribution (63% women Free 2009; 50% Brendryen 2008a and Brendryen 2008b). Control groups in all studies received 'usual care' but this differed according to the setting of each study, from one text message a fortnight Rodgers 2005; Free 2009) to self-help booklets with (Brendryen 2008a) or without (Brendryen 2008b) access to free NRT.

Risk of bias in included studies

Randomization was considered adequate in all trials. Blinding was an issue in two of the four trials (Rodgers 2005; Free 2009) where participants were aware whether they were receiving the intervention or not, although research staff were blind to allocation at follow-up data collection. In the other two trials participants were blind to allocation, that is they were not aware what others were receiving in comparison to what they were receiving, and all follow-up data were collected by web-based questionnaire (across both conditions) (Brendryen 2008a; Brendryen 2008b). There were few other quality issues.

In one study (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 is likely to have caused a differential loss to follow up at six months (69.4% in the active group provided data 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). The two other studies with long-term follow up (Brendryen 2008a; Brendryen 2008b) both demonstrated a decrease in the number reporting quitting (no smoking in the past seven days) from four weeks to six months, however this was followed by an increase at 12 months in all groups (ranging from an increase of 1 to 13 participants in each group). This demonstrates the importance of measuring continuous abstinence in long-term outcomes.

All studies presented short-term self-reported point prevalence abstinence (defined as no smoking in the past seven days) as an outcome measure. This was variably taken at four weeks post-quit day or six weeks post-randomization (with quit date set between one and three weeks from randomization). We consider that these describe approximately the same time period. Two studies presented long-term outcomes at six months as both point prevalence (no smoking in past seven days) and continuous abstinence (no smoking since quit day but with up to three lapses (Rodgers 2005) or five cigarettes (Free 2009) allowed). The remaining two studies used repeated seven-day point abstinence (abstinent on all previous measurement points) at six months and 12 months (Brendryen 2008a; Brendryen 2008b).

Two of the trials attempted verification of self-reported quitting status with salivary cotinine (Rodgers 2005; Free 2009). However in Rodgers 2005 only 49 of 125 invited self-reported quitters at six weeks (39%) provided a saliva sample. Free 2009 was more successful at six months with 30 of a possible 38 (79%) undertaking a salivary cotinine test.

Intention to treat (ITT) analyses were presented in all trials; however two trials excluded those who had already quit or who were registered by family members without their consent after randomization (Brendryen 2008a excluded four participants out of 400; Brendryen 2008b excluded six out of 296). Assuming those participants lost to follow up to be smoking is standard practice in cessation studies. Sensitivity analyses were used to test the effects of other possibilities on the results in Rodgers 2005.

Effects of interventions

We undertook separate analyses for the studies where interventions were delivered solely by mobile phone (Rodgers 2005; Free 2009) and those delivered equally by mobile phone and Internet/email (Brendryen 2008a ;Brendryen 2008b). However, combining all studies for short-term point prevalence (where the outcome measured was the same in all four studies) produced very similar results to those presented here. Long-term outcome measures varied and so could not be combined. Standard ITT analyses are presented

here, but complete case analyses of all permutations made minimal difference to the findings.

Mobile phone-only interventions

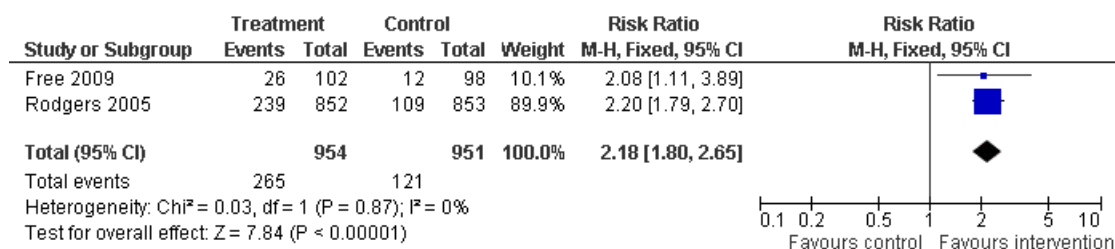
Six-month prolonged abstinence (no smoking since quit day but allowing up to three lapses or up to five cigarettes): As mentioned above, one study (Rodgers 2005) suffered from differential loss to follow up at six months. The ITT analysis in this study showed a 25.4% point prevalence abstinence rate in the intervention group (216/852) and 23.7% (202/853) in the control group (RR 1.07, 95% CI 0.91 to 1.26, P = 0.4), and a prolonged abstinence rate (allowing three or fewer lapses) of 7.5% (64/852) quit rate in the intervention group and 4.6% (39/853) quit rate in the control group (RR 1.64, 95% CI 1.12 to 2.42, P = 0.01).

The other study included here (Free 2009) was a pilot study, and therefore not powered to provide statistically significant results, self-reported point prevalence (and prolonged abstinence with fewer than five cigarettes) at six months was 15/102 (14.7%) in the intervention group and 19/98 (19.4%) in the control group (RR 0.76, 95% CI 0.41 to 1.41).

There is substantial heterogeneity between these two studies with respect to long-term outcomes (as evidenced by $I^2 = 77%$) and so these data have not been pooled.

Short-term self-reported point prevalence abstinence: Data for these outcomes have been pooled. At four weeks post-cessation (Free 2009) or six weeks post-randomization (Rodgers 2005) (considered to approximate the same time period as the quit date in this study was within 30 days of randomization), mobile phone interventions appear to increase self-reported point prevalence abstinence (no smoking within past seven days) compared with control programmes (RR 2.18, 95% CI 1.80 to 2.65) Figure 1.

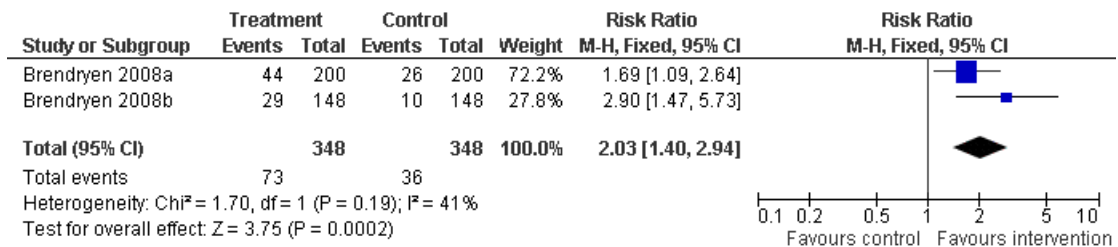
Figure 1. Forest plot of comparison: 1 mobile phone intervention v. control, outcome: 1.2 short-term self-reported point prevalence abstinence.



Mobile phone and Internet/email interventions

12-month repeated point prevalence abstinence: These two studies (Brendryen 2008a; Brendryen 2008b) using the same intervention programme (known as “Happy Ending”) presented 12 month repeated point prevalence (self-reported abstinence for the past seven days at one month, three months, six months and 12 months) and demonstrated an increased quit rate in those receiving the programme compared to the control groups (RR 2.03, 95% CI 1.40 to 2.94) Figure 2.

Figure 2. Forest plot of comparison: 2 mobile phone plus internet intervention v. control, outcome: 2.1 12 month self-reported repeated point abstinence.



Short-term self-reported point prevalence abstinence: Self-reported abstinence at four weeks post-cessation gave an RR of 1.89 (95% CI 1.52 to 2.35) in favour of the intervention.

Verified abstinence

There were insufficient data on verified outcomes to pool across studies. One study attempted to verify smoking status in a random sample of 125 (35.9%) of self-reported quitters at six weeks (Rodgers 2005), and one study attempted verification of all self-reported quitters at six months (38 participants: Free 2009). Both studies used salivary cotinine as the biochemical measure and, although numbers were small, over-reporting of quitting was evident in both intervention and control groups. In the Rodgers study 62.7% (52/83) of those in the intervention group who were invited to provide a cotinine sample did not attend, and 57.1% (24/42) of those invited in the control group did not attend; overall 60.8% did not attend. Of those who did provide a sample 54.8% (17/31) in the intervention group were verified as having quit, compared with 33.3% (6/18) in the control group. In the Free pilot study 16.7% (3/18) of self-reported quitters in the intervention group did not provide a sample and 25.0% (5/20) of self-reported quitters in the control group did not provide a cotinine sample. Of those providing samples, 53.3% (8/15) in the intervention group were verified as having quit by salivary cotinine level < 7ng/ml, and 40.0% (6/15) in the control group. Therefore these two studies demonstrate a higher degree of over-reported quitting by those in the control groups than those in the intervention groups.

DISCUSSION

Summary of main results

Few rigorous studies have been published on mobile phone-based smoking cessation interventions and as yet there is no evidence to support a long-term effect of the programmes delivered solely by mobile phone. However there is evidence of a short-term beneficial effect from the included studies, two of which describe a very similar programme delivered solely by text messages (Rodgers 2005; Free 2009), and two of which involved the same automated programme with both Internet/email and mobile phone components

(Brendryen 2008a; Brendryen 2008b). This second programme has shown evidence of a long-term effectiveness to 12 months, but the effects of the delivery mechanisms used in this programme can not be assessed separately as this is a complex multifaceted intervention. Nevertheless the fundamental elements of the intervention appear to be similar to the other two studies, involving automated messages, mostly proactive but with some reactive and interactive components.

There were some issues with the non-significant long-term results of the larger text messaging mobile phone study (Rodgers 2005). This study also had a much younger population than the other studies. Many cessation programmes have struggled to show long-term effectiveness with young adults and adolescents. The authors of the smaller pilot study are currently undertaking a large randomized controlled trial of the same intervention and study design (Free), and it is to be hoped that the findings of this study will usefully contribute to our review in future updates.

Overall completeness and applicability of evidence

As well as the Free trial there are several other ongoing studies in this area. Gritz and Vidrine are undertaking a large trial of an expanded version of the mobile phone proactive counselling intervention (Vidrine). The published study by Vidrine et al (Vidrine 2006) was excluded from this review because its short follow-up period (three months) did not meet the inclusion criteria for this review. Ybarra et al have been funded to develop and pilot a text message intervention in Turkey (Ybarra). Borland et al in Australia are comparing a text message intervention, an Internet intervention and a combined intervention (Borland). The research group that developed the text message programme (Rodgers et al) has developed a multimedia mobile phone programme that includes video messages, animated video clips and text messages, currently being trialled in New Zealand (Whittaker 2008). The MiQuit Study in the UK, led by Felix Naughton, is a feasibility trial of a computer-tailored smoking cessation intervention providing individualised written and mobile phone text message support to pregnant women who smoke and wish to quit, and is expected to complete recruitment in August 2009.

Quality of the evidence

With the publication of recommended standards for measuring and reporting cessation outcomes in intervention studies (West 2005; SRNT 2002) it is hoped that reporting six-month outcomes will become routine. This will enable comparison of results between different interventions and allow for more robust meta-analysis of findings.

It is also important that researchers report sufficient data, such as complete cases, to enable readers to determine the effects of any assumptions or imputations made in their analyses.

In this review only one study attempted biochemical verification at six months and one at six weeks. Some previous reviewers have stated that large community/population-based studies should not need to do this due to the large cost and resources involved, the high refusal rates, and the fact that misrepresentation is generally small and rarely differential across intervention conditions (SRNT 2002). On the other hand, adolescents may be a special population where over-reporting of quitting is more likely (SRNT 2002) and programmes based on new technology may be expected to have high proportions of young people, as seen in Rodgers 2005. Over-reporting of quitting was identified in the two studies in this review (Rodgers 2005; Free 2009), and more so in the control groups than the intervention groups; although these were very small numbers it is possible that reliance on self report in these studies could give an underestimate of the effect of the intervention. The other two studies included here (Brendryen 2008a; Brendryen 2008b) did not attempt verification.

The question arises: in these studies with no face-to-face interaction with participants, should the 'gold standard' outcome measures for cessation interventions be required, or is it acceptable to use self-reported quit status recognising that this is likely to be inflated but in the hope that it will have minimal effect on the relative risk? The feasibility of getting people to provide samples may be the final arbiter. Particularly in programmes aimed at young people, where minimal direct contact and anonymity appear to be desired elements, even attempting verification may have adverse effects on the collection of follow-up data.

In any case, where verification is undertaken full reporting of attendance and results should be presented. Sensitivity analyses to evaluate whether changes to the cut-off points for biochemical measures affects results would also usefully inform this debate.

AUTHORS' CONCLUSIONS

Implications for practice

There is as yet no conclusive evidence of long-term benefit for programmes delivered solely by mobile phone. Mobile phone-based smoking cessation interventions have been shown to assist people to stop smoking in the short term. There is no reason to believe that mobile phone interventions would result in greater rates of relapse after the end of the programme than other interventions, and they are already being introduced in conjunction with other programmes such as quitlines and nicotine replacement. The interventions in this review include: a purely text message-based programme with automated proactive text messages and some reactive (for help with cravings) and interactive (polls/quizzes) components; and an automated email/daily Internet page and mobile phone text/audio message programme with proactive and reactive components. The latter programme has also been shown to have benefit to 12 months.

Mobile phones have become a regular part of daily lives in many populations. Therefore it makes sense to use this common means of communication to provide access to smoking cessation support. Mobile phone programmes appear to be useful as an option to offer those who want to stop smoking. They have some advantages over most current treatment services: they can be delivered anywhere, at appropriate times, confidentially, and direct to the participant with minimal direct contact. These are characteristics which may be appreciated by some groups such as young people.

Implications for research

More rigorous studies of the long-term effects of mobile phone-based cessation interventions are needed to determine if the promising short-term effects are maintained.

Researchers should ensure the use of standard outcome measures of abstinence (e.g. Russell standard) to allow comparison and meta-analysis, and should present other data such as complete cases so that readers can determine the effects of any assumptions or imputations, and full details of any biochemical verification.

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Naughton *{unpublished data only}*

MiQuit study. Ongoing study due to close recruitment in August 2009.

Vidrine *{published data only (unpublished sought but not used)}*

Ongoing study 2006.

Whittaker *{published data only (unpublished sought but not used)}*

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Ybarra *{published data only (unpublished sought but not used)}*

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- * Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Brendryen 2008a

Methods	Country: Norway.
Participants	400 participants 18yrs and over; smoking 10 or more CPD; want to quit on a set day; access to internet, email and mobile phone daily. Characteristics: 50.8%/49.8% female; mean age 35.9yrs/36.4yrs; average 18.3/18.1 cigarettes/day; FTND dependance score =4.8/4.9.
Interventions	Fully automated programme delivered by email/internet & mobile phone. Daily email and daily webpage. Daily text messages, daily user-initiated call to pre-recorded audio message & proactive call from programme. Access to automated craving helpline. Plus sample pack NRT and access to free NRT via email ordering. Control: booklet with quitting info/calendar/log, national quitline number, links to online resources, sample pack NRT and access to free NRT via email ordering.
Outcomes	Point prevalence abstinence (no smoking in past 7 days) at 1,3,6 & 12 months post-cessation. Intention-to-treat analysis but 4 excluded post-randomization.
Notes	

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Central computerised randomization.
Allocation concealment?	Unclear	No information.
Blinding? All outcomes	Yes	Double blind (participants unaware if receiving intervention or control).
Incomplete outcome data addressed? All outcomes	Yes	Loss to follow up: 6 (control) and 3 (intervention) at 4 weeks; cumulative loss to followup 31 (control) and 24 (intervention) at 6 months.

Brendryen 2008b

Methods	Country: Norway.
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Brendryen 2008b (Continued)

Participants	296 participants 18yrs and over; smoking 15 or more CPD; want to quit on a set day; access to internet, email and mobile phone daily; willing to quit without NRT. Characteristics: 50.8%/49.8% female; mean age 35.9yrs/36.4yrs; average 18.3/18.1 cigarettes/day; FTND dependance score =4.8/4.9.
Interventions	Fully automated programme delivered by email/internet & mobile phone. Daily email and daily webpage. Daily text messages, daily user-initiated call to pre-recorded audio message & proactive call from programme. Access to automated craving helpline. Control: booklet.
Outcomes	Point prevalence abstinence (no smoking in past 7 days) at 1,3,6 & 12 months post-cessation. Intention-to-treat analysis but 6 excluded post-randomization.

Notes

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Central computerised randomization; "Stratified block randomization was applied to ensure equal numbers of both males and females in each group."
Allocation concealment?	Yes	"The names and identities of the subjects, however, were concealed to the experimenter during randomization."
Blinding? All outcomes	Yes	Double blind (participants unaware if receiving intervention or control).
Incomplete outcome data addressed? All outcomes	Yes	Lost to follow-up: 19 (control) and 5 (intervention) at 4 weeks; cumulative loss to follow-up 38 (control) and 26 (intervention) at 6 months.

Free 2009

Methods	Country: UK
Participants	200 participants 16yrs and over; smoking daily and interested in quitting; current owner mobile phone. Characteristics: 63% male; median age 36yrs; median 20 cigarettes/day; 7% FTND dependance score >5.

Free 2009 (Continued)

Interventions	Six month programme delivered solely over mobile phone based on programme in Rodgers 2005 but messages adapted for UK population. Participant nominates Quit Date (QD) and receives regular personalised text messages with advice, support and distraction, with a countdown to QD, intensive 4-weeks of 5-6 messages/day then maintenance phase of 1 message/2wks. Messages selected from database matched to participant characteristics. Free month of text messaging from Quit Date. Optional Quit Buddy, and Text Crave (messages on demand). Interactive polls and quizzes. Control: 1 text message/fortnight.
Outcomes	Primary: point prevalence abstinence (no smoking in past 7 days) at 6 weeks post randomization (approximates 4wks post-Quit Date). Secondary: point prevalence abstinence and continuous abstinence (<5 cigarettes) at 26 wks. Verification with salivary cotinine in quitters at 26wks. Intention-to-treat analysis.
Notes	Pilot study - full trial underway

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Central computerised randomization.
Allocation concealment?	Yes	Concealed until after assignment.
Blinding? All outcomes	Yes	Single blind (participants not blinded).
Incomplete outcome data addressed? All outcomes	Yes	Lost to follow-up: 4 (control) and 1 (intervention) at 4wks (98% follow-up); 8 (control) and 8 (intervention) at 6 months (92% follow-up).

Rodgers 2005

Methods	Country: New Zealand. Setting : community
Participants	1705 participants 16yrs and over; smoking daily; want to quit within next month; able to send & receive text messages on own mobile phone. Characteristics: 58% female; median age 22yrs; 20.8% indigenous NZ (Maori); 3.5% Pacific Islanders; average 15 cigarettes/day; FTND dependance score =5.

Rodgers 2005 (Continued)

Interventions	Six month programme delivered solely over mobile phone. Participant nominates Quit Date (QD) and receives regular personalised text messages with advice, support and distraction, with a countdown to QD, intensive 4-weeks of 5-6 messages/day then maintenance phase of 1 message/2wks. Messages selected from database matched to participant characteristics. Free month of text messaging from Quit Date. Optional Quit Buddy, and Text Crave (messages on demand). Interactive polls and quizzes. Control: 1 text message/fortnight.	
Outcomes	Primary: point prevalence abstinence (no smoking in past 7 days) at 6 weeks post-randomization (approximates 4 weeks post-Quit Date). Verification with salivary cotinine in small number of quitters at 6wks. Secondary: point prevalence abstinence at 12 wks and 26 wks, and continuous abstinence at 26 wks. Intention-to-treat analysis.	
Notes		
Risk of bias		
Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Central computerised randomization.
Allocation concealment?	Yes	concealed until after assignment.
Blinding? All outcomes	Yes	Single blind (participants not blinded).
Incomplete outcome data addressed? All outcomes	Yes	Lost to follow-up: 35 control (95.9% follow-up) and 46 intervention (94.6% follow-up) at 6wks; 179 control (79% follow-up) and 261 intervention (69.4% follow-up) at 6 months.

CPD: cigarettes per day

FTND: Fagerstrom Test of Nicotine Dependence

Characteristics of excluded studies [ordered by study ID]

Applegate 2007	Abstract describing intervention to increase adherence to the use of nicotine replacement gum in people attempting to quit smoking. Duration 8 weeks.
Haug 2008	Non randomized feasibility study. Duration 12 weeks

(Continued)

Lazev 2004	Not randomized. No control group. Feasibility study for the programme presented in Vidrine 06b.
Obermayer 2004	Not randomized. No control group.
Riley 2008	Small non randomized study with only 6 weeks follow up.
Vidrine 2006	Randomized trial, follow up only 3 months,

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

Borland

Trial name or title	
Methods	
Participants	
Interventions	Text message intervention v. internet intervention v. combination
Outcomes	
Starting date	2008
Contact information	Ron.Borland@cancervic.org.au
Notes	

Free

Trial name or title	TXT2STOP UK
Methods	
Participants	5900 participants in London, UK. Inclusion: 16yrs and over; smoking daily; want to quit within next month; able to send & receive text messages; current owner mobile phone; english speaking; able to provide informed consent.
Interventions	Six month programme delivered solely over mobile phone. Participant nominates Quit Date (QD) and receives regular personalised text messages with advice, support and distraction, with a countdown to QD, intensive 4-weeks of 5-6 messages/day then maintenance phase of 1 message/2wks. Messages selected from database matched to participant characteristics. Reimbursed for costs of text messaging. Optional Quit Buddy, and Text Crave (messages on demand). Interactive polls and quizzes. Control: 1 text message/fortnight.
Outcomes	Point prevalence abstinence (no smoking in past 7 days) at 6 weeks post randomization (approximates 4wks post-QD). Point prevalence abstinence and continuous abstinence at 26 wks. Verification with salivary cotinine in self-reported quitters at 26wks.
Starting date	2007
Contact information	caroline.free@lshtm.ac.uk
Notes	Based on pilot (Free 2008) and earlier NZ programme adapted for UK (Rodgers 2005).

Naughton

Trial name or title	MiQuit study
Methods	feasibility trial of a computer-tailored smoking cessation intervention providing individualised written and mobile phone text message support to pregnant women who smoke
Participants	200 pregnant women, currently smoking 7 cigarettes or more per week who own or have use of a mobile phone
Interventions	
Outcomes	
Starting date	due to close recruitment in August 2009
Contact information	Felix Mcnaughton (Fmen2@medschl.cam.ac.uk) UKCRN 5674
Notes	

Vidrine

Trial name or title	
Methods	
Participants	500 HIV positive participants in Texas, USA.
Interventions	3 month programme of 11 proactive counselling calls.
Outcomes	Follow up to 52wks.
Starting date	2006
Contact information	dvidrine@mdanderson.org (NCT 00502827)
Notes	Expanded programme based on (Vidrine 2006a&b)

Whittaker

Trial name or title	STUB IT
Methods	
Participants	1300 participants in New Zealand. Inclusion: 16yrs and over; smoking daily; want to quit; Vodafone mobile phone customers.

Whittaker (Continued)

Interventions	Six month programme by mobile phone includes video role modelling by short video messages; animated clips; text messages; immediate help with cravings.
Outcomes	Continuous abstinence at 6 months. Point prevalence at 4 wks. Verified abstinence.
Starting date	2007
Contact information	r.whittaker@ctr.u.auckland.ac.nz
Notes	

Ybarra

Trial name or title	SMS Turkey
Methods	
Participants	
Interventions	Developing and piloting a text message programme
Outcomes	6 week point prevalence. 6 month point & continuous abstinence
Starting date	2008
Contact information	michele@isolutions4kids.org
Notes	

DATA AND ANALYSES

Comparison 1. mobile phone intervention v. control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 26 week continuous abstinence (<5 lapses)	2		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
2 short-term self-reported point prevalence abstinence	2	1905	Risk Ratio (M-H, Fixed, 95% CI)	2.18 [1.80, 2.65]

Comparison 2. mobile phone plus internet intervention v. control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 12 month self-reported repeated point abstinence	2	696	Risk Ratio (M-H, Fixed, 95% CI)	2.03 [1.40, 2.94]
2 12 month self-reported point prevalence abstinence	2	696	Risk Ratio (M-H, Fixed, 95% CI)	1.49 [1.18, 1.90]
3 short-term self-reported point prevalence abstinence	2	696	Risk Ratio (M-H, Fixed, 95% CI)	1.89 [1.52, 2.35]

Analysis 1.1. Comparison 1 mobile phone intervention v. control, Outcome 1 26 week continuous abstinence (<5 lapses).

Review: Mobile phone-based interventions for smoking cessation

Comparison: 1 mobile phone intervention v. control

Outcome: 1 26 week continuous abstinence (<5 lapses)

Study or subgroup	Treatment n/N	Control n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
Free 2009	15/102	19/98		0.76 [0.41, 1.41]
Rodgers 2005	64/852	39/853		1.64 [1.12, 2.42]

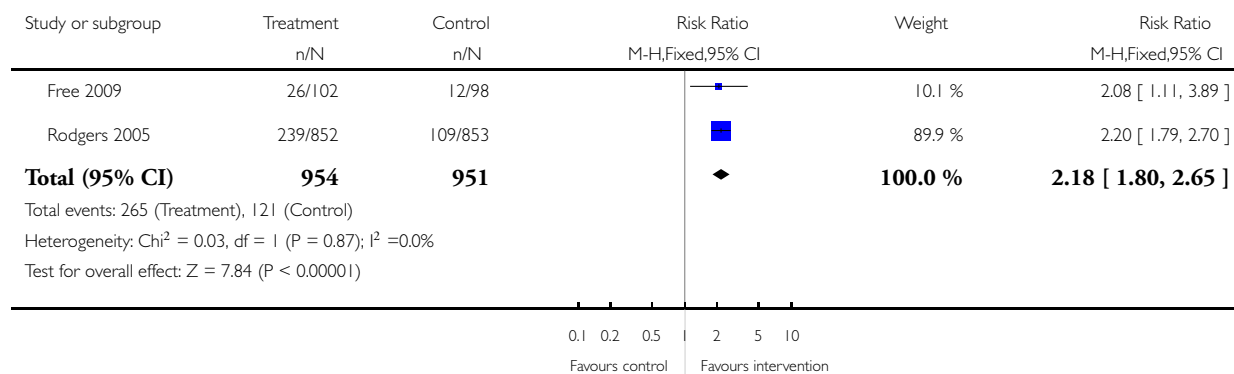
0.1 0.2 0.5 2 5 10
Favours control Favours intervention

Analysis 1.2. Comparison 1 mobile phone intervention v. control, Outcome 2 short-term self-reported point prevalence abstinence.

Review: Mobile phone-based interventions for smoking cessation

Comparison: 1 mobile phone intervention v. control

Outcome: 2 short-term self-reported point prevalence abstinence

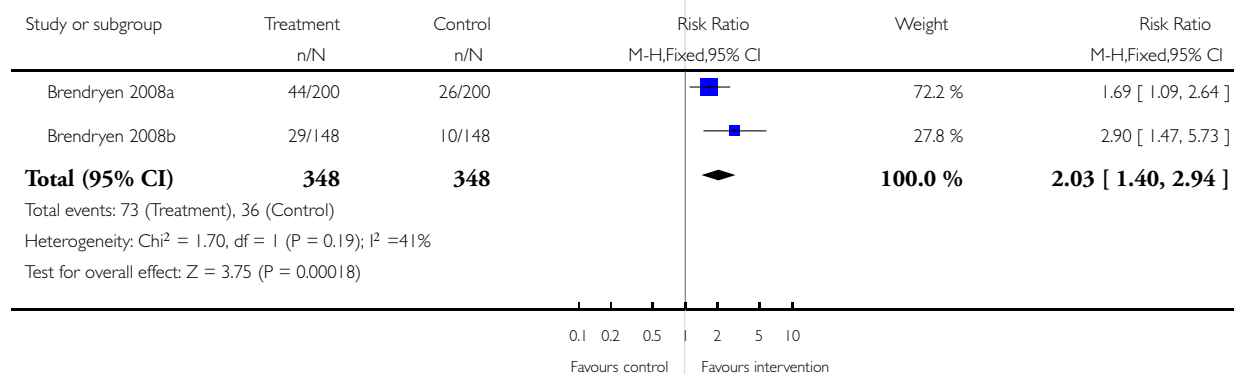


Analysis 2.1. Comparison 2 mobile phone plus internet intervention v. control, Outcome 1 12 month self-reported repeated point abstinence.

Review: Mobile phone-based interventions for smoking cessation

Comparison: 2 mobile phone plus internet intervention v. control

Outcome: 1 12 month self-reported repeated point abstinence

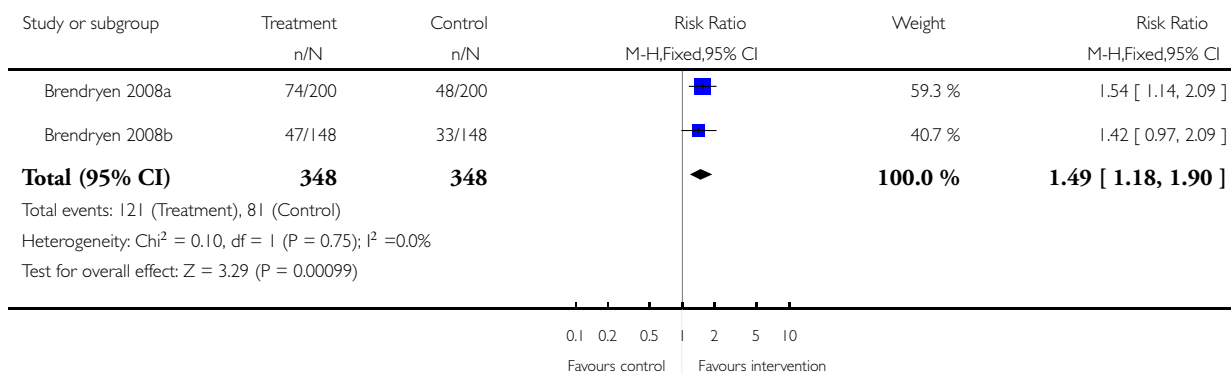


Analysis 2.2. Comparison 2 mobile phone plus internet intervention v. control, Outcome 2 12 month self-reported point prevalence abstinence.

Review: Mobile phone-based interventions for smoking cessation

Comparison: 2 mobile phone plus internet intervention v. control

Outcome: 2 12 month self-reported point prevalence abstinence

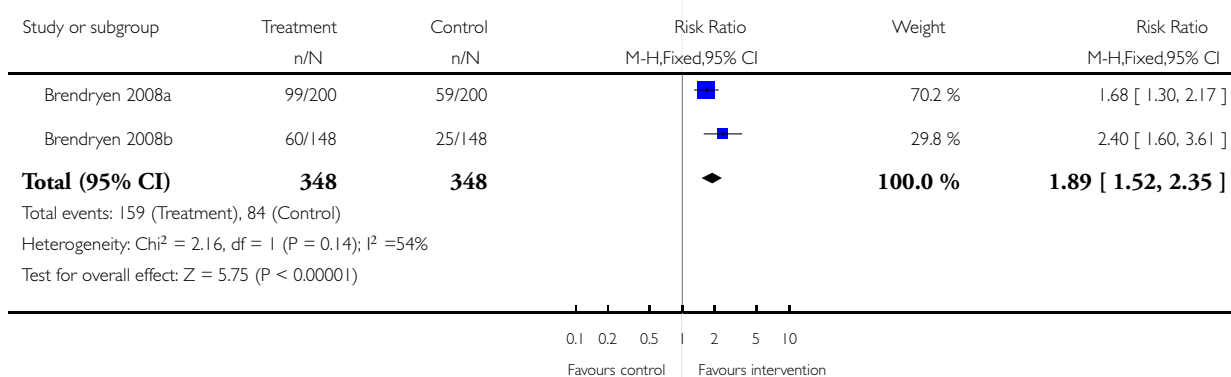


Analysis 2.3. Comparison 2 mobile phone plus internet intervention v. control, Outcome 3 short-term self-reported point prevalence abstinence.

Review: Mobile phone-based interventions for smoking cessation

Comparison: 2 mobile phone plus internet intervention v. control

Outcome: 3 short-term self-reported point prevalence abstinence



WHAT'S NEW

Last assessed as up-to-date: 28 June 2009.

15 July 2008	Amended	Converted to new review format.
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HISTORY

Protocol first published: Issue 3, 2007

Review first published: Issue 4, 2009

5 September 2006	New citation required and conclusions have changed	Substantive amendment
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CONTRIBUTIONS OF AUTHORS

RW is the lead author of this review. RW and HM selected studies for inclusion and these were reviewed by RB. RW and RL independently extracted data from the papers and undertook the analysis. All authors contributed to the writing and editing of the review.

DECLARATIONS OF INTEREST

One of the authors of this review was the Principal Investigator of one of the included studies ([Rodgers 2005](#));

R.Whittaker was a co-author ([Bramley 2006](#); [Free 2009](#)).

Auckland UniServices Ltd has entered into a licensing agreement for the programme developed from the intervention reported in the latter trial.

SOURCES OF SUPPORT

Internal sources

- Clinical Trials Research Centre (Auckland Uniservices), Australia.
- 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 as Mantel-Haenszel fixed-effect risk ratios rather than as odds ratios.